NASA'S INITIATIVE TO DEVELOP EDUCATION THROUGH ASTRONOMY (IDEA) *

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Abstract. We describe a progressive program in science education called the Initiative to Develop Education through Astronomy (IDEA). IDEA represents a commitrnent by the Astrophysics Division of NASA Headquarters to pre-collegiate and public learning. The program enlists the full participation of research astronomers in taking advantage of the natural appeal of astronomy and the unique features of space astrophysics missions to generate valuable learning experiences and scientifically accurate and educationally effective products for students, teachers and citizens. One of the premier projects is called Flight Opportunities for Science Teacher EnRichment (FOSTER) – a program to fly teachers aboard the Kuiper Airborne Observatory during actual research missions. IDEA is managed by a visiting scientist with extensive educational background (each of the authors have served in this role), and the program is unique within NASA science divisions for having a full time scientist devoted to education. IDEA recognizes that the rapidly shifting social and political landscape has caused a fundamental change in how science is expected to contribute to society. It is in the enlightened self-interest of all research scientists to respond to the challenge of connecting forefront research to basic educational needs. IDEA is exploring the avenues needed to facilitate these connections, including supplementing research grants for educational purposes.

1. Introduction

> "We scientists are taking part in an incredible adventure, one that opens up new worlds and new insights, not only into the universe but into ourselves... Our exploration is undertaken by a small number of professional astronomers on behalf of the entire human race. We are funded by taxpayers, and we work in the public trust. We have an opportunity, and an obligation, to share our adventure with the public." – Charles J. Pellerin, Jr. (former) Director of NASA Astrophysics

We must tap the tremendous potential of research scientists to help achieve the goal of global science literacy. Astronomy — here taken to include planetary sciences, space physics, solar physics, and astrophysics — has vast potential for contributing to this increasingly important goal. Public interest in astronomy is widespread, perhaps because gaining understanding of the universe is an ancient dream common to every race and culture. Among children, who seem to have an innate interest in the stars, astronomy is especially valuable for generating enthusiasm for science. Nevertheless, the educational potential of astronomy remains

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largely untapped, particularly for pre-collegiate and general public audiences. In an attempt to provide a model for engaging the research community to increase pre-collegiate and public educational opportunities, the authors have developed a new program in the NASA Astrophysics Division called the *Initiative to Develop Education through Astronomy*, or IDEA.

In the remainder of this paper we describe the social and political basis for IDEA, and details of the current and future educational projects associated with it. Although IDEA was created to capitalize on the unique educational potential of space astronomy at NASA, we note that the guiding principles behind it are generally applicable to all scientific research organizations. Such organizations can and must do more to connect their research missions with general public needs in education.

1.1. Unique Educational Aspects of Astronomy

Astronomy was at the core of math and science education from the time of the ancient Greeks until the end of the 19th century. In the US, the study of astronomy was an integral part of the curricula of high schools and college (Brown, 1991; Porcellino, 1992). It is only in this century that astronomy was taken out of the basic curriculum. At most high schools and colleges astronomy, if offered at all, is an elective course.

Nevertheless, public support for astronomy, which has a long history in the US (Brown and Ishee, 1991a), remains strong in spite of widespread misconceptions about basic astronomical facts (Porcellino, 1992). This provides a unique opportunity for astronomy to play an important role in revitalizing education. Recognizing this potential, the US National Academy of Sciences and NASA sponsored a workshop to explore how astronomers could contribute to education in the broadest sense. The workshop produced a report (Brown, 1991) recommending an *An Educational Initiative in Astronomy*. The report noted several important aspects of astronomy that offer particular educational value:

> "Astronomy's domain is broad and attractive. Its objectives are inspirational and creative. The public displays a voracious appetite for new astronomical knowledge.
>
> "Astronomy's human resources (scientists, engineers, programmers, opticians, managers, and administrators) constitute a set of instructive role models and career histories.
>
> "Astronomy's research methods (statistics, optical design, computer processing, space operations, and the scientific method itself) are powerful and generally applicable.
>
> "Astronomy research is fortified with cadres of semi-professionals and amateurs.

"Astronomy incorporates many other scientific disciplines in its program. Examples are physics, chemistry, mathematics, geology, and meteorology.

"Observatory, planetarium, and museum environments are conducive to motivating interest in science."

To this list we add several additional items that we believe make astronomy uniquely suited to contributing to the cause of science education and literacy on a global scale:

- The experience of gazing up at the night sky in wonder is common to nearly every child everywhere in the world. Further, astronomy is unique among the sciences in that it has deep, ancient roots in every culture. Astronomy is therefore ideal for generating interest in science among people of all ethnic and cultural groups.
- Modern astronomy has a long history of important discoveries made by women, and the representation of women in the ranks of professional scientists is greater in astronomy than in most of the other physical sciences. The existence of so many women role models can help to encourage scientific study by young girls around the world. (For more on the historical role of women in astronomy see, e.g., Dobson and Bracher, 1992; Fraknoi and Freitag, 1992.)
- The nature of astronomy makes it superb for use in an interdisciplinary context. Scientifically, astronomy bears on all of the physical and biological sciences, as well as on mathematics. In addition, as the "oldest science" astronomy is deeply ingrained in human culture, thus providing excellent subject matter for projects in the language arts, fine arts, and humanities. Astronomy can therefore be integrated into general pre- college curricula even outside of the sciences, helping to demonstrate the relevance of science and the scientific method to the everyday lives of all humans.

Finally, we emphasize that the educational potential of astronomy derives not so much from the collection of facts and theories that constitutes our current understanding of the universe, but rather from the incredible story of how humanity has achieved this understanding. In the quest for knowledge, it is often the case that the more we learn, the more questions we raise. It is this ongoing process of discovery that we must share with the public. More teachers and students must experience the excitement and value of the scientific mode of inquiry, and research scientists are well suited to assist in providing opportunities for such experiences.

1.2. The Politics of Science and Education

The authors believe there is an intrinsic value in applying scientific research for pre- collegiate educational benefits. Indeed, we have discussed this issue extensively with colleagues for many years, and we find that most astronomers are willing to contribute to pre-collegiate education for purely altruistic reasons. For example, many astronomers regularly visit schools, participate as judges in science fairs, offer public lectures, and perform other educational services without an

expectation of personal gain. (For reports on educational outreach by physicists see, e.g. Swartz (1991), Schwartz and Wynne (1991), Lederman (1992).) In this way, scientific research has become increasingly intertwined with pre-collegiate and public science education during the past several years. Nevertheless, research organizations and agencies can no longer rely solely on such altruism. We argue that it is becoming more important to the self-interest of research science to give greater formal attention to education. This is because a rapidly shifting social and political landscape has caused a fundamental change in how science is expected to contribute to society.

For most of the past several decades, funding for scientific research in the United States was, in general, politically disconnected from funding for pre-collegiate education. This situation was maintained because US education is largely governed and funded at the local level, while the major governmental agencies that support scientific research (e.g., the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), the Department of Defense, and the Department of Energy) receive their funding at the national level. Thus, even in fields like astronomy, politicians often supported research because it offered a symbolic demonstration of scientific and technological superiority over military adversaries.

The landmark report *A Nation at Risk* (NCEE, 1983), documented widespread failures in US education, and generated particular interest in education at all levels among politicians. By 1988, the issue had taken on such great significance that George Bush was elected President with a platform that included a promise to be known as "the education President". In 1989, a council of State Governors — led at the time by current US President Bill Clinton — developed a set of national education goals for the first time in US history (DoEd, 1989). Two of the six goals make explicit mention of improving achievement or competency in math and science, while a third ask that all adults "... will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship." Clearly, this includes raising the general level of mathematical, scientific, and technological literacy.

The intertwining of scientific research and pre-collegiate education accelerated with the end of the Cold War and the demise of the Soviet Union. Today, research expenditures are politically justified primarily by an evaluation of how the research contributes to social goals of excellence in economic competitiveness and education. Several recent reports advocate a far greater role for federal research agencies in education at all levels (e.g., OTA (1991), CCSTG (1991), FCCSET (1993)).

In fields like astronomy, the public and the politicians will increasingly demand connections between basic research, technological development and the causes of science literacy and education beyond the training of graduate students. Connecting forefront astrophysical research to basic educational needs represents a significant challenge (Brown and Ishee, 1991b). The scientific community must respond to this challenge, both because it is the right thing to do for society and because the

future health of science disciplines depend upon it. A science literate public will be more supportive and appreciative of the fruits of scientific research.

2. What is IDEA?

IDEA represents a commitment by the NASA Astrophysics Division to *pre-collegiate and public* learning. This emphasis on education outside of colleges and universities was chosen because it is where we feel the need for contributions from the scientific community is greatest. After all, because many scientists work at institutions of higher education, there already is a natural link between scientific research and undergraduate and graduate education. In the subsections that follow we describe the principles, origins, structure, and objectives of IDEA.

2.1. Guiding Principles of IDEA

The creation of IDEA was based on the following three guiding principles:

- Contributing to education must be established as an integral part of the research process. This applies not only to the long-established traditions of training selected undergraduate and graduate students to become future scientists, but to making concrete contributions to pre-collegiate and public education and scientific literacy.
- Agencies that sponsor research (like NASA) can use small augmentations of funding, and modest additional efforts by their scientists, to leverage their research programs for a large impact on education.
- The scientific community is generally interested in, and willing to contribute to, the cause of advancing science education. Agency policies can be modified to provide expanded opportunities for scientists to make such contributions.

2.2. Origins of IDEA

The impetus for the creation of IDEA began with increased attention to education by the National Academy of Science's Decade Survey Committee for Astronomy and Astrophysics, chaired by John N. Bahcall (NRC, 1991a). This Committee was charged with prioritizing research initiatives for the 1990s. The Committee's Policy Opportunity Panel, chaired by Richard McCray, recognized that education represented an important policy opportunity for astronomy (NRC, 1991b), and sponsored the creation of a special workshop on education and astronomy that met in February 1990. The workshop report, recommending an "An Education Initiative in Astronomy" (Brown, 1991), was endorsed both by the Policy Panel (NRC, 1991b) and the entire Decade Survey Committee (NRC, 1991a).

Around the same time that the workshop met in 1990, then-Director of NASA Astrophysics Charles Pellerin decided it would be appropriate for the Astrophysics Division to take a more active role in education. Pellerin decided that the best way to ensure that the Division could capitalize on its research program for the benefit of education would be to hire a scientist with educational expertise to

devote a full-time effort to this problem. One of the authors (Bennett) was chosen for this role, joining the Astrophysics Division as a Visiting Senior Scientist for a two and one-quarter year term that began in January 1991. Working closely with Pellerin and the rest of the Division staff, Bennett developed the concept and management structure for IDEA in mid-1991. The second author (Morrow) joined the Astrophysics Division as a Visiting Senior Scientist in September 1992; she has since assumed full responsibility for continued management and development of IDEA.

2.3. Institutional Structure of IDEA

IDEA, which is managed within NASA's Astrophysics Division, represents a small subset of NASA's overall education program, responsibility for which rests with NASA's Education Division. The Astrophysics Division works with the Education Division in developing IDEA programs, and the Education Division has been immensely helpful in establishing IDEA as a viable function of NASA. Nevertheless, we believe that the guiding philosophy behind IDEA differs from that of other NASA education programs in important respects. Education Division programs, as enunciated in their strategic plan (NASA, 1992a), are based upon using the space program to promote excellence in US education, but not necessarily upon eliciting direct contributions from the scientific community. IDEA is an education program managed like a research program in the Astrophysics Division, and seeks to actively involve research scientists in outreach activities. Other NASA space science Divisions also have a long history of programs in higher education (for a catalog of current programs see NASA (1992b)). In contrast, IDEA is intended for pre-collegiate and public education, and was initiated with the vision of attaining the same respect as a research program within the Astrophysics Division. The institutional structure for IDEA is unique at NASA (and, to our knowledge, unique among all scientific research agencies).

Like all of the Division's research programs, responsibility for IDEA is assigned to scientists (to date, the authors), and management decisions are made with the direct involvement of the Division Director. The Division allots a special line for IDEA in its annual budget, and the entire Division staff works together to develop concepts and strategies for IDEA programs. This management structure serves to institutionalize IDEA and to encourage its long-term viability. We strongly believe that all scientific research organizations and agencies should create similar institutional structures in order to ensure that education takes its appropriate place as an integral part of the research process.

2.4. The IDEA Objectives

IDEA is exploring strategies for achieving greater involvement of both the professional and amateur astronomical research communities in improving education. We have identified four objectives for IDEA, which are modifications of the objectives

described in Brown (1991). More specifically, we are developing programs that take advantage of the universal appeal of astronomy to:

1. *Enhance the mathematical, scientific, and technological literacy of all people.* We emphasize that this objective seeks not only to generate enthusiasm for astronomical research, but to use that enthusiasm for the cause of raising the overall level of scientific literacy.
2. *Promote learning and studying in every area, particularly at the elementary level, by integrating the excitement of astronomy into the everyday school curriculum.* As in described in Section 1.1 we believe that astronomy can play a role in promoting learning in nearly every subject, not only in the sciences.
3. *Increase the representation in science of women and of members of ethnic and cultural groups who are currently underrepresented.* We believe that the future of science depends critically on ensuring that all people can participate in its adventure.
4. *Improve the content accuracy and presentation quality of astronomical information available to the public.* To achieve its educational potential, astronomical science must be presented in a clear and stimulating manner.*

3. IDEA Programs

We employ three basic strategies in developing programs under IDEA that can fulfill the above objectives. First, we seek creative ways to facilitate the participation of the space astrophysics community in educational activities. Second, we seek unique opportunities to capitalize on the educational potential of space astrophysics missions. Third, we seek to develop outreach products for bringing the excitement of astrophysics to teachers, students, and the general public. At present, IDEA encompasses a number of rapidly evolving programs, each of which employs one or more of the above strategies. In the subsections that follow we describe each of the current IDEA programs.

3.1. Astrophysics Grant Supplements for Education (AGSE)

The Astrophysics Grant Supplements for Education (AGSE) program was designed to encourage scientists with current research grants from the NASA Astrophysics Division to spend a fraction of their efforts on pre-collegiate or public education. The program has been offering small (maximum $5,000 in 1991 and 1992, increased to $6000 for 1993) supplements to existing research grants to be used for the express purpose of developing an educational program. The process of applying for an AGSE parallels that of other grant programs in the Astrophysics Division. Eligible researchers submit short proposals which are reviewed by a panel made up of members of NASA's science and Education Divisions. Proposals are judged

* NASA routinely distributes tens of thousands of copies of each educational product produced. We therefore urge all astronomers to take a more active role in producing and reviewing astronomical information for the public, and in recognizing and helping to correct common misconceptions.

on the quality and potential impact of the proposed educational effort. In addition, all proposals must meet the following requirements. First, the educational project must be based upon the use of astronomy to improve education; it need not, however, directly involve the proposal author's specific area of research within the field of astronomy. Second, the Principal Investigator must be actively involved in the project, not merely acting as a consultant or supervisor. Third, the project must involve a collaboration between the scientist and members of the educational community (e.g., teachers).

Approximately 80 AGSE awards were made during the first two years of the program. Most of the projects fall into three categories that were explicitly called for in the program announcement: (1) astronomy workshops for school teachers; (2) innovative concepts for bringing the excitement of astronomy to women and members of cultural groups currently underrepresented in the sciences; and (3) development and use of interactive, educational software. (For a listing of projects see NASA (1993).) According to estimates provided by 1992 AGSE grant recipients, 1000 teachers and 30,000 students were touched by these outreach efforts. Other NASA space science divisions have started related programs, but thus far these programs have engaged far fewer researchers.

3.2. Ask-An-Astronomer Exhibit

Another particularly successful means of providing opportunities for astronomers to participate in educational outreach has been the creation of a traveling exhibit called "Ask-an-Astronomer". The exhibit itself is relatively simple, featuring a set of six paintings that illustrate the scale of the universe. Science posters and other useful outreach products are generously distributed wherever the exhibit is displayed. The real power of the exhibit, however, lies with the astronomers we recruit on a volunteer basis to spend time answering questions about astronomy. The most important venue for the exhibit is the annual meeting of the National Science Teachers Association, which typically draws 15,000 pre-college science teachers from all over the US. Teachers are encouraged to interact with the astronomers staffing the exhibit. As a reward for asking a good question, teachers are given a button to wear featuring a photograph of a recent image from the Hubble Space Telescope and the inscription, "I Asked an Astronomer". The exhibit has proven very popular, and the astronomers are generally engulfed by inquisitive teachers. We note that many of the science teachers state that it is the first time in their careers that they have had the opportunity to talk "face-to-face" with a working scientist.

3.3. Flight Opportunities for Science Teacher EnRichment (FOSTER)

Flight Opportunities for Science Teacher EnRichment (FOSTER) provides teachers with an exciting opportunity to fly aboard NASA's Kuiper Airborne Observatory (KAO) during a research mission. FOSTER is a premier example of fulfilling

the potential of a NASA Astrophysics mission to create a unique educational opportunity.

The KAO is a modified C-141 cargo plane carrying a 1-meter telescope used for infrared observations. It typically makes over one hundred research flights per year; home base is the NASA Ames Research Center in California. A mission team usually includes five to ten scientists, graduate students, and crew. Often, there is room for guests, who can be taken along for no additional cost beyond the fuel consumption due to their weight. The idea of providing this guest opportunity to school teachers was first mentioned to author Bennett by NASA's Chief of Infrared Astrophysics, Larry Caroff, and by David Koch from the NASA Ames Research Center.

To ensure that the flight experience is more than just a ride, FOSTER teachers participate in two intensive workshops, one before and one after their flight. The workshops prepare teachers for their flight, and help them to develop ideas for integrating their personal experience back into their classroom. During the mission preparations and flight teachers work with the KAO scientists, most of whom have indicated a willingness to maintain ongoing communication with the teachers. The pilot phase of FOSTER began in September 1992, with ten teachers chosen from the area local to NASA's Ames Research Center. The operating plan calls for FOSTER to grow over the next five years until it is open to approximately 40 teachers per year from all across the US. FOSTER is being run by Dave Koch and Carl Gillespie of NASA Ames, and Edna DeVore of the SETI (Search for Extraterrestrial Intelligence) Institute.

We note that FOSTER already has provided an important example of the intertwining of education, science and politics. For years, the astronomical community has been seeking funding to replace the KAO with a more advanced airborne observatory, known as the Stratospheric Observatory For Infrared Astronomy (SOFIA). SOFIA is envisioned to be a Boeing 747 airplane carrying a 3-meter class telescope. So far, the US Congress has not acceded to this request. Recently, a group of infrared astronomers visited numerous members of Congress to explain the scientific benefits of SOFIA. The group was accompanied by two school teachers who had flown on KAO during a "pre-pilot" phase of FOSTER (funded by an AGSE award to Texas astronomers Dan Lester and Mary Kay Hemenway). Many of the members were especially interested in hearing the teachers talk about their experience and the potential educational benefits of SOFIA. Thus, although FOSTER was begun primarily as a strategy for using a NASA Astrophysics mission to enhance education, it may yet turn out to be an important factor in obtaining Congressional approval for SOFIA.

3.4. Educational Product Development

IDEA supports the creation of numerous, high-quality educational products distributed to tens of thousands of teachers through NASA's network of Teacher Resource Centers. Products developed to date include: the *Perspectives From*

Space set of 8 posters with classroom activities; a Space Astrophysics slide set for educators; two Hubble Space Telescope posters and an educational brochure; and Educational Briefs on the Compton Gamma Ray Observatory and the Extreme Ultraviolet Explorer. Many more products are expected in the future.

3.5. Perspectives From Space

Perspectives From Space has a dual nature. It represents a concept designed to focus attention on the humanistic side of the space program, and also refers to a specific project which involved the creation of eight educational posters packaged in a single set (NASA 1992c). The *Perspectives From Space* concept was suggested by one of the authors (Bennett), who also led the development of the poster set. As such, we consider it an IDEA program, even though its scope goes beyond astrophysics to encompass all of the space sciences.

The stated purposes of the *Perspectives From Space* concept are:

(1) to promote space-based research as a means for developing new ways of looking at ourselves as humans (perspectives from space) that will help us to confront the appreciable tasks of forging a better future;

(2) to emphasize the linkage between the grand endeavor of coming to understand our universe, through scientific study and space exploration, and the practical concerns of the peoples of the world, particularly in the areas of science education, environmental awareness, and international cooperation;

(3) to demonstrate that the study of space, and of the Earth from space, has already contributed to our appreciation of the beauty and fragility of the Earth, and of the value of human cultural diversity to the strength of our civilization.

The concept of *Perspectives From Space* was adopted by the Space Agency Forum for International Space Year (an organization of space agencies and ministries from around the world) as the theme for space science activities during the 1992 International Space Year (COSPAR, 1992). The poster set was created to bring the *Perspectives From Space* concept to the public, and particularly to educators. The set consists of eight distinct posters, each illustrating a different perspective. The back side of each poster features background scientific information and suggested classroom activities; all of the poster backsides together make a 32-page teachers guide to the *Perspectives From Space* concept. The set also includes a 4-page "users guide", and a return-mail evaluation from. 35,000 poster sets are being distributed to educators. The set also has been displayed in numerous scientific and public forums, including at the 2nd United Nations/ESA Workshop on Basic Space Sciences for the Benefit of Developing Nations held in Bogota, Columbia in November 1992. We believe that the *Perspectives From Space* concept is especially valuable for showing the connections between space science and the everyday concerns of the general population, and we continue to seek new ways to make use of the concept for this purpose.

3.6. Space Astronomy Update

Space Astronomy Update offers a new format for press conferences intended to help the news media better explain astronomical discoveries to the public. Unlike traditional NASA press conferences, which use the "talking heads" approach of having scientists talk one at a time, Space Astronomy Update features lively discussions about the *implications* of new discoveries by a panel of distinguished astronomers. To reach a wider audience of reporters, Space Astronomy Update is televised over NASA Select television. Space Astronomy Updates have led to many superb newspaper articles and television news segments about recent astronomical discoveries. In the future we hope to make use of the videotapes to produce an educational video that refers to the discussions amongst the scientists as illustrative examples of scientific reasoning.

4. Future Directions for IDEA

The three guiding principles listed in Section 2.1, and the four objectives quoted in Section 2.4 will remain the basis for IDEA programs. In this context, future directions will involve greater emphasis on assessing and improving the effectiveness of existing projects, on enhanced development of outreach products and experiences for women and underrepresented groups, and on exploring strategies for bridging the gaps between research astronomers and specialists in education who must work more together to achieve the goal of greater scientific literacy. Greater attentiveness to public education will also characterize future IDEA projects.

4.1. Assessment and Improvement of Outreach Products

IDEA will partner with NASA's Education Division to fund an assessment of the educational value of the internationally distributed *Perspectives from Space* poster set described in Section 3.5. Author Bennett and a graduate student in education will conduct the evaluation based on responses to the questionnaire that was enclosed with the posters. Thus far we have received several hundred responses, and expect to discern the value of the posters in classrooms and other public settings.

The IDEA program is also trying out a new method for reviewing a NASA Education Brief. We began by drafting a Brief on black holes that we believed to be scientifically accurate and educationally effective. Before proceeding to print, (which would have been standard procedure) we distributed the draft with a questionnaire at two presentations on Hubble Space Telescope at the last meeting of the National Science Teachers Association. The questionnaire included inquiries about the draft's content, intellectual level, clarity, and vocabulary. We used the results of the survey to hone the Brief for its intended audience. In the process we learned there is great demand for information on black holes, particularly information that addresses directly the imaginative questions that young students are bound to ask of a teacher. The survey also revealed an enormous number of misconceptions about black holes that we have worked very hard to dispel creatively in the Educa-

tion Brief. We will work to have this method of testing a product on the intended audience more generally adopted by NASA. Given the large distribution of such products, it is well worth the effort to make them of the very highest quality.

4.2. Assessment and Improvement of Existing Programs (AGSE, FOSTER)

The latest AGSE (Astrophysics Grant Supplements for Education) review was the most thorough to date. A diverse assortment of experts in education, science and program management gathered to critique approximately 50 proposals from research astronomers. Proposals were for teacher workshops, innovative uses of computer technology, creative opportunities for research experiences, and other special activities and materials.

The closer scrutiny of AGSE proposals drew out many important items to emphasize with researchers who are just beginning to become involved in educational outreach. Research astronomers need guidance about how to make an outreach effort that can be usefully integrated into a school's curriculum, how to prepare and follow up an effective teacher workshop, and how to expand the outreach efforts and/or disseminate special ideas or materials that are developed. The AGSE review committee made a strong recommendation for a conference of AGSE participants to discuss such issues in addition to the content of the various outreach efforts. The review committee also suggested that a follow-up meeting be conducted to determine the best way to implement the grant supplements — either as a separate informal announcement of opportunity as is currently the case, or as a formal section in all of the Division's research announcements.

Next year, our goal is for the AGSE program to engage at least 15–20% of the research astronomers funded through the NASA Astrophysics Division. This amounts to somewhere between 90 and 120 professional astronomers. Our vision is to develop a national interactive network of research astronomers who are active in educational outreach, and who can feed back on how best to continue development of the IDEA program. We have recently published and distributed a participants directory for the 1992 awards (NASA, 1993) to facilitate awareness and communication of AGSE efforts.

The FOSTER project to fly teachers aboard the Kuiper Airborne Observatory (KAO) is still in its pilot phase, and our goal is to prove that this extraordinary opportunity for a research experience can be cost effective in terms of the money expended per student, teacher or citizen impacted by the teachers who fly. All FOSTER teachers will develop creative ways to share their experiences with a wide variety of audiences with special emphasis on incorporation into school curricula. They are also being asked to keep a logbook of their outreach activities, including classroom and school engagements, presentations to local communities, talks at conferences on scientific research and/or education, interactions with politicians, and so on. The vision for the FOSTER program is to build up a nation-wide network of teachers who have enjoyed this direct experience with the research comrnunity. In this vision all FOSTER teachers are linked by computer through

the NREN (National Research and Education Network — Internet) and all serve as NASA ambassadors for astronomy education. These teachers provide natural focal points for the future possibility of real time down links between the SOFIA aircraft and pre-collegiate classrooms across the US. FOSTER teachers will also serve as a resource in testing and evaluating NASA outreach products and curricular materials for astronomy.

4.3. Products and Activities for Women and Underrepresented Groups

In collaboration with NASA's Education Division and other NASA science divisions we have initiated a series of posters entitled, *Superstars of Science*, which is intended to present young people with an artistic and biographical rendering of potential role models. Our first poster is based on African Americans who have been successful in science (including astronomy) or engineering with NASA. The poster front will be an artful montage of portraits, and the poster back will include short biographies of each scientist, including personal interests outside of the professional realm. The poster back will also incorporate information on career choices in space science and engineering and what to do in school to achieve them. The planned focus of the next poster is women in modern astronomy. Hispanic "Superstars of Science" will be the natural next step.

IDEA is investigating other uses of the Ask-An-Astronomer exhibit that can have particular impact on underrepresented groups. We are collaborating with NASA's Public Affairs and Education Division offices in producing an exhibit at the Urban League meeting in Washington DC. We will have the Ask-An-Astronomer exhibit adjoined to a large video wall presentation about space science and African American astronauts on Space Shuttle missions. We also seek to expand our participation in career fairs for young women. We recently took the exhibit to a career fair sponsored by The American Association of University Women (AAUW) in Maryland. Most of the astronomers who participated were women (some were graduate students) from the Space Telescope Science Institute. The event was held in a shopping mall on a Saturday, which proved to be an extraordinarily successful means of outreach. We note that the participation of science graduates and undergraduates in this sort of outreach activity can be especially effective in connecting with young people.

Both authors are currently engaged in planning an Education Session for the 3rd annual United Nations meeting on Basic Space Sciences for the Benefit of Developing Nations to be held in 1993 in Lagos, Nigeria. In addition to an interactive session, we expect to distribute products that are especially suited for an international, multi-cultural audience. These include the *Perspectives from Space* poster sets and a relatively new brochure entitled, Mission to the Universe. This brochure describes humanity's quest to understand the universe through observing from space, and it lists the more than 20 space astronomy missions from all over the world that either are or will be operating during this final decade of the twentieth century.

4.4. Addressing the Gaps Between Research Astronomers and Educational Specialists

Gaps in communication and missed opportunities for collaboration between research astronomers and education specialists exist both within NASA and at the universities. In the NASA Astrophysics Division, the employment of a full time scientist devoted to education is proving to be a substantial advantage in establishing a cooperative relationship (in spirit and in funding) with the neighboring Education Division. Although astronomers at universities are explicitly involved in education through the teaching and training of undergraduates and graduate students, fruitful relationships between science departments and Schools of Education that can result in benefits to *pre-collegiate* education do not generally exist . IDEA will explore two potential avenues for collaboration. One is the use of astronomy researchers in helping future elementary teachers to achieve mathematical and scientific literacy, and the other is the use of science trained graduate students in Education to help translate effectively the experience of NASA astrophysics missions to the pre-collegiate arena.

Exploration of the latter avenue is beginning with support for a graduate student at the University of California at Berkeley whose thesis work in Education will involve bridging between the research investigators on a NASA Small Explorer satellite being developed at Berkeley and the students and faculty at a local high school. The satellite is called the Fast Auroral SnapshoT (FAST) and the job of the graduate student will be to engage the students creatively and actively in the science, technology and operations of the satellite project. If this endeavor is successful, IDEA will pursue the recommendation that future support for such graduate students in Education be available through the regular NASA program of support for graduate students in science and engineering.

Workshops are another medium for bridging the gaps being discussed here — not just workshops for teachers (including pre-service teachers) that involve scientists as presenters, but also workshops for researchers that involve teachers and education specialists as presenters. Such workshops should address topics like, "What Works in the Classroom at Various Levels", "How and Where does Astronomy Fit into Existing and Evolving School Curricula", "What are the Issues in National Educational Reform", "What do the Emerging National Science Standards Look Like", "How to Plan and Conduct a Successful Teacher Workshop", "How to Disseminate Developed Products and Experiences to a Wider Audience". In a sense, there is an educational literacy to be gained by research scientists, just as there is a scientific literacy to be gained by teachers and other education specialists.

4.5. IDEA Ideas for Public Outreach

Future IDEA programs will explore at least two innovative concepts for public outreach in astronomy. The first of these involves the use of the Astrophysical Data System to obtain all-sky data in various wavelengths. Astronomers at the

University of Colorado have shown that these types of data can be transformed into a set of slides that project all sky images onto a planetarium dome. This idea has the potential to bring real NASA data to the public in planetaria across the country and all over the world. The second concept for public outreach involves finding clever ways in which information about astronomy can be conveyed through the arts and humanities. In addition to exploring these concepts, the new AGSE announcement is encouraging professional astronomers to write or consult for educational media programs (radio, television, newspapers, etc.) that have a very large public distribution.

5. Obtaining Further Information

Regular updates concerning IDEA are offered in *Inside Astrophysics*, the newsletter of NASA's Astrophysics Division. To be added to the newsletter mailing list and/or to make comments or suggestions about IDEA, write to: Inside Astrophysics, Code SZ, NASA Headquarters, Washington, DC 20546.

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