

Defining Long Term Goals and Setting Priorities for Education and Public Outreach

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Abstract. The Education and Public Outreach Panel for the 2003-2013 Decadal Survey has generated this report to assist NASA and the planetary sciences community with planning and prioritization of E/PO activities. We recognize the significant achievements of the NASA Office of Space Science (OSS) E/PO efforts in recent years which address many of the issues noted in this report. The key issues identified by the panel are: Communication, Scientist Involvement, Public Relations, Access to

Resources, Underrepresented Groups, Leveraging, and Feedback to the Decadal Survey. Recommendations have been made in each of these key areas to enhance E/PO activities through the years 2003-2013. Also included are suggestions for maintaining future capabilities in several areas including Workforce Development and Teacher Training.

EXECUTIVE SUMMARY

The Education and Public Outreach Panel for the Decadal Survey was assembled under the auspices of the Division of Planetary Sciences of the American Astronomical Society. The members of the panel represent a variety of scientific interests and involvement in E/PO activities. Members cover the range from full time E/PO professionals to full time scientists, engineers and students. Panel members volunteered from large universities, NASA centers, small colleges, private industries, and other science and education institutions. This report is a compilation of the ideas generated by this diverse panel suggesting what key issues, priorities, and recommendations should be highlighted in continued E/PO activities, by NASA and the greater planetary sciences community, over the 2003-2013 decade.

Education and Public Outreach (E/PO) activities are an integral part of NASA's mandated mission and detailed in its Strategic Plan. The Office of Space Science Solar System Exploration (OSS SSE) E/PO program has made great strides in defining priorities and achieving its goals in the last five years. The issues and recommendations identified by this panel have in many cases already been targeted and acted upon. They appear here so that the panel may present a complete list and underscore their importance in planning for the 2003-2013 decade. Key issues identified by this panel are: Communication, Scientist Involvement, Public Relations, Access to Resources, Underrepresented Groups, Leveraging, and Feedback to the Survey. The panel has developed recommendations to augment OSS SSE E/PO activities in the next decade in each of these key areas.

The communication between planetary scientists and the OSS E/PO Support Network needs significant strengthening. Such communication is a two way street, with both educators and scientists needing to take an active role. OSS should consider a promotional campaign to underscore what the OSS E/PO is doing, why scientists should want to be involved, and how scientists can get into E/PO activities most effectively.

Because of tight funding in all phases of their work, planetary scientists are spending most of their time just maintaining status quo doing research science. Old paradigms of scientific elitism and lack of encouragement for E/PO activities stop many scientists from getting involved. Having limited venues for involvement, and problems with funding cycles and mission-oriented funding create problems for scientists interested in E/PO activities. The crowning barrier to deeper involvement is the seeming lack of rewards or incentives for scientists from their home institutions and professional societies. Change must be initiated by management of those places where scientists are employed so that E/PO is truly rewarded with funds and tangible career progression.

Planetary scientists, in general, do not understand and are confused by the distinction between E/PO and Public Affairs at NASA. NASA's codes should fully integrate their needs and plans and present a consistent, unified strategy and requirements to the community it funds. OSS (Code S) and Public Affairs (Code P) should together define the goals for public affairs and E/PO. Synergy between E/PO and Public Relations (Public Affairs) will allow each to work more effectively, and eliminate confusion in the public and scientific community.

The internet is the most high profile method to access resources at the present time. NASA should present one very easy to find and navigate site (or modify an existing site) for use as a clearinghouse by educators without the organizational divisions that have no significance outside of NASA. Such a site should have its content evaluated for accuracy by appointed scientists and educators. Those who maintain the site should also develop a dynamic plan for updating it so that it continues to provide value.

Further work needs to be done to assure that women, minorities, the financially disadvantaged and the disabled have equal access and are being effectively reached at all levels by science education endeavors. It may be helpful to have more materials translated into languages such as Spanish or presented in Braille. There is a large subset of the population that cannot be reached by internet programs because they have little or no access to computers. NASA TV should be examined to see if there are other, more productive means of utilizing it as a E/PO resource, especially for those who do not have computer access.

Creative and innovative relationships and methods have evolved from OSS activities. Efforts need to continue to make good programs and products more universally available. The best means of generating more at lower cost is to better utilize existing programs within NASA as well as state-based organizations. The OSS should emphasize partnering with community colleges as a cost effective means of reaching large numbers of college students. In addition to the OSS Education Conference, NASA should sponsor a national meeting bringing scientists and educators together to develop a strategic plan for how NASA can achieve the greatest impact for its investment.

The Decadal Survey as a whole will generate a series of science recommendations for the OSS to follow over the next ten years. These will have direct impact on E/PO. It is important for the OSS to know how the planetary science community views the relevance of these recommendations to the public, and all audiences served by OSS E/PO programs. Once the science priorities have been determined the OSS should return to the consideration of E/PO issues, and determine how scientists view their public engagement potential.

In addition to the key issues and recommendations, this panel has also made several suggestions to maintain future capabilities. A comprehensive plan should be initiated to ensure workforce development in the areas of science, engineering and technology. Funding sources should remain stable to ensure that the investment made in developing new resources is not lost when the time comes to maintain those resources. Emphasis on the professional development of teachers will continue to be very important for science education in the 2003-2013 decade.

REPORT

1. Scope

This report is intended for use by the National Aeronautics and Space Administration (NASA) to help identify, define, and implement improvements and new programs related to its education and public outreach (E/PO) efforts. Specifically, this report is targeted at the needs of the Office of Space Science (OSS) division of Solar System Exploration, and the planetary sciences community at large, for the decade 2003-2013. However, since education and outreach are a part of every division of the OSS, overlap with other programs is to be both expected and desired. Therefore many of the issues and recommendations discussed in this report are relevant to all areas of science education at NASA. The reverse is also true; how NASA conducts E/PO in other divisions and departments is relevant to the functioning of OSS Solar System E/PO endeavors.

2. Current State of Knowledge - Background and Perspective

Before defining goals and priorities for the next decade, we first present a general look at NASA's overall motivations for involvement in E/PO and what large scale structure has been established. This provides a context within the current NASA E/PO framework for the interpretation of the issues and recommendations that we present in this report.

2.1. NASA motivations and objectives

Why is NASA involved in Education and Public Outreach, and what are its stated motivations and objectives? Both the National Space Act of 1958, and NASA's Strategic Plan define the foundation on which NASA has built its programs for E/PO.

The National Space Act of 1958 mandates that NASA Administration "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof." A key element of NASA's strategic plan is to "Communicate Knowledge". The strategic plan further states "The knowledge generated by NASA's activities is without purpose if it is not shared with those who can use it. This includes ... science and technology communicators such as educators, publishers, museums, and the media, and every citizen of the United States and the world." The Plan outlines specific goals in E/PO with respect to its major areas of operation in: Space Science (Share the excitement and knowledge generated by scientific discovery and improve science education), Biological and Physical Research (Use space research opportunities to improve academic achievement and the quality of life), and Human Exploration and Development of Space (Share the Experience and Benefits of Discovery).

2.2. NASA programs to achieve education objectives

NASA has developed programs both in and outside of the OSS to define and meet E/PO goals and objectives. Further information on NASA's present position, current direction and "state of knowledge" in education can be therefore found

by looking, for example, at the NASA Education Implementation Plan, the Space Grant Strategic Plan, and OSS E/PO Strategic Plan, amongst others.

The NASA Education Implementation Plan notes NASA's desire to strive for "Educational Excellence", involving "the educational community in our endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds." The Mission statement in this Plan is for NASA to "use its resources to support educational excellence for all." The customers of this department are the formal and informal education community. ("The formal community is defined as K-12, Community College, Undergraduate, Graduate, and Post doctoral. The informal community includes both K-12 and post-secondary levels, as well as science and technology centers, museums, planetariums and other nonprofit education organizations.") This department is targeting certain improvement initiatives: Focus and Coordinate State-Based Efforts, Enhance Instructional Products and Dissemination, Improve Education Program Integration and Coordination, Facilitate NASA Research in the Education Community, Support Pre-service Education, and Target Informal Education.

The Strategic Plan of the NASA Space Grant College and Fellowship Program lists a number of priority items which show a grasp of current trends and needs for E/PO in general, although naturally specifically targeted for undergraduate education including: Teacher preparation, classroom teaching, research opportunities for undergraduates, and interdisciplinary curricula; Formation of partnerships between engineering schools and education institutions, industry, and government; Stress development of interdisciplinary courses and curricula; Enhance pre-college teacher education (Pre-service) programs through collaborations among education, science, and engineering disciplines; Promote development of community college initiatives, high technology and distance learning projects, career retraining, and the development of new technical courses; Aeronautics, science, and technology-based programs or activities that serve industry, state or local government, nonprofit organizations, children and adults such as non-technical courses, lectures, science fairs, and assorted media format, museum and planetarium programs, and other activities that are offered outside of a formal academic setting and; Focus on involving women, underrepresented groups, and persons with disabilities in all aspects of education.

The Earth Science Enterprise has established a set of basic principles which for the framework that supports the development of the ESE Education Program. Earth science is strongly connected to Solar System science, providing the best in-depth look at a planet. The ESE principals are: to demonstrate relevance to the society, to operate and work within NASA's strategy for education, to focus the implementation of a sustainable Earth system science education program that is consistent with externally imposed education standards, to increase the involvement of ESE scientists in education, to involve teachers in the development and decision-making aspects of education activities, to coordinate (and perhaps integrate) strategy and programs with other agencies and organizations, to ensure equity and diversity in all ESE education activities, and finally to leverage the resources of external groups.

2.3. Office of Space Science E/PO

Along with E/PO conducted by these programs, the Office of Space Science (OSS) has developed its own program for E/PO. OSS has stated its vision and mission for education in its Strategic Plan as follows “The Office of Space Science will use its knowledge and discoveries about the Sun, the solar system, the galaxy, and the universe to develop education and public outreach opportunities and activities that enhance science, mathematics, and technology education and the scientific and technological literacy of all Americans. The education mission of OSS is to engage its community of research scientists, managers, engineers, and support staff across the nation in education and public outreach activities to fulfill its vision. To this end, OSS will use all its resources, specifically drawing on the inspirational nature of space science; the remarkable results from its missions; and the special talents of its research community in universities, institutes, and laboratories throughout the country.”

To meet its goals the OSS has developed a “Support Network” of Forums and Brokers/Facilitators. Each Forum is associated with a scientific theme, and each Broker/Facilitator associated with a geographical region. The Forums work both independently and in partnership on certain programs. E/PO is supported by the OSS in several core ways in addition to the Broker/Facilitator and Forum programs. E/PO is an integral part of all space science missions. E/PO is optionally available to all OSS supported research activities, and also is funded independently of these activities through the IDEAS program - which supports scientist-educator partnership activities. The OSS specifically has targeted areas for continued development as listed in The Annual Report of the OSS E/PO.

The specific goals of the OSS E/PO are:

- Use space science missions and research programs and the talents and resources of its research and development communities to make significant and measurable contributions to meeting national goals for the reform of science, mathematics, and technology education, particularly at the K-14 level, and the general elevation of scientific and technological literacy throughout the country.
- Continue to support the education and training of graduate students and postdoctoral fellows in space science in order to create the talented scientific workforce needed for the 21st century. OSS will expand its efforts in support of the education and training of undergraduate students.
- Promote the involvement of women, underrepresented minorities, and students with disabilities in its educational programs and their participation in space science research and development activities.
- Facilitate and cultivate strong and lasting partnerships on local, regional, and national scales between the space science research and development communities and the professional communities in science, mathematics, and technology education.

2.4. OSS Solar System Exploration E/PO

As listed above, NASA has identified and outlined important objectives that are common to all of its E/PO programs, including those of the OSS. These programs

tend to work independently of both one another and of public relations activities. The specific Solar System Exploration E/PO program of the OSS (that which is most relevant to the scope of this report) places emphasis on the following objectives:

- Engaging its community of planetary scientists in education and public outreach activities
- Inclusion of minorities, traditionally underrepresented groups, women and the disabled
- Development of partnerships with groups and organizations outside of NASA
- Improving access of scientists and educators to resources for E/PO

The SSE E/PO community has already put in motion several programs to address these objectives, the details of many of which follow as each key issue is discussed. This panel hopes that this report will provide useful recommendations to the OSS SSE E/PO effort, and the general planetary sciences community, for further addressing these stated objectives and the key issues detailed below.

3. Key Education and Outreach Issues

Key issues which this panel believes need to be addressed in the next decade include both items that have been previously identified (as noted in the Background and Perspective section of this report) as well as others that have been seen to require new emphasis based on recent changes in both science and education. Some of these issues are very general, and apply to all E/PO endeavors, and some are tightly focussed to the programs and needs of the OSS.

It is important to note that the OSS has already independently identified and begun to work on addressing some of these issues. The presentation of those issues here reinforces their importance as seen by this panel and the communities they represent. We recognize efforts of the OSS on some of these issues where the panel is aware of them. In many cases this work has not yet had time to generate all the results that are expected, therefore further ventures in these areas that may result from recommendations in this report must be considered in the light of any existing programs.

The major issues identified by this panel are:

- **Communication:** The need for more communication with NASA OSS regarding E/PO, and assistance in understanding the needs of the education community that NASA OSS is being asked to serve.
- **Scientist Involvement:** The need for more effective and widespread involvement of planetary science professionals in E/PO activities. This requires addressing several topics:
 - Eliminating Elitism
 - Validating of E/PO for Scientists

- Expanding Roles for Scientist Involvement
- Improving Funding Cycles/Mission Centered Funding
- Public Relations: The perceived confusion between NASA E/PO and public relations
- Access to Resources: Access to resources for EPO for scientists, educators and partner organizations.
- Underrepresented Groups: Reaching traditionally underrepresented groups, women, minorities, and the disabled.
- Leveraging: Making consistent use of existing programs and resources.
- Feedback to Survey: Putting in place a system to gain feedback from scientists and others on the public engagement potential of the final science recommendations of the Decadal Survey.

3.1. Communication

At the crux of a successful implementation of E/PO as part of NASA OSS activities is the essential link of communications between the communities involved. Open and effective methods of dialog and information exchange must be provided for between the E/PO infrastructure of NASA OSS/SSE and the planetary science community. The responsibility of this communication rests equally on both groups.

Communication is also important because it allows for the free flow of information from one group to another so time is not wasted developing resources that exist elsewhere. It also allows for fruitful collaborations to be created which can stretch budget dollars further for all organizations involved.

In addition, the planetary science community needs to understand the needs of the communities it is being asked to serve through its E/PO efforts. Creating useful programs for educators requires an understanding of their needs based on their audience and their general experiences. We anticipate the first OSS-sponsored education conference June 12-14, 2002, and the associated proceedings document, as an opportunity for developing communication with and knowledge about the education community.

3.2. Scientist involvement

Getting scientists involved *effectively* in E/PO activities is one of the most important issues that must be addressed in the next ten years. This is a highly complex topic as current paradigms, programs, and approaches to scientist involvement are all in need of change in order to improve the level of involvement of planetary scientists in E/PO activities. We attempt here to mention some of the key points that we have identified as critical to improving scientist involvement.

Eliminating elitism: Scientific Elitism, in its many forms, is the basis of the current paradigm that separates scientists from more personal and effective involvement in E/PO activities. What follows is a stereotypical description of the current paradigm, but the overall impression it provides is accurate. From the

scientist perspective, research science is the pinnacle of learning. The mindset has been one of tenured faculty taking on apprentice graduate students, and then in due time producing a “clone” of the mentor who continues working in the same area and who, of course, obtains the same tenured faculty position at a university. While this was an accurate model of the development of the mentor/student relationship 30 years ago, it is no longer a viable model. This mindset includes the idea that other pursuits such as education and public outreach are “lesser” and a waste of time, and those involved in these endeavors are also somehow lesser because they could not “cut it” to go into, or remain in, science. The mindset propagates into the perception of how the scientist relates to the public.

The public is viewed as simple, uneducated and lacking in critical thinking skills. It is not generally viewed as the client or end consumer of what the scientist produces. This elitism also makes any synergistic communication with the education community problematic at best. Eliminating this ineffective, unrealistic, and isolationist paradigm is a critical issue which needs to be addressed. Of course not all scientists feel this way, but some aspects or ripples of the elitism paradigm effect almost every program or institution that includes research scientists.

Validating E/PO for scientists: One of the contributing factors to Elitism is the fact that E/PO activities for scientists are not validated and rewarded. The scientific culture of “publish or perish” leaves little room for time to be spent on E/PO. Any amount of time spent on an area that is not perceived to further one’s career or that does not directly contribute to one’s livelihood is, not surprisingly, considered a poor use of time. Although many institutions say they support E/PO activities, when the time comes to reward or advance a scientist who has given time to these activities (say the award of tenure for a scientist in a university environment) some institutions use the involvement as evidence against the serious career research intentions of the scientist. Culturally, scientists did not go into their field as a public service. In order to change the view of scientists, the organizations that employ and fund them must also change their paradigm to view E/PO as necessary and valuable, and reward and fund scientists for their involvement.

Expanding roles for scientist involvement: At present there is a perception that there are few acceptable ways for a scientist to be involved in E/PO, such as teaching a formal class or giving a public talk. Many scientists do not want to be involved in E/PO because they are not good at teaching or public speaking. Some believe that E/PO must include interfacing with young people, and they are unsure of their abilities with children. They therefore avoid E/PO activities. However, education and outreach can be targeted for each scientist according to their strengths. Those who have abilities with the web could be called upon to help evaluate and post content to education websites. For those who do well mentoring students, opportunities (such as Space Grant) should be provided for matching students with prospective scientist mentors. For those who are good writers, education pamphlets or even books for public consumption could be an approved E/PO activity. NASA OSS is currently addressing this issue by raising awareness within, as well as identifying opportunities for, the scien-

tific community, a variety of types of participation. The “Explanatory Guide to NASA Office of Space Science Education and Public Outreach Evaluation Criteria” discusses general types of activities that involve scientists and which are supported in mission and NRA E/PO programs. We recognize the recent restructuring of the NRA E/PO proposal process. This is accompanied by the Internet-based “Menu of Opportunities for Scientists in Education” (MOSIE), which lists specific opportunities for scientist participation in support of E/PO for NRAs awarded by OSS or volunteer efforts, and we anticipate its further population. Further access to the informal education community is provided by the “Space Science Access” website for museums and planetariums.

Improving funding cycles: The means whereby E/PO is funded is not amenable to easy scientist involvement. Most scientists are funded in a “soft money” situation. In order for funding to be useful it must be of a significant amount and time span. The attachment of E/PO proposals to science proposals through the OSS is a frustrating enterprise. The E/PO proposal is an afterthought because it is rarely funded, even when scientists receive excellent reviews for their E/PO proposals. It is no longer viewed as a good use of time to submit such proposals at all.

The mission funding cycles are also not realistically thought out. E/PO for the missions are initiated as much as ten years in advance of a mission returning any data at all. The requirement that some funds be allocated for E/PO for each funded mission is not well thought out, and presents impediments for more than a small number of scientists to be constructively involved.

The idea of attaching education to major programs has many problems that are not related directly to encouraging scientist involvement, one being the quality of programs and products emerging from them varies greatly. In some instances, the focus still is not on what the students (and educators) need or want. The focus in these cases is often on the major program. The emphasis on educational needs and standards can become an afterthought to the promotion of the mission or research itself.

Further, attempting to promote the relevancy of each mission to members of the general public may not be the most effective way to communicate why NASA’s exploration of the solar system matters to them.

3.3. Public affairs/Public relations

There is perceived confusion between how NASA views E/PO and how it views public affairs (also referred to as public relations). These are not the same thing, although there can be overlap in areas such as press releases, press conferences, etc. NASA further divides the two by operating each out of different codes at HQ, who are apparently not synergistic in their needs and even communications about what is important or how scientists might address their needs.

3.4. Access to resources

Particularly as related to the Internet, the concept of “data” storage appears to be very important. “Data” in this context could mean actual science data, but more to the point would be lesson plans, laboratory write-ups, reports, etc. that could be of use to educators. These data can be highlighted by a single Internet

site designed to serve as one point which all educators could turn to in order to find space science related resources and materials that are in some way related to NASA and its mission.

We recognize the recent unveiling of the on-line Office of Space Science Education Resource Directory as a significant movement in this direction. This searchable directory is focused on the needs of educators, and provides access to OSS educational and supplementary materials that are available in electronic format. In addition, this site is structured in a standard way that allows the materials to be fed into the Eisenhower National Clearinghouse website that provides access to all educational material produced by government agencies. The OSS site provides ready links for scientists so they have access to existing, tested, and approved materials. The site was developed with considerable beta-testing in the education community.

It is also critical to provide materials that are scientifically validated. We recognize the recent implementation by OSS of an independent product review process involving the evaluation of OSS materials by educators and scientists.

K-12 teachers in particular need to be involved early and at all stages of planning new programs. Any activity that does not respect their knowledge, ability and experience is unlikely to succeed in the long term. The projects that bring these teachers in as partners from the outset have the best chance of being successful. NASA OSS should therefore acquire K-12 teacher input on new plans and activities, as well as this white paper.

3.5. Underrepresented groups

We recognize that OSS has made some valiant forages into serving the needs of underrepresented groups with its Minority University Initiative, its work with Minority Professional Societies, and a large number of other collaborations (see, for example, the OSS Support Network efforts documented at <http://serch.cofc.edu/serch/special.htm>). Nevertheless, further work needs to be done to assure that women, minorities, and the disabled have equal access and are being effectively reached at all levels by science education endeavors. Also of note are the financially disadvantaged. With the advent of home computers and the Internet in the last few decades, science education has a new and powerful arena in which to operate. However there is a large subset of the population that cannot be reached in this fashion because they have little or no access to computers.

3.6. Leveraging

In an attempt to develop E/PO programs from a grass-roots level, many creative and innovative relationships and methods have evolved from OSS activities. This takes advantage of different external expertise and experience and avoids favoritism or focus on single organizations. However, much of the lessons learned and knowledge gained in these relationships and programs remains with those directly involved with the individual program. Efforts need to continue to make good programs and products more universally available. Individual partnerships between scientists and educators should not be overlooked, and can eventually lead to broader involvement.

3.7. Feedback to survey

It is extremely important for those involved with OSS SSE E/PO to know how the planetary community views the public engagement potential of the final science recommendations that come from this Decadal Study. The study will generate a large number of recommendations and possibly initiate restructuring of science priorities in the NASA OSS. These will have direct bearing on E/PO programs and activities. It is important that the SSE E/PO community be able to ascertain the view of the planetary science community on the relevance of any new priorities and recommendations to the public, and all audiences served by SSE E/PO activities.

4. Recommendations

4.1. Communications

Communication is the critical link for improving E/PO over the next decade. Clearly, this is a very complex endeavor and requires the expertise of many people and organizations with diverse skill sets (scientists, teachers, science educators, teacher educators, informal science educators, educational technology specialists, etc.). OSS E/PO should continue to be inclusive, and find new ways to communicate with this large and varied population. While scientist involvement is critical, the input of people from all these areas will be required to meet the goals of the next ten years and beyond.

NASA OSS must seek the most effective ways of disseminating information for easy access to the planetary science community. Equally, the planetary science community must take responsibility upon itself to recognize the importance of reading and absorbing this information and seeking assistance and guidance from NASA OSS in its implementation. One suggestion to improve the dissemination of information is to have a publicity campaign about why scientists should do E/PO, what types of E/PO are available, and where to go for more information (and help when necessary). This campaign would have several key events, as well as smaller events at conferences, meetings, and perhaps a traveling “exhibit” to participating institutions.

The “Space Science Access” website for museums and planetariums should be expanded and advertised fully in the planetary science community, who should also be encouraged to contribute collaborative ideas and projects.

4.2. Scientist involvement

Scientists must view involvement in E/PO as a means for furthering their career. They need to recognize that this is an integral part of every scientist’s job, particularly those that are being funded from public money. This may require a redefinition or rethinking of what E/PO is for scientists and how they are rewarded for this activity. Innovative ways must be identified and implemented to reward and encourage scientists for active involvement in E/PO. Ideas must be collected about how the culture can be encouraged to change and evolve. E/PO activities must carry as much prestige for scientists as research does. The home institutions of scientists like universities, institutes, centers, etc., must recognize, require, and reward E/PO involvement.

This panel recommends that NASA OSS convene a group of scientists, administrators of institutions that house the scientists, and experts and advocates for scientist involvement in the communication of science (National Science Foundation and the American Association for the Advancement of Science) to specifically address these issues. NASA should allocate a specific amount of funds to both fund the group and to carry out their imperatives. Questions they could ask are what would it take to change the way scientists feel about education, where should the culture be going, and what is NASA's overall vision for continued communication between the education and scientist communities. Such a panel should not primarily consist of people who have vested interests in existing E/PO programs and architectures at NASA.

We have generated some suggestions which the recommended group of experts could consider. Some E/PO funds cannot be used for salary, only materials. Institutions should be encouraged or required to provide matching funds, which can be used for salary. That would encourage scientists to apply for E/PO money. NASA has recently been giving very visible awards for E/PO, such as NASA's Exceptional Service Medal being awarded for solar system outreach. This should be encouraged. Major societies (like AGU, Meteoritical Society, etc.) should offer prestigious awards to those who excel at outreach activities. The DPS offers such an award. In addition to this, award of medals which are not directly assigned on the basis of E/PO activities should not be hindered by the scientist having been involved in E/PO. Many scientists will not "jeopardize" their long-term chances for a prestigious society medal by spending time in E/PO, so such activities should be viewed favorably by committees which choose awardees. In addition to these suggestions, programs targeting the education and involvement of graduate students could support the needed culture change.

Some scientists are not involved in E/PO because they do not understand the system in place to help them get connected. Part of this problem goes back to Communications, already discussed. NASA OSS should carefully define the nature of the Broker/Facilitator and Forum representatives. NASA should consider working to eliminate any possible conflicts of interest between scientists and educators/brokers proposing for E/PO money.

We await the availability of the electronic Journal of Astronomy in Education developed by the National Optical Astronomy Observatories and the Astronomical Society of the Pacific as an avenue for peer-reviewed publication of work done in this area by planetary scientists. Such a journal or journals dedicated to publication of peer-reviewed work will allow scientists to continue to publish scholarly work at the same rate (or better) while involved in high level E/PO activities.

We recommend that further study into more flexible avenues for scientist involvement be done (or better promotion for those studies in this area which have been done already) which may result in more scientists being interested in these opportunities rather than turned off or intimidated by them. PI's do not want to have the only option for involvement be "signing on" to pre-packaged, large programs. The system should allow the flexibility to encourage an investigator involved in small, local programs to succeed alone. If PI's can only subcontract parts of their proposals to established institutes to succeed then opportunities for innovative scientist involvement will be missed.

NASA should carefully examine how funding cycles impact the desire of scientists to participate in education and outreach. Understanding that the vast majority of scientists are NOT hard money, but instead live grant-to-grant will promote a more friendly and workable environment for scientists to be involved and active in E/PO.

NASA OSS must understand its major project/mission goals versus education and outreach goals. The needs of students and educators for a useful end product should be the top priority of E/PO. Having each E/PO activity directly based to specific missions may not best suit this purpose. NASA OSS should emphasize the funding of a portion of E/PO activities independent of missions and proposals to lessen the possibility for conflict. Integration activities such as the “National Science Education Standards Quilt” (from JPL) for access to standards-based solar system exploration products and the space science concepts matrix (from GSFC) should be supported and integrated NASA-wide. Programs such as the IDEAS program should be re-examined and enhanced if necessary to continue to provide a venue for non-mission related activities.

In order to make our missions and research more relevant to the public, NASA should emphasize an integrated picture of the solar system and its exploration. The PI of any large mission which has E/PO funds attached must give high priority to E/PO. The rest of the mission team will take their lead from the PI - if the PI regards E/PO as important and necessary, then the rest of the team will be willing to assist those involved with E/PO in their efforts.

4.3. Public affairs/Public relations

In order to provide a consistent story to its constituents, NASA’s codes should fully integrate their needs and plans and present consistent, unified strategy and requirements to the community it funds. In particular, OSS (Code S) and Public Affairs (Code P) should together define the goals for public affairs and E/PO. Particularly when initiating a new mission activity, the public affairs goals and budget, and the E/PO goals and budget should be set out clearly and separately. The same holds true for NASA’s Education Division (Code FE). The E/PO goals must be centered on what educators and students need, not from a scientist or mission oriented perspective. These messages should be consistently and coherently communicated and practices in all these offices. Experience with previous mission E/PO activities (such as NEAR Shoemaker) have pointed out that a clear division between E/PO activities and PR activities needs to be made early in the mission process. Having E/PO and PR activities defined well and separately, but working in tandem will allow for the most cost effective outreach. PR and E/PO should work synergistically, with PR getting the public “turned on” to science, and then E/PO activities providing a wide net to effectively turn this interest into understanding.

4.4. Access to resources

NASA should present one very easy to find and navigate site (or modify an existing site) for use as a clearinghouse by educators. There appear to be such central sites for each NASA code, as well as the education division, but “one-stop-shopping” with a seamless access to all NASA material should be available, and presented without the organizational divisions that have no significance out-

side of NASA. The content of the unified site should be synthesized, evaluated, and actively moderated by a special group of educators and scientists. Only approved materials should be included in the repository. The information that resides in the repository could include duplicate content available elsewhere (with permission). NASA OSS should consider coordinating this effort with other nascent Digital Library for Science, Math, Engineering and Technology projects going on around the country. NASA should consider allowing non-NASA materials (or materials produced without NASA funding) to be included provide they pass the review process. This will allow for better leveraging and cost effective presentation of material.

The moderator of the web site should collect information and comments from users of the site as to how the site could be improved and how it should change and evolve to meet the needs of students and educators. Evaluation of any resource is a critical component to its development and upkeep.

While the OSS site provides “one-stop-shopping” access to material that is available and/or downloadable electronically, educators still need access to print and multimedia material. The relationship with the NASA Central Operation for Resources for Educators (CORE) should evolve to include access to these OSS materials, at low-cost to educators and at no reproduction cost to the providing mission or scientist.

Websites that are related to outreach for current, high profile missions need special attention. Such sites (as we know from Pathfinder) can take massive numbers of hits in a short time period.

4.5. Underrepresented groups

All NASA programs have mentioned the need to reach out to underrepresented groups. This should persist as a priority. Special programs should be continued and augmented to help reach women and minorities. Programs for the disabled have been the most lacking, and a great deal more can be done here to reach this population with science education. For both of these groups it may be helpful to have more materials translated into languages such as Spanish or presented in Braille. For the financially disadvantaged, computer access is a major issue. For this group it is likely that television is still one of the best ways to reach and teach. This should be examined more closely, and television should not be dismissed as “old hat” as compared to Internet-based teaching, but instead each outreach method should be evaluated for its particular strengths in education and employed on that basis. NASA TV should be examined to see if there are other, more productive means of utilizing it as a E/PO resource, especially for those who do not have computer access. In addition to this, for those who do not have cable access, we recommend the OSS continue study on the potential of broadcast TV.

4.6. Leveraging

Further communication of the elements of successful programs and relationships should be communicated and shared among those OSS-funded E/PO efforts. An emphasis should be placed on modeling or expanding existing approaches to working with the education community and to bringing the results of our programs to the public, and on growth in new directions. NASA must be flexible

to reach its E/PO goals. The OSS E/PO should continue to look outward (as well as inward) to establish partnerships with other agencies/ organizations.

The strongest and most long-lasting leverage of existing groups may come from modeling and expansion of programs which work with the pre-service teachers (teachers in training) and finding further ways to understand what their needs are, especially for K-6 teachers whose content domain spans the entire universe of topics. This requires both work with content courses and the methods courses in our Schools/Colleges of Education. It is important to note that such educators may be limited in their interactions by rigid state rules for teacher accreditation that make change a challenge. This should include a priority to expand partnerships with colleges, universities, and K-12.

Of note are community colleges, which educate vast numbers of first and second year college students, but have not acquired the same amount of perceived importance as traditional four year universities. Partnering with community colleges may be a very cost effective means to reach large numbers of college students.

The best means of generating more at lower cost is to better utilize existing programs within NASA (NASA Space Grant program, Solar System Ambassadors, Solar System Educators, OSS Broker and Facilitator, NASA's Educator Resource Center network), between NASA and other agencies (EPSCoR), as well as state-based organizations including the NSF/ED Systemic Initiative, the National Alliance of State Science and Mathematics Coalitions, the Aerospace States Association, the National Aerospace Education Alliance, the Space Grant Directors Council, the Association of State Supervisors of Mathematics, the Council of State Science Supervisors, and relevant education associations (NSTA, NCTM, ITEA, ASEE, USRA, and GENIP) and the NASA OSS. This will require continued emphasis on communication and partnership building. Further communication should be developed to promote and utilize NASA on-line educational resources such as NASA Spacelink, NASA Television, and the NASA Learning Technologies Project. The OSS should also continue to leverage partnerships with AAPT, AAS - Education Office, ASP and NGTA.

In addition to the OSS Education Conference, NASA should sponsor a national meeting bringing scientists, educators, and folks that work with both populations (science educators, educational technologists, Planetary Society, ASP) to brainstorm a strategic plan for how NASA can achieve the greatest impact for its investment. DPS members could be called upon to provide a leadership role in such a meeting. NASA OSS should be sure that representatives of "informal education" (science centers, museums, planetariums, etc.) are well-represented at such a meeting, and in offering input on new initiatives and programs that influence them.

NASA OSS should be certain to recognize the achievements of smaller programs which may be involved in large (or small) missions or other E/PO endeavors. Being willing to properly and publicly promote and share proper credit (particularly with organizations NOT related to NASA) will encourage partnership with all organizations, and eliminate some of the frustration of being a small (but important) part of a large E/PO project.

4.7. Feedback to survey

Obtaining feedback from the planetary science community on the E/PO engagement potential of the science priorities from this survey will need to be an iterative process. After the science recommendations and new priorities have been established, we recommend that the science community be tapped to discover their viewpoint on the relevance of the new priorities to the public and other outreach audiences. This could be worked out through the NRC and/or the DPS. This information will be of critical use to those conducting E/PO programs. This issue should therefore be kept open, to be addressed after the science survey recommendations have been finalized.

5. Maintaining Capabilities for the Future

It is clear that a consistent, reliable source of funding is the most important factor in maintaining the programs, partnerships and resources developed during the next ten years. Excellent web sites have been developed using NASA funding, but in spite of overwhelmingly positive feedback, funding was eventually dropped (see *Volcano World*). Web sites need constant upkeep and maintenance, or the investment originally placed to create them can become lost. When NASA agrees that the creation of a resource, such as a web site, is in order, then NASA should commit the funds for both the development and maintenance of that resource.

There is interest and demand for a variety of products from straight public affairs shots to lesson plans to original data, however there is little market for it. Any steps suggested or taken by NASA OSS need to have some method of support that does not involve schools buying products or subscriptions, because the funds for such transactions are simply not there. NASA will be required to support such initiatives on its own.

Any plans for change, new programs, activities and initiatives taken by the NASA OSS should be emphasized and targeted for the long term. Reform trends which are not carefully implemented with a consideration for their long term effectiveness waste time and money. Any new programs that are not practical and useful will eventually disappear. Teachers and other educators will just wait out changes they think are ill-advised, or have had no input on until they pass (the half-life seems to be about 5 years).

NASA OSS should consider involvement in a comprehensive plan of workforce development. This will help assure that over the next ten years that young people continue to consider technical careers. This plan might also branch out to include investigating how to encourage those with the necessary interest and education to continue their involvement or employment in technical/science careers and endeavors. Such a plan should be developed in tandem with NASA's overall program to enhance the number of young people seeking employment in technical fields.

An effective approach to long term development is to emphasize teacher education. An expert teacher who is always present at a school or museum is an important resource. NASA OSS should continue to support and investigate ways of promoting the development of Expert or "master" science teachers who can then educate both students and other teachers.

Obtaining feedback from the planetary science community on the E/PO engagement potential of the science priorities from this survey will need to be an iterative process. After the science recommendations and new priorities have been established, we recommend that the science community be tapped to discover their viewpoint on the relevance of the new priorities to the public and other outreach audiences. This could be worked out through the NRC and/or the DPS. This information will be of critical use to those conducting E/PO programs. This issue should therefore be kept open, to be addressed after the science survey recommendations have been finalized.

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