Slide 1

Scientist Involvement in Education and Public Outreach

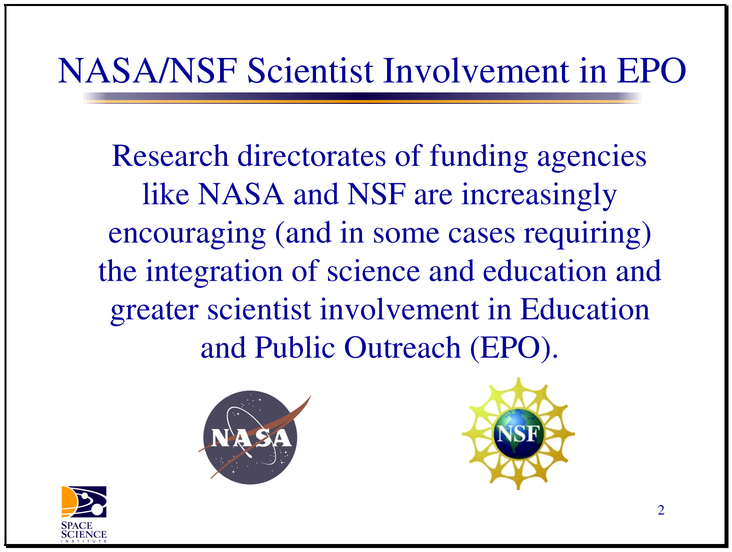
Making the Case

PHOTO CAPTION: Dr. Robert Hoffman of NASA's Goddard Space Flight Center and educator Sheri Klug interact with students at Flatirons Elementary School in Boulder, Colorado. The visit was a part of the the Space Science Institute's annual workshop for scientists on K-12 education, which is supported by NASA's Education Division [For more information see http://www.spacescience.org/Education/ResourcesForScientists/Workshops/1.html]

This draft presentation package was prepared by Dr. Cherilynn A. Morrow of the Space Science Institute in Boulder, Colorado, with support from the NASA Office of Space Science, the NASA Education Division, and the NSF Geosciences Directorate. Please send comments to camorrow@spacescience.org

We would greatly appreciate it if you would drop a line to let us know when and how you make use of this presentation or portions of it [camorrow@colorado.edu].

Slide 2



The NASA Office of Space Science (OSS) EPO strategy and implementation plan both call for EPO to become an integral part of the space science community's professional activities. Every OSS flight project (e.g., Hubble Space Telescope, Mars Pathfinder, etc.) is now *required* to have a significant EPO program (1-2% of the overall mission budget, including spacecraft, mission operations, and data analysis). In addition, smaller OSS research grant proposals have the *option* of including EPO segments up to $10K per year. [See *Implementing the Office of Space Science Education & Public Outreach Strategy* (1996) http://spacescience.nasa.gov/education/edprog.htm] Another component of the OSS EPO program is the Initiative to Develop Education through Astronomy and Space Science (IDEAS), which is a small grant program for scientists and educators who partner together on innovative EPO projects. [http://www.ideas.stsci.edu]

The NSF Geosciences Directorate has published an education strategy that includes a recommendation for the directorate to expand its educational agenda by promoting increased geoscience outreach to teachers, students, and the public. The strategy also recommends providing the information and training geoscientists need to become more effective contributors to such EPO. [See Geosciences Education: A Recommended Strategy. A report based on a workshop of the Geoscience Education Working Group to the Advisory Committee for Geosciences and the Directorate for Geosciences of the National Science Foundation (29-30 August 1996). NSF 97-171]

Slide 3

The Need for Improvement

Third International Mathematics and Science Study (TIMSS)

Overall Comparative Findings
U.S. Performance Relative to the International Average

Content Area	Fourth Grade	Eighth Grade	Final Year of Secondary School	Advanced Math & Science Students
Mathematics Overall	Above	Below	Below	——
Science Overall	Above	Above	Below	——
Advanced Mathematics	——	——	——	Below
Physics	——	——	——	Below

SOURCE: National Center for Education Statistics (1996-1998). For more information visit the TIMSS website: http://nces.ed.gov/timss

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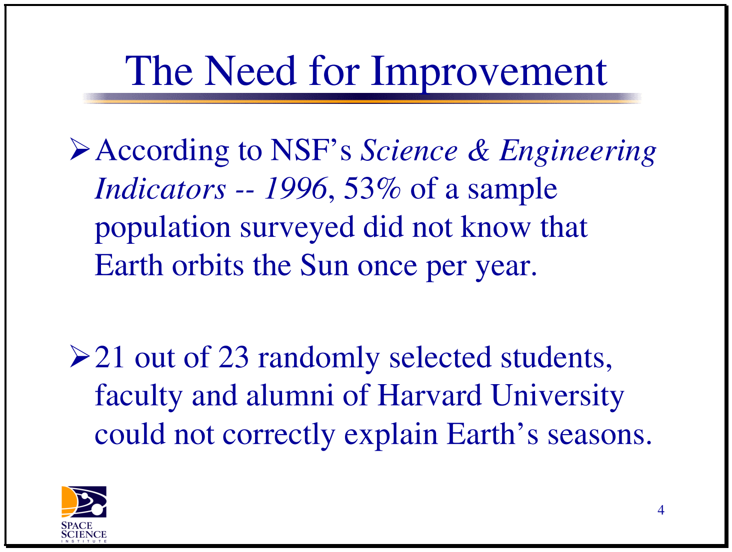
Background Information on TIMMS:
With information on a half-million students worldwide, including more than 33,000 U.S. students in more than 500 U.S. public and private schools, the Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and most rigorous international study of schools and students ever conducted. During the 1995 school year, students from 41 nations including our country's major trading partners were assessed at three different grade levels (fourth, eighth, and in the final year of secondary school) to compare their mathematics and science achievement.

Key Findings from TIMMS:
At fourth grade, U.S. students were above the international average in both science and mathematics. In the eighth grade, U.S. students scored above the international average in science and below the international average in mathematics. At the end of secondary schooling (twelfth grade in the U.S.), U.S. performance was among the lowest in both science and mathematics, including among our most advanced students.

Slide 4



National Science Board, *Science & Engineering Indicators - 1996*, Washington DC, United States Government Printing Office, 1996.

The Harvard students, faculty, and alumni were interviewed at a Harvard graduation and some of the interactions are documented in a video developed by Harvard-Smithsonian Center for Astrophysics called "A Private Universe". This videotape has proven very striking to scientists who report gaining valuable perspective and insight into common barriers to learning. This 21-minute video is available from the Astronomical Society of the Pacific [http://www.aspsky.org; Order # VT 129]

Slide 5

The Need for Improvement

- In August 1999, the Kansas State Board of Education voted 6 to 4 to remove the teaching of evolution from the state standards.
- Scientists are needed to become advocates of sound policies and standards in science education.

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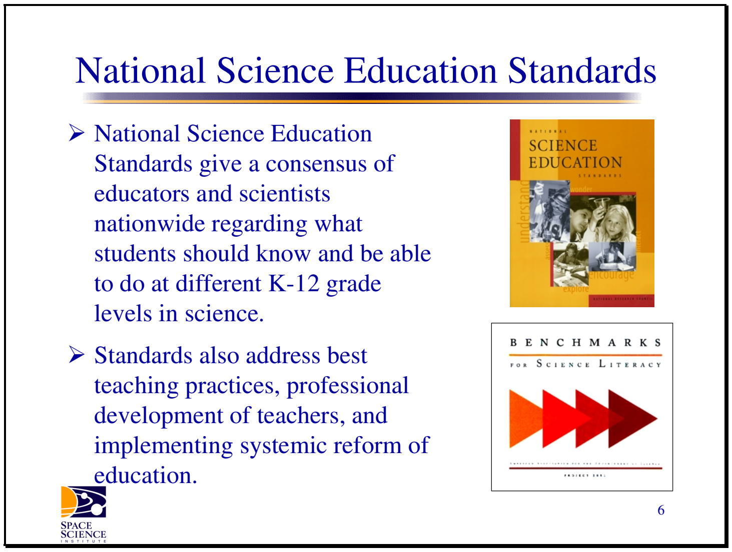
Slide 6



Links to Science, Math and Technology Education Standards
Academic content standards describe what every student should know and be able to do in the academic content areas (e.g., mathematics, science, technology, geography). There are several standards-related documents and resources available at the McREL website (http://www.mcrel.org) including an integration of the NRC National Science Education Standards (http://www.nap.edu/readingroom/books/nses/), the AAAS Project 2061 Benchmarks (http://project2061.aaas.org/tools/), and other relevant education standards.

Browse the Standards in all core academic content areas starting at:
http://www.mcrel.org/standards-benchmarks/docs/contents.html

Science Standards – Earth and Space
http://www.mcrel.org/standards-benchmarks/standardslib/science-1.html

Note from Bullet #2 that
STANDARDS ARE MORE THAN CONTENT STANDARDS!

Slide 7

Importance of Partnerships

"I now view effective science education partnerships between scientists and precollege education science teachers in a completely different light - as the only hope for lasting systemic change in precollege science education and, therefore, as an important national priority for the United States."

-Bruce Alberts,

President of the National Academy of Sciences, 1993

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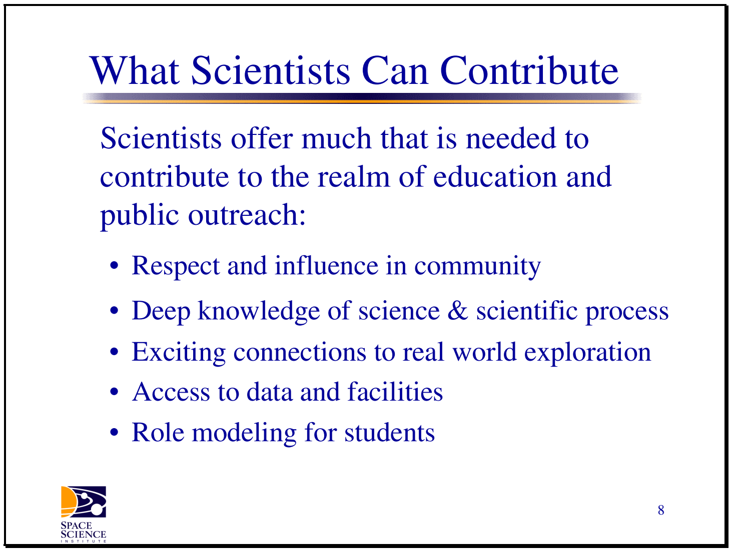
Slide 8



Examples of how these contributions may be of value:

Respect and influence in the community are valuable when it comes to advocating improvements to science and education, and in challenging politicians and school board members who promote science illiterate policies.

Deep knowledge of science and scientific process can be used in service to science teachers who are attempting to align their teaching with the idea of "students as scientists" rather than students as receptacles of facts and information (see next two slides on science education reform).

Connections to real-world exploration can enable exciting live educational programs linked to ongoing research that may be broadcast to classrooms and museums via the Internet.

Facilitating timely access to scientific data can be of great value to developers of curriculum, textbooks, museum exhibits, or other EPO products.

Slide 9

Modern Science Education Reform

- Students as "scientists" with teachers as facilitators of learning
  - Teacher as "a guide on the side" rather than a "sage on the stage".
- "Inquiry-based" process of learning
  - "The way scientists *do* science rather than the way they were *taught* science."

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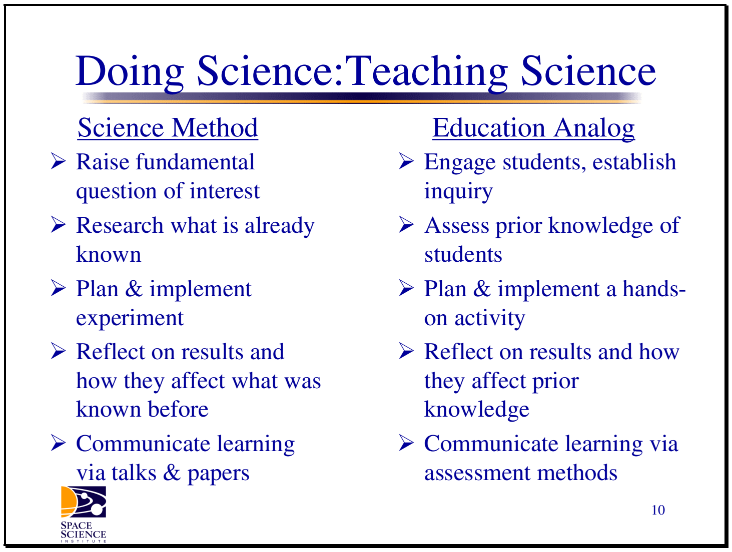
Slide 10

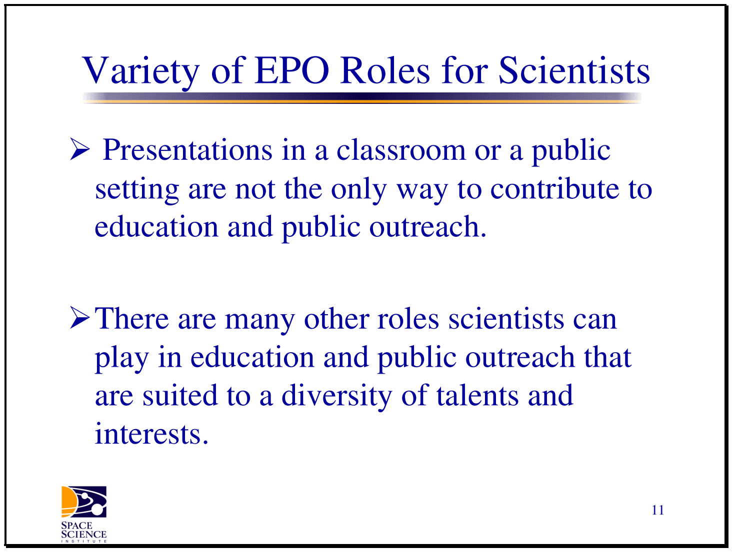


The slide shows the close analogy between how a scientist practices science and how modern science education reform advocates the teaching of science.

Note that hands-on activities alone do not constitute a complete lesson. Assessing students' prior knowledge without judgment and reflecting on how hands-on activities have extended or challenged that knowledge are essential components of learning cycle.

One effective 4-phase learning cycle used in lesson design is: Discuss, Explore, Reflect, and Apply.
1. Discuss: (assess students' prior knowledge and set up inquiry for activity/lesson)
2. Explore: (do activity)
3. Reflect: (look back at activity, analyze and discuss)
4. Apply: (apply learning in new contexts, communicate learning to others, identify questions that lead to next Discuss phase)

Slide 11



It is a common misconception among scientists that they should leave EPO to those who are exceptionally good at public presentation. There are many other ways to contribute that take advantage of a diversity of talents and interests in the science community (leads to presentation of Roles Matrix on next slide)

Slide 12

A Sampling of Roles for Scientists in Education

LEVEL OF INVOLVEMENT ==>>	**ADVOCATE**	**RESOURCE**	**PARTNER**
K-12 STUDENTS	• Participate in PTA. • Talk to school board about importance of science education.	• Judge a science fair. • Answer student e-mail. • Give tour of research facility.	• Mentor a student in your laboratory. • Partner with students in a research project.
IN-SERVICE K-12 TEACHERS	• Speak out in support of appropriate professional development opportunities for teachers.	• Answer teacher e-mail about science content questions. • Present in teacher workshop or some aspect of science.	• Work with a teacher to implement curriculum. • Hire a teacher intern.
SCHOOLS OF EDUCATION (Pre-Service Teachers, Graduate Students, Faculty Members)	• Speak out in your department or organization in favor of closer ties with Colleges of Education. • Promote the teaching profession in your undergraduate classes.	• Teach a science course or workshop segment for pre-service teachers. • Collaborate with education faculty to improve courses on teaching science.	• Hire a graduate in education to work as evaluator or co-developer of education project. • Develop a science course or curriculum for teachers-to-be.
SYSTEMIC REFORM (District, State, National)	• Speak out at professional meetings about the importance and value of scientist involvement in systemic change.	• Review science standards for science accuracy. • Review the state framework for science education.	• Collaborate on writing or adapting science standards. • Participate on state boards for adoption of standards, instructional materials, or teacher certification.
EDUCATIONAL MATERIALS DEVELOPMENT (NSRC, EDC, Lawrence Hall)	• Speak out at a school board meeting for adopting exemplary educational materials.	• Agree to serve on an advisory board for a science education project. • Review science educational materials for science accuracy.	• Collaborate to create exemplary science education materials.
INFORMAL EDUCATION (Science Centers, Scouts, Planetaria)	• Participate on the board of a science center, planetarium, environmental center, or museum.	• Review science content of scripts for science exhibits, planetarium shows, or environmental programs. • Give talk at a science center.	• Collaborate in creation of a museum science exhibit or planetarium show. • Serve as science coordinator for a scout troop.

The far left column constitutes various entry points into the E/PO realm. The subsequent columns labeled, “ADVOCATE”, “RESOURCE”, and “PARTNER” represent a graduation in the time and energy spent on E/PO, with “ADVOCATE” taking the least amount of time, and “PARTNER” taking the most amount of time.
ADAPTED FROM: “Improving Science Education: The Role of Scientists,” Bybee, Rodger W., and Cherilynn A. Morrow, Fall 1998 Newsletter of the Forum on Education of the American Physical Society

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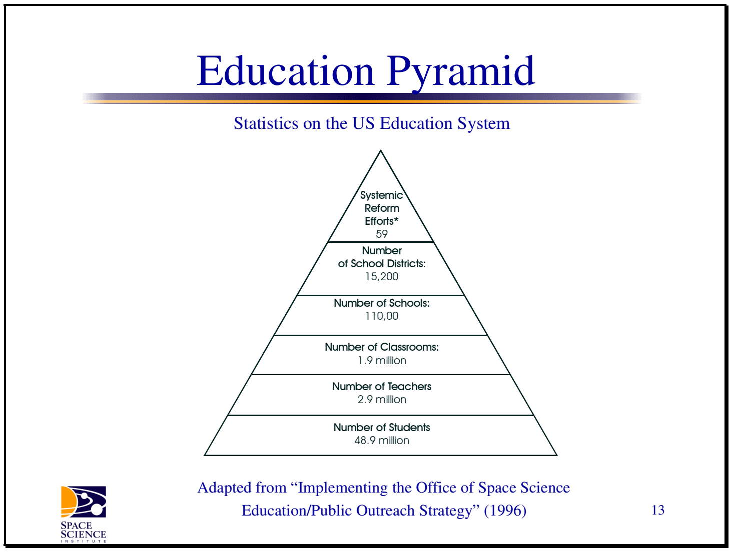
12

The far left column constitutes various entry points into the EPO realm. In general, as you move down the left column, the potential for reaching greater numbers is increased. There is sometimes a trade-off between numbers reached and the impact on those affected. The subsequent columns labeled, “ADVOCATE”, “RESOURCE”, and “PARTNER” represent a graduation in the time and energy spent on EPO, with “ADVOCATE” taking the least amount of time, and “PARTNER” taking the most amount of time.

This chart is adapted from: “Improving Science Education: The Role of Scientists,” Bybee, Rodger W., and Cherilynn A. Morrow, Fall 1998 Newsletter of the Forum on Education of the American Physical Society. To request a copy of the paper by Bybee and Morrow, please email camorrow@colorado.edu.

The activities listed in the chart are representative of the ways scientists can be involved. This is by no means a comprehensive selection, but it is hoped that scientists of a diversity of talents and interests can see themselves making substantive contributions to EPO.

Slide 13

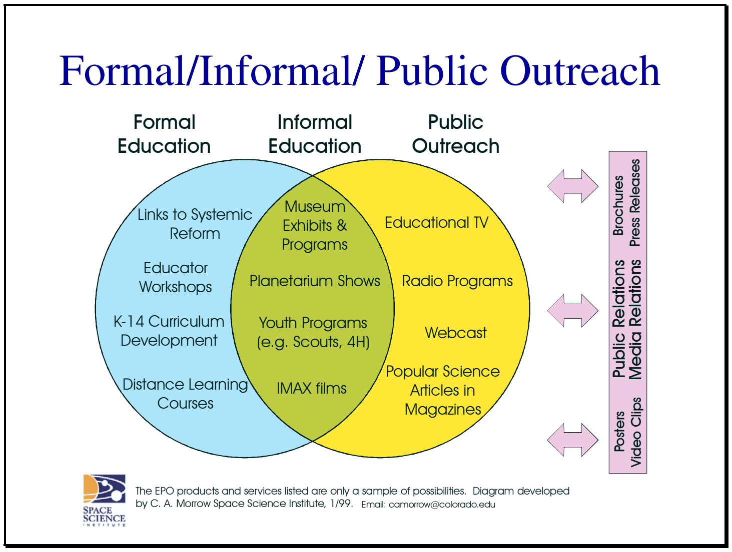


There are a few ten thousands of space and earth scientists and millions of students, teachers, and other citizens. It is important to amplify the efforts of individual scientists as much as possible by choosing an appropriate entry point into the education system.

For a more specific breakdown of statistics in the pyramid (e.g. private vs. public schools) visit the center for Education Reform's "Education Statistics At-a-Glance" website at http://edreform.com/pubs/edstats.htm.

*Systemic Reform Efforts consist of NSF's Systemic Initiatives including 18 Statewide Systemic Initiatives, 20 Urban Systemic Initiatives, 2 Rural Systemic Initiatives and 17 Comprehensive Partnerships for Mathematics and Science Achievement.

Slide 14



As scientists respond to the EPO charge, there is often confusion about the difference between “Education”, “Public Outreach”, and the various efforts referred to as “Public Affairs’, ‘Media Relations’ and ‘Public Relations.’

The diagram in the slide shows a spectrum of Education and Public Outreach (EPO) endeavors mapped onto a 2-circle Venn diagram. The circles contain representative activities and products for each of the realms; the listings are by no means comprehensive. “Formal Education” refers to efforts involving or affecting students in classrooms and the formal education system. “Public Outreach” refers to efforts outside the classroom that reach out to the wider public in their homes or cars where they may be conveniently tuned in to hear or see.

The overlap between “Education” and “Public Outreach” may be referred to as "Informal Education" which offers learning opportunities in unique settings that are outside both the classroom and the home (e.g. nature centers, museums, planetariums, aquariums). Products and activities in the informal education realm tend to combine the educational substance of formal education with the excitement and relevance of successful public outreach.

EPO efforts are distinct from Public Affairs, Media Relations, and Public Relations whose customers are news reporters and special interest groups respectively. Nevertheless, there can be favorable sharing of resources between these realms. For further discussion, please request a paper “On the Difference Between Education and Public Outreach and their Relationship to Media Relations and Public Relations” from camorrow@colorado.edu.

Slide 15

Formal Education

Provides a sustained opportunity to deepen knowledge and understanding of fundamental ideas and concepts that are useful in contributing to and interpreting the world around us.

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PHOTO CAPTION:
Eda Davis-Butts, director of the SMILE program for minority outreach at Oregon State University, interacts with students during a field trip to Flatirons Elementary School (1999) as a part of the Space Science Institute's annual workshop for scientists on K-12 education. For more information on these workshops, please see http://spacescience.org/Education/ResourcesForScientists/Workshops/1.html (Photo by Susan Solari)

Slide 16

Informal Education

Offers engaging learning opportunities in unique environments (e.g. museums, planetariums, nature centers) that motivate further learning and life long interest.

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16

PHOTO CAPTION:
School girls interact with a prototype rover that will become a part of the Space Science Institute's MarsQuest traveling science exhibit. For more information on this exhibition, please see http://spacescience.org/Outreach/TravSciExhibits/MarsQuest/1.html.
(Photo is courtesy of Kennedy & Associates)

More than 100 million Americans visit science centers each year. This is more than all major sports events combined.

Slide 17

Public Outreach

Reaches out to where people may conveniently tune in to hear or see in their everyday lives with information

that excites, interest and arouses curiosity (e.g. TV, radio, home computer, magazines).

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Slide 18

Three C's for Education Partnerships

- COLLEGIALITY
  (find mutual respect with educators; acknowledge their expertise in education and the way it can complement your expertise in science)
- COMMUNICATION
  (do not condescend or try to take over; be very conscious of scientific jargon)
- COLLABORATIVE SPIRIT
  (collaborate rather than compete with educators)

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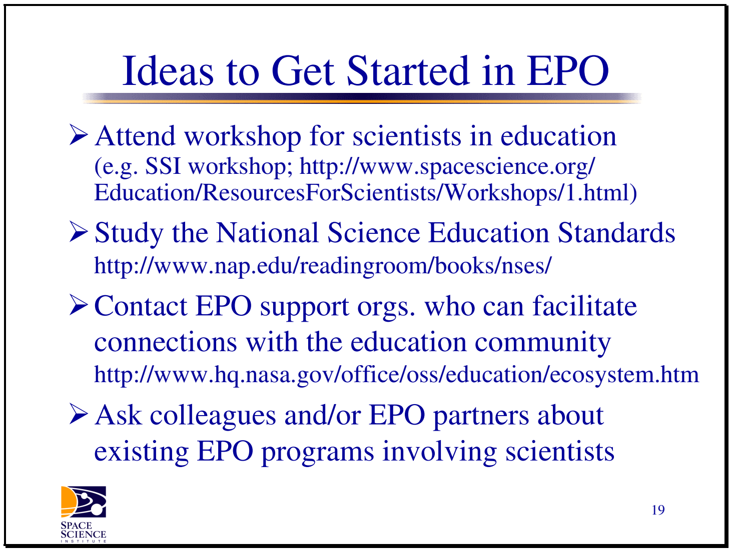
Slide 19



Contact any of the following Brokers or Education Outreach Leads for more information:

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Slide 20

Conclusions

- There is a strong need to improve science education and science literacy in the US.
- The participation of scientists in collegial partnership with educators and outreach specialists is vital to meeting this need.
- There are a wide variety of valuable EPO roles for a scientist depending on his or her particular talents and interests.

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