

FINAL REPORT -- NAG5-3876

Submitted to the Office of Space Science/NASA

Grant Title: Outreach to Space Scientists Interested in K-12 Education

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This is the final report for work on NASA grant NAG5-3876. It outlines what was accomplished during the two years of support and one year no-cost extension (October 1995-September 1998), the first year being funded under NASA Headquarters Award NAGW-4826.

1. SSI Manager for Education & Outreach

Starting in October 1995 the PI assumed the role of Manager for Education and Outreach at the Space Science Institute (SSI) -- a newly established non-profit dedicated to excellence in space science research and education. This role was sustained throughout the performance period of the grant.

2. SSI Strategic Plan Development

The PI assisted with the development of the SSI Strategic Plan, in particular co-authoring Vision and Mission statements that reflect SSI's unique integration of research and education activities, and its proven potential to break down barriers between the research and education communities. The PI also designed a plan outlining SSI's areas of strategic interest and initiatives in education and outreach, including professional development of scientists in education, professional development of educators in space and earth science, informal education, curriculum development, and collaboration with research scientists and missions to devise effective plans for education and public outreach.

3. Pre-College Education Workshops for Scientists

In all years of the grant, the PI assisted with the design and implementation of the second, third and fourth NASA-funded Pre-College Education Workshops for Scientists. These 4-day workshops offer opportunities for research scientists to experience directly what science education reform really means. In preparation for assisting with these workshops, the PI attended a 2-day training on the National Science Standards in Colorado Springs (October 1995).

The main goal of the workshops is to produce a cadre of scientists who are well informed about ongoing science education reform efforts, and about how to form effective partnerships with the education community in support of these efforts. Participants are regarded as leaders and role models for scientific colleagues who become involved in K-12 education.

Workshop participants encounter experts from the educational community on cognitive development, science standards, science curriculum, teacher enhancement, and instructional technology. They also receive direct experience with exemplary, hands-on activities and make an interactive field trip to an elementary school classroom.

The PI also became Co-Investigator on a renewal proposal for these workshops, taking a larger role in designing and implementing workshop presentations on Roles for Scientists in Education and Outreach, and engaging teachers meaningfully in dialogue with the participating scientists. The PI has compiled information from these workshops that have since supported two publications serving the interests of this grant:

- 1) "Improving Science Education: The Role of Scientists," Bybee, Rodger W., Cherilynn A. Morrow and Gerhard Salinger, Fall 1998 Newsletter of the Forum on Education of the American Physical Society.
- 2) "Explanatory Guide to the NASA Office of Space Science Education & Public Outreach Evaluation Criteria" (1999)
A document prepared for NASA/OSS in support of efforts to engage scientists and educators more effectively in partnership on education and public outreach segments to NASA/OSS research proposals.

This work also spawned working with the Aspen Global Change Institute in developing sessions on education for the scientists participating in their summer workshops.

4. SSI Web Site Development

PI Morrow participated in the renovation of the SSI World Wide Web site and was responsible for the Education and Outreach portions. She began development of a unique section entitled "Education Resources for Research Scientists", which includes: 1) an extensive list of how researchers can involve themselves in education and outreach, 2) a link to the Space Telescope Science Institute's (STScI) information on the Initiative to Develop Education through Astronomy (which offers funding opportunities to astronomers who propose education projects), 3) a link to the NASA/OSS Education Strategy, and 4) information about SSI's NASA-funded Pre-College Education Workshops For Space Scientists. The PI has contributed to periodic updates and improvements to this site, ultimately providing a baseline of information that ultimately supported the development of the website for the Western Region Education and Outreach Broker/Facilitator program whose intention is to partner NASA space scientists and educators in meaningful and effective ways.

5. Science Presentations for the Public

The PI has contributed to many major public presentations related to space science. Selected highlights are listed below:

i) Delivered workshop entitled "Making the Connection Between Earth and Space Science" for the Educator's Conference of the Colorado Space Education Initiative. Colorado Springs, CO -- January 1996.

ii) Coordinated use of several astronomy posters (developed for use with Outward Bound workshops in the field) in support of all NASA astronomy talks at the AARP convention. Denver, CO -- May 1996

iii) Presented a slide show on astronomy to the Challenger Center Foundation's annual conference for teachers. Westminster, CO -- July 1996.

iv) Presentation on scientist involvement in education and outreach to CEDAR graduate students and post docs for the University Corporation for Atmospheric Research. Boulder, CO -- Spring 1997

v) Presentation on Sun-Earth connections to St Vrain Earth Systems Science teacher workshop for the Cooperative Institute for Research in Environmental Sciences. St Vrain, CO -- Summer 1997

vi) Contributed presentation on the Cassini mission and the Saturn Educator Guide to participants in a workshop put on by the Earth and Space Science Technological Education Project (ESSTEP) (an NSF-supported activity). Boulder, CO -- Summer 1997

vii) Pro-Cassini stance in public radio debate on the risks involved in the Cassini mission. Boulder, CO -- Fall 1997

6. Service to Community

The PI participated on two NSF review panels on Undergraduate Physics and Astronomy Curriculum Development (1996 and 1997), and one NSF review panel on Informal Education (1997).

7. Astronomy for Outward Bound

In Year 1, the PI established a collaboration with the Colorado Outward Bound School (COBS). She wrote a proposal that was awarded a \$20K grant from NASA's Initiative to Develop Education through Astronomy (IDEA) to bring astronomy training to COBS instructors. The IDEA grant paid the PI only one month of time, and so much of the work on this project has been supported by NAGW-4826/NAG5-3876.

COBS is a program of excellence in experiential education that conducts more than 100 extended wilderness courses each year. In 1994 alone, over 4,000 students of all ages, representing a tremendous diversity of social and economic backgrounds, participated in Outward Bound courses.

In partnership with Colorado's amateur and professional communities in astronomy, and the University of Colorado's (CU) School of Education, the PI has been conducting and assessing appropriately tailored workshops in astronomy and skywatching for currently active COBS instructors. The workshops are specifically designed to facilitate the instructors' ability to convey useful and interesting information about astronomy to their students during a wilderness experience. In Year 1 Morrow conducted the following workshops:

- 1.5 day workshop for desert and river instructors
Moab, Utah -- April 1996
- 1.5 day workshop for mountaineering instructors
Leadville, Colorado -- May 1996
- Evening workshop for the Instructor Training Course
Turkey Creek, Colorado -- June 1996
- Evening workshop for the Semester Leadership Course
Vedauvoo, Wyoming -- July 1996
- Evening workshop for the COBS Teacher Practicum
Leadville, Colorado -- July 1996

The PI has been working concurrently with a PhD candidate in CU's School of Education to collect data from COBS instructors who have participated in the 1.5 day workshops. Interviews and questionnaires have been designed to see what influence the workshops are having on instructors' teaching astronomy to students during their wilderness courses. Preliminary results are encouraging.

During Year 2, the PI extended this work to include workshops for girl scouts and troop leaders in the Mile-Hi Council. Certain curricular activities first developed with Outward Bound and Girl Scout workshops are presently being tailored as standards-based lesson plans for use with K-12 teachers [including upcoming presentations at AAS and national and regional NSTA meetings].

9. Science and Technology Training for Women & Girls

As science and computer technology play an ever increasing role in our classrooms and everyday lives, we must be proactive in addressing the barriers to the interest and involvement of women and girls. During Year 1, the PI attended the NSF Women In Science Conference in Washington, DC, and delivered a presentation summarizing the conference to the Women in Science group at the University of Colorado. The PI also planned and conducted a series of meetings that facilitated a collaboration of local women in science.

10. Designing a Major Science Education Center

During Year 1, the PI facilitated a series of meetings between local representatives of various visions for a major science education center in the Rocky Mountain region. The visions include: 1) a Center for Advanced Technology in Education (CATE) devoted primarily to teacher training, 2) a Challenger Learning Center devoted to direct learning experiences for children, and 3) an "Exploratorium" of the Rockies, called the Rocky Mountain Discovery Center. The meetings were intended to develop a common vision in order that the strengths of each individual vision can be realized in an efficient, mutually supportive way.

11. Teacher's Guide for Cassini Mission to Saturn

During Year 1, PI Morrow worked with K-12 teachers from the Boulder Valley School District to evaluate outreach material provided by Cassini mission managers at the Jet Propulsion Laboratory (JPL). She also initiated a collaboration with representatives from the Mid-continent Regional Educational Laboratory (McREL) who have an educational Memorandum of Understanding with JPL. As a result of the teacher evaluation and a mini-proposal prepared by Morrow, the Cassini project approved funding to transform the outreach material into a Teachers' Guide.

In Year 2, Morrow managed the production of the Cassini Teachers' Guide which provided the connection between existing exemplary classroom activities and the science and technology of NASA's flagship mission to Saturn. The work was done in partnership with JPL scientists, McREL, and teachers from the Boulder Valley School District. The Guide was field tested in the Fall of 1997 and the modified Saturn Educator Guide delivered the following year. JPL is still working on the publication and dissemination of the Guide.

12. Math Literacy for Liberal Arts Students

During Year 1, the PI taught a course entitled, Quantitative Literacy and Mathematical Skills (QRMS 1010) in the CU School of Continuing Education. This course fulfills a core requirement for non-technical majors in the College of Arts & Sciences. Morrow used astronomy as one of many contexts designed to excite student learning about mathematics. In collaboration with colleagues in the Astrophysical, Planetary and Atmospheric Sciences (APAS) department, she began an investigation into what sort of mathematical

preparation is necessary for success in undergraduate astronomy courses. QRMS 1010, or a course like it, may be used in support of an undergraduate major in astronomy being developed at CU.

Other innovations associated with the QRMS 1010 course were:

i) Service Learning Component

The PI incorporated a service learning component called CSUMS = Community Service Using Mathematical Skills. All students prepared a CSUMS proposal as a part of their mid-term grade. Two students carried through on community service projects as a part of their final grade: 1) tutoring disabled children in math, and 2) providing financial advice to senior citizens.

ii) Class Partnerships and Peer Tutoring

Each QRMS 1010 student was required to choose a class partner for moral and logistical support throughout the semester. Class time was often devoted to stronger students tutoring weaker students on homework assignments or on the results of class quizzes.

iii) Required Computer Accounts

All students were required to obtain a computer account and to log on at least once per week. Although Morrow was apprehensive that non-science students would rebel against this requirement, she was instead greeted with their unanimous approval.

In Year 2, Morrow again taught QRMS 1010, continuing to develop along the lines of the innovations listed above. A paper was spawned from this work:

"Handling Math Anxiety in Undergraduate Astronomy Course for Non Majors," Morrow, C.A., 1998, Contributed Paper to ASP Symposium. A graduate from the CU Astrophysical and Planetary Sciences department is now co-instructing the course.

13. Assisting with the Development of Education & Outreach Plans for OSS Flight Project Proposals

During year 2 when it became required for all OSS flight projects to have a substantive education and public outreach (EPO) plan, the PI assisted several missions in development of their proposals' EPO segments.