

TRAINING THE TEACHERS: WORKSHOPS IN SCIENCE EDUCATION AND RESOURCES (PROJECT WISER). S. K. Croft^{1,3}, A. M. Baldrige¹, L. F. Bleamaster¹, S. R. Buxner^{1,2}, T. L. Cañizo¹, F. C. Chuang¹, D. A. Crown¹, S. J. Kortenkamp¹, L. A. Lebofsky^{1,2}, E. Pierazzo¹, and R. A. Yingst¹, ¹Planetary Science Institute, 1700 E. Fort Lowell Rd., Suite 106, Tucson, AZ 85719 (scroft@psi.edu), ²University of Arizona, Tucson, AZ 85721, ³Science, Pima Community College, Tucson, AZ 85719.

Introduction: The Planetary Science Institute (PSI), in partnership with the Tucson Regional Science Center (RSC), offers a series of professional development workshops targeting elementary and middle school science teachers in Tucson, Arizona. Using NASA data sets, the results of currently funded research investigations, and a team of Earth and space scientists and educators, these workshops provide teachers with in-depth content knowledge of fundamental concepts in astronomy, geology, and planetary science. By participating in hands-on exercises using images, maps, and the results from their own experiments, the teachers model the processes and skills scientists use. With a stronger knowledge of science content and of how science is actually conducted, the workshops instill greater confidence in teachers' ability to teach Earth and space science. Seventy K-9 science teachers from 39 schools in the Tucson area have attended 12 offerings of our four developed workshops. Workshop participants teach over 6000 students and represent schools with minority student populations ranging from 46% to 95%. A measure of our success is that nearly 50% of our teachers have attended two, three, or four of our workshops, and teachers cite the hands-on activities, modeling of scientific process, and interaction with scientists as the three top benefits of the workshops.

In addition to and in support of the workshops, we are developing 1) a series of instructional rock kits and hands-on learning activities for teachers, students, and the public [1], 2) a series of computer-generated visualizations to demonstrate key concepts in planetary science; and 3) a web-based Ask-An-Expert tool focused on areas of expertise of PSI scientists. See www.psi.edu/epo.

Professional Development Workshops: Our professional development workshops are designed to meet the following objectives: 1) supply content knowledge, 2) improve conceptual understanding, 3) instill greater scientific confidence, 4) increase understanding of how scientific research is conducted, and 5) provide strategies to help students develop more positive attitudes towards science and science education. The workshops feature active participation by NASA supported research scientists. Our partnership with the Tucson RSC ensures that the workshops meet the Arizona Science Education Standard, Strands 1 (Science and Inquiry), 2 (History

and Nature of Science), 3 (Personal and Social Perspectives), 4 (Life Science), 5 (Physical Science), and 6 (Earth/Space Science).

Each 12-hour workshop is conducted over three sessions, two four-hour Saturday sessions and a mid-week two-hour follow-up combined with a two-hour homework assignment. Sessions 1 and 2 consist of lecture and directed discussion, inquiry-based activities, and hands-on investigations. In the third session, instructors and teachers identify ways to incorporate these experiences into their grade-level curriculum and to meet the pertinent requirements of the Arizona Science Standard.

When complete, our workshop series will include the following seven offerings:

- 1) *Moon-Earth System*
- 2) *Exploring the Terrestrial Planets*
- 3) *Impact Cratering*
- 4) *Asteroid-Meteorite Connection*
- 5) *Volcanoes of the Solar System*
- 6) *Deserts of the Solar System*
- 7) *Astrobiology and the Search for Extrasolar Planetary Systems*

Workshop Evaluation: The goals of the workshops are to give teachers a firm understanding of Earth and Space Science content knowledge, to practice authentic science process skills through the use of the most current data available and to gain a greater understanding of the scientific community by interacting with PSI scientists. To ensure that the PSI program meets these goals, on-going evaluation is essential. The team uses both formative and summative evaluation strategies to measure these gains. Formative evaluation provides information for improving or revising the workshops; summative evaluation determines to what degree the workshop goals have been achieved.

Formative evaluation includes: observations, journaling, teachers' informal and formal questions, final evaluations from teachers, and team review meetings following the workshops. For summative evaluation, we analyze teachers' pre and post workshop responses to a multiple choice and open ended response instrument of 15-20 questions. Each workshop team of scientists and educators compose the questions for the survey to be aligned with the workshop's "Big Ideas" and activities to best measure changes in teachers' understandings and identify areas

in which the workshop did not impact their knowledge [1]. Additionally, in collaboration with the Science Center of Inquiry (Phoenix, AZ) - our external evaluation partner – we will be collecting long-term information about what aspects of the workshop teachers are able to use in their classrooms.

Instructional Rock Kits: We are creating a series of instructional rock kits and related informational materials to be used in our professional development workshops and in classrooms by teachers provided with supporting materials and training [2, 3]. In addition, our rock kits are available for loan and use in museums and other informal educational settings. Development of these instructional kits provides an important hands-on experience with natural materials that is essential to instruction in the Earth and space sciences. We have completed a set of *Impact Rock Kits* and *Meteorite Rock Kits* for the *Impact Cratering* and *Asteroid-Meteorite Connection* workshops, respectively. We are developing two additional kits, the *Volcanic Rock Kit* and *Rocks of Southern Arizona Kit* for use in the *Volcanoes of the Solar System* and *Deserts of the Solar System* workshops.

Scientific Visualizations: We are developing ray-tracing computer codes to generate animations that demonstrate critical concepts in the planetary science. The animations are being incorporated into workshop presentations and archived as an accessible web-based library (www.psi.edu/Planets_in_Motion/). Current visualizations include topics that support both workshop content (e.g. the Moon-Earth system and the distribution of small bodies in the solar system) as well as topics prominent in Arizona Science Education Standard for elementary and middle school students (e.g. phases of the Moon and the reasons for the seasons.)

Interactive Web-Based Tools: We are in the process of creating an *Ask-An-Expert* web-based tool that will allow teachers, students, and the general public to submit questions to various PSI experts. Responses will be emailed and also posted on the web as a FAQ. We are also cataloging and posting as FAQs questions asked by teachers during our professional development workshops. Finally, we are developing web-based tours and field trip guides to supplement our workshops. *The Explorer's Guide to Impact Craters* supports the Impact Cratering workshop. A field guide to Southern Arizona geology will be in support of the *Deserts of the Solar System* workshop. The tour pages will include a GIS geodatabase of images and maps.

Extension of Tucson-based E/PO Activities to Other Regions: PSI's science staff is located in a number of areas nationwide, which fact we will use to positively impact communities in other parts of the US.

We are creating complete workshop guidebooks, including all materials and presentations as well as notes for future instructors for each workshop.

This work is supported by NASA grants NNX06AB65G, NNX08AM10G, NNX10AE56G, NAG5-13429, and NNG06GG48G.

References: [1] Cañizo T. L. et al. (2010) *LPS XLI*, Abstract #1164. [2] Lebofsky L. et al. (2010) *LPS XLI*, Abstract #1192. [3] Lebofsky L. et al. (2011) *This volume*.



Participants “observing” a model planet-satellite system as part of a group activity during a recent Asteroid-Meteorite Connection workshop. In this activity, participants first observe the “planet” from a distance (the group in the background) and then from close-up (the pair in the foreground). The results from each type of observation are discussed to evaluate cost vs. time vs. gain in scientific understanding. They also use “flyby” data to plan a “sample return” mission to understand how space missions build on each other.



A participant in a recent Asteroid-Meteorite Connection workshop has measured and plotted the reflectance spectrum of the meteorite sample on the table at left-center.