

PROFESSIONAL DEVELOPMENT WORKSHOPS FOR K-8 TEACHERS AT THE PLANETARY SCIENCE INSTITUTE. L. A. Lebofsky^{1,2}, S. W. Anderson^{1,3}, L. F. Bleamaster^{1,4}, T. L. Cañizo¹, S. K. Croft^{1,5}, D. A. Crown¹, S. Kortenkamp¹, and E. Pierazzo¹, ¹Planetary Science Institute, 1700 E. Fort Lowell Rd., Suite 106, Tucson, AZ 85719 (lebofsky@psi.edu), ²Steward Observatory, University of Arizona, Tucson, AZ 85721, ³Mathematics and Science Teaching Institute, Ross Hall 1210, University of Northern Colorado, Greeley, CO 80639, ⁴Trinity University Geosciences Department, One Trinity Place, San Antonio, TX 78212, ⁵Science, Pima Community College, Tucson, AZ 85719

Introduction: The Planetary Science Institute (PSI), in partnership with the Tucson Regional Science Center, offers a series of professional development workshops targeting elementary and middle school science teachers within the Tucson, Arizona area. 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.

Workshop Design: The workshops are designed to support the Tucson Regional Science Center's kit-based science curriculum and are aligned closely to the Arizona Science Standard, including Strands 1 (Science and Inquiry), 2 (History and Nature of Science), 3 (Personal and Social Perspectives), 5 (Physical Science), and 6 (Earth/Space Science). Recent budget cuts in education funding in Arizona have reduced or eliminated professional development opportunities that school districts have traditionally provided. PSI workshops give the benefit of credit hours required by the state in order to renew teaching certificates. These workshops also provide future science teachers with the experience and content that will help them pass the AEPAs (Arizona Educator Proficiency Assessments) Middle Grades General Science Test, a state requirement in order for a teacher to teach science at the middle school level.

Recruitment: Teachers learn about the workshops through school representatives who meet periodically with the director of the Regional Science Center. We are also able to directly reach science teachers via electronic announcements. Local science-related events are another valuable way to publicize the workshops. Personal contacts have proven to be important; teachers who participate often recommend our workshops to their colleagues.

Current Workshops: To date, 57 elementary and middle school science teachers from 42 schools in the Tucson area have attended six offerings of our three currently developed workshops: *Moon-Earth System*, *Exploring the Terrestrial Planets*, and *Impact Cratering*. Workshop participants teach approximately 3,600 students from grades 1 through 9. Teachers who have participated in our workshops represent schools with minority student populations ranging from 46% to 95%.

Our current workshops, detailed below, are supported by a series of NASA E/PO awards: *The Explorer's Guide to Impact Craters* (2003–2007) and its successor *Motivating Learning about STEM Careers, Research, and Content through the Study of Impact Craters* (2006–2009), and *Planets are Places Too! Inquiry-based Professional Development Workshops for K-8 Teachers* (2007–2009) and its successor: *Planets are Places Too: Professional Development Workshops for Elementary and Middle School Teachers* (2009–2011).

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. Days 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. It is important to note that the focus of these workshops is to provide science content knowledge to the teachers (teachers as learners) and not necessarily activities that are ready-to-be-used in the classroom (teachers as teachers).

Workshop Content:

Moon-Earth System:

- “Observing the Moon”—rotation and revolution, lunar phases, lunar surface features
- “Photogeology from image data sets”—scale exercise, surfaces, craters and plains
- “Impact experiments”—scale relationships, effect of target materials, crater features
- “Age of the surface”—geologic relationships, crater counting

“Insights into geology of Earth from study of the Moon”—formation of the Moon, crater history and age of the surface
 “Future exploration of the Moon”

Exploring the Terrestrial Planets:

“Big picture comparison of physical properties of terrestrial planets”
 “Review/introduction to the Earth-Moon system and terrestrial planet global data sets”
 “What makes the surfaces of some planet young”—Physical/chemical weathering, etc.
 “Half-life exercise”—radiometric age dating
 “Photogeologic mapping exercise”— examination of surface images of Mercury, Venus, and Mars

Impact Cratering:

“Introduction to impact craters on Earth”— distribution, size, age; morphology of terrestrial craters; target influence; criteria for recognizing impact craters
 “Virtual field trips of impact craters”—Meteor Crater, Haughton Crater, and Ries Crater
 “Learning about impact rocks”—introduction to impact rocks, rock textures and characteristics
 “Impact experiments”—scale relationships, effects of target materials, crater features, limitations of the experiment
 “Chances of impact”—review the population of solar system objects, potential danger of NEOs, use of the “Impact Effects” website to evaluate a potential hit

We are developing an additional workshop, *Volcanoes of the Solar System* under our existing awards. We have recently received another NASA grant: *Workshops in Science Education and Resources (WISER): Planetary Perspectives*. This grant will allow us to develop several other workshops (*Deserts of the Solar System* and *Astrobiology and the Search for Extrasolar Planetary Systems*) and to disseminate the program to other states with the support of local PSI scientists. Details of the content of all of our workshops can be found at www.psi.edu/epo/pdworkshops.

Conclusion and Lessons Learned: Formative and summative assessment of these workshops can be found in Cañizo et al. [this issue]. A measure of our success is that 33% of our teachers have attended two or three of our workshops, and teachers cite the hands-on activities, modeling scientific process, and interaction with scientists as the three top benefits of the workshops.

Input from teachers has been critical to the continuing success of our workshops. Our original schedule was two six-hour days. The teachers felt that this was too many hours in one day. We therefore modified the workshops to the present format: two four-hour days and a two-hour after-school follow up. This new format has proven to be extremely successful. It allows the scientists ample time to provide, in the final session, formal, in-depth, answers to the questions that the teachers write at the end of Day 2 and for all of the teachers to learn from the questions of others. Many of these questions are higher-order questions that require more than simple “off-the-cuff” answers by the scientists. Finally, the teachers’ journal responses are used during the final session to guide discussions and also to create posters in small groups so that the entire group can observe and compare their colleagues’ thoughts—something that could not be done in the original two-day format.



Teachers participating in the PSI Professional Development. Upper Left: examining the surface of the Moon, Upper Right: studying the impact rock kit and researching an impact crater online Lower Center: the half-life activity.