EVALUATION STRATEGIES FOR PROFESSIONAL DEVELOPMENT WORKSHOPS FOR K-8 TEACHERS AT THE PLANETARY SCIENCE INSTITUTE. T. L. Cañizo[1], S. W. Anderson[1, 2], L. F. Bleamaster III[1, 3], D. A. Crown[1], and L. A. Lebofsky[1], [1]Planetary Science Institute, 1700 E. Ft. Lowell Road, Suite 106, Tucson, AZ 85710 (tcanizo@psi.edu), [2]Mathematics and Science Teaching Institute, Ross Hall 1210, The University of Northern Colorado, Greeley, CO 80639-0090, [3]Trinity University Geosciences Department, One Trinity Place, San Antonio, TX 78212.

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, and by participating in hands-on exercises with NASA images and data, teachers model the processes and skills scientists use. With a stronger knowledge of science content and processes, the workshops instill greater confidence in teachers' abilites to teach Earth and space science.

The need for well-designed and -executed professional development for K-8 science teachers is clear. Most elementary school teachers have had limited coursework in the sciences, little training in how to use an inquiry-based pedagogical approach in their classrooms, and are typically not aware of how new information relates to standards. At the middle school level, science teachers may or may not have academic backgrounds in Earth and space science, and may also lack the ability to structure their classroom lessons around authentic science practices. For teachers, direct interaction with scientists during professional development programs is rare despite its value. The significance of this interaction is the basic premise guiding the development of PSI workshops.

To ensure that the PSI program brings about gains in teachers' knowledge of science content and processes, on-going evaluation is essential. The team uses formative and summative evaluation strategies that are described here. See Lebofsky et al. [this issue] for information on the design and content of our currently offered workshops.

Current Workshops: Since September 2008, 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%. 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.

Formative Assessments:

A. *Observation.* Team members work with teachers during hands-on activities. We participate in group work and observe factors such as the time allotted for each workshop activity, and whether the length of certain activities need to be changed; the clarity of instruction; level of participation by group members; and indications of confusion or off-task behavior. These observations are discussed at meetings the team has after a workshop and inform changes in design for future sessions.

B. *Journaling.* There are prompts for teachers to respond to in writing at the beginning and end of each workshop session. Examples include asking the teachers to write about: a) their science preparation; b) their goals in attending the workshop and what they hope to learn; c) their attitudes and comfort level in teaching science; d) their understanding of new concepts or areas of confusion; and e) relating the workshop information to their curriculum. 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. Originally the intent of the journaling was to have teachers respond and reflect on their experiences privately, and use the entries as a type of self-assessment. In recent workshops, the journal entries have been collected for the team to gather more information about teachers' thinking and misconceptions.

C. *Teachers' informal questions.* Teachers ask numerous questions during the workshops, and these are recorded by one of the workshop instructors. The questions are examined to discriminate between factual and higher order questions and to see whether there is a progression from factual to conceptual over the course of the workshop. The questions bring to light factors such as teachers' prior knowledge and how clear the instructions have been, and they give insight into the nature of the workshop format and comfort level between participants and scientists. Teacher

questions are typically based on content and, to a lesser extent, on science processes. Types of questions asked are for definitions, confirmation, clarification, and elaboration. To date, the level of questions has not progressed from lower to higher level during a workshop. An informative practice is to link the level of questioning to the teachers' science coursework at the university level, their teaching experience, and/or familiarity with curriculum and state science standards. In general, those teachers with more science coursework and at the middle school level ask fewer questions but at higher levels. There have been notable exceptions, with middle school teachers of limited science backgrounds and elementary teachers with strong science backgrounds. There have been no questions about pedagogy related to the topics presented, perhaps indicating that teachers see the scientists in the role of expert apart from classroom instruction.

D. *Teachers' formal questions*. During the second session of each workshop, teachers review their journals and their notes, and submit a list of remaining factual and conceptual questions. During the final workshop session, one of the scientists hands out written responses and reviews these with the group. This has a benefit for all the teachers since they hear others' questions in addition to their own. The questions often extend and go beyond the content of the workshop. This may be the case because the process is more formal and both their questions and the scientists' responses are in written form.

E. *Final evaluations from the teachers*. Teachers complete a final evaluation for the workshops with both a numeric scale and open-ended responses. They indicate the value of the workshop and how much they have gained in understanding the topics on a scale of 1(low) to 10 (high). Thus far the average value is rated at 9.0 and the gain in understanding at 8.7. The ratings have improved from 8.5 and 8.4 in the first workshop to 9.0 and 8.7 for the most recent. The evaluation form also asks the participants to identify the most helpful parts of the workshop, to give suggestions for topics or activities to add, and to provide any general suggestions or comments. Common themes appear in these responses. The use of hands-on activities is important for the teachers. It is very frequently listed as the most helpful part of the workshops and also among suggestions for adding more to future workshops. Another common theme is the value of modeling scientific processes, learning from scientists and researchers, and in general, the interaction with them. On this evaluation teachers first refer to classroom applications and activities, either wanting to use the activities from the workshop directly in their classrooms or asking to do classroom activities for students during the workshop.

F. *Team meetings*. Our team of scientists and educators conducts planning meetings for each workshop. Before the workshops, we discuss the activities and materials and assign tasks. After each session, the team meets to debrief. We may make adjustments for future sessions after we share observations and discuss ways to make improvements.

Summative Assessments: A multiple choice survey of 15-20 questions given both at the beginning and end of each workshop provides an indication of how teachers' knowledge may increase during the workshop. Scientists compose questions at different levels of difficulty to reflect the topics he/she will present. Our team reviews these and after discussion, we make revisions and prepare the survey. Both scientists and educators on our team then do a careful check of the final version. Teachers take the survey at the start of the first session and again at the start of the third session, and team members compare the results.

The surveys are now being reviewed and revised; some preliminary revisions have been to modify the technical language used in the responses and to make the lengths of the responses more uniform. In addition, it may be necessary to add more difficult questions to our instrument, as pretest scores were generally very high, and therefore may not allow us to measure gains that are occuring as a result of the workshop. For future surveys, the focus will be on "gain" rather than "change" in scores. A confidence component has also been added to measure how confident the teachers are of their answers on both surveys. While work continues on revisions, the surveys have given our team preliminary ideas of teachers' mastery of topics, and taking the pre-survey gives teachers an idea of what topics will be addressed in the workshop. The survey in session three is followed by a group discussion so participants can discuss their initial and final responses and get clarification of any remaining questions.

Lessons Learned: The suite of evaluation strategies we have employed provides important insights regarding the teachers' knowledge, confidence, and skills. We are using the results of our assessments to actively improve our program. To increase the value of the surveys and select the appropriate level of difficulty, we are matching teachers' responses to their confidence in those responses. Modifying journal prompts and the final evaluation to elicit more specific feedback, creating templates for the collection of teachers' questions, and giving more attention to observations of teachers' use of scientific processes will give a comprehensive framework to evaluate their learning with greater accuracy and to inform the design of future workshops.