Exemplary Science: Best Practices in Professional Development

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Applying the National Science Education Standards in Alaska: Weaving Native Knowledge Into Teaching and Learning Environmental Science Through Inquiry

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Setting

The Observing Locally, Connecting Globally (OLCG) or Global Change Education Using Western Science and Native Observations program, funded by the National Science Foundation, focuses on professional development in environmental science for K–12 teachers in Alaska. The OLCG program, begun in 2000, is based at the University of Alaska, Fairbanks (UAF) School of Natural Resources and Agricultural Sciences and is co-directed by three UAF faculty members who are also the course instructors for the program. Rather than simply delivering science content, the program weaves together localized environmental research, Native knowledge, and best teaching practices in science and math with the goals of enhancing the inquiry abilities and the cultural well-being of K–12 students. Through an intensive summer institute and ongoing program support, the program employs a number of strategies for teaching science process, bringing content alive, and making it more relevant and tailored to local conditions, both environmental and cultural.

The OLCG program was originally intended to work primarily either with teachers in small, rural Alaskan villages whose residents are predominantly of Aleut, Yupik, Inupiat, or Athabascan Indian heritage or with teachers in urban and suburban communities with predominantly Native American student populations. While this focus has shifted a bit because of teacher interest, the majority (35) of our total participants (53) in 2003 (the year reported on in this chapter) taught in rural Alaska villages that are only accessible by air or water, and are separated by hundreds of
miles—as well as by different languages and cultures. Many villages now have some internet capability and adequate-to-excellent physical environments at the schools, but often lack curricula or teaching strategies that connect school to home and culture. The teachers come from classrooms representing all grades (K–12) and have a wide range of goals, skills, and experiences in teaching. About half of our participants teach at an elementary school level, while the other half teach grades 6–12. Urban grade level and course distributions look much like they do anywhere in the United States (e.g., single-grade elementary school classes, with certified secondary science teachers responsible for courses within their major). In rural Alaska, however, because student numbers are small, teachers often have a multigraded classroom (e.g., grades 2–5), or are responsible for multiple classes in multiple disciplines across grade levels (e.g., science, math, and technology classes for grades 6–12). This wide variation in demographics makes the program quite challenging, but also quite rewarding as we learn from each other.

**More Emphasis Conditions and the National Science Education Standards**

Table 1 shows which *More Emphasis* conditions in professional development from the National Science Education Standards (NRC 1996) have been met and how they tie in to the Goals for School Science (NRC 1996, p. 13). OLCG uses a constructivist framework and developmentally appropriate and culturally responsive teaching that includes inquiry and a learning cycle model integrated with science content. Teachers use new knowledge to teach about the local environment. OLCG supports the sharing of teacher expertise as mentors and lead teachers provide professional development opportunities. Using their new knowledge, teachers have influenced OLCG program development, other teachers, and local communities. Teachers identify and discuss important environmental issues relevant to their community.

**Program Leaders**

The OLCG program is led by three UAF faculty members, known as co-principal investigators, and by a program coordinator from the Fairbanks North Star Borough School District. Collectively, the four program members represent a wide range of experience and perspectives. Dr. Elena Sparrow, the principal investigator, is a microbiologist with more than 25 years of research experience. She is coordinator of the Alaska GLOBE partnership and has been involved in education outreach for many years. Sidney Stephens has a master's degree in cross-cultural education and has taught almost 30 years, including K–12 classrooms and preservice and inservice science, math, and environmental education courses, with a focus on cross-cultural education. Dr. Leslie Gordon is an education specialist and master teacher of science and math, with numerous teacher awards. She taught elementary school in Fairbanks for over 20 years and currently teaches science and math classes for preservice teachers at UAF. Martha Kopplin, program coordinator, has a master's degree in biology and coordinates grant activities. Program personnel collaborate with many exemplary teachers, scientists, and Native Elders and experts, using a range of learning environments, as described below.
### Table 1. National Science Education Standards Professional Development More Emphasis Conditions Met in the OLCG Program and How They Tie Into the Goals for School Science

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Variety of professional development activities for lifelong learning</td>
<td>Meet science education goals 1, 2 and 3, given below.</td>
<td>OLCG provides a summer institute, face-to-face follow-up sessions, on-site visits, phone calls, and e-mails throughout the year to meet the needs of teachers with different experiences, expertise, and proficiencies. Continuous program assessment provides ongoing feedback to teachers and program.</td>
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<tr>
<td>Learning science through investigation and inquiry</td>
<td>Produce students who can experience the richness and excitement of knowing about and understanding the natural world (goal 1)</td>
<td>Teachers investigate climate change of critical importance to Alaska and are introduced to scientific literature, media, and technological resources, learning both science content and how to teach inquiry by doing their own inquiries in the classroom, in computer labs, and in the field with scientists, Native experts, and staff.</td>
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<tr>
<td>Integration of science and teaching knowledge</td>
<td>Produce students who can use appropriate scientific processes and principles in making personal decisions (goal 2) and can engage intelligently in public discourse and debate about matters of scientific and technological concern (goal 3)</td>
<td>OLCG provides frequent opportunities for individual and collegial examination and reflection on classroom practice through fast-writes at workshops and during the year via e-mail journals, surveys, phone calls, and face-to-face meetings.</td>
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<tr>
<td>Teacher as intellectual, reflective practitioner</td>
<td>Produce students who can engage intelligently in public discourse and debate about matters of scientific and technological concern (goal 3)</td>
<td>OLCG encourages teachers to participate as teams in OLCG and provides considerable time for collaboration, discussions, and other continuing support activities among people involved in the program (e.g., teachers, teacher educators, scientists, and Native Elders), with clear respect for the perspectives and expertise of each.</td>
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*The Goals for School Science also appear on page 13 of National Science Education Standards (NRC 1996).*

### Unique Features

*Inquiry-based pedagogies, constructivism, localization of science, culturally responsive curriculum, and reflective practice* are all common buzzwords in professional development programs, but the OLCG program has focused on these concepts and practices in earnest as it designs and refines its program for Alaskan teachers. OLCG strives to provide teachers and students with opportu-
nities to engage in original global-change research using the international GLOBE investigations (Butler and MacGregor 2003) and other climate-change studies relevant to Alaska, in ways that are tailored to local environmental and cultural conditions and that support teachers from the time they join the project. This constructivist theoretical framework (Brooks and Brooks 1993) and culturally responsive theoretical framework (Alaska Native Knowledge Network 1998) underlie all of our professional development efforts as we strive to address the More Emphasis conditions listed in Table 1 and discussed more fully below.

Provide a Variety of Professional Development Activities for Lifelong Learning
The OLCG program recognizes the developmental nature of teachers' professional growth and the diverse needs of Alaska teachers, who have a range of teaching assignments and varying degrees of experience, education, and proficiency. We also acknowledge and learn from the fact that each teacher will make his or her own meaning and implement what is personally and professionally relevant from any staff development opportunity. Consequently, the OLCG program provides continuing relevant, research-based professional development opportunities to program participants in the often far-flung reaches of our state.

OLCG offers a two-week intensive summer institute, a two-day face-to-face workshop in December, and other occasional one-day sessions to work on specific tasks, such as developing a climate-change interview/survey to be used with Elders. Travel, lodging, and meal support are included for these activities. Program staff members are available throughout the year to consult with participants via phone or e-mail; they are also available to travel to teachers' classrooms for the purpose of modeling lessons, troubleshooting difficulties, developing appropriate strategies, or just plain collaborating. The staff also helps teachers connect with Native Elders and scientists for classroom visits, which are subsidized by the program. Included in program support are release time to visit other classrooms; science and pedagogical resources; GLOBE Teacher's Guide; scientific equipment; videotapes; Project Jukebox programs documenting local knowledge on climate change; and websites for OLCG (www.uaf.edu/olcg) and GLOBE (www.globe.gov).

Learning Science Through Investigation and Inquiry
Fundamental to the OLCG program is the goal of learning science through inquiry. According to the National Research Council (2000), inquiry has two different but related meanings: (1) it is what students need to know, and be able to do, in order to design and conduct scientific investigations, and (2) it entails the teaching and learning strategies that teachers use to help students master science concepts through hands-on investigations. We believe, and research suggests, that teachers learn best how to teach science by doing it (Darling-Hammond 1997). As a consequence, the majority of the time spent in the summer institute is dedicated to providing experiences wherein teachers learn science through modeling, guided practice, and their own inquiries. Teachers actually have an opportunity to participate in all the activities they will be using with their students when they get back to their classrooms.

Teachers regularly and actively investigate phenomena that can be studied scientifically, interpret results, and make sense of their findings consistent with currently accepted scientific
understanding. On days one and two of the summer institute, teachers participate in an overnight field trip on the Tanana River with Athabascan river experts who share their observations and understanding of the environment as an interconnected Earth system. Teachers are asked to reflect on the nature of Elders’ observations, collect data, make inferences, and generate questions about the changes to the river. They also do exploratory science activities and receive training in the use and adaptation of GLOBE protocols and learning activities. This process continues throughout the two-week institute with the ultimate goal of having teachers and students become comfortable with inquiry—with asking and answering their own questions about the environment and “messing with” the gray areas of science.

These learning activities are all focused on the issue of climate change and related environmental change because while global climate change is an issue of critical importance throughout the world, it takes on a particularly visible and immediate character in Alaska. Climate trends over the last three decades have already shown considerable warming and have had major impacts on the environment (Weller and Anderson 1998). To understand, monitor, and prepare for changes in their environment, K–12 students must develop a deep understanding of the place in which they live. They must also be able to compare their own observations with historic information about that same environment, and they must develop a sense of the cyclic, interrelated, and nonlinear nature of Earth system processes and human interaction. Elders and other expert observers can often provide just such knowledge because they have a very detailed and highly refined awareness of their environment gained from years of living on the land. For these reasons, Elders are a critical part of our summer institute and supporting activities. They lead our initial river exploration, share observations throughout the institute, and visit classrooms when invited. The information they share, and the way they share it, stimulates not only inquiry questions but also discussion about the similarities and differences between science and Native knowledge systems and the strengths and limitations of each system (Stephens 2000). Because it is sometimes difficult for teachers to identify or access Native experts in their communities, we have also begun to audiotape some Elder/expert discussions of the effects of climate change and have made these tapes available to teachers and students in the Project Jukebox section of our website (www.uaf.edu/olcg).

Beyond immersing teachers in inquiry activities and exposing them to observations and conceptions of the environment through Elder/expert sharing, we introduce teachers to a variety of climate-change resources such as research scientists, current reports, videotapes, and internet sites. We also provide training and all of the equipment necessary to do
the basic GLOBE protocols that can then be used or adapted for use in local environmental-change investigations.

Integration of Science and Science Teaching Knowledge
Teachers need more than content knowledge to be good science teachers (Loucks-Horsley et al. 1998). They also need to understand the ways in which students with diverse interests, abilities, and experiences construct knowledge. In addition, they need to know how to support student inquiries, how to develop curriculum, how to manage materials, and how to assess understanding in a variety of ways. Generally these “how-to’s” take many years, and a good deal of support, to master.

Hence, science and science teaching knowledge are completely interwoven during the summer institute and in implementation support throughout the year. Because the program has a constructivist theoretical perspective, we have modeled differentiation of the learning environment and curriculum for teachers from the beginning, and our teachers are supported to do the same. Some examples of these differentiations are

- ongoing discussions, in person and on the internet, on how to make GLOBE and environmental research developmentally appropriate for primary students;
- scaffolding the learning of science in Native villages by the use of Native expertise and culturally responsive teaching strategies;
- professional development on alternative assessment to help teachers understand what their students know and are able to do as a result of local environmental studies; and
- integration of research-based strategies such as using the learning cycle model in order to design lessons and applying the theory of multiple intelligences (Gardner 1983).

In addition, teachers can request staff visits to their classrooms to model or troubleshoot a lesson or lessons with which they are having difficulty. Teacher reflection also promotes learning and plays a key role in the OLCG project, as we see in the discussion that follows.

Teacher as Intellectual, Reflective Practitioner and Source and Facilitator of Change
An important part of supporting teachers as they work toward their own goals for learning consists in providing opportunities for them to ask and answer their own questions, to reflect on their practices, and to make personal decisions regarding the changes they wish to implement in their classrooms (Loucks-Horsley et al. 1998). Consequently, teachers are asked to reflect regularly on their thinking and on student reactions. They do this through fast-writes and discussions within small and large groups during workshops and through e-mail journals sent from their classrooms to course instructors during the year. These reflections have been invaluable and serve a dual purpose. They provide the teachers with an opportunity to reflect on the teachers’ learning in content and pedagogy, and they provide feedback to the course instructors about additional support and staff development that might be valuable. Teachers have repeatedly told us that the opportunity to network and reflect on their teaching has greatly supported their efforts to change.
Teacher as Leader and Member of Collegial, Collaborative Professional Community

Collegial support and reflection are key components of the OLGC program and are fundamental to professional development in science teaching. When teachers apply to our program, they are encouraged to apply as a team with other educators (e.g., aides, resource teachers, environmental specialists, and Native Elders) at their site. During the summer institute and December follow-up meeting, teachers share their successes and frustrations as they network with other teachers from their site and other schools. This collaborative support continues back in the classroom through e-mail conversations (formal and informal), phone calls, and classroom visits.

The OLGC program staff relies on partnering with Native Elders, scientists, teachers, and teacher leaders to plan and implement program activities. OLGC provides funding for honoraria for teacher presenters, Native Elders, and other local experts and for release time so that teachers can visit other classrooms. Feedback from course evaluations, conversations, journals, and surveys are all used to adjust the content and timing of program plans. Feedback to teachers influences their classroom practice. OLGC also encourages teachers to take a leadership role by providing opportunities for teachers to be lead teacher presenters during the institute and follow-up sessions, or to be teacher mentors. Following these experiences, teachers have conducted their own teacher workshops funded by external sources and/or taught science courses for preservice teachers at the University of Alaska.

Evidence of Program Effectiveness

The OLGC program is conducting a long-term evaluation to try to understand its impact on teachers and students. A variety of quantitative and qualitative assessment procedures are being used.

Assessment Activities Related to the Summer Institutes

- Formative and summative evaluation by internal and external evaluators—Leslie Gordon, co-principal investigator, designed and collected assessments, analyzed and interpreted data, and wrote the annual report; Tom Hinojosa, from SRI, wrote the outside evaluator’s report.
- Needs assessment (conducted at the beginning of the institute).
- Pre- and Posttest Attitude Assessment for Teachers—This Likert-scale attitude assessment contains 11 items that address comfort levels with global climate-change teaching, the integration of Native knowledge/local experts into the classroom, and best practices in science education (e.g., inquiry learning, constructivism, teaching for understanding). This instrument was administered to each teacher on the first day of the summer institute and the last day.
- Pre- and Posttest Teacher Content/Achievement Assessment—Teachers were asked to discuss their understandings of the value of using Native Elders in the classroom and various aspects of GLOBE. This instrument was administered on the first and last days of the institute.
Daily Fast-Writes—The fast-writes included formative assessment questions to determine how much teachers were learning, what their perceptions were about the benefits of each day, and what their questions and concerns were.

Final Teacher Survey—Program leaders used this Likert-scale instrument at the end of the institute to determine teacher perceptions about the relative benefits of each component of the summer institute.

Inquiry Project/Multiple Intelligence Final Assessment Project—Presentations on personal inquiry projects related to teachers' local environments that were begun at the institute will be continued with students during the school year. Teachers attended an inservice workshop on the theory of multiple intelligences (Gardner 1983) and then were given the opportunity to demonstrate what they had learned from their inquiry using their preferred intelligence(s).

Research, Assessment, and Evaluation Related to Implementation in the Classroom

Pre- and Posttest Student Achievement Assessment—This instrument, adapted from one developed by TERC and SRI, was piloted in the spring of 2000 and has been administered to students in participating classrooms each spring and fall. It provides a locally relevant color photograph to students and asks them to respond to certain questions about global climate change and Native knowledge based on what they observe in the photo of either a tundra or boreal forest environment similar to theirs.

Pre- and Posttest Student Attitude Assessment—This Likert-scale attitude assessment, piloted also in 2000, was administered to all students in participating classrooms in the fall and again in the spring.

Teacher Attitude Assessment—The same assessment that teachers took as a pre- and posttest during the summer institute will be repeated each spring to track any longitudinal effects.

Student Performance Assessment—This assessment focused on the student collection and reporting of environmental data to the GLOBE website and on other student work submitted by teachers.

Level of Implementation Analysis—This analysis examined the project's impact by focusing on the level to which each teacher implemented each strand of the program into his or her classroom. Findings will then be compared to student attitude and achievement test results to see if there is any relationship.

Teacher journal entries—These journal entries were submitted monthly in response to prompts from the local evaluator.

Student journal entries—These journal entries were submitted monthly in response to prompts from the local evaluator.

Teacher-designed assessments of student learning.

Needs assessment—This assessment was conducted after the summer institute to determine topics/areas to be covered during follow-up.

Videotapes of students working on OLCG activities.
OLCG and the Teacher as Intellectual, Reflective Practitioner, Collaborator, Producer of Knowledge, and Facilitator of Change

Teachers in the program have proved to be thoughtful and honest reflectors and have had a great deal of influence on the contemporary format of the project. Feedback from the teachers has supported, and even extended, our understandings in areas as diverse as student assessment and the potential for teacher change. The following excerpts are a few of many teacher reflections about how the program has affected them and their students.

_I have a new realization. It is to affirm my students and their culture, and the things that they know and observe outside of school.... I think it's especially important as a white teacher in the village to make sure that I learn from them, if I expect them to learn from me. GLOBE is a great way to connect the things we learn from each other. The way that the GLOBE protocols are all hands-on student inquiry is a great way to teach things through the practice of self-discovery._ (KD, 9/2002)

_I think my students have gotten to be more “experimental” in their thinking; not just following steps in an experiment. I emphasize “predictions” and the change of variables in everything we do._ (JJ, 2/2001)

_My students have definitely benefited positively. Expectations were higher, more work was required, and they rose to those levels—many changed their opinions of science from a negative to a positive—they feel science is fun._ (AH, 12/2002)

Teachers have also taken a leadership role in solving problems and issues that arose in their classrooms as they attempted to implement the project. One example of this is the Listserv set up for the primary teachers who were trying to understand how GLOBE could successfully be adapted for use in K–3 classrooms, where many concepts and skills are not developmentally appropriate. Throughout the fall, primary teachers shared the things they tried and their results. They also designed a number of wonderful teacher assessment instruments since GLOBE did not have any. By sharing these ideas, teachers definitely helped each other (“I really enjoyed the integration part as I learned a lot from my peers. They gave a lot of good ideas for us to use in our own classrooms” [MS, 12/2002]).

The following are examples of program changes made in response to teacher feedback:

◆ Lengthening the river trip to two days
◆ Restructuring time with Native Elders to better facilitate comfortable sharing of stories and information, using the Elder knowledge as a basis for inquiry projects
◆ Decreasing the number of GLOBE protocols taught (many were made optional as teachers
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decided which ones to use in their classrooms)
◆ Spending less time on pedagogy assignments (e.g., lesson writing) and more time on modeling and writing individual inquiry plans
◆ Moving assessment discussions to follow-up workshops
◆ Creating a script to help teachers administer student achievement assessments
◆ Brainstorming sessions on what student evaluations would be appropriate for K–2 students

Learning Science Through Investigation
Inquiry and Integration of Science and Teaching Knowledge
While inquiry is a primary goal of our program, we know that teacher implementation is highly dependent on individual teachers’ needs. As a consequence, the program’s implementation looks different in each of our classrooms. Some teachers complete wonderful inquiries during their first year in the program and others need a good deal of support to integrate simple hands-on investigations. Others feel that enhancing their connections to culture and local environmental studies is critical, and they focus on that. Still other teachers have become teacher leaders in the project, offering their wealth of knowledge about integrating inquiry or local knowledge into curricula and about assessing what students are understanding and able to do because of the OLCG program. All accomplishments are celebrated.

The following is an example of one successful teacher in our program who has become a teacher leader. Mary loops with her class between second and third grade. She took the OLGG summer institute two years ago and was very stressed about how to make it work with primary students. After the institute, she decided to do a year-long inquiry about wetlands and to use the GLOBE phenomenology and atmosphere protocols, as well as the OLGG supplementary unit on water. Her journal entries throughout the year indicated that she spent a great deal of time helping her students gain inquiry skills. She tried a variety of alternative assessments to understand what the students were learning. Staff members were asked to visit her class regularly to help teach important concepts and skills and to observe important milestones. Her students presented their studies during the institute and follow-up workshop.

Teacher feedback over the years definitely suggests an appreciation of both the inquiry approach to teaching and the integration of science and teaching knowledge. During the final institute evaluation each year, teachers are asked to rank 11 key elements of the institute. The best practices components (e.g., hands-on science, inquiry, collaboration, multiple intelligences) have consistently ranked in the top five. Reflections from teachers during the school year continue to support this ranking, as this quotation attests:

*Working with the OLGG program has supported my goal of incorporating more hands-on curriculum in my classroom. It also is conducive for teaching using all content areas, or better said, across the curriculum. The cloud protocol (Atmosphere) has been an easy subject to involve Elders coming in and talking to the children.* (MM, 12/2002)
Teachers also ranked the contributions of Native Elders in the top five elements of the institute. The following is an example of a reflection commonly expressed:

*Interacting with and listening to Elders helped me to feel more at home with the idea of involving Elders in my classroom. It also helped me see more clearly what they have to offer and how to use their knowledge and life experience to improve the learning and enjoyment of my students.* (FH, 6/2002)

**Results of the Teacher Attitude Assessment Related to Inquiry and the Achievement Assessment**

To track changes in teacher attitudes and achievements, assessments were administered to all participants before and after the institute; the attitude assessment was also administered to every participant each spring. The instrument was a 5-point Likert scale, and two of the questions on the teachers’ attitude assessment related to inquiry. Table 2 shows the mean gain change in attitude for all teachers and all years for items related to inquiry and significance levels of results from paired *t*-tests. The positive score change for both items was significant. Analysis of the data suggested that teachers from all three years of the program felt more comfortable using inquiry for their own learning and for supporting science learning in their classrooms.

<table>
<thead>
<tr>
<th>Item</th>
<th>Change Score</th>
<th><em>p</em></th>
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<tbody>
<tr>
<td>“I feel comfortable with inquiry learning and teaching.”</td>
<td>+1.31</td>
<td>0.00*</td>
</tr>
<tr>
<td>“I feel comfortable integrating inquiry learning into my classroom.”</td>
<td>+1.18</td>
<td>0.00*</td>
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* Level of significance *p* < 0.05

On the teacher achievement assessment, which addressed understandings related to Native knowledge and global climate-change education, each item had a possible score of 3 points, and a rubric was used to score each item. Content validity was established using experts in the field. Inter-rater reliability was established at 80%. Analysis using paired *t*-tests of the data from the achievement assessment suggested that there was a significant improvement for every item, at a significance level of *p* < 0.05 (Table 3). This represents a mean improvement of 0.45 out of a 3-point scale.

Results of both teacher assessments suggest that the use of inquiry in learning science has supported these teachers’ understanding of key science concepts related to Earth sys-
tems and global change. The teacher comments below are typical of many that seem to support these results.

Best practices—I am really pushing this year to add more inquiry and performance assessments. Having OLCP has kept me on track so I don’t regress or forget best practices and their benefits. (CM, 12/2002)

In my pilot study, individual teams developed a research project (inquiry) and I made the GLOBE equipment and protocols available to them in addition to the protocols the entire class did (green up and soils). I also have started the year with information on multiple intelligences and had the students do an MI self-evaluation. This year I’ve done a better job of trying to give opportunities for a variety of assessment activities using different intelligences. (KE, 12/8/2002)

<table>
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<tr>
<th>Item</th>
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<tbody>
<tr>
<td>“List and discuss several of your ideas about the value of engaging your students in long term research in your local environment.”</td>
<td>0.00*</td>
</tr>
<tr>
<td>“List and discuss several of your ideas about global environmental change and its impacts on your local community.”</td>
<td>0.02*</td>
</tr>
<tr>
<td>“List and discuss several ways in which your students might benefit from integrating Native knowledge into your studies of the local environment.”</td>
<td>0.04*</td>
</tr>
<tr>
<td>“List and discuss several ways in which you might integrate Native knowledge to support and enhance student understanding of their local environment.”</td>
<td>0.00*</td>
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</table>

* Level of significance p < 0.05

Results of Student Achievement and Attitude Assessment
The Pre- and Posttest Achievement and Attitude Assessments given in the fall and spring each year to students of OLCP teachers also suggest that students are experiencing growth in their understanding of the key concepts of science covered by the program as well as changes in their attitudes about science. The Attitude Assessment is a Likert-scale instrument that asks students if they enjoy learning the different areas of science supported by the project. Every year students have shown a significant change from pre- to posttest on a majority of the attitude items. The Achievement Assessment is a color photo similar to the area in which they live; students are asked questions about Earth systems and their components (e.g., hydrologic/water cycle, nutrient cycle) as well as plants and animals. Results for this assessment over the years also consistently indicate a significant improvement from pre- to posttest for the majority of items, with an average of 12% improvement for all students on all items. Feedback from the teacher journals also suggests that students have been positively impacted by OLCP (e.g., “I believe my students are a lot more aware of their environment and are aware of how much impact we have on the land. I think it has also sparked a growing curiosity about the cause and effect of climate change” [KD, 12/2002]).
Furthermore, students of OLCG teachers have conducted their own inquiries and presented their investigations at many local science fairs, the district science fair, the Alaska State Science and Engineering Fair, and the Alaska Statewide High School Science Symposium. Two Alaska high school projects were chosen from a national competition and presented at the International GLOBE Conference in Croatia in July 2003.

With our focus on Earth systems and global change, we have been able to integrate all eight of the NSES Science Content Standards into our program, at the same time supporting teacher change in grades K–12. Table 4 lists some of the methods of inclusion for each content area.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Methods of Inclusion</th>
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<tbody>
<tr>
<td>Unifying Concepts</td>
<td>OLCG students and teachers study Earth as a system and global climate change.</td>
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<tr>
<td>Science as Inquiry</td>
<td>At the OLCG institute and in the classroom, the focus is on learning science through inquiry.</td>
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<tr>
<td>Physical Science</td>
<td>OLCG has developed supplementary units for GLOBE atmosphere and hydrology protocols on the physics of air and water.</td>
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<tr>
<td>Life Science</td>
<td>Life science is addressed in the plant inquiry unit and the GLOBE phenology and land cover strands.</td>
</tr>
<tr>
<td>Earth and Space Science</td>
<td>OLCG teachers and students study GLOBE Earth as a system, atmosphere, soils, hydrology, land cover, and phenology strands.</td>
</tr>
<tr>
<td>Science and Technology</td>
<td>OLCG teachers and students use/design tools of technology to support science inquiries and better understand local environments.</td>
</tr>
<tr>
<td>Science in Personal and Social Perspectives</td>
<td>OLCG students and teachers study change in their environment, its possible causes, and its observable and potential impact on community life.</td>
</tr>
<tr>
<td>History and Nature of Science</td>
<td>OLCG teachers and students engage in original research and contribute data to ongoing investigations supported by GLOBE and UAF. They also compare the similarities and differences between Native knowledge systems and science, and the strengths and limitations of each.</td>
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Dissemination of the OLCG professional development model has begun. Components have been used in two other Alaska science institutes for teachers and two national professional development workshops.

**Summary**

The OLCG professional development program for K–12 teachers intertwines Western science, Native knowledge, the National Science Education Standards, and inquiry-based pedagogies focused on the local environment and climate change in Alaska. It is constructivist in nature and provides teachers with a variety of professional development opportunities that are tailored to teacher needs and to local environmental and cultural conditions. These opportunities are planned
with teacher input and actively engage teachers in doing the activities they will perform in their classrooms. Teachers are asked to reflect regularly on their own practices and on student responses to such practices. OLCG also promotes a collegial, collaborative learning community (including teachers, Native Elders, and scientists) in which teachers learn from each other as much as they do from the instructors. This entire process has not only supported teacher efforts to change but has provided the program with valuable feedback. Analysis of the data collected from a variety of evaluation tools indicates that the program is beginning to increase teacher understanding and implementation of scientifically accurate and culturally relevant best classroom practices. We have learned a great deal in the last four years about how to support teachers from diverse backgrounds and environments as they implement a culturally responsive and rigorous science inquiry curriculum in their classrooms. OLCG also has started to influence other professional development efforts in Alaska and elsewhere in the United States.

References


