An Immersion Professional Development Program in Environmental Science for Inservice Elementary School Teachers

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ABSTRACT

Poor performance by elementary school students on science assessment tests is due in part to inadequate science education for teachers. Environmental Science for Inservice Elementary School Teachers (ESEST) is a 14-year collaboration between university faculty in geology and biology and public school teachers in Ohio. The primary goal of this immersion, field-based program is to increase K-6 teacher knowledge of basic principles of environmental science. Participants and instructors take daily trips to field locations; hands-on activities are used to illustrate concepts such as geologic time and use of biotic indices to assess stream quality. Qualitative and quantitative assessments indicate a two-fold increase in content knowledge and an improvement in teaching skills by our participants. Further, participants return to their classrooms with the confidence to teach state academic content standards and an increased sense of independence. We argue that partnerships between K-12 and post-secondary institutions are critical to effective teacher education: most school systems do not have the infrastructure or funding to deliver a program of this nature on their own. ESEST meets multiple criteria for professional development for teachers. Our experience indicates that the program is successful because participants are immersed in a physically and mentally challenging, collaborative, outdoor learning environment.

INTRODUCTION

Only one third of 4th grade students in the United States performed at a level of 'proficient' or above on recent science assessment tests (Grigg et al., 2006). In part, poor performance by students is related to inadequate science preparation for teachers. Teachers with strong subject-matter proficiency tend to have positive impacts on their students' achievement test scores and attitudes toward science and mathematics (Darling-Hammond, 1999; Kahle et al., 2000; Fetler 2001; Wayne and Youngs, 2003; Borman and Kimball, 2005). Despite the documented relationship between teacher quality and student achievement, subject-area education degrees tend to emphasize courses in education to the detriment of content courses in the subject itself (Ingersoll, 2003; Desimone et al., 2003; Stamp and O'Brien, 2003). In a survey by Horizon Research (2002), only 25% of teachers responding received more than 15 hours of science-related instruction in the three years before the survey. In summary, there is a clear need to address the problem of insufficient subject-matter knowledge in the existing educator workforce.

For the past 14 years, we have attempted to meet this need by offering a professional development program entitled Environmental Science for Elementary School Teachers (ESEST). Our program's goal is to provide K-6 educators with the content knowledge and preparation to teach their students with an inquiry-based approach. Environmental science - the core of ESEST - is less abstract and more tangible than other sciences and lends itself to a hands-on approach that keeps children interested and stimulated (Sussman, 1993; NSRC, 1997; Riggs, 2004). In this article, we describe our long-running program and highlight particularly successful elements of the course.

GENERAL DESCRIPTION

The first part of ESEST is a two-week, four graduate-credit summer session held at Miami University's Geology Field Station near Dubois, Wyoming. A professional geologist, a professional zoologist, a master botanist, and eight public school Master Teachers provide instruction to 85 participants (divided between two 14-day sessions) on two interdisciplinary and interrelated topics. The first topic, Geological Evolution, focuses on earth science and on interpreting the landscape by understanding the rock cycle and other geological phenomena (Table 1). The second interdisciplinary topic, Biological Communities, concentrates on understanding biological communities and succession using the principles of plant and animal diversity and adaptation to the environment (Table 1). Daily field lectures and hands-on activities at diverse locations within the Wind River Range, the Grand Tetons, and Yellowstone National Park are supplemented by classroom lectures, group discussions, and study sessions (Figure 1; Table 2). During lectures, instructors make connections to social studies and language arts curricula by interspersing science content with Native American legends, western American folklore, and local history (see Table 3 for course textbooks).

The second part of ESEST is a one graduate-credit workshop held for the summer participants at Camp Ohio, near Utica, Ohio in October. The Ohio Environmental Science Follow-Up Workshop, required for all participants from the summer session, is designed to (a) make connections between content learned during the field station experience and the Ohio Academic Science Content Standards; (b) implement environmental science across the Ohio elementary
## Geological Evolution

<table>
<thead>
<tr>
<th>Processes Shaping Earth</th>
<th>Mountain forming; chemical and mechanical weathering; geothermal activity; volcanic eruptions; earthquakes; lithospheric plate movements; geologic time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth Systems</td>
<td>Rocks; soil; water; mineral and rock classification</td>
</tr>
</tbody>
</table>

## Biological Communities

<table>
<thead>
<tr>
<th>Characteristics and Structure</th>
<th>Living/non-living; basic needs of living things; structure of plants, leaves, and flowers; plant and animal communities/populations; ecosystems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversity and Interdependence</td>
<td>Plant and animal habitats; identification of rocks, plants, and animals; succession; food webs, producers, and units; adaptations to winter, alpine environments, and fire; dispersal of pollen and seeds by animals; human impacts on ecosystems (habitat loss, overgrazing, fire, roads, snowmobiles, pollution)</td>
</tr>
</tbody>
</table>

### Table 1. Topics covered in ESEST.

<table>
<thead>
<tr>
<th>Field laboratory time (includes travel, hiking and hands-on activities)</th>
<th>66 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field lectures</td>
<td>20 hours</td>
</tr>
<tr>
<td>Classroom lectures</td>
<td>16 hours</td>
</tr>
<tr>
<td>Scheduled study sessions/grade-level group meetings</td>
<td>11 hours</td>
</tr>
<tr>
<td>Campfires</td>
<td>5 hours</td>
</tr>
<tr>
<td>Total</td>
<td>118 hours</td>
</tr>
<tr>
<td>Average Hours per Working Day</td>
<td>9.8 hours</td>
</tr>
</tbody>
</table>

### Table 2. Summary of contact hours during summer session of ESEST, Wyoming.

- Interpreting the Landscape: Recent and Ongoing Geology of Grand Teton and Yellowstone National Parks, Grand Teton National History Association
- Keepers of the Earth: Native American Stories and Environmental Activities for Children, Fulcrum
- National Audubon Society Field Guide to the Rocky Mountain States, Knopf
- Pond Life (Golden Guide), St. Martin's Press
- Quick Flip Questions for Critical Thinking, Edupress
- Rocks, Gems and Minerals (Golden Guide), St. Martin's Press

### Table 3. Textbooks provided to participants of ESEST.

School curriculum; and (c) provide pedagogical instruction on the nature of science and scientific inquiry. The weekend (17 contact hours) includes Project Wild certification (www.projectwild.org), grade-level group discussions, and standards-specific field and classroom activities.

Daily programs for the summer session and the Follow-Up are available on our website (www.units.muohio.edu/cryolab/education/courses.htm#ESEST).

### PARTICIPANTS

Since the inception of ESEST, we have received a continuous series of 14 Dwight D. Eisenhower and Improving Teacher Quality Professional Development grants from the Ohio Board of Regents. This competitive in-state program funds professional development partnerships between post-secondary institutions and high-need schools and districts (defined by the poverty level of children and the certification needs of teachers within the schools/districts). Our participants are selected from K-6 teachers from low income rural and inner city schools throughout Ohio, with an emphasis on Cleveland Municipal School District (one of the poorest inner city districts in the U.S.) and 29 Appalachian counties (eastern Ohio). Data we have collected show that of the 179,000 students taught by the teachers who participated in our program from 2001-2005, 35% received free or reduced-fee lunches, 5% were disabled or handicapped, and 15% were minorities. Nationally, 67% of 4th grade students eligible for free or reduced-fee lunches and 42% of 4th grade students in inner city schools perform at a level below 'basic' on science assessment tests (Grigg et al., 2006).

In our program received tuition waivers, room and board, books (Table 3), hand lenses and other field supplies, and in most years, a small stipend to defray travel costs (the stipend recently was discontinued due to funding cuts). Further, we send each participant's principal a letter requesting district support for travel costs not covered by the grant, and for educational materials for use in the participant's classroom. From 2000-2005, participating school districts provided $74,269 to teachers participating in our program.

### HIGH QUALITY PROFESSIONAL DEVELOPMENT

ESEST meets multiple criteria for high quality professional development for teachers (Rényi, 1996; Garet et al., 2001; AFT, 2002; Supovitz and Turner, 2000; Desimone et al., 2003). Our program: (1) provides sustained professional development; (2) increases content knowledge and understanding of learning; (3) provides opportunities for active, collaborative learning.
by teachers in the same school or grade; (4) is part of a coherent program of teacher improvement; (5) results in increased teacher knowledge, confidence, and skills, and a concomitant improvement in classroom teaching practice; and (6) is being continuously improved.

**Sustained Professional Development** - The summer session of ESEST is an immersion program of extended duration. Total contact with participants during 12 days of instruction is 118 hours (Table 2). Recent research suggests that significant changes in teaching practice occur after 80 hours of professional development (Supovitz and Turner, 2000). The Follow-Up provides a further 17 contact hours, but more importantly, increases the span of the program to four months (Garret et al., 2001; Ent, 2001). Between the summer session and the Follow-Up, participants are given a written assignment in which they reflect on the materials and teaching strategies used in the summer session (Garet et al., 2001). For example, participants are asked to write a contemplative paragraph for the following question: "What teaching strategies, if any, were not effective for you during the summer session, and why? Give a specific suggestion for differentiating instruction in ESEST." The written assignments form the basis of grade-specific panel discussions during the Follow-Up.

**Focus on Content Knowledge** - The primary goal of ESEST is to increase participant knowledge of basic principles of geology and biology. At the outset of the course, participants are provided with reading assignments, a glossary of important terms, and environmental science concepts essential for success on the final exam in the summer session (drawn from topics in Table 1). The exam is composed of a written test (multiple choice and essay questions) and a laboratory practical (identification of rocks, trees, antlers, scat, and aquatic insects). Content is a focus of virtually every activity of the summer session.

A second goal of the course is to improve teaching skills. In both sessions of ESEST, effective pedagogical practice is modeled rather than taught in a static fashion (Supovitz and Turner, 2000; Desimone et al., 2002). Instructors use metaphors and visual aids to clarify complex ideas, and also use frequent review, mnemonics, alliteration, storytelling, and humor (Figure 2; Tate, 2004). Furthermore, participants are exposed to specific strategies for incorporating inquiry-based activities in their classrooms, ranging from the appropriate use of tools, to reading and interpreting tables and graphs, to designing simple investigations. For example, teachers learn how to safely use rock hammers, hand lenses, and rock identification cards when they search for samples of feldspar and mica. During the stream study - a perennial favorite of alumni - participants are broken into three groups to measure current velocity and dissolved oxygen, and to collect and identify aquatic invertebrates. The velocity group is further subdivided into teams of three to four teachers; each team receives a stopwatch, a measuring tape, and an orange. Teams have about five minutes to design and carry out an appropriate way to measure the velocity using the tools at hand. One alumnus of ESEST said, "I use not only the knowledge I acquired last summer, but also the teaching techniques I observed while taking the course."

**Active, Collaborative Learning** - As with children, adults learn best when learning is active and collaborative (Sandholtz, 2002; Lawler, 2003; Tate, 2004). ESEST instruction promotes this type of learning environment in five ways.

First, the program is the result of a long-term collaboration between university science faculty and public school teachers (Coble and Azordegan, 2004). Each of the Master Teachers in our program has over 20 years of teaching and/or administrative experience in Ohio public schools, and most have more than 10 years of experience as instructors in ESEST. They are integral to the development and improvement of the ESEST curriculum and administration (AFT, 2002), and model best practices in science education to participants (Garet et al., 2001). Master Teachers also improve the learning potential of participants by providing pre-program briefings on the physical and psychological conditions participants should expect in Wyoming (Riggs, 2004). Lastly, many of our participants have rarely or never been away from home and family for extended periods, are inexperienced in outdoor situations and primitive living conditions, and/or have not taken science content courses in years. Master Teachers build positive morale by accommodating differing levels of physical fitness, by
providing encouragement, and if needed, by diplomatically resolving interpersonal conflicts. Teachers tend to respect fellow teachers more than "outside experts"—educators who are seen as knowledgeable in their field of study, but who are unlikely to understand the realities of classroom teaching (Sandholtz, 2002).

Second, program activities are physically challenging. Participants hike daily, often over rugged terrain, and move about during field activities to look for samples and identify geological features and plants (Figure 3). Movement is thought to facilitate learning by decreasing stress and increasing alertness, creativity, self-esteem, and cooperative behavior in both adults and children (Pierson, 2002; Allegrante, 2004; Stevens-Smith, 2004; Tate, 2004).

Third, the ranch’s isolation, the housing arrangement (participants and staff live in no-frills bunkhouses), and daily van rides promote frequent, informal interaction between the participants and instructors, and opportunities to synthesize and reflect on content, share job-related concerns, and collaborate on projects for their classrooms (NRC, 1996). Furthermore, participants are immersed in the course and removed from the daily distractions of their normal lives. Alumni regularly comment on the value of constant access to colleagues: e.g., "I am amazed at what I have learned in two weeks... Discussion of possible lessons and ideas to use in the classroom were coming up on hikes, in cabins and even in the showers."

Fourth, we encourage cooperative participation by groups of educators from the same school or district, in part by allowing a few previous participants to reapply to the program as "teacher-leaders". Teacher-leaders recruit teams of educators from their school district, mentor their teammates during the summer session (providing both academic and personal support), and devise plans with their school administrators to implement and disseminate environmental science knowledge and teaching methods in their schools. In this way, participants are encouraged to exercise leadership and are therefore more likely to enhance long-term improvement in their schools than those with little involvement in their learning community (Rényi, 1996).

Lastly, participants work in groups in both the field and the classroom. During the day, for example, teachers collaborate to identify geological and biological features

| Earth and Space Science | 74% |
| Life Science | 87% |
| Physical Science | 50% |
| Science and Technology | 40% |
| Scientific Inquiry | 100% |
| Scientific Ways of Thinking | 100% |

Table 4. Percent of Ohio Academic Content Standard Indicators taught during the summer session of ESEST, Wyoming.

and to solve problems. During the evening, groups use study sessions to review course content. With the exception of formal grade-level groups led by Master Teachers during periodic discussion sessions, group membership is dynamic and flexible.

Coherence of Program - Professional development programs for teachers have greater impact when aligned to the improvement plans of districts, schools, and the teachers themselves (Rényi, 1996; Garet et al., 2001; Desimone et al., 2003). The ESEST program fosters coherence with overall professional development activities in three ways.

First, we select participants whose professional goals are most likely to be met by ESEST. The top four goals cited by the 85 applicants chosen for the class of 2005 were to increase content knowledge (48%), to obtain personal experience and/or classroom resources such as rock samples (39%), to share information and skills learned in the course with colleagues in their district (35%), and to increase their confidence in the use of hands-on and/or inquiry activities (35%) (Figure 4).

Second, our program specifically prepares participants to teach Ohio’s Science Academic Content Standards (ODE, 2003), which are aligned with National Science Education Standards (NRC, 1996). Program activities correspond directly with 39 (89%) of the K-8 Benchmarks in Earth and Space Science, Life Science, Scientific Ways of Knowing, and Scientific Inquiry. Participants also receive training in the majority of Indicators within the Benchmarks (Table 4).

Finally, we encourage administrative support for increased resources and curriculum changes by accepting several teacher/administrator teams. Feedback from previous years indicates that these collaborative teams facilitate the implementation of environmental science and inquiry-based practices into their Ohio curricula (Supovitz and Turner, 2000) and extend the "shelf-life" of the enthusiasm generated by the immersion experience (Rényi, 1998). One administrator commented, "The teacher development provided by this course has provided a model in having teachers as active participants in their learning. This has resulted in better instruction with meaningful, integrated curricula."

Another stated, "I continue to encourage teams of teachers from our building to participate in ESEST... Teachers who have taken part in this training share ideas with others."

Increased Knowledge and Skills - Since 1996, we have measured the improvement in content knowledge of ESEST participants by administering pre- and post-program environmental science tests specifically aligned with grade-level benchmarks of Ohio’s Academic Content Standards (Table 5). In each year, the
Ohio Grade Level Benchmarks

**Sample Question**

The climate of North America west of 100° Longitude:
- causes mountain glaciers.
- causes deep narrow canyons.
- is drier than east of 100° Longitude.
- is hotter and more humid than east of 100° Longitude.

Quartz differs from feldspar in granite:
- by lacking cleavage.
- being white instead of gray.
- being more abundant.
- having a brighter luster.

Alpine insects may be characterized by:
- small body size and large wings.
- wing atrophy and prolonged life-cycles.
- limited resistance to cold and desiccation.
- short life spans.

In the mountains of the Greater Yellowstone Ecosystem the two abiotic factors that are largely responsible for controlling the vegetation types are:
- topography/soil type.
- slope and aspect/elevation.
- relief/latitude.
- prevailing winds/soil pH.

<table>
<thead>
<tr>
<th>Sample Question</th>
<th>K-2</th>
<th>3-5</th>
<th>6-8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ohio Grade Level Benchmarks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 5. Alignment of sample questions from pre- and post-environmental science tests with Ohio’s Academic Content Standards.** There are 50 multiple-choice questions on the test (21 geology and 29 biology). Letter designations correspond to specific Benchmarks within Earth and Space Sciences (ESS) and Life Sciences (LS) (ODE, 2003). Corresponding page numbers of the Standards are in parentheses.

**Figure 5. Increase in content knowledge of ESEST participants, as measured with pre- and post-summer session environmental science tests.** Error bars are ± 1 SE. All differences between pre- and post-program tests are highly statistically significant (p < 0.001).

Scores of participants increased by 25-46% after completion of the summer program (yearly matched-pair t-tests: all t-statistics > 20.9, range of yearly N = 72-85, all p-values < 0.001; Figure 5).

Starting in 2005, we administered a matched pair of pre- and post-program questionnaires to assess participant confidence in teaching 30 state-mandated topics within the categories of earth and space science, life science, and scientific ways of knowing/scientific inquiry. In the first year of this assessment, participants indicated a significant increase in confidence in their ability to teach content standards after they completed the summer program (matched-pair t-tests: N = 84, all t-statistics > 10.7, all p-values < 0.001; Figure 6).

Unsurprisingly, the largest gains were in earth and space science and scientific ways of knowing/scientific inquiry.

In the spring of 2002, we evaluated self-reported changes in teaching practice with a questionnaire sent to 370 ESEST alumni from 1997-2002 (195, or approximately 53%, of those surveyed responded). As a result of their participation in the program, educators agreed or strongly agreed that their science teaching had improved across a number of important dimensions (Table 6). Additionally, the majority of teachers surveyed (99%)...
improvements were outside the scope of our program. We had shared information and skills gained in ESEST with other teachers. Classroom observations of teaching improvements were outside the scope of our program.

An important result of ESEST is that many educators feel empowered and inspired; they subsequently develop new, or use existing, presentation and leadership skills. Although we did not measure this in a quantitative way, the above-mentioned survey sent to alumni revealed that former participants gained the confidence and rediscovered the enthusiasm to expand their roles as educators (Table 7). To provide effective and stimulating science education, teachers need to be "excited about teaching science" (CSEPP, 2005).

**Continuous Improvement** - Continuous improvement entails the use of performance indicators, need assessments, and evaluation data to identify strengths and weaknesses of a program (Desimone et al., 2003). The current ESEST course was preceded by three previous courses for teachers: Field Geology for Teachers (1985-1988), Field Geology for Middle School Teachers (1989-1991), and Alpine Biology (1989-1991). The post-course evaluation instruments described above and annual all-inclusive alumni rendezvous have been used to analyze the successes and failures of each year's course. The surveys and post-course networking have allowed us to more precisely meet the needs of the teachers and their students. Our success in refining the course is underscored by our granting success. We have funded this project through a series of 14 external, one-year grants (totaling approximately $1,560,000).

**WHY WYOMING?**

The Wyoming experience is a cornerstone of our program, but why is it so effective to transplant 85 teachers far from home for two weeks? As 'Doc Rock', one of the lead instructors puts it, "To study mountains and mountain forming, you have to be able to see, and have access to, the mountains." Natural phenomena of any type can be difficult to observe in the eastern U.S., particularly with a large group. Human settlement is substantial, public-access land is limited, visibility is restricted because of dense vegetation, and wildlife is elusive. Contrast this situation with that of the western U.S.: it is sparsely populated, public-access land is abundant, visible panoramas extend for miles, and wildlife 'poses' in open areas. Moreover, the wide variation in the Rocky Mountain relief and rainfall enables participants to have exposure to a wider variety of environmental principles in two weeks than can be seen during a lifetime in Ohio. Finally, most of our applicants are from low-income districts with a significant population of economically and/or culturally disadvantaged students. A common theme among essays of ESEST applicants is the desire to return to the classroom and take their poverty- and crime-stricken students, who are unlikely to do much traveling in their lifetimes, on a 'virtual trip' around the world. Participants bring to their classrooms CDs containing photographs of the course (provided by one of the instructors), mementos, memories, and experiences that will generate more interest and have more impact than information in a textbook.

**SCIENCE EDUCATION PARTNERSHIPS**

Most professional development programs for teachers in the U.S. are conducted within schools or districts by outside experts, are of short duration (2-4 days), and are not active or collaborative (Garet et al., 2001; Desimone et al., 2002; Sandholtz, 2002). Despite the wealth of research on best practices in professional development, many districts simply do not have the resources to implement reforms. High-quality programs require a significant commitment of time, personnel, equipment, and - of course - money (Garet et al., 2001; Desimone et al., 2002). A lack of resources is particularly problematic in districts with a high proportion of students from low-income families (Barton, 1998; Kahle et al., 2000). Unfortunately, teachers in poorer districts are often in need of more education in science content and inquiry-based instruction than their wealthier counterparts, yet have less administrative support and fewer opportunities for

<table>
<thead>
<tr>
<th>Statement</th>
<th>% Agreement (# Respondents)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved science teaching</td>
<td>98 (184)</td>
</tr>
<tr>
<td>Increased use of hands-on, discovery-type activities</td>
<td>92 (167)</td>
</tr>
<tr>
<td>Improvement in my students' overall performance as measured by exams or standardized tests</td>
<td>94 (136)</td>
</tr>
<tr>
<td>Improvement in students' science performance as measured by the Ohio Proficiency Test</td>
<td>94 (97)</td>
</tr>
</tbody>
</table>

**Table 6. Percent agreement with statements on questionnaire sent to 370 ESEST alumni from 1997-2002 (53% response rate). Many participants had not received their students' most recent test scores at the time of the survey.**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Supporting Quote</th>
</tr>
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<tbody>
<tr>
<td>Presented at national conference(s)</td>
<td>&quot;Each year I plan at least one extensive science unit, based on proficiency outcomes and standards, with fellow teachers...that attended the class in Wyoming. We teach these units and share them at local and national...conventions.&quot;</td>
</tr>
<tr>
<td>Presented to the community</td>
<td>&quot;I still share my samples, videos, pictures and knowledge with my students, church groups, colleagues and anyone's organization that needs a speaker.&quot;</td>
</tr>
<tr>
<td>Mentored colleagues</td>
<td>&quot;We took what we learned as a team and impacted our whole school's student community by in-servicing the entire staff and then doing an entire school wide unit...&quot;</td>
</tr>
<tr>
<td>Applied for grants</td>
<td>&quot;As a result of my participation in ESEST I have applied for a $43,000 Learn and Serve Ohio Grant.&quot;</td>
</tr>
<tr>
<td>Assumed leadership role(s)</td>
<td>&quot;I am on the Board of the Ohio Resource Center for math, science and reading...I was appointed to the ODE's ESEA Committee of Practitioners and am on the OEA's Executive Committee.&quot;</td>
</tr>
<tr>
<td>Earned national certification</td>
<td>&quot;Since then I've also earned my National Board Certification.&quot;</td>
</tr>
</tbody>
</table>

**Table 7. Activities undertaken by educators inspired by participation in ESEST.**

One solution to this disparity is for public schools to partner with post-secondary institutions (Desimone et al., 2002; Stamp and O'Brien, 2005). We argue that collaborations between elementary school teachers, who can provide pedagogical expertise and age-specific teaching strategies, and college/university faculty, who can provide up-to-date science content, research skills, and grant-writing savvy, are necessary for science education reform (Desimone et al., 2003; Stamp and O'Brien, 2005). Teachers find professional development activities associated with school/university partnerships far more valuable than the traditional school- or district-based model (Sandholtz, 2002). Faculty themselves also benefit professionally (Desimone et al., 2003). For example, agencies that provide external funding for basic scientific research often require evidence of outreach or other science education activities. Finally, post-secondary institutions may have existing field stations, laboratories, or other infrastructure that can be used for professional development activities. For instance, our program is held at Miami University's Geology Field Station, a natural laboratory that has been used to educate geologists for the last 60 years. This partnership model has been very successful in ESEST: to date, 1,324 teachers have completed ESEST and the courses that preceded it.

SUMMARY

ESEST is a high-quality professional development opportunity for Ohio teachers. In our experience, the program is so successful because participants are immersed in the learning experience; are physically and intellectually challenged; spend the bulk of the program outdoors in a natural "laboratory"; are continuously engaged in professional collaboration for the duration of the course; learn content from expert instructors, most of whom have taught elementary school and all of whom use a variety of hands-on instructional techniques; and contribute to the continuous improvement of the course through their responses to numerous evaluative questionnaires and surveys. These program elements result in educators who return to their classrooms with a better understanding of environmental science, with new tools for incorporating inquiry into their curricula, and with an increased sense of self-worth and independence. As many former participants have expressed, "The class in Wyoming is a life-changing experience."

ACKNOWLEDGMENTS

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