PolarTREC: Researcher-Educator Partnerships and the Legacy of the IPY

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Introduction
Polar TREC—Teachers and Researchers Exploring and Collaborating, was a three-year (2007-2009) NSF-funded International Polar Year (IPY) teacher professional development program that advances Science, Technology, Engineering, and Mathematics (STEM) education by improving teacher content knowledge and instructional practices through Teacher Research Experiences (TRE) in the Arctic and Antarctic. Leveraging profound changes and fascinating science taking place in the polar regions, PolarTREC broadly disseminated activities and products to students, educators, researchers, and the public, connecting them with the Arctic and Antarctica and sustaining the widespread interest in the polar regions and building on the enthusiasm generated during the IPY. Although the International Polar Year observational period has ended, the polar regions will continue to be investigated by researchers accompanied by teachers. PolarTREC will be funded by the National Science Foundation during 2010-2013.

PolarTREC Teacher Research Experience Model
The PolarTREC Teacher Research Experience Model (Figure 2) illustrates the connections between professional development activities and program participants. The IPY emphasized improved scientific understanding through innovative approaches to education and outreach programming. Tested during the IPY, PolarTREC can serve as a model teacher research experience program for application in other contexts and locations to help scientists share their research with a broader public and progress student understanding. PolarTREC incorporated the following elements, integrating known best practices of teacher research experiences:

- **Hands-On Field Research Experience**: immerses teachers in a two to six week expedition in the Arctic or Antarctic. As members of research teams, teachers participate firsthand in the scientific process and polar content. Researchers share their scientific expertise and the excitement of working in polar regions.

- **Intensive Orientation**: prepares teachers to work in the Arctic or Antarctic, use state-of-the-art technology to communicate successfully from the field, and develop polar science outreach and education plans.

- **Researcher-Teacher Collaboration**: ongoing and conducted in person, via the website, and by e-mail, and includes pre-field coordination on classroom activities, public outreach, and presentations at relevant conferences and meetings.

- **Classroom Connections**: transfer the polar research experience into instructional activities for the classroom through pre- and post-field guidance from Partner Teachers—former TRE teachers who serve as mentors.

- **CARE (Connecting Arctic/Antarctic Researchers and Educators)**: supports the long-term integration of polar teacher research experiences into classroom curriculum through networking activities including online forums and webinars between teachers and researchers.

Teacher Impacts
PolarTREC teachers have been satisfied with their PolarTREC experiences. During post-field experience interviews, 100% of the 31 teachers interviewed about the program made one or more positive comments. Teachers cited personal change, positive relationships with a researcher, excitement about a science topic, ARCUS support, and ongoing collaboration with the researchers as reasons they have been satisfied with the program. Satisfaction in the program is reflected in the concepts that have been reported to be learned by PolarTREC teachers (Figure 4). Teachers reported learning the most about career options, the scientific process and methods, research equipment, and science content. Numerous comments reflected the vast number of things PolarTREC teachers learned, including:

"In the five weeks that I was up there, I learned more about atmospheric chemistry than I have in my entire life until that point...I learned more in those five weeks than I did in all of my college length combined."

- Anonymous PolarTREC Teacher

Student Impacts
Students of PolarTREC teachers were given an interest survey prior to and following their teacher’s research experience. The student pre and post survey have the same questions. It is delivered in an online format and focuses primarily on student interest in STEM careers and self-reported knowledge of 28 multi-disciplinary science topics covered by various PolarTREC expeditions, including glaciology, geology, climate change, life sciences, human dimensions, scientific methods, etc.

As shown in Figure 6, following their teacher’s research experience more students specified that they knew something or knew a lot about the topics. After their teacher’s field experience, students also described exploring science research activities in school and on their own time more often. Students surveyed described having more fun in their science classes and that they no longer find science boring.

The results of the student survey in regards to polar careers showed no significant change, but given that most of the students were middle school (5-8), it may be likely that students at this level are not prepared to make serious choices. Most students surveyed were middle and high school students, even though we have some elementary (K-Grade 5) teachers in the program.

Student Impacts Figure 6: Percent change in student responses to the question, “Please select how much you know about the following science topics.” As illustrated, a greater change in percentage of students reported “I know something about the topic” and “I know a lot about the topic.”

Researcher Impacts
Although the primary focus of the program is teacher professional development, researchers have also learned a lot through the program. Eighteen researchers participated in the evaluation post-field interviews, and nearly all of them had positive comments about the program.

Researcher satisfaction is reflected in the interest to repeat the experience, and many researchers have applied to host an additional PolarTREC Teacher. Participating scientists reported positive relationships with their teachers and that the outreach activities related to the PolarTREC teacher positively impacted their project. They cited the ARCUS support in finding, matching, and training teachers as essential. They have also cited improvements in the actual scientific process because they are forced to answer new questions about their research, therefore looking at it in new ways. Because their communication skills have been improved, researchers also described being better able to communicate and work with colleagues outside their disciplines, after working with a teacher.

One researcher had this comment regarding PolarTREC’s impact on their project’s outreach:

"Transformed it. I want to do it again and have applied the methods, principles and ideas to other NSF and non-NSF research."

- Anonymous PolarTREC Researcher

Program Evaluation Methods
The PolarTREC evaluation used a mixed method design incorporating descriptive components and a simple before/after design to measure what teachers and students learned over the course of teacher participation in the project (Figure 3).

The use of a before/after design is likely to provide a reliable measure of the impact on teachers and students because knowledge of the Polar Regions is unlikely to change spontaneously over the program year.

The evaluation questions are based on Guskey’s five-level framework for evaluating teacher professional development, including:

1. teachers’ reactions to professional development experiences;
2. the knowledge and skills that educators gain from professional development experiences;
3. organizational support and change;
4. teachers’ use of their new knowledge and skills;
5. improvements in student learning.

Figure 3: PolarTREC evaluation data collection methods.