

3 Education and Outreach Goals

The Homestake Scientific Collaboration and the State of South Dakota envision a world-class education and outreach program that is integral to the entire laboratory enterprise. This program has two overarching goals: 1) to enhance understanding of, and appreciation for, scientific research among the general public; and 2) to leverage the resources of the laboratory to address well documented pipeline issues in science, technology, engineering, and mathematics, especially among under-represented minorities.

The Homestake Scientific Collaboration envisions extensive programming and profound innovations to reach these goals. The magnitude of this vision stems in part from the generous pledge of T. Denny Sanford to develop a science education center. The Sanford Science Education Center will expand the education and outreach that would otherwise accompany the underground laboratory.

American Competitiveness and Global Stewardship: Urgent needs exist nationally to improve science, technology, engineering and mathematics education. Compelling rationale is detailed within such sources as [“Rising Above the Gathering Storm”](#) [11], a recent report from the National Academies. Homestake DUSEL takes, as a central part of its charge, becoming a global leader within the education arena.

Serving Diverse Audiences: Important regional audiences that have historically been underrepresented in science, technology, engineering, and mathematics include Native Americans, women and girls (at least in the fields of physics and engineering), and rural Americans. The Homestake Scientific Collaboration is deeply committed to serving these audiences.

Sparkling Public Interest and Increasing Public Understanding: Core to the Education and Outreach mission is helping the general public understand science. A citizenry that understands and appreciates science is invaluable to the overall scientific enterprise. Such a citizenry will support financial investment in research and demand high quality instruction for the next generation. Toward this end, an interactive visitor center within the Sanford Science Education Center will stretch minds and captivate imaginations. Visitors of all ages will have opportunities to experience underground science in action and engage with hands-on exhibits. A large tourist audience already exists, and even greater numbers are anticipated as the interactive science center at Homestake DUSEL develops into a national attraction and links with other science learning centers across the country.

Capitalizing on Unique Attributes of Homestake DUSEL: Education and Outreach has a great opportunity to capitalize on the interdisciplinary nature of the science and the unique attributes of the site. Underground science addresses some of the most captivating questions imaginable. The technological and engineering challenges are similarly intriguing. The site is also rich with history, both in terms of mining and science. There also exist magnificent opportunities for surface nature trails that highlight local geology and ecology.

Research Experiences: The Homestake Scientific Collaboration seeks to support students at a wide range of levels, from secondary school through the postdoctoral level, in contributing to the scientific enterprise. Research experiences will provide enrichment opportunities for the region's most motivated and talented middle and high school students. A scarcity of existing

opportunities for this audience is a prominent local need. Research experiences at the university level will attract high caliber undergraduate and graduate students to regional institutions.

Supporting Kindergarten through 12th Grade Teachers: Kindergarten through 12th grade teachers represent a critical leverage point for our education and outreach goals. Teachers will have opportunities to engage with research in order to deepen their content knowledge and to become reenergized about their discipline. Homestake DUSEL education and outreach staff will also draw upon scientists and engineers to help facilitate workshops and graduate courses for teachers, to bolster district and statewide systemic reform efforts, and to offer lectures with classroom teachers as a primary audience.

Recruitment and Preparation of Future Teachers: While supporting and helping to retain teachers who are already in the field represents a top priority, there is perhaps none greater than recruiting and preparing the next generation of teachers. Colleges of education have actively participated in planning efforts to date and will serve as core partners into the future.

Partnering with Regional Institutions: Faculty from less research-intensive institutions will benefit significantly from opportunities to connect with world-class science, both for themselves and for their students. Creation of new doctoral programs is considered, both within the pure sciences and also in the fields of math and science education. Area tribal colleges, some with their own teacher preparation programs, have engaged in planning to date and are especially valued partners in reaching and serving Native American communities.

Economic Development: Enhancing the regional climate for science-related entrepreneurship and strengthening the local economy in general are both key goals. Together with the South Dakota Governor's Office of Economic Development, the Collaboration recognizes great potential for spin-off technologies, for new job opportunities, both at the lab and in the vicinity, and for partnerships with technical and vocational schools to prepare a specialized workforce. The Education and Outreach team is planning to infuse entrepreneurship components within programming for kindergarten through 12th grade students and to engage the business community in identifying and addressing needs for a scientifically and mathematically proficient workforce. In addition, undergraduate and graduate-level summer programs will bring science and business majors together for innovation and entrepreneurship training. The first year of a pilot program related to this last concept is, in fact, already underway with other NSF funding.

Distance Learning: Homestake DUSEL resides at considerable distance from many of the partner institutions that will be sending visiting scientists, and is about an hour's drive from the universities at Rapid City and Spearfish. Furthermore, the science laboratories themselves will be thousands of feet below the surface. Remoteness in all directions renders a powerful cyberinfrastructure and other communication networks especially important. Also, given that kindergarten through 12th grade education throughout the surrounding region is highly rural, motivation is especially strong for developing new approaches to teaching and learning via distance technologies.

Specific goals include a captivating web presence, web-based simulations, virtual underground tours, internet-accessible data sets, data visualization tools, and on-line university coursework. A broadcasting and videoconferencing studio will allow scientists to connect with each other, with kindergarten through 12th grade schools, and with the general public. Finally, two tractor-trailer mobile science labs (Figure 3.1), already in use in South Dakota, are available to take hands-on

science modules featuring underground science to the most remote and highest-need school districts.



Figure 3.1 Students in the rural town of Stickney are conducting a chemistry experiment onboard one of South Dakota's Mobile Science Laboratories. Photo by Jerry Opbroek, Black Hills State University, 2003.

Innovation and Research on Teaching and Learning:

The Sanford Science Education Center will engage education researchers, K - 12th grade teachers, scientists, engineers, corporate visionaries, and students themselves to study and enhance the teaching and learning of science and mathematics. New doctoral programs in science

and mathematics education and a residential pre-college school for testing educational innovations are under consideration. These could serve as powerful engines for transforming education.

Fostering an Intellectually Rich Environment: For the sake of students and faculty in extended residence at the lab, Homestake DUSEL must provide an enjoyable and stimulating environment. Homestake DUSEL has great potential to become an interdisciplinary learning campus for all ages, across multiple disciplines, and across vocations (engineers, scientists, education researchers, kindergarten through 12th grade teachers, and technicians). Accommodations, dining facilities, common areas, and recreational outlets will all contribute. Given the interdisciplinary nature of the research, "in-reach," through which scientists educate and learn from those outside their disciplines, will be especially important. The collaboration is eager and well suited to help facilitate this.

Supportive Climate and Infrastructure: Researchers are busy. It will be essential to establish an education and outreach infrastructure that maximizes scientist impact and gratification within this arena and minimizes burdens. Scientists need myriad ways to contribute, and a culture must be nurtured where contributing is the norm. Toward that end, everyone who participates in education and outreach activities must be learning—scientists and engineers will learn about education; educators and students will learn about science and engineering.

Evaluation: Rigorous program evaluation will be a critical hallmark for all education and outreach components. Programmatic refinements will be driven by evidence. Extensive data across multiple dimensions (e.g., student growth in content knowledge, improved disposition, teacher changes in classroom practice, etc.) will be gathered, and these data will undergo careful analysis to establish connections between interventions and impacts.

Dissemination and Replication: The successes in education and outreach that are accomplished at Homestake DUSEL will be greatly leveraged if programs ultimately become portable and replicable. As noted above, Homestake DUSEL is distant from major cities and it will not be feasible for most United States citizens to visit. To achieve the profound impact on science education that the Homestake Scientific Collaboration envisions, the documentation and dissemination of lessons-learned will be especially crucial. DUSEL staff, visitors and users will author and publish papers in scholarly journals, post reports online, and be ever vigilant to identify pieces that might be transferable and to support field-testing within new contexts.