

St. Anthony Falls Laboratory and the National Center for Earth-surface Dynamics—Supporting Broadened Participation through Networking, Mentoring, Team Building, and Institutional Change

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For a decade and more, the National Center for Earth-surface Dynamics (NCED) has been headquartered at the St. Anthony Falls Laboratory (SAFL), University of Minnesota. This has allowed us to pursue a sustained approach to increasing diversity across our partner institutions, and to develop an approach to broadening participation in the geosciences that is informed by current research on diversity and inclusion, directed by an ongoing strategic planning process, and supported by a strong network of collaborative partner institutions.

SAFL/NCED Diversity programs take advantage of the best research on promoting and supporting STEM participation by underrepresented groups. Our diversity programs are focused on broadening participation of Native Americans in the geosciences. The proximity of Native American reservations to the University of Minnesota was the initial impetus for collaboration with a tribal college as a specific focus of our diversity programming efforts. Northern Minnesota is spanned by Ojibwe (Chippewa) reservations, including the Fond du Lac Band of Lake Superior Chippewa, which lies just southwest of Duluth, Minnesota. The Fond du Lac Tribal and Community College has been an NCED institutional partner since our inception. Since that time, we have demonstrated the extent to which a research center with an Earth focus can have a strong connection with Native American communities, which have a cultural tradition of observing and caring for environments across this continent and an ongoing interest in improving natural resource management on reservations and in areas where reservations have rights based on treaties with the US government.

A report by the American Indian Science and Engineering Society gives guidelines for improving STEM education for American Indians: “provide students with the opportunity to develop themselves as whole persons: emotionally, spiritually, physically, and mentally and include a needs analysis of student learning styles and cultures” (AISES, 1995). However, there has been very little research done to show exactly how one can take a holistic approach that strives to teach to the whole student and incorporate different learning styles. In order to implement these guidelines in a practical form, we developed the “Seven Elements of STEM Learning,” to promote learning in Manoomin Science Camps that is both holistic and individualized and incorporates the “needs analysis of student learning styles” called for by AISES. In order to ensure that the activities develop the whole student in preparation for STEM undergraduate work, Dalbotten identified these Seven Elements that are essential to meeting the academic needs of the student. Dalbotten developed these ‘Seven Elements’ by synthesizing information from research on American Indians and STEM learning, particularly that from AISES, as well as research on college-readiness for STEM majors, and articles from government and industry outlining the STEM employee of the future and needed skills. NCED’s gidakiimanaaniwigamig program developed a systemic approach (the Seven Elements) to informal education that encourages the student to: See,

Describe, Tinker, Quantify, Understand, Relate, and Grow, accommodating participants' individual learning styles. In addition, working with tribal elders, we have articulated the *Circle of Learning*, a conceptual framework that emphasizes trust- and relationship-building between researchers, teachers, students, and American Indian community members. More information can be found in the paper "NSF-OEDG Manoomin Science Camp Project: A Model for Engaging American Indian Students in Science, Technology, Engineering, and Mathematics" which will be published in the upcoming (May 2014) Journal of Geoscience Education Special Issue on Place-Based Education.

Our strategic approach towards supporting diversity in the geosciences has four main elements:

1. *Creating a network of supporting researchers and establishing trusted, long- lasting partnerships is a first step in mentoring.*

At SAFL, mentoring is part of the laboratory culture, and is planned into every program, as well as supported and acknowledged. Positive outcomes in mentoring relationships are particularly dependent on clearly articulated expectations for both mentors and participants. Effective mentoring begins long before mentor and student meet. To support this, active listening sessions with stakeholders and target audiences are an important part of program design and evaluation. Particularly, in support of the work of SAFL/NCED partner institutions towards broadening participation, existing mentoring structures were reviewed, weighing their potential for maximizing student success and mentor satisfaction.



Fig 1. NCED PI Chris Paola (on bucket) at an informal mentoring session with REU and Faculty-to-Faculty participants at the St. Anthony Falls Laboratory, University of Minnesota.

2. *Every student has the ability to reach their potential if they feel part of a community and are presented with engaging opportunities.*

At SAFL, we know that there are many capable students who have the capacity to participate in STEM careers but are failing to be identified and recruited through normal operational channels. Barriers to success are often found more in circumstances than in abilities. For example, there are a large number of non-traditional undergraduate students who fail to be recruited into research programs or other academically enriching activities because they have barriers to their participation such as: spouses, children, jobs, aging parents, checkered academic careers, etc. Our philosophy is one of meeting the student at least half way. For example, recent statistics on community college students show that the



Figure 2: NCED recruits and supports non-traditional students as participants in our programs. Carla, who is working on an Environmental Science degree at Lac Courte Oreille Tribal College is the first grandmother to participate in the Research Experience for Undergraduates on Sustainable Land and Water Resources, but she was joined by six other parents who were REU participants in summer 2012.

average age is 29, 59% are part-time, and 27% are parents (<http://www.aacc.nche.edu/AboutCC/Trends/Pages/enrollment.aspx>). These colleges, along with other Minority-Serving Institutions (MSIs), such as tribal colleges and universities, are the starting point, academically, for the majority of students

from underrepresented groups. By designing our programs such that they are flexible, located where the students live, and take into account students' academic challenges during the admissions process, we have the best ability to break barriers that keep students from achieving academic success in STEM careers. We try to meet our mentees halfway, figuratively as well as literally, by working hard to find out what motivates and interests our students, and where they find relevance in their lives. We have place-based and community-inspired research projects central to all of our programs that support broadened participation in the geosciences. By involving students in research projects that are directly related to their community we reach out to students and help them see the relevance of science, engineering, and mathematics to their lives and their communities.

3. A team approach can improve the student mentoring experience.

At SAFL, our team mentoring structure is enhanced by the highly interdisciplinary and collaborative nature of SAFL research. SAFL diversity programs all incorporate mentoring teams of students on topics where a team effort and a diverse disciplinary expertise is needed (e.g., the REU on Sustainable Land and Water Resources has teams working on groundwater, stream restoration, and wild rice history interpretation from lake cores). There is also value in having a team of mentors, as opposed to one advisor, so students have a variety of people with whom to interact. We also believe that a structure which allows all of our mentors and participants to both teach and learn is satisfying to both participants and mentors. Mentoring teams at NCED include faculty members, graduate students, and other specialists who guide students in acquiring skills in communication, writing, metacognitive processes, and life skills to support academic excellence. NCED mentor teams often include Native American faculty, elders and community members, who support us in creating culturally-responsive mentoring policies and processes and in offering culturally-aware mentor training. Peer mentoring and near-peer

mentoring are encouraged; students who continue in any NCED program beyond their first year become leaders among their peers and are encouraged to take on a mentoring role themselves. Graduate students are encouraged to act as mentors to undergraduates and K-12 students.



Fig. 3. Students and faculty and team mentors from one of our earliest NCED Undergraduate Summer Internship Program cohorts in Summer 2005 at the end-of summer University of Minnesota Research Symposium.

4. Support institutional change at the University of Minnesota and nationally.

After a decade of NSF support through NCED, SAFL embraces the responsibility of taking leadership within our institution, and on a national basis, for supporting broadened participation in STEM. By continuing to advance our network of collaborators and partners through alliances such as the Geoscience Alliance, SAFL works to promote new approaches and collaborations towards this end. Permanent change in the representation of the whole population in the STEM enterprise requires a focus on system-wide barriers and new methods for addressing these barriers. Existing and new networks and ongoing collaborations will be nurtured as part of the essential mission of SAFL to promote broad participation in all SAFL enterprises. SAFL alumni who are now faculty at institutions across the country, nurtured in an environment that promotes better broader impacts, will be supported by SAFL as they work on developing new education, engagement and public outreach programs. SAFL will continue to play a central role in the College of Science and Engineering to promote diversity at the University of Minnesota and support STEM learning across the state and the nation. .

References: American Indian Science and Engineering Society (AISES). 1995. Educating American Indian/Alaska Native elementary and secondary school students: Guidelines for mathematics, science, and technology programs, in Proceedings of a conference on the educational needs of American Indian/Alaska Native students in science, mathematics, and technology (Boulder, CO, May 19-22, 1994), published by AISES.