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GIDAKIIMANAANAWIGAMIG'S CIRCLE OF LEARNING: A MODEL FOR PARTNERSHIP BETWEEN TRIBAL COMMUNITY AND RESEARCH UNIVERSITY

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Abstract

Since 2002, the National Center for Earth-Surface dynamics has collaborated with the Fond du Lac Band of Lake Superior Chippewa, the Fond du Lac Tribal and Community College, the University of Minnesota, and other partner institutions to develop programs aimed at supporting Native American participation in science, technology, engineering, and mathematics (STEM) fields, and especially in the Earth and Environmental Sciences. These include the *gidakiimanaanawigamig* math and science camps for students in kindergarten through 12th grade, the Research Experience for Undergraduates on Sustainable Land and Water Resources, which takes place on two native reservations, and support for new majors at tribal colleges. All of these programs have a common focus on collaboration with communities, place-based education, community-inspired research projects, a focus on traditional culture and language, and resource management on reservations. Strong partnerships between university, tribal college, and Native American reservation were a foundation for success, but took time and effort to develop. This paper explores steps towards effective partnerships that support student success in STEM via environmental education.

Keywords: American Indian; Native American; Tribes; Resource Management; STEM Education; Place-Based Education; Community Based Participatory Research; Culturally Responsive Pedagogy

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INTRODUCTION

“Gidakiimanaanawigamig,” which means “Our Earth Lodge” in the Ojibwe language, is a major educational and research program initiated in 2002 to engage Native Americans in earth science as part of the National Center for Earth-surface Dynamics (NCED, a National Science Foundation-funded Science and Technology Center,

www.nced.umn.edu). Through K-12 (kindergarten through 12th grade) camps and related activities, *gidakiimanaaniwigamig* supports academic success and interest in science, technology, engineering, and mathematics (STEM) careers for Native American students (Dalbotten, Ito, Myrbo, Pellerin, Greensky, Howes, Wold & McEathron, 2014). *Gidakiimanaaniwigamig* has fostered collaboration among the Fond du Lac Band of Lake Superior Chippewa, the Fond du Lac Tribal and Community College (FDLTCC), the University of Minnesota (UMN), and other partner institutions of NCED. Over the past 15 years, *gidakiimanaaniwigamig* has evolved with changing funding structures, new partners, and changes in theme and curriculum. Since 2009, the program has been largely independent from NCED but continues to exist with collaboration of the original partners, new partners from within the University, and new tribal partners. The strong foundation for collaboration laid in the early years of *gidakiimanaaniwigamig* has assured the continued success of the partnership. This paper explores the elements that have fostered successful collaboration across cultures. We offer advice that is the product of years of research and lived experience developed from this active collaboration.

The need for more Native American environmental scientists

The environmental challenges all Americans face, from the local to the global level, require a scientific response; these challenges are of particular importance to Native American communities. Population growth, impacts of global climate change, challenges to the food and water supply, technological change, sustainable management of natural resources, and ensuring a healthy population all require an increasingly educated scientific workforce. Not only do Americans need the participation of all its young people in producing the next generation science workforce, but Native American scientists are also sorely needed to help native communities face these challenges (James, 2001). Native Americans have long been intimate observers of the land and have passed down traditional knowledge about the Earth from generation to generation. Through this knowledge, Native American communities successfully co-exist with the Earth. Yet Native Americans remain some of the most underrepresented groups in STEM careers (NSF, 2007).

As more Native American youths pursue STEM careers, it opens avenues for incorporating traditional knowledge into science pursuits. As Native American students acquire a formal education in the sciences, and especially if they go on to become PhD-level scientists, professors, and researchers, they will have a stronger voice among our country's leaders and decision makers when important policies are being developed that impact tribal lands (Nelson-Barber & Trumbull Estrin, 1995). They will also participate more fully in decisions about all the land and water resources of our nation. Educating new generations of young Native American scientists opens a pathway of communication blending traditional and modern science in the interest of caring for the Earth.

An in-depth understanding of the natural and physical sciences is imperative for wise and effective resource management. Land and water resources have always been of concern for the United States (and every country) in general, and for tribal communities in particular. With increasing evidence of, and concern over, climate change, the fate of these resources is the focus of both scientific research and natural resource management. Research in support of land and water management is vitally important to the health of our country. Effective and responsible management of natural resources in the US is becoming increasingly complex as factors such as climate change, land use changes, invasive species, mining, and urbanization stress resources. Transboundary and interagency administration compound these complexities, particularly on tribal lands where sovereignty concerns are involved.

It is estimated, for example, that a significant fraction, about 20%, of all U.S. fresh water is contained on tribal lands (Blasch, Hundt, Wurster, Sando, & Berthelote, in preparation). The National Congress of American Indians' (NCAI) recent report, *Securing Our Future* (NCAI, 2013) highlights the importance to the United States of excellent resource management on native reservations, noting that there are nearly 100 million acres of tribal lands in the US. Tribal lands include more than 997,000 lakes and 13,000 miles of rivers. There are 18 million acres of tribal forestlands on 287 reservations. Tribal lands provide vital habitat for more than 525 federally protected plants and

animals, many of which are both ecologically and culturally significant to tribes. Tribes operate approximately 114 fish hatcheries, with many producing fish species that are classified as threatened or endangered. Tribal resource managers are expected to sustainably manage all these resources while dealing with the effects of climate change, such as habitat changes and invasive species.

And yet, many treaty rights and federal reserved water compacts are still left unresolved, which highlights the need for resource managers capable of working on tribal lands and communicating with tribal communities. As these stresses continue, the need for responsible and fair management of these resources will increase. One of the first steps to effective management is to educate young tribal members to fill resource management positions on reservations. The need for professionals versed in geosciences greatly outpaces supply throughout Indian country. There is an immediate need for culturally responsive, place-based environmental education and research with a focus on Native American students and communities. More scientists from native communities will strengthen rather than challenge tribal sovereignty and identity.

A local connection can be a key factor in giving students a context for understanding what would otherwise be abstract material. Native Americans traditionally hold a strong connection to the natural environment: “As Indigenous people, we have a unique relationship and connection to the land, to Mother Earth. We come from the earth. She has given us life, so, in return, we respect her and acknowledge her in our prayers and ceremonies (Bergstrom, Cleary, & Peacock, 2003, p. 36). Native Americans’ connections to their local communities have an additional importance because of the treaty rights and obligations they hold over reservation lands and usufructuary rights they exercise over natural resources in treaty areas. Educating Native Americans to take an active, central, and powerful role in land and water management issues on their lands is crucial for the future of Native American communities and their role in managing our nation’s collective natural resources.

Native science evolved in relationship to places and is therefore instilled with a “sense of place.” Therefore, the frame of reference for a Native science curriculum must be the “place of the community, its environment, its history and people.” Native students must be made to feel that the classroom is reflective of “their” place...Given this orientation, stewardship of place is an important part of indigenous science education. (Cajete, 1999, p. 4).

Education on sustainable landscape management created by and for Native Americans can enhance these unique qualifications. By encouraging students to rediscover their local landscape from a Western scientific perspective, we connect Western science to their land and lives and give additional meanings to the landscape. By communicating with leaders from the community, we can also make sure we carry out our Western scientific enterprise in a way that acknowledges and honors traditional ecological knowledge and community values (Suzuki & Knudtson, 1992).

BRINGING TOGETHER UNIVERSITY, TRIBAL COLLEGE, AND TRIBE

Research centers with an Earth and environment focus can have a strong connection with Native Americans, who have a cultural tradition of observing and caring for environments across this continent (e.g., see NCAI, 2000). Recent research has shown the value of place-based education in engaging youths in science that affects their community and lives (Semkens, 2005, 2008; Riggs, 2005). Tapping into this cultural interest, *gidakiimanaaniwigamig* engages the young people (from middle-school to tribal college) of the Fond du Lac Band of Lake Superior Chippewa (FDL) and their communities in issues affecting land and water management. The goal of *gidakiimanaaniwigamig* is to help young people develop the skills, critical thinking, and experience necessary to succeed academically and to develop a personal/community motivation to choose to be a part of future research in these areas. To accomplish this, scientists at the University of Minnesota have had to connect and build trust with the local community—teachers, students, elders, tribal scientists, and community members such as parents or community leaders. Abuses by the research community when working

with Native Americans, past and sometimes current, have led to distrust of science and academia in some cases (Letiecq & Bailey, 2004). *Gidakiimanaaniwigamig*, which brings together these disparate communities, has helped foster collaboration with members of FDL and the FDLTCC, facilitating university researchers' becoming a part of the community over time.

Furthermore, a good relationship with the tribal community builds connections between cultural traditions and values and science learning so that both tribal and University *gidakiimanaaniwigamig* participants learn to critique and utilize scientific research strategies in connection to their respective communities' belief system. *Gidakiimanaaniwigamig*'s long-term vision is to build a strong intercultural (university and community) network that can support the scientific understanding and growth of the young people in the program, making careers, and thus potential new discoveries and strategies in science, possible.

The *gidakiimanaaniwigamig* program promotes involvement of students in active, hands-on science research. This means that several kinds of community-based research projects are simultaneously occurring—the research projects students carry out (some are camp activities, some are science fair projects, and some are undergraduate research projects) which may also have University and reservation scientists involved, and the research on education, which is an ongoing part of the *gidakiimanaaniwigamig* program. In this program, University researchers collaborate with tribal scientists, tribal college faculty, and community members to develop research questions and subsequent problem-based educational content around issues of importance to the tribe, such as fish, wildlife, and wild rice. These research questions have been explored in greater depth in the Research Experience for Undergraduates on Sustainable Land and Water Resources, another program developed through this partnership (Dalbotten, Haaker-Santos, & Zurn-Burkhimer, 2014).

Planning for the *gidakiimanaaniwigamig* camps incorporates current research on Native American education to promote student success. For more information on the structure

of the *gidakiimanaaniwigamig* program, see Dalbotten et al., 2014. Review of the literature (AISES, 1995; Aikenhead, 1997; Cayton Swisher & Tippeconnic, 1999; Demmert, Jr., 2001; McRel, 2005;) shows that the following are best practices for improving math and science learning by Native Americans:

- incorporating a cultural context and indigenous languages
- providing relevance to the student's interests and culture
- taking a holistic approach that considers the entire student
- involving the community, family, and elders
- providing a communal learning environment
- using problem-based or real-world-based activities

Active learning can encompass many of the best practices outlined above (Cordeiro & Campbell, 1996; Semken 2005, 2008; Riggs, 2005). It allows students to explore a topic from many different perspectives, increasing the chance that the students will find it relevant to their lives. Taking an interdisciplinary approach, using multiple learning strategies, and learning about cutting-edge technologies can all help to make the project more relevant to the student. Exploring many aspects of the project, students learn systems thinking, how to work in teams, and how to fit the project into a conceptual framework. The content engages students, individually and in teams, in relevant science projects, and draws explicit connections between traditional ways of knowing and the research pursued by today's science community. These connections support students' conception that Native Americans have always been scientists, engineers, and mathematicians and can also practice Western science, engineering, and mathematics.

The need for active and respectful listening

Collaboration on *Gidakiimanaaniwigamig* brought University and Reservation members into a new relationship that had the potential to fail but that, with a strong focus on active and respectful listening, was able to survive and flourish. The impetus for the program was funding from the National Science Foundation (NSF) to create the National

Center for Earth-surface Dynamics, an NSF Science and Technology Center (NSF EAR 1246761). At NSF, an emphasis on the broader societal impacts of research projects they fund and the Science and Technology Center Program's encouragement of diversity and education outreach required UMN faculty to develop a partnership with a Minority Serving Institution (MSI). Since tribal colleges and universities (TCUs) are the primary MSI in the region, faculty decided to invite a TCU to collaborate, and Fond du Lac Tribal and Community College was identified as a Minnesota TCU with a strong STEM program and an Environmental Institute. The initial approach was one faculty member (Gary Parker) at UMN reaching out to one faculty member (Andrew Wold) at FDLTCC. Commonly, this might not have gotten any results, but Dr. Wold was motivated to respond by his interest in the proposed research, a multidisciplinary and multi-institutional approach to improving the quantitative and predictive understanding of lakes, coastal areas, and wetlands.

In response to program directives, and in hopes of attracting future graduate students, UMN faculty were most interested in developing programs that would bring undergraduates at FDLTCC to the UMN for research experiences and transfer into UMN undergraduate and graduate STEM programs. However, the faculty partners at FDLTCC saw this as unrealistic and had different goals. The STEM programs at FDLTCC had few Native American students as majors, and almost none who had the appropriate credit distribution to transfer to 4-year programs in STEM at UMN. The tribal college was much more interested in developing K-12 programs to increase the number of Native American high school students with stronger academic skills, bringing more Native American students into FDLTCC STEM programs—a longer-term approach to addressing educational pipeline issues. This was the first point at which listening and developing a plan that met shared goals kept the partnership alive. Together, the partners decided to develop the *gidakiimanaaniwigamig* Youth Math and Science Immersion program, which was a K-12 camp program with other supporting activities.

This first phase of *gidakiimanaaniwigamig*, funded via NCED Education and Outreach funds, provided *open-ended development* of the program. With several years of

adequate funding and the ability to try out activities, making changes and adjustments, *gidakiimanaaniwigamig* went through its infancy and grew into a strong, independent program. Those open-ended NSF Broader Impacts funds really mattered.

It was in the first few years that the Circle of Learning principles were articulated as a philosophical roadmap for teaching and collaboration. These were developed in a listening session with Holly Pellerin and Lowana Greensky, who had worked together on Native American youth success and college preparation programs for several decades.

THE CIRCLE OF LEARNING

Gidakiimanaaniwigamig directors have developed a model for scientist/community partnerships based on traditional Native American methods of sharing knowledge. Holly Pellerin, Program Director for *gidakiimanaaniwigamig*, is a Native American Elder who lives on the Fond du Lac Reservation; she has 50 years' experience working with youths at camps, and has 21 grandchildren and 5 great-grandchildren. She is a traditional dancer and has taught dance and culture at the Fond du Lac Tribal and Community College and in the local schools. Lowana Greensky is Director of Indian Education for St. Louis County School District and evaluator and teacher coordinator for *gidakiimanaaniwigamig*. Pellerin and Greensky have run camps and outreach programs together for the past 40 years. Together with Diana Dalbotten, NCED's Director of Diversity and Broader Impacts, they articulated principles that bring together traditional native education methods and their combined experience. In the *gidakiimanaaniwigamig* program, community educators, local teachers, and scientists are brought together into a Circle of Learning with agreement by all on these principles:

Everyone teaches and everyone learns.

This means that all adult and youth participants should be humble and understand that, while they may have much of value to impart, they also should be listening and learning and trying to take something away from the experience. Input from even the youngest participants is valued and respected. Program leaders learn from one another.

Conflict management is handled by the elders.

Everyone else teaches and learns. This means teachers and scientists are not expected to have to deal with discipline issues that may become disruptive, but can trust the elders to manage disputes. This also minimizes tension among students, teachers, and scientists, so that the teachers and scientists can be more effective at imparting knowledge and keeping things engaging for the students.

Community leaders are the best people to identify participants.

Engagement of community leaders with good connections to parents, to the school administrators, and to local experts in the community is critical for the long-term success of the program.

Students are recruited based on their interest rather than on merit criteria.

This helps to discover hidden talents among all students.

Native (or community) traditions are respected, acknowledged, valued, and applied in camp.

Native languages are used and taught whenever possible. This approach reinforces positive behaviors and the youths' self-image. It enriches the camps and the community that comes together to teach and learn.

The primary expectation for all is that we are creating together a positive learning environment.

All participants are expected to contribute to that environment. As participants accept these expectations, disciplinary problems diminish. Disputes and negative behaviors are more often quelled before they begin, frequently at the initiative of the students. Students learn to value a positive environment for learning, as well as ways to support this environment in other areas of their lives.

All participants act as role models for younger participants.

This is achieved by sharing their excitement and enthusiasm about what they know, what they want to know, and how they learn.

Teaching is primarily oral and hands-on-project-driven.

Students are asked to read, write, record, and compute. But they are first and foremost asked to do, think, question, experiment, play, model, listen, and observe.

All student participants have the ability to be scholars and scientists in the future.

They each have the capacity to contribute to our nation's scientific and technological enterprise. They share the responsibility of all our nation's citizens to apply knowledge to the problems that face the continued existence of our planet and human life on our planet. Their innate capacity to become responsible adults who have something to contribute to the decision-making processes of our nation needs to be developed, and they need to be kept on the right path as they grow. This is the responsibility that the teachers, scientists, and community leaders commit to when they join the Circle of Learning.

Shared goals drive our planning.

We identified shared goals when we formed our Circle of Learning, and we keep returning to our goals so all participants are on the same page as we make decisions. We recognize that each participant brings to the Circle her or his own set of goals, but through the process of communication and negotiation, we develop a set of shared goals that gives our group its purpose.

Evaluation is an essential task of the Circle of Learning.

It enables the program to become stronger and helps contribute to the educational enterprise of the nation. It also allows the program to adapt and change so that it becomes stronger.

The Circle of Learning model is cooperative—each member of the group brings to the learning circle a background of knowledge and experience to share with the others. The grounding assumption is that each person in the group is there to learn as well as to teach. Respect for elders, a fundamental Native American value, is a basic principle of organization. The youths know they must behave in a respectful fashion toward the adults in the group, and this behavior is reinforced by the elders who attend. The pre-service and in-service teachers also model this behavior for the youths. Elders also stress the importance of treating one another with respect, and help all participants—scientists, teachers, and students—to treat Mother Earth respectfully.

Program Director Holly Pellerin explains how the Circle of Learning has been used to build an effective learning community on the Fond du Lac Reservation:

The Circle of Learning is not a new thing or an Indian thing. It has been around since people first began to learn. The way that we teach in our camp is in a small group with adults and students together learning about an idea or a problem. Everyone has a chance to contribute whether they are in the third grade or have a Ph.D. We listen respectfully, take turns and have open minds. We have hands-on activities to enhance what we are learning and this all takes place at camp. When learning is reinforced by an activity that all participate in, and everyone gets to be a part of the group and play a real role in the process of discovery, then learning happens all around (Dalbotten, Ito, et al., 2014, p. 230-231).

The emphasis of the camps from the beginning was on environmentalism and on understanding the environment of the reservation from a perspective of the changing seasons, so learning was based around phenology, observation, and hands-on activities. However, *gidakiimanaaniwigamig* was not specifically designed as a place-based program. When the program was designed, it incorporated many elements that fit that rubric. The camps are held seasonally, and focus on the local landscape. Students are tasked with observing the local environment and discovering how the land has changed over the seasons. For example, every camp incorporates a “phenology walk” in which

students take their journals out into the woods and record their observations. The walks are led by both a scientist (for example, an expert on lichens) and an elder. Students are encouraged to ask questions about anything they observe, and the experts point out specific aspects related to the camp topic. When the groundbreaking work of Semken (2005) and Riggs (2005) first appeared, it confirmed for *gidakiimanaaniwigamig* program organizers that this local connection can often be a key factor in giving students a context for understanding what would otherwise be abstract material.

Since its beginning, *gidakiimanaaniwigamig* has encouraged participation from students of all ages. Although participants have primarily been middle- and high-school students, we have welcomed students from grade school to college, which increases the family atmosphere of our program and makes it possible for parents to participate either as students or teachers (or both). This is a traditional learning style among the Ojibwe (Stiegelbauer, 1997). It works well to encourage participants to bring younger siblings, and in *gidakiimanaaniwigamig* camps the older students are exceptionally gentle and supportive with the younger ones. Bringing in undergraduates as role models supports future college attendance and is a way to support undergraduate participation in research as well.

LEARNING TO BLEND CULTURES

The first few years of the program were years of cultural clash, because *gidakiimanaaniwigamig* was not only bringing together Native Americans with other ethnicities and cultures, but was also blending University students with K-12 students, Urban with Rural, and a Tribal College with a Research University. University researchers were learning about native culture, indigenous traditional knowledge, and the culture of the K-12 community and of the tribal college. Teachers and native leaders were learning about the culture of the University and the requirements of NSF-funded research projects. There were many barriers to partnership to be overcome.

University researchers had to recognize and understand the history (reaching back more than 400 years and continuing through very recent history) of dominance and abuse that has created walls between the tribes and research universities such as the UMN. Through the camps, UMN researchers and program directors were able to learn about how treaty rights have been ignored, and even how UMN research programs were violating tribal rights. As part of the Biennial Nibi-Manoomin Symposia (<https://www.cfans.umn.edu/wildrice>), UMN faculty continue to interact with the community and share knowledge and opinions on touchy subjects and to build trust.

Excellent guidance is available, especially recently, on protocols for conducting research programs on tribal lands and with the participation of tribal groups. (For example, see Kawagley, 1990; Snively, 1995; Barnes, 2000; Wilson, 2001; Klump & McNeir, 2005; Cochran, Marshall, Garcia-Downing, Kendall, Cook, McCubbin, & Gover, 2008; National Congress of American Indians, 2009; Dano-Sacco, 2010; Chilisa, 2011; Smith, 2013; and Lambert, 2014). As late as 2002, much of this work wasn't yet published and/or UMN researchers associated with the project had no knowledge of these protocols. Through the *gidakiimanaaniwigamig* partnership, and with the Circle of Learning principles as a guide, the *gidakiimanaaniwigamig* Project leadership team has learned a good deal about making a partnership between University and tribal Community work. The primary paradigm shift for University researchers involved in *gidakiimanaaniwigamig* was reflected in the adoption of the informal policy to stand back and follow tribal leadership on the project. This process continues as every new University participant has to individually experience this conversion.

As the *gidakiimanaaniwigamig* program matured, it had to move from NCED funding to develop a jointly funded model. The program directors developed the *manoomin* (wild rice) project as a collaborative program. An important aspect of a move toward more directly place-based projects involved the incorporation of new researchers from the UMN into *gidakiimanaaniwigamig*. After meeting camp elders Pellerin and Greensky at an NCED meeting in 2006, Emi Ito, Director of the Lacustrine Core Facility (LacCore) at the UMN, and her senior staff were invited to a winter weekend camp at the UMN

Cloquet Forestry Center (CFC). (LaCore and the associated Continental Scientific Drilling Coordination Office provide infrastructure for scientists utilizing core samples from Earth's continents in their research.) The LacCore staff gave a presentation in the evening about how lake sediments are cored from ice surface and for what purposes.

The next day everyone went to a frozen lake that had been chosen by Fond du Lac Resource Management Division scientists. (Even at this one-time show-and-tell, the Reservation played an active role, and collected cores for their own research projects as well.) The staff demonstrated coring and took several short cores. Back at the CFC, some of the cores were extruded, and all got their hands dirty examining the mud and describing in words what they were seeing with their eyes and feeling with their hands. This introduction of LacCore to the Fond du Lac Reservation led to increased interest by participants and LacCore staff alike.

In early summer 2008, a request for proposals from the Opportunities for Enhancing Diversity in the Geosciences (OEDG) program by NSF's Geoscience Directorate spurred the further development of this new partnership. The goal was to extend the *gidakiimanaanawigamig* program beyond NCED's 2011 sunset, while revamping the program to create a greater focus on a single research theme; to develop a theme that was of particular significance to the community; and to increase the depth and breadth of understanding of scientific concepts by participants. The program leaders also wanted to increase participation by high-school and undergraduate students while maintaining participation by younger students. A meeting at FDL brought together stakeholders from FDL, FDLTCC, and UMN, including senior staff of the Fond du Lac Resource Management Division (FDLRM); FDLTCC Biology Instructor Andrew Wold, an NCED principal investigator (PI); and UMN researchers and staff from NCED and LacCore. Ito explained the OEDG program and the possible funding from it as a way to continue *gidaakiimanaanawigamig* activities. She emphasized that any proposal had to have an Earth science theme; that a major aspect of the proposal was education of student participants; and that LacCore's expertise was to work with sediments. Resource

managers from FDL took turns speaking about what environmental issues concerned them most.

While a myriad of concerns related to land and water resources were discussed, protecting *manoomin* and its habitat was the topic that kept coming up repeatedly because of the central role this resource plays for the tribe. It was agreed that student participants and researchers in this new project would investigate how long and where *manoomin* has been growing in the Reservation lakes and what conditions promote the presence of *manoomin*, so that its future could be assured. The result was an OEDG grant (NSF GEO-0914694) “*manoomin*: Investigating the past, present and future condition of wild rice lakes on the Fond du Lac Band of Lake Superior Chippewa Reservation”. Science activities for the *manoomin* project were created keeping in mind the ultimate objective of the OEDG program, which is to increase the number of Earth scientists from traditionally underrepresented groups. *Manoomin* received funding, and coring wild rice lakes was the emphasis of the camps from 2009 until 2014. After five years, the research itself became the foundation for further UMN/FLD collaboration on wild rice research projects, and continues into the present.

In 2014, with five years of extensive research on *manoomin*, the program leaders were interested in bringing the focus of *gidakiimanaaniwigiamg* back to a more general emphasis on the environment of the reservation and the work that is done by tribal scientists who are employees of FDLRMD. Two grants were submitted. One was developed by FDLTCC, with faculty member Courtney Kowalczak as the lead PI. The other was developed by the UMN, with Ito and Dalbotten as co-PIs. NASA funded the FDL award (NNH13ZHA002N-NICET) with an emphasis on teaching about global climate change, in particular its impacts on tribal land and native culture. NSF funded the UMN award (NSF EAR 1422917), which focused on the science behind resource management on reservations. Since both projects involved the *gidakiimanaaniwigamig* camps and programs, a new phase of collaboration developed. Two separate programs had to be managed and evaluated in tandem. As the projects have developed,

gidakiimanaaniwigamig has taken on new partners within the UMN community and from outside the University.

At each new phase in development of the program, cultural clashes have occurred that necessitated a return to the Circle of Learning principles and getting together to hash out shared goals and to renew commitment to the partnership.

IMPACTS OF THE PARTNERSHIP BEYOND *GIDAKIIMANAANIWIGAMIG*

One of the most exciting aspects of participating in the *gidakiimanaaniwigamig* partnerships has been witnessing the impact of the program on the development of other programs associated with NCED and the UMN. NCED recognized the need to promote partnerships like *gidakiimanaaniwigamig* as a way of multiplying the impact of the knowledge created, and so in 2007 Dalbotten created the Geoscience Alliance. The Geoscience Alliance is a national alliance of individuals committed to broadening participation of Native Americans in the geosciences. Its members are tribal colleges, universities, and research centers; native elders and community members; students (K-12, undergraduate, and graduate); formal and informal educators; and other interested individuals. The Geoscience Alliance has had three national conferences that promoted opportunities to students, allowed students and others to highlight the research they are doing, and supported new partnerships. The Geoscience Alliance has recently been awarded a grant to become an NSF Research Coordination Network that will focus on promoting greater social capital for participants in support of furthering academic and career success.

An offshoot of the Geoscience Alliance was a new partnership between the UMN and the Salish Kootenai College (SKC) in Pablo, Montana. This partnership arose at a Geoscience Alliance planning meeting held at the national American Indian Science and Engineering Society meeting in 2009. There Dalbotten met SKC faculty member Antony Berthelote, who joined NCED with the purpose of collaborating on the development of 2- and 4-year Hydrology degrees at SKC, which are now in place and are graduating

students. As a center, NCED had promoted undergraduate research through the NCED Research Experience for Undergraduates on River and Coastal Restoration (REU RCR). As the Native American partnership expanded, the NCED directors decided to shift the orientation of the REU to Native American communities and Community-based Participatory Research (CBPR). This idea had been piloted as part of the *gidakiimanaaniwigamig* program when undergraduates from the REU RCR were placed at Fond du Lac to support the *manoomin* research. Because the University had developed a positive reputation of working ethically and respectfully with the Ojibwe tribe, and (through the Geoscience Alliance) with Salish Kootenai College, the NCED project directors were empowered to create this new opportunity. The Research Experience for Undergraduates on Sustainable Land and Water Resources was developed, with partnerships from Salish Kootenai College, the Confederated Salish and Kootenai Tribes of the Flathead Reservation, and existing partners from the Fond du Lac Band of Lake Superior Chippewa. Undergraduate teams are placed at both of the reservations and at the University of Minnesota's St. Anthony Falls Laboratory. Community-based research projects are developed with the reservations to do research projects based on tribal concerns. Research on *manoomin* continues, with the participation of FDL and new faculty participants, from University of Minnesota, Duluth. Natural resource scientists from FDL participate in defining the research themes and developing the projects. REU participants have the opportunity to present their research to the tribes during the summer, and at national science conferences during the following school year.

Community-inspired projects have the potential to make research more valuable for communities and especially tribal communities. Resource managers with deep knowledge of tribal lands and the species that depend on them, and who work to preserve tribal lands for future generations, can point research scientists to research questions that will support better management and help in legal battles involving protection of these resources. Problems that need immediate solutions, such as adaptation strategies to changing climate conditions, can be the impetus for fruitful collaboration between University researchers, tribal college faculty, and reservation

resource managers. Learning to do research in this way is a valuable experience for our students and their science mentors, who can incorporate these experiences as they become future scientists. It is difficult to ethically do any research on tribal lands without incorporating CBPR because researchers need to obtain permission to work on tribal lands, respect sovereignty issues, and support tribal goals. According to a study done by the National Indian Education Association,

Tribes have established tribal research institutional review boards to approve and oversee research/evaluation conducted among their tribal members and CBPR has emerged as a preferred research/evaluation approach....CBPR is an approach recommended by the National Indian Education Association, the National Congress of American Indians, the National Science Foundation, the American Indian Higher Education Consortium, the Substance Abuse and Mental Health Services Administration, the Harvard University Native American Program, the Native American Center for Excellence, the National Institute of Environmental Health Sciences, numerous tribal entities, and others throughout the health and education fields for research and evaluations conducted in Native/tribal settings. (Mackety, 2012).

Recent research highlights the connection between CBPR and environmental justice regarding other minority communities as well (Wilmsen, Elmendorf, Fisher, Ross, Sarathy, & Wells, 2008).

An important step in resolving environmental challenges in indigenous and minority communities is educating students from groups underrepresented in STEM careers. Recent research has shown the value of incorporating CBPR into undergraduate education. Students learn valuable techniques for working in diverse environments. Undergraduates have access to community members who can provide support and information that is different from that offered by University researchers (Fontes, Bravo, García, Palencia, Alonzo, Rosario, Fuentes, Hernández, Granberry, & Torres, 2014; Martinez, Perea, Ursillo, Pirie, Ndulue, Oliveira, & Gute, 2012; Fontaine, 2006).

SUGGESTIONS FOR PARTNERSHIPS BETWEEN UNIVERSITIES, RESEARCHERS AND TRIBAL COMMUNITIES

This section focuses on advice our team would like to share that comes from 15 years of partnership. Thanks to wonderful, patient, and understanding elders, teachers, and reservation scientists, the University community was able to learn and develop important skills needed for collaborating with tribal communities and supporting Native American students on their academic journeys. In this section we offer best practices identified through the experience of our partners in *gidakiimanaaniwigamig*, through rigorous evaluation of *gidakiimanaaniwigamig* (Dalbotten et al., 2014) and ongoing reflection and communication. There is great diversity among Native Americans, including diversity of geographic locality, tribes, size of tribes, homogeneity of communities, specific cultures and traditions of each tribe, and reservation versus urban settings, as well as the mixed ethnicity of some participants (Pewewardy, 2002). This paper, while hopefully avoiding blatant stereotyping, points to some characteristics of native communities and of native youths and young adults which are common across tribes, and may particularly impact those who are trying to set up an informal education program with native participants. There is a great deal of literature available that outlines Indigenous Research Protocols (e.g. Chilisa, 2011; Smith, 2013; and Lambert, 2014); we highly recommend reading it before developing a partnership of this type or doing research involving Native American tribal lands.

Listening to the Concerns of All Participants from the Very Beginning of the Partnership

Central to a successful partnership of this type is the listening session. The diversity among native communities makes it all the more important to spend time at the beginning of a project listening to potential partners to make sure that a suite of shared goals is developed. It is best to discuss those shared goals before beginning the process of finding funding, but if funding for a program with specific goals and planned outcomes pre-exists the partnership, it is still important to make sure those goals and outcomes are integrated with the goals of native partners and incorporate their needs

with the needs of the research project. It is important to be frank from the start about the expectations of grant or funders, but it is also necessary to have flexibility in designing a program that incorporates the ideas and needs of the partner community. It is sometimes necessary after preliminary discussions to redesign aspects of research methodology or evaluation that conflict with the expectations, desires, and culture of that community. It is critical to be sensitive to particular concerns that arise when carrying out a research program on tribal lands or incorporating traditional tribal knowledge (Wax, 1991), supplementing normal procedures regarding research ethics with forthright and sensitive attention to these issues. If there is any doubt about whether tribal officials ought to be consulted, it is useful to work with potential native partners and consult their officials. When designing a program, it is a good idea to build in a preliminary phase in which work on establishing warm, trusting, and cordial relations within the community can be done, and only then move towards development of a program with structured standards, research methodology, and evaluation.

Clarity of Expectations of the Roles of All Partners

All stakeholders of the project (University, tribal leaders, TCU faculty, elders, teachers, students), should be at the table at preliminary planning meetings. Important questions that must be answered, whether the project will be scientific research, an educational project, or some combination of the two, include:

- Will the research be cooperative?
- Will tribal/community members and students participate in carrying out the research?
- Who develops the research questions?
- Who determines the research methods?
- Who determines the evaluation questions and metrics?
- How will we assure openness about all arrangements?
- Who owns the data that is derived from the project?
- Are there incentives for the tribe to participate? Who chooses the incentives?

- How will information be disseminated to the tribe and to others?
- If we are raising funding with a grant proposal, which institution will lead, or will the proposal be collaborative?

In *gidakiimanaaniwigamig*, the University partners follow the lead of the tribe. The research is cooperative; the research questions and methods, and the evaluation questions and metrics, are developed in partnership. No research is carried out that is not approved by the tribe. The tribe owns the data, and nothing is disseminated without tribal approval. The expectation is that all results will be disseminated to tribal members. The issue of funding can be complicated. Some tribal colleges or tribes lack the infrastructure or personnel for grant management and prefer that the University take the lead on a proposal and on managing the funds. Clear and open sharing of budget information and agreement on distribution of funds can make this work. However, it is generally preferable that the TCU or tribe be the lead institution or that the funding structure be a collaborative proposal.

The Importance of Personal Connections

Introductions are very helpful, and face-to-face interaction usually works better than phone or email. Acquaintanceship with someone who is enrolled in the tribe can lead to useful contacts with the appropriate community leader. Finding someone within the research institution who already is working in a native community may lead to an introduction to education leaders or elders in the community. Tribal college faculty and teachers in the schools are often overwhelmed with duties and may not be immediately responsive. In addition, past collaborations that didn't meet their needs or expectations may have led them to be unresponsive to new partnerships. This stage of a partnership can take persistence and is often where attempts at collaboration between academic and native communities fail. If first attempts to talk to someone are unsuccessful, it is important to try again, or to contact someone else. One useful strategy is to work to augment or strengthen an existing program. For tribal college faculty, an offer of an extended partnership that includes opportunities for educational and scientific collaboration might prompt serious consideration. Meeting with various stakeholders

(e.g. teachers, community leaders, tribal college faculty) to find out what can be done in the community and what needs exist is an essential route to successful partnership.

Involving Leadership from within the Community

To initiate a successful partnership, it is crucial to involve a community leader in the collaboration who is already well known in the community (McAvoy, Winter, Outley, McDonald, & Chavez, 2000). It is sometimes a challenge to identify that leader; for undergraduates at a tribal college, it is worth visiting and talking to people in the tribal college to find out who is interested in collaboration. When setting up a K-12 program, the tribal college is still a good starting place. The tribal college faculty and administration often have good working partnerships with local schools. It is also useful to talk to teachers or administrators in the tribal schools or contact the local school district's Director of Indian Education.

Logistical Considerations

It is important that researchers who want to initiate collaboration don't go in with their ideas fixed about what they want to do. The design of a research program should be based on the results of a listening campaign. Furthermore, it is fruitless to expect that everyone from the community will work on the project as volunteers. When expecting people to work outside of their normal work schedule, the project should be prepared to pay teachers, community leaders, and elders for their time, and have that salary or stipend money in the project budget. Transportation is an issue. It is best not to expect participants to always come to the lead institution—when running an outreach program for students, teachers, or undergraduates in a community remote from the lead institution, it is a good idea to take the program on the road, rather than expecting participants to go to the University.

Learn from Teachers and Elders how to Respond to the Needs of the Students

Trust elders and community leaders to take the lead when working with undergraduates or K-12 students (e.g., in recruiting, organizing, and managing students). This allows the researcher to keep focused on the teaching message and avoid looking like he or

she is trying to be the boss, leader, or disciplinarian. It is generally fine to leave that role to elders. Often students in the program will seem distant and quiet at first. Students usually need time to get to know visiting researchers and other unfamiliar adults. Even if they are not actively responding, they are gathering information. Traditional learning methods reinforce respectful listening, so students who seem unresponsive may just be behaving according to how they have been taught (Demmert, 2001). Elders and local teachers have emphasized this aspect to our University scientists, suggesting that students may need to learn trust before they become active participants. We have seen that students will open up and become more responsive, but often not until they become better acquainted and have the feeling that they are working with someone who will be coming back. We have found that a good practice is to guide the students into opening up by asking questions in their student journals, or in small group brainstorming sessions. If students have time to think about questions or ideas and write them down, they will feel more comfortable participating. It's best to contribute to a culture of learning by actively acknowledging positive participation.

Connecting with Students' Families is Crucial for Success

When working with native students, consideration of family and community issues is essential (AISES, 1995). These connections should be developed as strengths of a program instead of allowing them to become barriers. For example, participants or staff sometimes can't attend without bringing a younger sibling or child because day care is an issue. Traditionally, native education often included mixed-age groups. To develop a successful program, it is actually easier to have fluid boundaries in terms of who participates than it is to have hard and fast age rules. *The family is traditionally the primary place where learning occurs for native children.* A program won't succeed if program staff don't have a good working relationship with the students' families. It's a good idea to encourage parents to feel comfortable sitting in for part or all of a program session so they can see what their children are doing. A useful strategy is to listen carefully to their concerns, and if things are still unclear, to raise the issue again with program teachers and elders from the community. If particular parents consistently attend, it is sometimes possible to hire them to teach or assist the teachers, depending

on their skills. Although it is a good idea to respect traditional practices and knowledge and incorporate them into the program, it is also important to remember that *this is primarily a function of the family*. A way to build connections to families is to build in funding for shared meals, which are a traditional aspect of most Native American functions and an important place for developing relationships and sharing experiences.

Pay Attention to Group Composition and Team Dynamics

As our team learned through our own trials, it is unrealistic to expect that everything will work in a program right from the start. Things are often chaotic as participants, teachers, and staff figure out their working relationships. Changes in leadership, starting new projects, or reconfiguring the camp format can cause new upheavals. Frequent meetings between all the leadership can support a good learning environment. It is crucial to build a climate for learning by teaching students how they are expected to act. This was a valuable lesson we learned from working with elders and teachers in the camps. An informal learning program may be a new environment for participants, neither school nor play, so it is often difficult for participants to know what is expected. Breaking students into small groups and completing projects in teams as often as possible allows students to talk and have fun while they are learning. A helpful strategy we have used in the camps is assigning a consistent teacher for each group throughout the day. Someone who is well-acquainted with the participants decides the composition of each group, to minimize potential problems or conflicts and provide a supportive environment for quiet or shy students. Sometimes dividing the older students among teams provides a peer mentor for each group; giving them the opportunity to be a role model for younger participants can guide the older students to take on responsibility for creating the learning environment.

Group Activities

It is important to keep the child-to-adult ratio low. Activities should be structured so that students get breaks and a chance to get outside. It is a good idea if some projects involve physical activities and are hands-on learning projects or creative tasks. Minimizing lectures and keeping them fun, avoiding jargon, explaining difficult

concepts with examples, and building in opportunities for questions and discussion are other strategies for creating a successful learning environment. Learning is fostered when students bring their existing knowledge about concepts rather than having adults hand them facts.

Fostering Good Working Relationships with Teachers and Tribal College Faculty

It is necessary to spend the time it takes to get to know the teachers or faculty in a new program, working with them to talk about what they would like to do in conjunction with the program's teaching objectives. After getting to know the teachers, it is possible to start working more formally to shape a program around the research plan, state or national standards, and objectives such as curriculum development. Taking the time to get to know teachers first and allowing them to participate in developing the program helps establish a respectful working relationship as professionals from different fields. As a program progresses, it is possible to create opportunities for professional development for participating teachers. In the case of tribal college faculty, it is important to keep in mind the many other responsibilities and demands on their time.

Formal Evaluation using an Indigenous Evaluation Framework

Beyond education assessment, evaluation of the project can benefit from the involvement of an outside evaluator who is knowledgeable about the special considerations of evaluation design for programs with Native American participants (AEA, 2011). *An Indigenous Evaluation Framework: Telling Our Story in Our Place and Time* designed by American Indian Higher Education Consortium (AIHEC) (LaFrance & Nichols, 2009) employs collaborative and contextualized evaluation practices that align with the cultural values of the program stakeholders, including principal investigators, tribal leadership and project staff, students, and families. This framework aligns with more mainstream evaluation methodologies embedded in Appreciative Inquiry and Participatory and/or Empowerment evaluation theories.

The four cornerstones of this framework are:

1. creating the story that the program stakeholders want to tell,
2. building a scaffolding that provides a structure in alignment with Indigenous values,
3. gathering information from multiple perspectives over an extended period of time, and
4. engaging the community and celebrating the learning from the evaluation.

When it is not possible to involve such an expert, the program evaluator should at least become knowledgeable about the literature available on this topic and ensure the inclusion of elders and Native American staff members in the design of the evaluation program (Fisher & Ball, 2003; LaFrance, 2004; Letiecq & Bailey, 2004; Richmond, Peterson, & Betts, 2008).

Evaluation planning and data collection must ensure that the network participants, particularly Native Americans, understand that they are helping determine the goals and how the data will be obtained. The Tribal Institutional Review board (IRB) committee must approve the evaluation plan, with the understanding that they have ownership of the data and control of broader dissemination.

IMPLICATIONS FOR SUCCESS: IMPORTANCE OF STRONG INTERPERSONAL RELATIONSHIPS

Gidakiimanaanawigamig has addressed several challenges in order to meet its goals. Teachers and researchers had to develop shared goals and a common language in order to work together. Mistrust and miscommunication fostered by historical conflicts had to be overcome before researchers were seen as a welcome presence on the reservation. Native students had to become comfortable interacting with adults from outside their community. The Circle of Learning is at the core of our success in engaging Native American students in STEM because it focuses on overcoming these challenges by strengthening relationships between students, teachers, researchers, and the community.

An important element of our work has been actively seeking to improve relationships between the researchers who willingly devote their time to our project and the teachers and staff who are the life force of *gidakiimanaaniwigamig*. These relationships don't happen automatically; they require planning and forethought. Teachers in the program need to be valued and empowered to do well. Teachers are at the heart of the program. The work they do is essential not only to the success of the camp but to their willingness to carry the knowledge they build in the camps into the classroom.

Learning takes place in an environment that is both holistic and individualized. This is accomplished by concentrating on the students' abilities in seven key areas: quantitative, spatial, conceptual, social, mechanical, metacognitive, and verbal (Dalbotten, et al., 2014). Regular contact is the surest way to have a lasting positive impact on a student. Students have the opportunity to be a valued part of the Circle of Learning and to build strong relationships with the adults in the community. Holding camp several times per year also means that the adults build a trust relationship more quickly with one another.

Given the significance of strong, trusting relationships for success in programs for engaging Native American students, we recommend carrying out these programs for a number of years. Programs that begin and end in a span of two or three years might do more harm than good for the development of long-term relationships between Native American communities and academic institutions if the collaboration isn't planned with the potential for sustainability beyond the initial collaboration.

Students feel there are rewards for their active participation and for staying on the "good path". These rewards are sometimes tangible, such as opportunities to participate in national science fairs and fun field trips; but they are just as often intangible—better relationships at school and in the community, and a strong sense of self-esteem.

Community elders have been an essential part of the Circle of Learning. They play several roles, including connecting the program to Native American traditions, helping to build community among all participants, and, most of all, instilling in the students values that support their future success. Elders, because of the central role they play in Native American communities, are a bridge to the students' parents and extended families. Often, they have known the students for years. The elders in *gidakiimanaaniwigamig* are well acquainted with the students' parents, in some instances because the parents, as children, were themselves taught by these elders. Elders and community provide continuity for students as researchers and visitors participate in the camps.

The primary focus of continued collaboration among all the partners has been broadening participation of Native Americans in the geosciences. Partnerships have expanded to include supporting undergraduate programs; developing the national Geoscience Alliance, and through that organization, developing new collaborations; and supporting graduate education and faculty development. The goal is that students will have multiple pathways toward success and that in the future, Native Americans will play a greater role as professionals on reservations, regionally, nationally, and globally, enhancing management of the environment.

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Emi Ito, PhD, was born in Japan but spent some of her formative years in US (2 years between age 11 and 13) and moved here permanently during her last year of high school. She hold a BS in Mathematics from University of Chicago, and a MA in Geological Sciences from Princeton. She took a 2-year leave from academic pursuit after her MA and taught mathematics and earth sciences to middle and high school students at an open school in New York City. Ito returned to Chicago for her PhD in geochemistry (Dept. Geophysical Science) and came to Minnesota following a 2-year post-doc at the Carnegie Institution of Washington. Ito shifted her research focus from ‘hard-rock’ geochemistry to ‘soft-rock’ and water geochemistry about 20 years ago and currently direct the Limnological Research Center. Ito also holds faculty appointments to Quaternary Paleoecology Free-standing Minor and to Water Resource Science. For the past 8 years, she has been involved with informal science camp program at Fond du Lac Reservation and with wild rice sovereignty issues.

Susan Eriksson, PhD, graduated from the University of the Witwatersrand, South Africa and was Associate Professor in the Department of Geosciences and Associate Dean in the College of Arts and Sciences, Virginia Tech. She was the first director of the Virginia Tech Museum of Natural History and founded the Education and Outreach program of UNAVCO, Inc. She has planned and implemented over \$5m in grant-

funded programs and is now an independent consultant in strategic planning and evaluating science programs and grass-roots, arts organizations.

Holly Pellerin, AA, is the Program Director for the *gidakiimanaaniwigamig* Program. She is a Native Elder and has 40 years experience working with kids at camps. She lives on the Fond du Lac Reservation and has 21 grandchildren and 5 great-grandchildren. She is a traditional dancer and has taught dance and culture at the Fond du Lac Tribal and Community College. She currently teaches traditional cultural and language in the Cloquet public schools.

Lowana Greensky, MeD, is the Director of Indian Education Services for St. Louis County Schools. She also works for the STEM immersion camps called *gidaakiminaniwigamig* in a variety positions for the past 20 years. Encouraging American Indian students to enter into careers in a science and math field has been a lifelong passion. Watching American Indian children find the connections to; begin to develop their unique perspectives, and to place value on their traditional knowledge is a remarkable journey. Lowana is licensed 1-6 Elementary education and a K-12 Bilingual/Bicultural education.

Courtney Kowalczak, MEd, has over twenty years of experience in water resource research and educational outreach. Currently Courtney is Fond du Lac Tribal & Community College's Environmental Institute Director where she oversees coordination of research and extension projects between Fond du Lac Tribal & Community College and other partners. These projects include the NASA *Gidakiimanaaniwigamig* (Our Earth Lodge) STEM Camp: Investigating climate change and its effect on Ojibwe lifeways, EPA Tribal EcoAmbassador Dragonfly Research project, and USDA NIFA funded projects such as the St. Louis River - River Watch, Bimaaji'idiwin Ojibwe Garden, Building Capacity in STEM, and Thirteen Moons.

Antony Berthelote, PhD, is a descendent of the Pend D' Oreille, Salish, Kootenai, Lakota, and Chippewa Cree peoples. He holds a Bachelors in Geology, Masters in Geophysics, and a PhD in Geosciences. Dr. Berthelote is currently the Head of the Hydrology Department he helped create at Salish Kootenai College in Montana, the only geosciences degree program at a Tribal College or University. He has been directly involved with the Geoscience Alliance since 2009, a National organization dedicated to increasing Native American participation in the geosciences, he is the SKC AISES Chapter Advisor, AIHEC Science Bowl coach, and helps advise the SKC Student Senate through the Student Advisory Council. He has completed Kootenai, and Pend D' Oreille aboriginal watersheds in Montana. His past research projects have primarily focused on surface water-groundwater characterizations using hydro-geophysical methods but is now focused on Education and Diversity initiatives for undergraduates. Dr. Berthelote has a passion for

protecting native lands, increasing STEM capacity in Indian country, and educating the next generation of environmentally responsible Native leaders.

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