AC 2011-184: A UNIQUE UNIVERSITY-TRIBAL COLLEGE COLLABORATION TO STRENGTHEN NATIVE AMERICAN PATHWAYS TO STEM EDUCATION

G. Padmanabhan, North Dakota State University

G. Padmanabhan, Ph. D., P.E., M. ASEE, F. ASCE is a professor of civil engineering at North Dakota State University, Fargo, North Dakota. He is a long standing member of ASEE and ASCE. Currently, he is also the Director of North Dakota Water Resources Research Institute. He has been active in STEM education outreach activities to minorities at the college and high and middle school levels for the last ten years.

Robert V. Pieri, North Dakota State University

Bob Pieri is Professor of Mechanical Engineering at NDSU in Fargo, ND. He has many conference publications on engineering education and design. His primary professional interest areas include: Engineering Education, CADD, Design, Fracture Mechanics, Materials Science and Alternative Energy Options. During the 2003-2004 academic year, Dr. Pieri spent a sabbatical teaching math & engineering courses at Turtle Mountain Community College on the Turtle Mountain Reservation in North Dakota. Since the fall of 2008, Dr Pieri has held the position of Coordinator of Tribally Controlled Colleges NDSU Partnerships under joint appointment to the Equity, Diversity and Global Outreach Division, Extension Service and Mechanical Engineering Department. In this unique position, he actively works to develop authentic partnering opportunities with the TCC’s and many disciplines across campus. Prior to joining NDSU, he taught for 10 years at the US Air Force Academy. Prior to his time at USAFA, Dr Pieri was a Research & Development Engineer with the Air Force, studying problems of pollution in the earth’s atmosphere.

Carol Davis, North Dakota State University

Dr. Carol Davis is a member of the Turtle Mountain Band of Chippewa. Among her educational experiences that she considers important is the time she spent in a boarding school for American Indians in South Dakota. She married Lynn Davis, also a member of the Turtle Mountain Band of Chippewa, 44 years ago and they raised six children there at Turtle Mountain. She still resides with her husband on the Turtle Mountain Reservation where she enjoys spending time with her family, especially her fifteen grandchildren. She received her bachelor’s degree in elementary education from Mayville State University in 1980. She taught middle school for eight years. She earned her Masters Degree from the University of ND in 1989 and was assistant high school principal for one year before transferring to Turtle Mountain Community College, a tribal college on her reservation. She remained there for seventeen years as an administrator. During her tenure, she received a doctorate in education in 2000 from Walden University. For the past 4 years she has worked for North Dakota EPSCoR as the Tribal College Liaison. In that position, she is helping to create a pathway for American Indian high school and tribal college students into STEM careers through STEM camps and Sunday Academies. She also supports the ND EPSCoR/Tribal College research capacity building effort at the five North Dakota Tribal Colleges.
A Unique University-Tribal College Collaboration to Strengthen Native American Pathways to STEM Education

Abstract

The authors and some of their colleagues have been engaged in strengthening the STEM education pathways in the North Dakota Reservations for the past eleven years through several activities. The focus of the activities have been at the interaction of tribal high school, tribal college, mainstream universities and engineering profession stakeholders to facilitate the recruitment, education and support of tribal students to acquire and hone the skills that will allow them to enter the engineering profession. Throughout this period the collaborative activities were carried out in a culturally sensitive and supportive fashion. Collaborative activities started with one tribal college in the State and developed to its full scope when all five tribal colleges joined the effort. One on one university-tribal college collaboration is not uncommon. However, this collaboration is unique in engaging the two mainstream universities, all the five tribal colleges, and Reservation high schools in the State. The student pathways are engaged at various entry points: middle and high school, tribal college, and universities and also at different personnel levels: administrators, faculty, and high school teachers. All of the activities such as Sunday academies, summer camps, and research mentoring were developed collaboratively with input from tribal college and university faculty and high school teachers. Such a collaborative approach allowed us to develop activities common to all participating sites and at the same time to retain the unique needs of the individual sites. This approach also provided a leveraging of engineering professors’ time for content vs. the tribal high school instructors’ efforts on student connections and delivery pedagogy. Another unique feature is that we were successful in having some of the students who participated in these activities aid the process as peer mentors/instructors. For example some of the college students who benefited from this program earlier were helping us in the high school summer camps. This paper will summarize the experience of the authors with the university-tribal college collaborative effort over the last eleven years: how did it all start, where does it stand now, and what lessons did we learn.

Background

North Dakota has approximately 30,000 Native Americans (NA) distributed geographically in four reservations. It is the fastest growing population in the State. They represent about 5% of the total population of North Dakota. Each Reservation is served by a tribally controlled college (TCC): Cankdeska Cikana Community College (CCCC), Fort Berthold Community College (FBCC), Sitting Bull Community College (SBC), and Turtle Mountain Community College (TMCC). One other TCC, United Tribe Technical College (UTTC) is not located on a Reservation. These TCCs are vital links for higher education on Reservations. Most of the high school students on the Reservations aspiring to pursue careers in STEM areas are likely to enroll in the TCCs first and then move on to four-year universities. The TCCs continue to make great strides toward improving the lives of their members on the Reservation by creating culturally sensitive educational opportunities. However, there is concern with the low enrolment in STEM courses. NA students have not traditionally been drawn to higher level math and science courses. It is essential to offer additional math and science exposure to all students to attract and prepare them for math, science and engineering careers. As premier universities of the State,
North Dakota State University (NDSU) and University of North Dakota (UND) have always been keenly aware of the TCCs positive impact on their communities despite their limited resources. The two research universities in the State are in a unique position to work with the TCCs and Reservation schools to design new and strengthen the existing pathways for students to launch STEM careers. If done collaboratively by the university and tribal college faculty and teachers, these activities are more likely to be better designed and delivered.

Collaboration

Throughout Indian country, there are initiatives that are attempting to stimulate Native American students to launch science, technology, engineering, or mathematics (STEM) careers. In 1998, the North Dakota tribal colleges had been the recipients of National Science Foundation Rural Systemic Initiative program funds to enhance STEM programs on their campuses\textsuperscript{1}. The desire and in some cases, the institutional infrastructure for Native American students to seek careers in STEM at the North Dakota tribal colleges was beginning to take shape, but the students were not declaring STEM majors. This was becoming a concern at the tribal colleges. In order for this situation to improve, programs not only to motivate the NA high school students to pursue college education in STEM but also to guide and nurture them through graduation need to be developed. Pathways need to be developed and/or strengthened for students K-12 and beyond. Another 5-year grant from the Office of Naval Research (ONR) paved the way for a strong collaborative project\textsuperscript{2}. A core group of faculty from the universities and tribal colleges worked together to conceive, design, and implement different STEM-enhancement activities for the tribal college and Reservation high and middle school students\textsuperscript{3}. This project with the participation of extremely dedicated faculty established a collaborative platform which is often the most difficult thing to accomplish. As the ONR funding ended in 2004, the North Dakota Experimental Program to Stimulate Competitive Research (NDEPSCoR) agreed to include the project in their proposal to the National Science Foundation (http://www.ndsu.edu/epscor/NATURE/index.html). The project continued with the funding from NSF under the title Nurturing American Tribal Undergraduates in Research and Education (NATURE). Major activities under the project continued to be Sunday Academy\textsuperscript{4} and Summer Camps\textsuperscript{5,6}. A tribal college student research mentoring component was added to NATURE in 2007 as a pilot program funded by the National Science Foundation Tribal College and University Program. It was later included as a component of NATURE by ND EPSCoR\textsuperscript{7}. The collaboration has expanded continually from 1998 to the current status. The collaborative activities were supported also by other grants such as the National Science Foundation Rural Systemic Initiative (RSI) and Tribal College and University Program (TCUP), the National Institute of Health Biomedical Research Infrastructure Network (BRIN), and the Packard Foundation grants. Resources from and collaboration with other NDSU, UND, and TCCC programs are constantly sought to continue and enrich the pathway activities. It should be noted that the tribal colleges have enriched their local efforts by obtaining funding from a variety of sources to enhance NATURE. While there are elements of NATURE in programs at tribal colleges in other States, no one has created a pathway to STEM careers that identifies NA students in high schools and nurtures them utilizing a culturally appropriate STEM curriculum through their bachelor’s degree and beyond.
Component Activities

The program components included enrichment activities for Reservation middle and high school students (Sunday Academy and TCC Summer Camps) and activities to facilitate smooth transfer of tribal college students to four-year colleges or universities (University Summer Camp and undergraduate research experience).

Sunday Academy

The academy sessions (seven per academic year) are designed to relate mathematics and other sciences to problem solving with carefully selected examples. Each lesson begins with a tribal leader correlating the lesson with cultural knowledge. The instructors introduce mathematics, physics, chemistry, biology, geology, and computers, all in problem solving contexts.

High School Summer Camps

Each participating tribal college hosts the summer camp for the high school students in their vicinity. University professors, TCC faculty, cultural teachers, and high school teachers participate in the camp instruction. This camp also provides a great opportunity for university faculty to experience an immersion in the native culture.

NDSU Camp for TCC Students

This camp has two tracks, one for students and another for the TCC faculty and high school teachers. Besides academic sessions, laboratories, and industry visits, students at the camp are provided opportunities to participate in the activities of the university multicultural student service center, student chapter of American Indian Science and Engineering Society, and other local NA organizations. The TCC faculty and teachers work with university professors to develop lesson plans for the Sunday Academy sessions and high school summer camps. One of the unique features of this camp is both tribal college faculty and the students come together on the university campus. Though the faculty have a parallel track of activities designed for them separately, this camp presents a great opportunity for the tribal college faculty to become familiar with and observe the students as they engage in STEM lessons.

The lesson plans for the high school camps and Sunday Academy are developed collaboratively by the university, and TCC faculty and high school teachers during the university camp at NDSU. Before the beginning of the academic year, the participating faculty and teachers meet again at NDSU in a 3-day workshop to finalize the hands-on, minds-on Sunday Academy activities proposed for the succeeding year.

Another unique feature is that we were successful in having some of the students who participated in the summer camp activities aid the process as peer mentors/ instructors.

Research Experience for Tribal College Students and Faculty

The research component has two goals. One is to promote undergraduate research capacity building at the tribal colleges and the second is to retain NA students in STEM careers. To
accomplish these goals, each year two stem tribal college faculty from each TCCC receive training to mentor two NA TCC students as they engage in research at their respective TCCs. Each TCC faculty mentor is teamed with a university professor with research experience who mentors the TCC research.

Scholarships

Another component of the project in the initial five years provided scholarships and opportunities for students to participate in cooperative work experience positions with professionals from mathematics, science, and engineer disciplines in the private sector. Scholarship ranging from $1000 to $5000 at various stages –high school to TCC and TCC to NDSU-- were awarded. The participating university faculty members served as mentors to the students to fulfill their scholarship expectations.

Outcomes in terms of Student Progress

At least in one of the participating tribal colleges, the number of students declaring Associate of Science as a major has increased from 31 in 1988 to 204 in 2010. Thirteen students have graduated with STEM bachelor degrees. Four have graduated with engineering bachelor degrees. Two have received STEM doctorate degrees. One is currently registered in an environmental science doctoral program, and two in M.S. program in engineering. At least eight graduates have entered the STEM workforce and are currently holding responsible positions. Currently, we have a number of students in various levels of undergraduate STEM programs.

Approximately 50-60 students in the program have attended/presented in local and regional engineering conferences on their research carried out under the research experience component of NATURE. In three of the participating tribal colleges, courses on research skills are being taught since last year.

One of the students researched the prevalence of radon in homes on the Turtle Mountain Reservation for four semesters before she went on to earn her bachelor's degree in secondary science teacher education. She became a certified science teacher and currently teaches science at one of the schools immediately adjacent to the Turtle Mountain Reservation where the student population is made up of 95% tribal students.

North Dakota EPSCoR sponsored a state-wide cyberinfrastructure conference over the interactive video network March 3, 2011. The event was broadcast to all of the state colleges, universities, tribal colleges, and various agencies and K-12 schools with approximately 250 participants in attendance. One of the presenters in the day-long conference was a student at Turtle Mountain Community College who is doing a multi-phase research project on leeches located in waters on the Turtle Mountain Chippewa Reservation sponsored by NATURE. The student and his tribal college mentor were joined by two international leech experts from Southern Utah University. The purpose for their presentation was to share the student’s research on the eating habits of leeches, *Glossiphoniidae complanata*, in their natural environment and provide an example of an interstate collaboration that would benefit from expanded bandwidth. The rural colleges in ND have similar limited bandwidth issues.
Continuing Partnership

North Dakota State University recently began participating in a collaboration funded by the National Science Foundation, TCUP PEEC program. The collaboration is titled 2+2+2+Infinity: Pipeline for Tribal Pre-engineering a cross-cutting program that collaborates with NATURE to focus on the American Indian students that intend to pursue careers in engineering. This collaboration among ND tribal colleges and NDSU is the culmination of more than 11 years of active engagement in STEM education on the reservation via ND EPSCoR and the NATURE Program. The TC-University partnerships have been the drivers for leading to the PEEC proposal and subsequent award. Associate of Science (AS) Degrees offered at the participating tribal colleges are enabled by this collaboration agreement to bring some of the NDSU engineering courses into CCCC, FBCC, TMCC, and UTT. PEEC envisions that students completing their AS will transfer to a research university to complete their third and fourth year leading to a BS in engineering. Under this effort, engineering faculty have been hired at one or two of the participating tribal colleges. The first engineering course in the program from NDSU started this semester using teleconference resources with support from on-campus faculty at the collaborating colleges. NDSU Native American students have been hired by the grant to aid in the identification of transferring students’ needs and possible strategies to improve transfer strategies for retention. Talks about a common pre-engineering curriculum are continuing.

Key Factors for the Success of the Collaboration

Cultural Relevance

The cultural contexts of the topics were emphasized. Many educational researchers have noted that students experience an increase in academic achievement when instructors use content that relates to the students’ lives. NA students will have a more positive attitude toward learning science topics if the curricula included Native cultural knowledge. Examples of traditional activities in the NA culture were related to the science topics whenever possible. It is important for the students to be convinced that science and technology are not in conflict with their culture and belief system. In the NATURE program the faculty and teachers made a sincere attempt to find suitable material and accommodate it in the lesson plans to highlight the relationship of the topic to the cultural background and way of life of the Native Americans.

Learning Styles

Another aspect of culturally relevant teaching is to accommodate the learning styles of the particular minority group, in this case NA students. While NA students as a whole do not have one learning style preference, many NA students tend to prefer hands-on activities, particularly in outdoor situations. Therefore, many outdoor and hands-on activities and field visits were included in the curricular activities.
Experiencing American Indian Culture

Cultural awareness is critical in adapting to culturally relevant teaching and mentoring. Incorporating Indigenous science concepts into lessons helps to bridge the NA students’ life experiences with current STEM concepts. Opportunities for learning each other’s culture were built into the project activities. NDSU faculty participating in the Sunday Academy and Summer Camps at TCCs experienced the AI culture at a variety of levels. Activities such as tribal ceremonies, social functions, history lessons, visits to historical sites, and discussions with tribal historians, elders, and officials who carry out the tribal constitutions were also arranged. In addition, the camp activities offered opportunities for conversations with the elders and the parents of the students. The cultural awareness activities provided NDSU faculty opportunities to develop sensitivity to students’ needs.

Collaboration with TCC Faculty and High School Teachers

Most teachers in North Dakota reservation high schools have high teaching loads and some are inadequately prepared and equipped to explain science and engineering concepts. One of the reasons identified for declining interest among high school students in mathematics and science is the way these subjects are taught in high schools. This is not to say that the teachers are not qualified. The majority of high school teachers are inadequately prepared to teach these subject areas in interesting ways that keep students motivated to pursue a career in STEM. There is clearly a lack of information and resources for high school teachers to improve their knowledge and readiness to spice up their teaching with applied examples and hands-on activities.

Many universities offer summer and regular school year programs for high school teachers for professional development. High school teachers typically work with the university faculty on methods and techniques for effective teaching, advising etc. The academic sessions as conceived in NATURE involve high school teachers at all stages from the topic selection, content development, instruction, evaluation, and feedback. The sessions provide the teachers excellent opportunities to interact with the engineering and science faculty and high school students to observe and contribute to the motivational and skills-development aspects.

Lessons Learned

The project hinged very much on the successful collaboration among the university professors, TCC faculty, and the high school teachers. Institutional and cultural sensibilities do come into play. It is absolutely essential to develop a mutually trusting atmosphere in the collaborative process. Some of the elements, the importance of which became apparent as the project progressed are:

Cultural

NDSU faculty, teachers and TCC faculty gain a better understanding of each other’s culture. Mutual visits and face-to-face meetings with TCC faculty and reservation school teachers are important. Students bridge their culture with the formal lessons. Continued building of trust with the participants, both at the professional and personal levels is of utmost importance. Mutual
visits allowed spending considerable time with the participants over breakfasts, lunches, and other social settings. Professionally, it extended to try to understand the day-to-day context of the working positions of the tribal participants. We believe the interaction with parents and siblings was very important. In NATURE, such interaction occurred at closing ceremonies of activities to some extent. We were there to see generations of families and the occasions allowed us to obtain a level of trust impossible over a long-distance phone call or single visits (even if they are several days long). Showing up for the “not so great times” is also important, i.e. funerals, illness, students returning to home, etc.

**Faculty and Teachers**

High school teachers have varied academic backgrounds and teach many different subjects. In some of those subjects they are not certified as highly qualified in accordance with North Dakota State Standards.

TCC faculty and high school teachers need to be engaged from the beginning stages of the lesson plan development all the way to lesson delivery. If the lesson plans are developed and given to them, although happy initially, they do not seem to be happy implementing them as intended.

Hands-on activities need to be included and supervised properly to develop problem solving and analytical skills. The activities need to be tested well in advance. There is a common tendency to believe it will work once conceived on paper.

Though direct interaction between NDSU and Reservation high school teachers was not envisaged in the original proposal, it became increasingly clear that such interaction did improve the delivery of the activities considerably and therefore was retained as a key feature of the collaboration.

**Students**

The lesson topics, when connected to NA relevance, appeared to retain the attention of students better. Hands-on activities and field work appear to interest the students most. Stipends are important to attract students because of poverty on the Reservations.

**Parents**

Inviting parents into on-going hands-on sessions provides an opportunity for the parents to observe their children involved in science activities. It worked well. Many parents did attend such occasions and that appeared to motivate them to encourage their kids to attend these special programs.

**Conclusions**

This collaboration among two universities, five tribal colleges, and Reservation high schools is unique in the nation. The collaboration has successfully developed pathways for NA students
from Reservations aspiring to pursue STEM careers. The impact of the collaborative activities and the lessons learned are very encouraging. The unique challenges faced by the Reservation youngsters that discourage them from pursuing STEM degrees and career have been explored by this collaboration. The academic activities developed and presented are successful in fulfilling their purpose of motivating the high school students to consider a college education. A solid university-tribal college collaborative platform has been established via NATURE and its predecessors. The platform could serve as a launching pad for other collaborative STEM initiatives.

References


