Scholarly Guideposts for TCUP Faculty

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QUALITY EDUCATION FOR MINORITIES (QEM) NETWORK
STEM Leadership Development Project for the National Science Foundation (NSF)’s Tribal Colleges and Universities Program (TCUP)
ABOUT THIS DOCUMENT

_Scholarly Guideposts for TCUP Faculty_ is one of two publications for which the Quality Education for Minorities (QEM) Network received National Science Foundation (NSF) support under Award #0832260 from the Tribal Colleges and Universities Program (TCUP). _Scholarly Guideposts_ seeks to provide STEM faculty and staff at Tribal Colleges and Universities (TCUs) as well as Alaska Native-serving and Native Hawaiian-serving Institutions the opportunity to share their knowledge of Science, Technology, Engineering, and Mathematics (STEM) teaching and outreach.

Since 2001, NSF TCUP has been a catalyst for the development of STEM research and education initiatives at TCUs, Alaska Native-serving institutions, and Native Hawaiian-serving institutions. _Scholarly Guideposts_ seeks to capture perspectives and insights of faculty and staff from a range of initiatives at TCUP grantee institutions, and of other individuals with extensive knowledge of and/or experience in the higher education of Native Americans, to share with the broader STEM community.

This document will be available electronically to enable dissemination to a wider audience of STEM scholars and teachers.

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ABOUT THE QEM/NSF TRIBAL COLLEGES AND UNIVERSITIES PROGRAM (TCUP) STEM LEADERSHIP DEVELOPMENT PROJECT

The Quality Education for Minorities (QEM) Network received a grant from the National Science Foundation (NSF) in support of leadership development in Science, Technology, Engineering, and Mathematics (STEM) at the Nation’s Tribal Colleges. QEM’s project is designed to further the goals of the Foundation’s Tribal Colleges and Universities Program (TCUP).

QEM’s STEM Leadership Development Project emphasizes faculty and staff professional development as a mechanism for building institutional capacity. Consequently, the project provides a range of activities to meet the needs of Tribal Colleges and Universities (TCUs), Alaska Native-serving institutions, and Native Hawaiian-serving institutions. Workshops focusing on curriculum, infrastructure, and/or faculty professional development are offered to prospective TCUP applicants, while special workshops provide support to current multi-year grant recipients related to project implementation, grants management, and student development.

Professional development activities for TCUP faculty are designed to stimulate faculty scholarly growth and expand STEM teaching capacity. The QEM/NSF TCUP Project also offers summer internships to provide students enrolled at TCUP institutions the opportunity to become familiar with science and science education policies and how they affect the education of American Indians and other Native Americans. Collectively, these activities are designed to provide an intensive level of support for TCUP-eligible institutions that is consistent with the goals of NSF’s TCUP program.

It is anticipated that the Project’s workshops, internships, and other professional development activities will benefit participants well beyond the life of the grant through resource development/management and the leadership enhancement of STEM faculty and students.
The Ten Commandments of Establishing and Maintaining a Viable Research Program: A Guide for Faculty at Small or Minority-serving Institutions

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Author’s Foreword
This short communication is intended to serve as a guide for science faculty at small institutions where research has not been a key component of the academic environment but where faculty and, hopefully, the administration have realized the value of establishing and maintaining active research programs as an integral part of a successful and productive science training program. Such institutions may include community or city colleges, small four-year institutions, and minority-serving institutions such as tribal colleges. After developing two research laboratories - one at a tribal college in western Montana and a second at a major university - I am in a position to share with readers the obstacles, pitfalls, essential requirements, and rewards associated with establishing and maintaining a viable research program.

It is my hope that by sharing this information, which has light-heartedly been formatted in terms of a set of commandments, more science faculty across the nation will choose to answer the call for increased engagement in the scientific endeavor, especially by those from groups which have historically have been underrepresented in the modern scientific community. In my opinion, there is no better way to teach science to students than to do science with students. This includes sharing every detail, from the development of a line of research based on a simple curiosity or a national need, to the completion of a project and subsequent publication of results. For those who choose to take-up the challenge of establishing a research program at a traditionally non-research oriented institution, I wish you the best of luck and hope to see your papers in peer-reviewed scientific journals in the near future.

Commandment #1:
Thou shalt obtain institutional commitment

Without institutional commitment, efforts to establish a research program are a complete waste of your time. Unless your administration truly believes in the value of faculty and student engagement in scientific research, you will find yourself in a mental institution pulling your hair out rather than in a new lab doing science. There is no better way for your institution to show commitment than by offering space, time, and money. In terms of space, request the best space available on-campus to establish your facility. It does not necessarily have to be a large space. Consider the type of research you are pursuing (e.g., chemistry, biochemistry, microbiology) and determine the types of instrumentation, equipment, and utility outlets that will be required. This will help to guide your request for lab space. Do not underestimate the costs of installing water
The Ten Commandments of Establishing and Maintaining a Viable Research Program: ...

lines, gas lines, vacuum lines, electrical outlets, and so forth. A smaller space with more utilities is often better than a larger space that lacks this infrastructure. In terms of time, emphasize to the administration that establishing a research program is a time-consuming endeavor. Secure commitments for “release time” to reduce your teaching load, especially during the initial stages of starting up your research program. Release time is an essential requirement for success. (Believe me, it is nearly impossible to teach five classes per quarter, write grant applications, and develop a lab. You will find yourself stressed out and running into doors as a result of fatigue.)

In terms of money, your institution should be willing to assist with some start-up funding. However, this will vary among institutions. There is no better sign of institutional support than for your administration to provide you with start-up funds. It is acknowledged that economic constraints, or even lukewarm administrative support, may leave you without start-up funds. If you find yourself in a “chicken-versus-egg” dilemma such that the administration will not commit space, release time, and start-up unless you, the faculty member, have secured external funding, then reconsider your efforts. It is difficult to secure extramural funding without a viable research facility and sufficient time (i.e., release time) to develop the proposals that bring in external funds.

However, if you decide to proceed anyway, expect to make a lot of personal sacrifices. This includes working off-hours to write the grant proposals and to develop dedicated lab space. In any case, be sure to establish working relationships with functioning labs so that adequate facilities are available to complete the proposed work while your laboratory is being developed. Attach letters of commitment from collaborating labs to your grant applications so that reviewers are aware that you have access to adequate facilities to complete the work being proposed. Typically, the more successful you are at securing external funding, the more institutional support you will realize. Remember the institution typically takes a percentage of the awards that you bring in under the category of “indirect costs” or “overhead.” Ask for a portion of those indirect costs to be returned to you to further support your research program.

Commandment #2:
Thou shalt prepare thyself intellectually and technically

In many cases, faculty at smaller institutions have not actively engaged in scientific research or been engaged in research for many years. In fact, at many smaller institutions faculty are not required to hold a doctoral degree in order to teach. Therefore, these faculty members have not experienced the rigor of starting, completing, and publishing a significant scientific project. In order to establish and maintain a viable research program, one must be certain that he or she fully understands what is meant by “publishable research.” Publication is the measure of a viable research program (see Commandment #8). Whatever your research interest, you must be aware of the latest concepts, theories, and experimental results from investigations within your chosen area of study. A comprehensive literature review is the minimum requirement for initiating a new research program. This includes a thorough understanding of and, when possible, “hands-on” experience with the latest techniques, tools, and instrumentation being used in the field.

This is not to say that every master’s degree-prepared faculty member must complete a doctorate. It is possible to establish a viable research program by building strong collaborations with successful scientists at other institutions (see Commandment #3). However, keep in mind
that “collaboration” is a two-way professional relationship and you must bring something to the table – namely, a knowledge base and a skill set complementary to that of your collaborator(s). Preparing yourself intellectually and technically greatly improves your chances of securing funding and completing a research-based doctorate does demonstrate competence.

**Commandment #3:**

*Thou shalt form strong and productive collaborations with successful scientists at major research institutions*

There is no better way to establish and maintain a viable research program than to work with others who have already done it. Whether it is with a principal investigator at a major university, a government research facility, or a private research laboratory, building research collaborations with established scientists who have similar research interests as you is the most important component in establishing your program. Do a summer internship at a collaborating laboratory. Go to another lab for a week during your spring break, if it does not overlap with spring break at the other institution. Invite a post-doctoral scholar or graduate student from a collaborating lab to visit your lab.

Whatever it takes, build professional relationships with successful researchers. These are often the people who will help you complete that first grant application. Their labs are often where you will collect that first set of preliminary data, which will be used in your grant proposals. Their labs are often where you will get the “hands-on” experience and technical training required to establish your own viable research program. But, again, collaboration is a two-way relationship. Be sure that you are a productive component of the collaboration. If you are always asking for assistance but never offer anything in return, your collaboration will likely be short-lived. Productive collaborations can result in co-authorship on peer-reviewed publications in the area of study upon which your research program will be built.

**Commandment #4:**

*Thou shalt secure IRB approval, sampling and/or animal-use permits*

If you intend to use human subjects in your proposed research program, one of the tasks that you can never start too early is securing approval from your institutional review board (IRB). IRB approval is typically required for any research that involves human participation or human tissue or blood samples. Even social and behavioral science research will require approval from an institutional review board. For tribal colleges, the tribal government may have an IRB in place if your school does not. In many cases, tribal institutions will have other concerns regarding the research that you wish to perform (e.g., cultural intellectual property issues).

Getting IRB approval prior to submitting a grant application for proposed research and, certainly, for conducting any research that falls under the auspices of IRB consideration should be done as soon as possible. If your proposed research requires environmental sampling or the use of animals, securing the appropriate permits is essential from the start. The submission of copies of such approvals and permits are often an integral part of the grant application process. Be certain that your research program will not be halted due to failure to comply with permitting processes.
Commandment #5: Thou shalt apply for extramural funding

The key to maintaining (and often establishing) your research program is external money. As you are probably already aware, laboratory supplies and equipment are very expensive. Furthermore, if you acquire extramural funding, this will often give you the leverage you need to convince your administration to provide you with release time. Often, external funds will allow you to engage students in your research program. External funds may be funds from government agencies such as the National Science Foundation, National Institutes of Health, National Aeronautics and Space Administration, Department of Defense, Department of Energy, Environmental Protection Agency, and others. Funding may come from private sources such as the Bill and Melinda Gates Foundation or from private industry. Talk to program officers and research officers at such agencies and institutions to determine which solicitations might be most appropriate for the line of investigation you wish to pursue.

Carefully read all application materials, noting submission deadlines and requirements for letters of support, copies of permits, and so forth to ensure that you are in a position to prepare a competitive proposal. Then, read, read, and read some more. Do not start to write a proposal before you have had an opportunity to read and review a successful proposal. If you do not know the language or agency-specific jargon and what is expected from a funding source and decide to write a proposal anyway, you will be wasting your time. The best way to write a competitive grant proposal is to know what one looks like. So, read, read, read and then write, write, and write some more. Most importantly, do not give up. Funding success levels can often be as low as 5%, depending upon the agency and number of applications. If your proposal is declined, carefully read the review comments and try, try again.

Commandment #6: Thou shalt develop thyself professionally

Apart from preparing yourself intellectually and technically for the line of research on which you plan to develop your program, you must develop yourself professionally through other means. Attending workshops and conferences, and serving on grant proposal review panels or as a peer reviewer for journals will greatly add to your general intellectual development and help you to differentiate between poor or mediocre science and good or great science. Having a base upon which to gauge your own scientific pursuits is an essential requirement for establishing and maintaining a productive research program.

If your teaching responsibilities will not permit you to travel to attend panels, then request to be an ad-hoc reviewer so that you can participate in the review process using web-based resources. However, if at all possible, try to personally attend panels and workshops. Moving around in the scientific community helps to build those strong collaborations that were mentioned earlier. Plus, some of the people you meet at panels may someday end up reviewing one of your proposals. Network, communicate, and build professional relationships as part of your personal professional development.
Commandment #7:
Thou shalt mentor students

A scientist is only as good as his or her students. People who claim to be scientists but who are not also mentors are not really scientists. The scientific endeavor is based on the idea that the work performed will someday lead to an enhancement in the quality of life. It often takes decades to get from the point of initiating a line of research based on an idea or a curiosity to the point of implementing results from that research into something tangible that benefits aspects of life. Even research that has a shorter ‘return on investment’ time period will often take years. Without students and apprentices to carry on the work, a line of research may never reach the goal of contributing to the enhancement of life.

Mentoring students is an integral and necessary component of engaging in the scientific process and must be an integral part of establishing and maintaining a viable research program. Yet, student engagement is probably the most tricky and time-consuming aspect of research. In fact, addressing all of the aspects of student involvement in research would comprise a much larger written work. Here, a few key aspects are provided as guidance.

When planning your research program, plan for student involvement. This means providing realistic estimates to the administration and to funding sources of the number of students per quarter or semester that you can effectively mentor as part of your research program. Although there is always a strong emphasis on high numbers, it is better to build close mentor-student relationships with a few students than to spread yourself too thin between too many students and end up adequately serving none. Also, plan on long-term student engagement. Science is slow, thus mentor-student relationships must be long-term to be productive.

Student selection is critical. Although lab rotations and temporary internships are excellent ways to provide students with initial opportunities in the sciences, only select those students who are emotionally prepared to work with you on a long-term basis. Students must be advised up-front that research requires dedication, long-hours, and, ultimately, sacrifice. If they are not prepared to commit in this manner, then you are only doing yourself and the student a disservice by keeping them in the program. Students must be advised that research internships and assistantships are not “financial aid” but are opportunities for them to develop themselves while receiving modest compensation. Coming to work in a lab “for the money” is not a good way to start a mentor-student relationship and will only result in a tenuous faculty-student relationship.

Be smart about developing student projects. Once you identify a dedicated and willing student, be sure to appropriately train the student in laboratory safety protocols. Also, be sure that the student has been appropriately trained on how to use and maintain laboratory instrumentation. Most importantly, ensure that the first project you assign to a student is a “sure thing.” Building confidence early in a student’s research effort is essential for retention and developing a good mentor-student relationship. Never ask a student to do something that you cannot do yourself early in the research experience. As time moves forward, the student will certainly learn the frustrations of research, but, in the beginning, design projects for the student that have a high probability of success. As the student advances, experiments with less certain outcomes can be assigned, and it is perfectly acceptable for a mentor to disclose to a student that the experiment or procedure is not well-developed.
Overcoming obstacles, dealing with experimental confounds, and struggling over difficult to interpret results are all part of research, and students should be informed ahead of time that the mentor does not always have the immediate “right” answer. Never assign a project to a student that is a critical component of your funded grant proposal. Do that work yourself! Your research award is your award. You alone are responsible for fulfilling the aims of the project. It is a disservice to the student and potentially disastrous to your research program to delegate a critical line of experimentation to an undergraduate student. There are, of course, exceptions to this rule. If you have a very advanced graduate student or a post-doctoral scholar who has demonstrated superior performance in a research environment, then an advanced project may be delegated. However, at a community college, tribal college, or small four-year college, these types of personnel are not likely to be available.

Encourage students by offering opportunities for presentation at conferences and/or authorship. Nothing keeps a good student researcher better engaged than the potential to show-off his or her research results at a national conference. As best as possible, outline in detail the amount and type of data that would be required to submit a quality research poster or oral presentation at a national conference. Then, assist the student in setting a series of milestones and a schedule to reach those milestones. This will help both you and the student to gauge research progress. If the student completes a series of projects with increasing complexity and has presented his or her results at a research conference, it would be prudent for the mentor to offer co-authorship on an impending publication resulting from the work. The mentor should be very clear about the expectations for student co-authorship. Likewise, the student should demonstrate to the mentor that he or she is aware of the requirements for authorship and acknowledge that if those requirements are not met, then the offer of authorship is rescinded.

Mentors must emphasize the importance of academic performance. If a student does not progress successfully through his or her degree program, then future opportunities to engage in research may be limited. Mentors have a responsibility to ensure that a student’s academic progress is not suffering as the result of participating in the mentor’s research program. Often, students will take to the lab or field and find that research is more enjoyable than sitting in a classroom or reading a textbook. It is the research mentor’s responsibility to emphasize the importance of both classroom and laboratory/field activities. After all, it is often the case that if the student does not make the grades, he or she may not be eligible for funding mechanisms that support student research activity.

There are other critical guidelines to mentoring students that could be extensively discussed. However, in the interest of brevity, it can simply be said that appropriately and successfully mentoring students is key to establishing and maintaining a viable research program.
Commandment #8:
Thou shalt present and publish thy research

As mentioned earlier, the measure of success in research is publication in peer-reviewed scientific journals. When your work is recommended for publication by other established scientists in the field of study, you can feel confident that you have established a viable research program. However, this is not an easy achievement for a new research program. Acquiring sufficient data and learning how to most appropriately present these data in the context of previously published work can take years. As a precursory step to publication, present your preliminary findings at regional or national research conferences. This will help you to refine your line of experimentation, identify gaps in your experimental approach, and hear what your peers have to say about your work. As you progress in your research and, ultimately, acquire enough data for a manuscript, talk to your collaborators to decide on the most appropriate journal for submission of the work. Rely on more experienced and well-published collaborators to assist you in the preparation of your manuscript.

Getting your work published in high profile journals can be just as difficult as getting extramural research funding. Given this, the same should be said about publication: If at first you get rejected, carefully read the reviewers comments and try, try again. Although the “publish or perish” paradigm is typically employed at larger institutions, you also should hold yourself to a “publication or bust” standard, even if tenure is not on the line for you. Publication shows funding agencies that you have productively used their money. Or, in the case of federal funding sources, publication shows that you have productively used the nation’s wealth (i.e., the taxpayers’ dollars).

Publication also is a key element of consideration during reviews of grant applications. I cannot recall a single panel on which I served where someone did not ask, “what’s his [or her] publication record like?” If you receive funding and do not publish, your chances for subsequent funding decrease significantly. And again, without funding, you are not going to be able to maintain your research program.

Commandment #9:
Thou shalt diversify thy research program

Once you have established your research program, consider smart ways to maintain it. One of the smartest things you can do is diversify your research in a manner that makes your studies appealing to more than one funding agency. For example, I study extremophiles. Specifically, I study archaeal viruses (and their hosts) that inhabit high temperature acidic volcanic hot springs – a topic that would be fairly boring to most people, I guess. However, by asking questions that relate extremophile biology to the effort to identify microbial-based extraterrestrial life, I was able to make this topic appealing to a NASA review panel. By asking fundamental questions related to the evolution of virulence and the emergence of viral-based infectious disease, this topic is now appealing to certain study sections of the National Institutes of Health. By developing thermophile enzyme sequestration platforms for biofuels production enhancement, the topic was of interest to the National Science Foundation and the Department of Energy.
Still, I study the same class of microorganisms but simply ask a different set of questions and pursue different lines of experimentation to fulfill the fundable interests of different agencies. It is important to note that only on rare occasions can two awards be granted for the same research effort. Thus, you must be certain that you are pursuing different specific aims with different general goals. But, by using the same model system and by using the same techniques, you can get the most out of your research program. A smart diversification of research activities, which makes your work appealing to more than one funding agency without spreading your efforts too thin, will put you in a better position to maintain your new research program.

Commandment #10: Thou shalt be fiscally responsible

Once you are successful in receiving extramural funding to maintain your research program, you must be fiscally responsible. Running out of money before the proposed work has been completed could end your research career. Keep clear and organized records of where grant money has been spent. This includes equipment purchases, faculty salaries, student stipends, travel, supplies, and any other expenditures charged to your grant. Although your institution’s grants management office will keep records of purchases and expenditures, you as the principal investigator (PI) should keep a separate, detailed set of records. Time that you spend on “book-keeping” can avoid career-killing disasters.

If you are fiscally responsible, then you will build a strong reputation with program officers at funding agencies. This will, in turn, increase your chances for future support. If any funding agency gets the impression that you have mismanaged government funds, then your research program will be short-lived. Institutional offices for research and grants management have a habit of recording purchases into convenient generalized categories, withdrawing funds from or charging to your grant by mistake, not correctly calculating indirect costs commitments, and so forth. You must keep your own set of records and alert your institutional grants officer of discrepancies. Below, I share a few “close-calls” that could have resulted in disaster for the funded project.

A research grant is not an educational enhancement grant. Several years ago, while working at a smaller college, I obtained a National Science Foundation research award. The college had previously been very successful at obtaining external funds for general educational enhancement. Such awards were often used as pseudo-discretionary funds for anything that departments needed to enhance curricula, courses, or classroom activities. However, the college had received very few, if any, bona fide scientific research awards in its 30-year history. Some time after receiving this NSF award, I met with the school’s grants officer who informed me that the department head had submitted a charge against my research grant to pay for supply needs for one of his classes. He was under the impression that since this was a grant to the college, it was reasonable for him, as the department head, to spend money from my grant.

Research grant monies are specifically for completing the work proposed in the research proposal.....period! If your college is new to research funding, then it must be made very clear that no charges against the grant are allowed unless they are directly related to the research project and approved by you, as the PI. Although the award is technically made to the college,
the PI is ultimately responsible for ensuring that these funds are spent in accordance with the proposal from which the award was generated.

**Student research internships are not part of a financial aid package.** On another occasion, I had a student intern submit a timesheet for 30+ hours of work in the lab when, at best, she had been in the lab for 4 hours that week. Furthermore, her time in the lab was questionable in terms of productivity. I had to make it clear to the student that I could not pay for hours that were not worked, and I could not pay her for time spent on a computer reviewing Myspace or Facebook accounts or for time spent on the phone talking or texting. She told me that the internship was part of her “financial aid,” and that she had a child to support, thus, I was obligated to sign her timesheet with the hours listed. Of course, a research internship is not financial aid, and a PI cannot disburse grant monies for hours that were never worked. As a PI, you must be selective in your choice of students, clear about student responsibilities and rules of conduct, and decisive in dealing with students as part as your commitment to fiscal responsibility. Nothing could be worse for your program than an audit that concludes you have misappropriated funds.

**Indirect costs are tricky.** Other more subtle problems also can arise. For example, I once authorized a university grants officer to make an adjustment to the budget on a grant application that was being submitted to NASA. Unfortunately, this grants officer lumped much of my equipment request into the budget line for “equipment” without thought for the cost of each item. At most research institutions (including mine), major equipment expenditures are not subject to indirect costs (IDCs). However, any instrument or piece of equipment that is less that $5,000 is considered minor equipment and is subject to IDCs as part of the “supplies” line. Since many of the items that had been lumped into the equipment line ended-up costing less than $5,000 per item, I later discovered that my original budget estimates for the project were inaccurate. Over $30,000 in equipment that was originally listed on the IDC-free equipment line was being charged institutional IDCs under the supplies line. At a 41.5% IDC rate, this resulted in more than $12,000 of unexpected IDC charges to the grant, thus $12,000 less available for me to complete the research project.

This event is how I became acutely aware of how tricky IDCs can be and also how I learned a valuable lesson about not leaving the fiscal responsibilities of your grant or grant proposal to others, even if they are supposed to be the experts at your institution. Check, double-check, and triple-check all budget lines during the proposal phase and keep organized detailed records of expenditures once a grant contract is in place. This can often be difficult and time-consuming, especially when it comes to salaries and stipends. However, this is an essential requirement for maintaining a successful research program. Another tricky area is faculty, student, and other project participant salaries, stipends, and other compensation. Health insurance requirements and other employee benefits charged to your grant can vary depending upon the status of the research participant (i.e., faculty versus staff versus student). Keeping up with where your grant money is going can be a daunting task. But, you must bear the burden of this task. This is an essential requirement to maintaining a successful research program.
SUMMARY

The Ten Commandments of Establishing and Maintaining a Viable Research Program:

**Commandment #1:** Thou shalt obtain institutional commitment
**Commandment #2:** Thou shalt prepare thyself intellectually and technically
**Commandment #3:** Thou shalt form strong and productive collaborations with successful scientists at major research institutions.
**Commandment #4:** Thou shalt secure IRB approval, sampling and/or animal-use permits
**Commandment #5:** Thou shalt apply for extramural funding
**Commandment #6:** Thou shalt develop thyself professionally
**Commandment #7:** Thou shalt mentor students
**Commandment #8:** Thou shalt present and publish thy research
**Commandment #9:** Thou shalt diversify thy research program
**Commandment #10:** Thou shalt be fiscally responsible

must be supplemented with a call to *persevere amidst tough challenges.* Depending upon the atmosphere and personnel at your institution, establishing and maintaining a research program can be very challenging. There might be some who oppose your efforts. There may be those who question why you should receive release time from teaching while they are required to teach a full load of courses. Professional jealousy can develop. Student issues may arise. At times, it may seem like nothing is going right. But stick with it!

Although establishing and maintaining a successful research program at a small institution involves significant effort and significant challenges, the rewards can be great. Try not to be discouraged or worn out by the daily “grind.” When things seem overwhelming, seek out assistance from those who support your efforts. Call someone who is going through or has gone through the same trials and ask for advice. Talk to program officers at your funding agencies for assistance in dealing with both internal and external discrepancies in spending that could potentially jeopardize the success of your research effort. Program officers can “pull funds” (i.e., cancel an award) if grant monies are being inappropriately used. They can be influential mediators when issues arise between you and your grants office. Remember, the college wants the indirect costs from your grant as much as you want the direct costs to maintain your research program. In the end, do not be discouraged.

Receiving notification of your first award, getting that first publication in a peer-reviewed scientific journal, finding out that one of your students received acceptance to a graduate school, and other such achievements makes all the hard work and effort worthwhile. Seeing your students successfully deliver and/or receive awards for an outstanding research presentation or poster presentation at a national conference will make all of the tough times seem trivial.

In closing, it must again be stated that engaging oneself and students in the scientific endeavor through a meaningful and productive research program is, ultimately, the only way to increase the number of people from underrepresented groups in the global scientific community. Therefore, if you believe that diversity and inclusiveness is or should be a national (or global) priority, then there is no better way to act on that belief than to take up the cause by providing
yourself and your students with real opportunities to participate in long-term scientific activity both within your home institution and beyond. Science can greatly benefit local, national, and the global community over the long-term. Since mankind itself is diverse in terms of culture, history, and goals for the future, it is reasonable to expect that this diversity should be reflected in the global scientific community, which over the decades has gained increasing influence worldwide as a body of professionals that provides valuable information to national and international policy-makers who are, in turn, stewards of our future.

About the Author

Michael Ceballos serves as Research Assistant Professor in the Division of Biological Sciences and Director of the Native American Research Laboratories (NARL) at The University of Montana. NARL’s mission is to provide American Indian undergraduate students and graduate students with “hands-on” research opportunities in basic sciences and biomedical sciences in a culturally-relevant cross-disciplinary and cross-cultural environment. Dr. Ceballos previously served as Director of the Molecular Biology and Biochemistry Research Lab at Salish Kootenai College (SKC). His paternal family is full-blood Tepehuan while his maternal family is descended from the Choctaw and Cherokee tribes.

Dr. Ceballos is the first in his family to obtain an advanced degree and he hopes to encourage other Native scholars to pursue interests in the sciences and mathematics. He completed a bachelor’s degree in Physics and Mathematics at The University of Alabama in Huntsville; a master’s degree in Neuroscience at The University of Alabama at Birmingham; and the Ph.D. degree in Integrative Microbiology and Biochemistry at The University of Montana.
Abstract
In 2000, the Interior-Aleutians Campus (IAC) embarked on a journey to help rural Alaska Native students successfully complete calculus. The Hutlee’ Project (2000-2005), funded by National Science Foundation grants for Tribal Colleges and Universities (NSF TCUP), was the campus’ first experience in providing culturally relevant STEM education to Alaska Natives and inspired development of an individual-centered, culturally relevant student support. This journey continues with IAC’s current NSF TCUP project, the Gaalee’ya STEM Project, designed to develop and improve delivery of culturally relevant STEM education, integrate indigenous knowledge, and increase Alaska Native students’ understanding of both Western and Native science.

The project, on one hand, is based on tenets of indigenous epistemology and values, and, on the other, embraces multiple cultures, including Athabascan, Inupiaq, Aleut, Yup’ik and Western. This paper tells a story of how, through the Gaalee’ya Project, IAC continues to work to develop and implement an evaluation process that expands validity through surfacing and documenting the context, values, and culturally based assumptions of those being evaluated as well as those doing the evaluation.

It was the last night of the second Gaalee’ya STEM Project Native Science camp. For four days, the students, faculty, and elders - Athabascan, Inupiaq, Yup’ik, and Caucasian - had picked wild blueberries and studied the various environments in which they grew through story, observation, and Western scientific sampling methods. The final Talking Circle was coming to an end, and Gwich’in elder and teacher Kenneth Frank wanted to close with a song. He sang one, and then another, and then another. Songs, he said, coming from his father and called forth from him by the land. Soon Shy, a young student and dancer from Kotzebue, offered an Inupiaq song, accompanied by her fellow Kotzebue student Jay, on the drum for the first time.

As the night wore on, others offered songs—a traditional Gwich’in song with a new verse, Inupiaq songs, gospel songs in English and Gwich’in, original compositions, rock and roll songs—each offering something of themselves and accepting something from others. One student likened each member of the group to a family member: this one, his aana (grandmother), another
his ‘crazy auntie.’ This evening might seem like inconsequential fun to some, but it was the culmination of a camp experience that supported and allowed students to be who they were, culturally, educationally, and spiritually, with elders and with faculty.

_Sometimes when students learn Native culture, they’re more happy with the school they’re involved with. With the native culture, you see your ancestor, what they had. You look at it, you touch it, you make connections. Whenever I teach, I’ve gotta have it in my hand. That’s how our people used to learn._

Elder and Advisory Member Kenneth Frank

Experiences like these are essential to the continued persistence and success of rural Alaska Native students in STEM and to the elders and faculty who support them. What does it take for the evaluation process to capture these experiences as evidence of success, and as importantly, to nurture and guide the development of this type of experience within the life of the project and beyond?

**VALUES, CONTEXT, AND CULTURE IN EVALUATION**

In the United States, systematic evaluation has documented histories of practice dating back to the mid 1800’s. The first systemic evaluations were designed to assess student learning and quality of instruction through printed tests that reflected the curriculum of the day and the prevalent Puritan philosophy (Stufflebeam and Shinkfield, 2008). This ‘assessment’ separates evaluation from social science research that does not establish standards or values (Scriven, 1991). Federal government involvement in evaluation began in 1958 with the launch of Sputnik. While evaluation draws heavily on social science research methodologies (Weiss, 1998), it differs from social science research in that it attempts to assess merit or worth (Stufflebeam, 2004). Further, it is key to understand that federal programs have a distinct political nature that affect the value, process, and outcomes of evaluation and brings into question whose values are promoted and used to validate a project’s success (Weiss in Rossi, Lipsey, & Freeman, 2004).

Values are at the core of evaluation practice, but for centuries have been considered outside the purview of scientific analysis. Beginning in the eighteenth century, reason became the primary source of legitimacy for authority while values became viewed as emotions and, as such, were not subject to scientific enquiry. In addition, in the scientific tradition, rationality required a detachment between the subject and the thinker. Objectivity, what Datson and Galison (2007) call “blind sight,” became a dominant epistemic virtue in the sciences and in turn the social sciences. Today, stemming from a growing use of qualitative methods in evaluation and an acceptance of culture as a legitimate and important variable in project design, implementation, and outcomes, the detachment between the evaluator and evaluand is diminishing, and values are becoming an acknowledged part of evaluative analysis. “Values are evaluations…and this analysis of values helps to legitimize qualitative research” (House, 2005, p. 1073).

Contexts are the supporting environment or ecology of place where culture develops. Contexts include the demographic dimensions of race, ethnicity, language, gender, age, religion, and sexual orientation, as well as the dimensions not as frequently discussed such as power, economy, living situation, class, equity, sociopolitical status, and culture (SenGupta, Hopson & Thompson-Robinson, 2004). In evaluation, culture may be both the traditional/historic culture of...
a people that becomes a piece of the context or the whole of the context. In the latter sense, multi-culturalism becomes a ‘culture’ in its own right. Drawing on Tedlock and Mannheim’s (1995) concept that culture is an emergent property of dialogue, the conversations between the evaluator, evaluands, and other participants creates the project as it develops through these dialogues and, ultimately, creates culture itself. Evaluation becomes an influence on the culture in which the evaluation is being conducted; thus, evaluators bear a responsibility to respect and honor the values of that culture.

Culturally relevant or multi-cultural evaluation methods attempt to address this responsibility and are an important addition to the evaluator’s toolkit. In culturally relevant evaluation, an evaluator must go beyond methodological training alone and build relationships with evaluands to gain an understanding and working knowledge of the values, context, and culture of the evaluands. Culture is always present in the contexts where evaluation is conducted and should be expressed in the program design, implementation, and outcomes as well as in the evaluation design.

Another approach that addresses these issues is ‘indigenous evaluation.’ All cultures have methods of evaluation, however, the practice of ‘indigenous evaluation’ as a systematic process to evaluate a program or a policy is only emerging and not well defined. At present, ‘indigenous evaluation’ is not a set of prescribed practices or approaches but rather a way of conducting evaluation that privileges indigenous epistemology and uses methods that work best for each indigenous-based project (Kawakami, Aton, Cram, Lai, and Porima, 2008; PASE, 2003 a, b; aruskevich, 2010). In addition, for Tribal Colleges, allowing for culturally relevant evaluation and indigenous evaluation are ways the United States government can honor its commitment to tribal sovereignty in that members of each tribe and culture have the right and responsibility to choose for themselves the approaches and outcomes that are relevant to their people.

IAC’S EVALUATION STORY

When we wrote the proposal for the Gaalee’ya STEM Project during the summer of 2007, IAC was on the brink of delving deeply into culturally relevant evaluation. In 2008, the campus director attended the Aotearoa New Zealand Evaluation Conference with the (now) Gaalee’ya Project evaluator. This conference introduced the campus to a strong tradition of indigenous evaluation and scholarship. Collegial friendships were extended and Maori evaluators began a three-year journey working and mentoring with IAC. A ten-year campus evaluation was completed by a team of indigenous evaluators from Te Ropu Whariki of Massey University and IAC began developing their own indigenous evaluation focus.

IAC began to develop the Uk’aa project which proposes to create a graduate certification in indigenous evaluation. In anticipation of that goal, IAC, with Title III funding and the help of the Te Ropu Whariki team, held two indigenous evaluation trainings attended by 20, primarily Alaska Native, prospective evaluators. In addition, a five-year strategic plan was developed by one of the team members, Sandy Kerr, to guide campus development and the IAC evaluation process. The plan is graphically depicted in the indigenous seasonal/cyclical model below (Figure 1).
The IAC Comprehensive Plan shows the importance of STEM to IAC foundations to help students pass gatekeeper courses in mathematics (*Hutlee*), and points to new directions of curriculum integration and the incorporation of Alaska Native culture (*Gaalee’ya*). These documents are significant to the NSF *Gaalee’ya STEM Project* in that they graphically illustrate the dynamic, responsive, vision-driven organization of IAC and its adaptations over time, and points to new directions in culturally appropriate evaluation.

Project evaluation in *Gaalee’ya*’s first year provided strong programmatic support through monitoring activities, data analysis, and a literature review on the topic of “indigenous science.” During Project Year 2, the evaluation continued to use multiple methods of data collection and analysis, but evolved to include a “hikoi” evaluation approach (Kerr, 2006). Hikoi is a Maori word for stepping out on a journey. In the emerging hikoi approach to evaluation, the evaluators and evaluands “walk together”, and the journey or process itself is as important as the evaluative findings. Although this approach draws from another indigenous tradition, it fits beautifully with the IAC motto, “come walk beside me along this trail,” provided by Koyukon elder and IAC Advisory Council member Jenny Peltola, who said “we need people to walk along beside us on this education journey—not in front of us, not behind us, but alongside us.”

As part of the hikoi approach and long standing relationship between many IAC faculty, staff, and the evaluator, a more holistic overview of the *Gaalee’ya Project* was gained through knowledge of sister academic programs, student services, and campus direction. Campus documentation provided insights to the importance of STEM disciplines to student and campus development and capacity building as well as the strong visionary/value foundations of the
campus plan. The innovative and developing nature of IAC, as documented in their 2010-2015 Comprehensive Plan, leads evaluation to another emerging approach. At the end of grant year Two, the evaluation under discussion for the next project year will employ tenets of developmental evaluation (Patton, 2009; 2011), which provides a framework to triangulate beliefs, knowledge, and action. Methods to be employed include a values-driven inquiry with faculty – where the process is as important as what is accomplished.

The evaluation will focus on the extent to which innovators are true to their values, are ‘walking their talk,’ and are supported through strong, visionary leadership. Data will be collected through a reflective practice cycle of questions and stories, followed by a process to analyze patterns and themes, identify implications, actions, lessons, and generate agreements for next steps. Thus, through discussion on beliefs/values, knowledge can be documented as evidence and project actions can become more informed and empirically based. IAC hopes this ongoing evaluation process will help the project continue to meet the changing demands and needs of its students, and the changing needs of the campus itself as well as help to build an indigenous cadre of evaluators in Alaska through student mentoring.

Alaska Native students, elders and communities, IAC, and NSF TCUP share a desire to increase Alaska Native participation in STEM. They seek to broaden participation in STEM not only through the education of Alaska Native students, but also through the broadening of ideas that culturally strong and knowledgeable Alaska Native students bring to their STEM classes and disciplines. Culturally relevant evaluation supports the attainment of these common goals. Evaluators can gauge their evaluation as appropriate from what comes from evaluands:

_Culture is in the eye of the beholder. There is not one way to check if something is culturally appropriate, and [it] certainly wouldn’t be asked as a question. Whether the program is a fit and a match and there is commitment, or is it something that has been superimposed and the [organization or] community is trying to make it fit…will come out in the stories. It will come out from the people, it will come out from observation, and it will come out from council resolutions._

Canadian practitioner, B. Larsson, in aruskevich, 2008

Culturally relevant evaluation is expansive and inclusive – it allows positive things to happen in an informed and respectful way.

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About the Authors

Jennifer Carroll is Assistant Professor and Chair in the Department of Indigenous, Community, and Tribal Programs at the Interior-Aleutians Campus, College of Rural and Community Development, University of Alaska Fairbanks (UAF). She currently serves as the Co-Principal Investigator and Program Manager of the Interior-Aleutians Campus’ Gaalee’ya STEM Project, funded by NSF TCUP. Dr. Carroll’s Ph.D. dissertation, “Maybe an Answer is in There: Life Story in Dialogue,” explores how story telling is used to sustain individuals and cultures amid dialogues that challenge cultural identity through the life story of a Gwich’in elder. She received a B.A. degree from Harvard University in 1990, a Master’s degree from UAF in 1995, and the Ph.D. degree from UAF in 2010, all in Anthropology.
kas aruskevich is Principal, Evaluation Research Associates, LLC. kas has worked as Development Director at the UAF College of Rural and Community Development, writing proposals for projects to serve Alaska Native peoples. She currently works with Alaska Natives and has worked with Native Hawai’ians to develop and evaluate indigenous-based projects. A graduate of the University of Alaska Fairbanks, the University of Alaska Anchorage, and the University of Hawai’i Manoa, Dr. aruskevich’s research focused on indigenous evaluation. kas' education and planning background has helped her to represent diverse interests in planning, project implementation, policy interpretation, analysis, application, and evaluation. She is working on a book to better relationships between Western and indigenous cultures.

WORKS CITED
INTRODUCTION

It has been twelve years since the chance meeting of representatives from Turtle Mountain Community College (TMCC), a North Dakota tribal college, and faculty from the North Dakota State University (NDSU) College of Engineering in 1998. This meeting took place at the School of Mines in Rapid City. Both entities were there in response to an invitation from a Montana tribal college, Salish Kootenai College (SKC). SKC convened the meeting with support from the Louis Stokes Alliances for Minority Participation (LSAMP) Program funded by the National Science Foundation (NSF). The goal was to promote collaborations among tribal colleges and state college and university faculty from science, technology, engineering, and mathematics (STEM) programs. And, that is exactly what happened.

THE COLLABORATION

Gerald “Carty” Monette, TMCC President, was the Principal Investigator on the NSF High Plains Rural Systemic Initiative grant that included 20 tribal colleges in six states and more than 100 tribal high schools. This program was helping tribal colleges realize the career opportunities that STEM degrees could offer tribal college students. There was interest among faculty and staff, and Dr. Monette was ready to promote student enrollment in STEM disciplines. It was this intent that inspired him to send a delegation to the Rapid City meeting.

It was a regular conference, where the usual pep talks occurred. Participants were introduced to model programs, resource opportunities, and experts. There was lots of encouragement to have students pursue STEM degree opportunities at tribal colleges that would lead to goal attainment in STEM disciplines. However, it wasn’t until the last day of the conference that a meaningful relationship evolved. Salish Kootenai grouped the conference participants by state. And, there they were: a table full of educators from North Dakota higher education institutions.

G. Padmanabhan, Chair of the Civil Engineering Department, North Dakota State University (NDSU) College of Engineering, introduced himself and immediately became of a point of interest. At that round table discussion, Turtle Mountain Community College and North Dakota State University agreed to partner when the opportunity arose. Turtle Mountain invited the other North Dakota tribal colleges to join the effort. All five North Dakota tribal colleges were on board, and the search was on for outside support. It didn’t take long for an opportunity to arise.
Several months after the Rapid City meeting, the Office of Naval Research sent out a solicitation inviting tribal colleges and other minority institutions to compete for grant funding designed to recruit and retain minorities in STEM disciplines. It was perfect.

Dr. Padmanabhan put his team together at the university. They included Wei Lin (Assistant Professor, Civil Engineering), Robert Pieri (Professor, Mechanical Engineering), and Floyd Patterson (Associate Professor, Electrical Engineering). Carol Davis, Vice President at TMCC, put together the tribal college team that included Erich Longie, President, Little Hoop (now Cankdeska Cikana) Community College; Laurel Vermillion, Academic Dean (current President), Sitting Bull College; Bennett Yellow Bird, Dean, United Tribes Technical College; and Elizabeth Yellow Bird-Demaray (past President), Fort Berthold Community College. Throughout the process, the tribal colleges sent other staff to help at different times and the university recruited additional helpers. This was a group effort that bonded the participants and enabled them to achieve consensus for action, a desired element when creating a vision.

PROGRAM DESIGN

The first meeting of the two groups was held in the Group Decision Center at North Dakota State University. Each sat at a computer. Sharon Cobb, Center Director, put the group through an intensive session where questions were posed and each person suggested activities that appeared possible from his/her individual perspective. The suggestions were posted on a big screen for all to see. When the questions and postings were complete, the group took the ideas and began to select those that appeared possible to achieve. At the end of the day, the outline of a proposal emerged. The next step was to put the ideas into a workable initiative. The group was so confident that at the conclusion of the exercise, they suggested that this initiative could become a model for recruitment and retention of American Indians into STEM careers. Current statistics bear out their confidence. And, the process deserves further examination.

One of the elements that emerged in the process was that all teaching units would incorporate the tribal knowledge of each tribe. The group did not want to create the “generic Indian.” They wanted the students to learn about their own tribes—Fort Berthold, home to the Arikara, Hidatsa, and Mandan; Sitting Bull College, home of the Lakota, Dakota and Nakota; Turtle Mountain Community College, home of the Chippewa; Cankdeska Cikana Community College, home of the Spirit Lake Dakota; and United Tribes Technical College, which was founded by the North Dakota tribes and enrolls students from each tribe. The group agreed that tribal knowledge would be an important part of teaching units, an acknowledged practice at tribal colleges.

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH

When the Office of Naval Research funding was ending in 2004, the co-Directors of the North Dakota EPSCoR program, David Givers and Richard Schultz, visited with the tribal college representatives. The group agreed to create a new partnership when North Dakota submitted their new EPSCoR proposal to the National Science Foundation. It was approved for funding, which enabled the STEM initiative to continue.
COMPONENTS OF THE PROGRAM

The desire and in some cases, the institutional infrastructure for American Indian 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. The low enrollment in STEM disciplines influenced the focus of the initiative. For example, TMCC had over 500 students, but only 31 had declared STEM majors. What the group designed was a pathway to STEM careers that began with recruitment activities and culminated in nurturing and retention initiatives. This understanding influenced the group to design two high school initiatives—the Sunday Academy and summer camps. To retain the students once they enrolled in STEM at the tribal college, two initiatives were designed—a two-week tribal college camp at the university and scholarships at the tribal colleges and universities.

To carry out the STEM learning activities required a teaching team. After deliberation, the group devised a process that brought high school STEM teachers, tribal college STEM faculty, and university STEM faculty together to develop a curriculum and manage the instruction in the program. This turned out to be a good move. The teaching team adopted a process for aligning instruction with North Dakota State STEM Standards and agreed that the incorporation of culture into course offerings was a critical element. The teaching team was to devote two weeks each summer to write the Nurturing American Tribal Undergraduate Research and Education (NATURE) Sunday Academy and Summer Camp teaching units. The cultural teachers took the lessons and wrote the culture lessons that accompanied the Sunday Academy lessons. They developed the summer camp lessons on-site during the summer session. Besides the academic collaborations, the teaching teams learned from each other, and the university staff became familiar with tribal college students as well as tribal history and culture. In addition, a NATURE database was developed. NATURE submitted an NDSU Institutional Review Board (IRB) application that was approved in 2006 and had been renewed each year. All data generated adhered to all human subjects requirements.

SUNDAY ACADEMY FOR HIGH SCHOOL STUDENTS

The Sunday Academy program brought the teaching teams together seven Sundays per academic year. Between fifteen (15) and thirty (30) American Indian high school students enrolled each Sunday on the campuses of the five (5) ND tribal colleges. The curriculum followed the lesson plans created in the summer camp by the teaching teams. The cultural leader opened each session with a prayer following by an overview on how the day’s cultural concept related to the days STEM lesson. The cultural teacher spent about 20 minutes helping the students grasp the concept from a tribal perspective. Next, the instructional leader introduces the scientific concept and, for the next three hours, the students learned theory and application of theory in a lab setting. Professors from the two North Dakota Universities led five of the seven units. The local NATURE instructional team taught the other two lessons.

Learning to use new lab technology is common practice in the Sunday Academy. For example, when the Hydrogen/Solar Cells unit was taught, the students assembled and used a fuel cell–solar cell system. To measure the photoelectric current generated by the cell, the students conducted experiments utilizing the voltmeter. The lesson culminated in an activity where the students built and operated a hydrogen-powered car. In another lesson where the students studied sensors and control technology, the students used reflective, absorption photography, thermal
emittance photography, and infra-red sensors to learn about remote sensors. When another lesson had students look for iron in water systems, the students connected a colorimeter to a computer interface. One lesson with a focus on analysis of data found in tables, charts and graphs had the students use CBLs with temperature probes to acquire the information needed to record data on a graph. Another common practice at Sunday Academy was to have students utilize computers to study topics. For example, the students accessed Google Earth maps and learned to maneuver utilizing the main window. Students learned to put place marks on maps, add image overlays, measure distance or area size, and other applications.

In order to attract students into the five-hour Sunday Academy program, stipends were offered to the students to defray costs they incurred traveling to the college. Also, a noon lunch was provided on site so that the students would not have to leave the campus. Lots of recruiting happened through the high school teachers involved. They recruited students from the schools where they taught. Also, coordinators visited reservation high schools showing PowerPoint presentations of the NATURE program to attract students. Many students came in as freshmen and stayed with the program throughout high school and into college.

**HIGH SCHOOL SUMMER CAMP**

Many of the Sunday Academy high school students spent two weeks on the tribal college campus during the summer. The format was very similar to the Sunday Academy Program. The students were introduced to six topics. The cultural teacher introduced each concept just as they did in the Sunday Academy. The students formed groups and selected a STEM topic. The teams explored one of the six lessons in depth. The students also advanced their media skills using Windows Movie Maker. Each day, a couple of hours were devoted to media technology, and students created a video that explained a STEM concept. This gave the students an opportunity to learn more about one of the STEM topics, do research, prepare reports, and present their findings while studying special effects used in making videos. Each group was responsible for making a presentation. On the last day, they showed their video to the other students as they explained their STEM concept. The students who participated were given stipends. Breakfast and lunch were served in addition to healthy snacks. At each tribal college, many students come in as freshmen and stay with the program throughout high school.

Lessons often engaged students in the use of technology. For example, when the students studied trajectory, they used parametric functions to display equations using graphing calculators. Sometimes the students used common lab equipment such as beakers and water to conduct fact-checking science, such as *Does Water Boil at 100 Degrees C?* Another lesson had groups of students studying epidemics. Each was assigned a disease and, using the internet, conducted a webquest and developed a PowerPoint presentation that was shared with the other students at the end of the day. Robotics also was a popular summer camp activity. The students utilized kits, followed instructions, and built robots. The robots were then raced, engaged in basketball games, and made to carry objects around the room. Other summer camp topics included Aurora Borealis, Clean-up of Oil Spill, Parametric Equations, What is Culture? (Tribal Culture and Care for Environment), Water Purification, Computer Programming, and Measuring Wind Velocity.
TRIBAL COLLEGE SUMMER CAMP AT THE UNIVERSITIES

The North Dakota State University/University of North Dakota STEM camp for tribal college students enrolled approximately 13-18 students per year in a two-week STEM immersion. This activity was designed to nurture, retain and prepare the tribal college students for STEM careers. Besides academic sessions, laboratory, and industry visits, the students participated in activities sponsored by the Multi-Culture Student Services Program at NDSU and the Native American Programs Office at UND. Students stayed on campus in the dormitories and ate their meals in the cafeteria.

The students toured STEM labs at North Dakota State University and spent one day doing the same at the University of North Dakota. Based on their tour of STEM labs at the two universities, the students selected a lab where they spent a week engaged in research. On the last day of the camp, they made presentations to the rest of the students about their lab experiences. It was very exciting when the students visited the nanoscience department at the University of North Dakota and found that one of the former NATURE summer camp students from Sitting Bull College was giving the presentation. He is a senior studying environmental science at Sitting Bull College and was selected to conduct summer research with one of his mentors. Over the years, students have participated in nanotechnology research, super computer research, neuroscience research where they studied seizures in rats, increasing sugar beet pulp solids loading rates, microbiology, aerospace studies utilizing simulators, Chemistry: Catalysis and Carbon Dioxide, Energy Joules using the Newton Meter, and Examining insects using the Scanning Electron Microscope,

While the tribal college students were engaged in the carefully designed STEM program, the instructional team, consisting of reservation high school teachers, tribal college STEM faculty, and university professors, was designing and developing the high school Sunday Academy and summer camp curricula. The STEM units were North Dakota standards based and related mathematics and science to problem solving with carefully selected examples. The instructors introduced mathematics, physics, chemistry, biology, geology, and computers with a heavy problem solving context (Padmanabhan et al., 2006).

An additional workshop was offered prior to the beginning of the academic year where the Sunday Academy units were refined. It was during this second session that the high school teachers and tribal college faculty learned to use new technology required in the lab application when the units were taught. A survey of the instructional staff revealed thirteen of the fifteen tribal college and high school STEM teachers used the information from the NATURE program to improve 35 instructional units. One of the high school teachers purchased a full lab including new technology needed to do water quality studies in her biology course after learning the technique in the NATURE program.

TRIBAL COLLEGE RESEARCH

Tribal college research didn’t come into the program until North Dakota EPSCoR took over sponsorship of the program. With research as one of the main objectives of EPSCoR, it was a natural off shoot of the original program. Evaluation of the program revealed a weakness at the tribal college level. High school graduates were falling into a vacuum when they arrived at the tribal colleges. A contact with the NSF TCUP program helped to get a pilot program funded.
Research made it possible for the students to continue with NATURE and for the tribal colleges to build research capacity and retain STEM students. Research became a regular activity of NATURE. Research also brought about another program element designed to engage tribal college students majoring in STEM.

A co-mentorship was arranged so that tribal college faculty and university professors, along with the students, formed research teams. The research was conducted at the tribal colleges and addressed research topics selected by the students. Most addressed reservation issues. Research topics engaged by the research team included Radon Mitigation, Math Lab Impact on Academic Achievement, Trace Metals and Contaminants in Tpinsila (Pediomelum Esculenta), Predicting Migration of Prairie Dog Towns in Relation to Water, Nutritional Analysis of Amelanchier Anifolia and Health Benefit Potential for Native American Diet, Propagation Techniques of Native June Berries, Godel’s Incompleteness Theorems, Mercury in Fish Population, Optimal Foraging Theory on Standing Rock Reservation, Social Behavior of Costa Rican Wasps, Wintering Owls on Spirit Lake Nation, and a study of Carbon-Nitrogen Ratio Important Tool to Determine Soil and Vegetation Health.

Students and co-mentors received stipends for their participation. Student research data for the past three years revealed that 41 tribal college students have conducted research; 12 tribal college faculty co-mentored student research; and 22 university research professors co-mentored student research.

**NATURE OUTCOMES**

Student success data revealed that there has been a positive impact on STEM success, as demonstrated by attainment of STEM goals by students. Success indicators included:

- STEM enrollment at TMCC increased, from 31 students in 1998 to 187 students in 2008.
- By Spring 2010, four students graduated with bachelor’s degrees in Engineering.
- One student graduated with a degree in Environmental Science and was awarded a North Dakota EPSCoR scholarship to pursue a graduate degree.
- One student earned a Clinical Lab Science degree.
- One student is a senior majoring in Pharmacy.
- One student is a senior majoring in Clinical Lab Science. This student has been elected the President of the American Indian Science and Engineering Society (AISES) regional organization and is organizing the 2011 conference at the School of Mines in South Dakota.
- One engineer graduate entered graduate school to seek a master’s degree in Civil Engineering. He was awarded an ND EPSCoR scholarship to pursue his goal.
- One female graduate is a science teacher at a reservation high school in North Dakota.
- One student is enrolled in a master’s degree in Civil Engineering program.
- One student received a Ph.D. in Physical Therapy.

Based on the success of the program, North Dakota EPSCoR and the tribal colleges determined that NATURE was a model program with a proven recruitment and retention strategy.
About the Author

Carol Ann Davis is the Tribal College Liaison for the North Dakota Experimental Program to Stimulate Competitive Research (EPSCoR). As Liaison, she is helping to create a pathway for American Indian high school students into STEM careers through STEM camps, Sunday Academies, and research. Dr. Davis brings unique relationships and experiences to this work. She is a member of the Turtle Mountain Band of Chippewa; born and schooled on the reservation and a high school boarding school for American Indians in South Dakota. Dr. Davis began her education career as a middle school teacher and then an assistant high school principal. For seventeen years, she served Turtle Mountain Community College as an administrator.

Dr. Davis received a bachelor’s degree in elementary education from Mayville State University, a master’s degree from the University of North Dakota, and a doctorate from Walden University. She is married to Lynn Davis, also a member of the Turtle Mountain Band of Chippewa, with whom she raised six children. She still resides with her husband on the Turtle Mountain Reservation where she enjoys spending time with family, especially her fourteen grandchildren.

ENDNOTES


INTRODUCTION

Tribal College faculty often ask me about techniques for incorporating culture into their science curriculum. This is certainly not an easy task and most instructors make no secret of their apprehension in developing culturally relevant activities and lessons. Their concerns range from a fear of lacking authenticity to feeling under-qualified to teach someone else’s culture. My response?

Relax.

No one is asking you to teach Dreamcatcher Construction 101, and certainly no one expects you to run a sweatlodge ceremony. What we are asking – and what is vitally important in capturing the interest and imagination of your students – is that you learn and teach science from the perspective of the people with whom you are working. Whether one calls this Indigenous Science, Native Science, Native Ways of Knowing, or Traditional Ecological Knowledge, this simply refers to the long term observational and experimental results of millennia of “participation with the natural world” (Cajete, 1999). That concept, first phrased by Gregory Cajete in his groundbreaking book, “Native Science: Natural Laws of Interdependence,” is key to the study, practice, and teaching of science from an Indigenous perspective. Native peoples have gathered scientific knowledge by taking part in the collection of long term data sets rather than attempting to keep themselves separate from them.

COMPARING NATIVE SCIENCE AND WESTERN SCIENCE

This “participation with the natural world” aspect is one essential difference between Native and Western Science. While the two epistemologies also share many similarities, it is important to distinguish one from the other. For example, some scientists argue that Native Science is not objective. This is, perhaps, due to the fact that Indigenous peoples are both the observers/experimenters as well as the ones being observed/experimented on. It would be safe to say that many Indigenous societies believe that the act of discovery associated with science – even Western Science – cannot be considered completely objective since it is based on observation, and observation is never wholly objective. The mere act of choosing to observe a particular occurrence or object over another is subjective. In addition, Native people have long known what quantum physics has only recently shown – that “by the very act of watching, the observer affects the observed reality” (Weizmann Institute of Science, 1998). This makes complete objectivity difficult.
Every scientist, no matter their cultural background, probably appreciates the rational empiricism and experimental methodology offered by Western Science, but many do not realize that these are also hallmarks of Native Science. Again, referring to Dr. Cajete’s definition: “To understand the foundations of Native Science one must become open to the roles of sensation, perception, imagination, emotion, symbols, and spirit as well as that of concept, logic, and rational empiricism. It is through this holistic worldview that we gain a true understanding of organisms and materials – whether defined as biotic or abiotic.

Native Science is widely known for its qualitative methodologies in contrast to the strict quantitative analysis that is so prevalent in Western Science today. Indeed, the commonly held belief is that one cannot purport to know anything with any degree of certainty unless a p-value accompanies the statement. The importance of statistical analysis, quantitative methodologies, and randomization cannot be overstated. These processes allow a degree of precision and statistical power that makes scientific theories vastly more credible. Most can attest, however, that Western Science was not always so reliant on the field of statistical analysis. Remember Dr. Jane Goodall’s amazing observational studies on chimpanzee behavior? As my statistics professor once said, “The days of ‘Jane Goodall science’ are over.” And, just as Western science evolved from qualitative observation-based research – so, too, is Native Science evolving to include rigorous analysis.

STRATEGIES FOR GETTING STARTED

It is important to remember that Native peoples have always been scientists. This simple fact will help to motivate and fascinate your students like never before. There are a multitude of examples to illustrate the validity and timeliness of Native Science, and I will discuss a few of these examples here. However, I urge each tribal college instructor or any interested person to gather examples that are contextual and directly relevant to your students. Unfortunately, this information does not exist in nice, neat packages with pre-made lesson plans – yet. It is up to you and your students to gather this information from elders and other knowledge holders in the community. Eventually, you will be able to create lessons and modules that can be shared amongst other institutions.

There are methods and protocols for gathering information that will vary greatly from community to community. For example, if you are going to visit an elder on the Standing Rock or Pine Ridge Reservations in North or South Dakota, you will need to go through a tribal IRB, which may be housed at their local tribal colleges. Traditionally, you will want to offer tobacco or some other gift to the elder or individual who is giving you information. This is a common reciprocal gifting that is practiced by Indigenous cultures all over the world. The appropriate gift may vary from culture to culture, but the act of giving is basically the same. Make sure to ask around to find out about proper protocols in your area.

When approaching elders or other knowledgeable people to gather information, open-ended questions are the best approach. For example, if I want to learn about Lakota scientific views on eagles, I would first ask, “Can you tell me about eagles?” This might elicit a lot of wonderful information on symbolism, spirituality, and even ceremony, which, with the permission of the
informant, may be very useful in your lessons. While you may not feel comfortable teaching this type of information in a science class, remember that cultural importance often leads students to gain a deeper interest in the topic and formulate a desire for conservation, sustainability, and scientific understanding.

When one is conducting these types of interviews, interrupting an informant is impolite and could result in cessation of the conversation. After they have finished telling you what they need to say, you may probe a little deeper into the “science behind the culture” by asking a more specific question. For example, “Where do eagles nest?” or “What do eagles eat?” Of course, you probably already know the answers to these questions, but what you are seeking is an understanding of these concepts from a Native perspective. Having the patience to learn Native Science directly from the knowledge holders is probably your most important asset. Your informant may give you new and exciting information such as feeding and nesting areas, species of fish that serve as food, mating habits, and more. This is relevant, contextual information that will enhance your curriculum in positive ways.

There are a number of ways to incorporate the information that you gather into your curriculum. One very powerful method is to use Western Scientific methodology to demonstrate the relevance and testability of Native Science. This is NOT an attempt to validate Native Science, because there is no need to do so. However, one of the most important (and fun!) qualities of Western Science is the ability to test results and demonstrate repeatability. This is an excellent way to infuse culture into your curriculum while staying in line with many tribal, state, and federal educational standards.

Cultural relevance is not just a tool for enhancing curriculum in the life sciences. Whether you teach ecology, physics, computers or astronomy, there are relatable scientific concepts that you can discover from within your tribal communities. Following are some examples of lessons that I use in various courses. They may not be relevant to your own communities, but I hope they will serve as models that you can use to meet your own needs. The information used to create the lessons has been gathered from elders on the Standing Rock and Cheyenne River Reservations. I was given permission to collect, use, and share all of these examples by the elders and knowledge holders in my area.

**EXAMPLES**

1) **Beebalm** (*Monarda fistulosa*) is a member of the mint family that has been used by numerous tribes for thousands of years to treat both internal and external bacterial infections. Students probably see and read all sorts of information in the mainstream media about herbal remedies and miracle cures. This is your students’ chance to quantify the antibacterial properties of a local, culturally important, plant. For this lesson, I have students inoculate an Agar plate with some type of bacteria; I like to use *Bacillus subtilis*, since it is relatively harmless to humans. However, you may wish to use some other bacteria or even a standard cheek swab. Simply apply dried or powdered beebalm leaves directly on top of the bacteria. You may wish to divide the dish in half and apply two different plants to compare results.
Labs such as this could get your students interested in ethnobotany, microbiology, and scientific inquiry. Allowing students to investigate plants that their grandparents have talked about or used as medicine will inspire them to appreciate Native Science. Extensions of this project might include making salves or other medicinal preparations that students can take home with them.

2) **Horsetail** (*Equisetum arvense*) is a distinctive plant that is found throughout most of North America. It has been used by tribes from Alaska to California to clean and polish eating utensils and cookware. The plant is very high in silica, which makes it perfectly suited as a scrubbing tool. Attach a polarized lens (try a cheap, old sunglass lens) to a microscope so your students can actually see the silica crystals within the plant. This is a great way to introduce microscope use, plant structure, and cultural relevance. Extensions of this lesson might include a discussion of glass, its chemical structure and development.

3) **Chokecherries** (*Prunus virginiana*) are an abundant food source for the Lakota and most other tribes of the Great Plains. Many assume that the chokecherry pits were removed before consumption similarly to today’s hybrid cherries. However, most tribes consumed the entire fruit – pits and all. Most *Prunus* species contain varying levels of cyanide in the pits, and as such they are frequently implicated in livestock deaths. So, if chokecherry pits contain deadly levels of cyanide, how is it that they are eaten by Native peoples in such huge quantities with no harmful side effects? One hypothesis is that the traditional preparation method of crushing the cherries with stones and drying the resulting paste into patties, breaks the bond that holds the cyanide within the pit. Thus, the cyanide is released as a gas, getting rid of the poison while leaving all the nutrition that the pits provide (Stolzenberg & Different Cloud, 2003).

This lesson examines the ingenuity and use of technology associated with food preparation. For engineering students, it might even be useful to examine the construction of tools used in food preparation. For example, the crushing stone was often attached to a split deer leg bone (for use as a handle) and then wrapped and tied with sinew. It is an ingenious tool that is perfectly suited to its use in crushing berries. Another example of a food preparation technology that is perfectly suited to its environment is the Hopi digging stick. This implement is one of the only tools that can efficiently plant Hopi corn in the hard, clayey soils of their reservation lands. Most Hopi tribal members still use a digging stick rather than a shovel, which also helps conserve topsoil by limiting disturbance.

4) Many young scientists assume that the **Scientific Method** was developed in isolation by Western scientists. However, Native Americans have long been using the same steps to gain an understanding of the natural world. For example, long ago, the Lakota observed that bison would congregate to areas that had burned the previous fall. The bison seemed to be attracted by the fresh, green grasses that grew in burned areas. The Lakota hypothesized that if they performed a controlled burn on a particular area, they could manipulate bison into selecting areas closer to Lakota camps. Hence, hunting would be much easier and less expensive. So, the Lakota designed an experiment in which they burned a selected area and then waited for spring to see if the bison would come. The tribe examined the results and revised the hypothesis accordingly.
All of these examples are consistent with the values of Native Science. The lessons, lesson plans, and topics are endless. All tribal nations have extensive scientific knowledge in astronomy, agriculture, physics, oceanography, and any number of other fields of scientific inquiry. A tribal college faculty member is only limited by their willingness to go out to the community and investigate scientific topics with knowledgeable people. Above all, it is most important to remember the basic, foundational reason for all of this talk of infusing culture into the science curriculum – the students. The journey towards an authentic infusion will surely bring challenges and difficulties, but they will be far outweighed by the success, motivation, and appreciation that will be exhibited by the community members that you serve.

About the Author

Linda S. Different Cloud is a Science Instructor at Sitting Bill College in Fort Yates, North Dakota. Her work focuses on efforts to make STEM content relevant to Indigenous peoples by showing ways in which it can be used to improve the health of Indigenous lands and people through a combination of Traditional Ecological Knowledge and Western Science. Dr. Different Cloud has developed culturally relevant high school science curricula for the Bozeman Montana Schools as well as Native Science courses for tribal colleges that incorporate the Native culture, Native science, and rigorous Western scientific content into classes. She also has served as a Project consultant for the NSF Beyond Earth grant to train reservation teachers to deliver and develop culturally relevant curriculum about space and space science.

Dr. Different Cloud is a recipient of an NSF Plant Genome Fellowship. She received the A.A. degree in Native American Studies from Sitting Bull College; the B.A. degree in English Literature, Anthropology, and Botany from Miami University of Ohio; and the M.S. degree in Science Education and Ph.D. degree in Ecology and Environmental Sciences from Montana State University.

REFERENCES


Expanding Curricular Offerings through Distance Learning

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SUMMARY

Science, meaning knowledge, is derived from the Greek. For Indian people, science is the story of the world and how to live in it. Cajete (2000) tells us that Science is storytelling for understanding of the natural world. It is a product of a creative journey and history and entails more than Western science. At Salish Kootenai College (SKC), a tribal college on the Flathead Indian Reservation in western Montana, science courses and classes blend Indigenous cultural knowledge and Western Scientific theory.

In 1996, SKC was the first tribal college to offer online classes. Since that time, faculty teaching STEM classes have developed innovative and creative ways of presenting their subject matter. With the boom in technological innovations and the concept of blended learning, or hybrid classes, STEM content linked with cultural content has improved retention of online students.

Students who attend Salish Kootenai College are fully immersed in the age of technology, while many instructors wallow in the Age of Aquarius and are challenged to keep current with the latest technological innovations. Students come to class chatting on cell phones, taking notes on laptops, iPods, and iPads. They have Facebook accounts, understand how to text messages, Tweet on Twitter, and go home to play World of War craft, or other global games on Xboxes. Most faculty can hardly keep up with these multi-taskers.

Fourteen years ago (1996), when Salish Kootenai College (SKC) began taking its first baby steps into online learning, also known back then as Distance Education, few students had access to a computer, much less knew how to operate one. It was demanding for faculty, students, and the administration to accept this new style of teaching/learning. No institution had attempted online teaching with American Indian students with their unique learning styles and historical trauma in academia. Today’s students are much more savvy.

Over the years, Distance Learning has exploded, and nowhere is that more evident than at Salish Kootenai College. Today, we speak of the process as e-Learning, which embraces all manner of technologies, from using podcasting, to computers, to hybrid classes and PowerPoints, or any type of technology that enhances students’ learning. The College hosts over 200 new online students a year. Most students who register for e-Learning classes hope to fit credits into an already overcrowded academic schedule. Students expect their institutions to include online and hybrid classes.
Our former President, Dr. Joe McDonald, once said, “The fast eat the slow, and if SKC doesn’t do it, someone else will.” The SKC e-Learning program has always enjoyed the full support of the College administration.

“The hybrid approach to learning has benefitted from the trials of early pioneers and the technological advances of recent years” (Demski, p. 19, 2010).

In May 2009, the Department of Education released its findings of a meta-analysis of online, face to face, and hybrid learning models. “The analysis found that online learning produced better student outcomes than face to face classes, and that blended learning offered an even larger advantage over face to face” (Demski, p.9, 2010).

But how do these results fare when compared with American Indians at tribal colleges? There have been two studies (Tyro, 2005; Fire, 2009) where SKC’s e-Learning program was the topic of the research. As yet, there has been no analysis of the SKC student population, but, from the experiences of faculty and students at SKC where relationships for American Indians are key to learning, blended/hybrid learning classes are extremely popular.

Since the inception of the e-Learning program, STEM classes continue to test instructors. However, collaboration among STEM faculty and the e-Learning program has led many to adopt the blended learning route. In a blended learning/hybrid class, students come to campus to participate in labs and take exams. Otherwise, all learning objects and documents are online. The development of blended learning courses begins with a decision from an instructor to develop content for online, or blended/hybrid delivery. Consent to develop a class for e Learning occurs with the department head and the academic vice president.

Salish Kootenai College offers bachelor’s degrees in the following STEM areas: Environmental Science, Biological Science, Computer Engineering, Information Technology, Nursing, Social Work, Secondary Education, and Forestry. Additionally, several classes in Mathematics (Statistics, College Algebra, and Developmental Math) are taught online or blended. In the case of developmental classes (Reading and Math), the instructor is present in the classroom, but all of the work is completed online and self-paced.

Every department at SKC offers several online or hybrid classes, and some degrees, such as the Bachelor of Science in Nursing for RNs, are totally blended. The Associate’s Degree in Liberal Arts is one class away from its fully online/hybrid counterpart. More and more instructors are planning classes as hybrid/blended learning offerings. The blended learning classes are extremely popular with STEM instructors who teach math, forestry, and biology, and chemistry. It is a greener way to teach. There is less paper waste and a smaller carbon footprint, as students do not travel to campus as often. Also, classrooms are not constantly in use.

Retention rates for online and hybrid classes match those of the on-campus classes (Dr. Elaine Frank, Director of Student Services, Personal Conversation, 2010).

The retention rates vary, from a high of 95% and as low as 40%. In addition to offering STEM classes as blended learning/hybrid, the cultural component in STEM classes seems to be
one of the keys to retaining students. When students see the connection to their lives, they work harder and succeed. It is difficult to see how algebra, physics, or microbiology impact their profession or their lives if they do not understand the connections to their own culture. Cajete states “Tribal teachers begin teaching by building on the commonplace” (1994, p.223). For example, the anticipatory set for Elementary Microbiology is a story of microbiology hunting. Instead of hunting with a gun, microscopes are used. Much like macroscopic or big game animals, microbes live in certain ecosystems and they eat certain things. The microbes can be “field dressed” on a microscopes slide. They also leave tracks in the form of diseases. An example is cryogenic and cryophilic microbes, which are similar to arctic animals such as seal and polar bear.

Also in beginning anatomy, instructors may indicate that many of the students in the class have been hunting. They may not know the names of the organs in Latin, but they understand their function. To help students remember the components of the Integumentary system in an anatomy class, instructors may tell the story of the Buckskin dress which is decorated with horse or other animal hair, and deer nails. “Culture and learning are intricately interrelated…cultural orientation is an essential consideration in the learning process” (Cajete, 1999, p.36). Instructors at SKC infuse cultural content into every syllabus and class, whether online or on campus.

![Relationships for American Indians students are another key for retention and for successful completion of online classes (Tyro, 2003).](image)

According to a recent guide in teaching Aboriginal students online published in Australia (Ridgeway, 2003), “Building relationships with students is critical when teaching online; because facilitators are not face-to-face with students, they cannot see how a student reacts or help them on the spot. A great deal of how facilitators “see” students will depend on how well they “read” them.” Technologies such as Skype, Google Video chat, Imovie and online asynchronous text help keep students and instructors connected. A few instructors allow students to call them at home. Additionally, many hold online office hours during the evening when students need critical help.

The College has undergone major changes in Learning Management Systems (LMS) since implementing the Distance Education/e-Learning program in 1996. Moodle is the current LMS platform of choice. It is robust and open source. After several workshop sessions, instructors are enthusiastic. They find it user friendly and have developed over 200 classes in Moodle. They also participate in a Moodle support group that meets weekly. It is a “Drop In-Drop Out” workshop where the agenda is led by faculty needs. According to recent surveys (Lambert, 2010), faculty who responded are highly satisfied with the LMS and the training. Most faculty at SKC do not require support after developing the first class.

In conclusion, it is not impossible to teach STEM classes online or as blended learning. Instructors need to think creatively how to go outside the classroom. There are many websites and virtual laboratory sites for chemistry, microbiology, mathematics, and physics that can help ease the burden on overwhelmed faculty. It takes time and energy, but is well worth the effort … Imagine teaching class from Australia, or the beaches of Hawaii.
About the Author

Lori Lambert is the Coordinator of the e-Learning Program at Salish Kootenai Tribal College on the Flathead Indian Reservation, where she has trained over 200 faculty members in Lotus Notes Learning Space, Pathways, and the Moodle Learning Management Systems. Dr. Lambert, a medical ecologist and medical anthropologist, is an enrolled member of the Abenaki Nation and a descendent of Mi’kmaq tribal members. With over 25 years of teaching at a distance via cable television, videoconference, and online, she makes a valuable contribution to the SKC Distance Education department.

Dr. Lambert is an internationally known researcher and lecturer and has authored numerous articles and five books. She was awarded the 2001 Excellence in Online Teaching Award from the Alfred P. Sloan Foundation. Dr. Lambert holds a diploma in nursing from Cambridge Teaching Hospital, Harvard University; a B.S. degree in Health and Physical Education/Therapeutic Recreation from Temple University; a Master of Environmental Science Education degree; a Ph.D. degree in Medical & Anthropological Ecology: Arctic Studies from the Union Institute and University; and a Post-Doctorate Certificate in Distributed Learning and Technology from the University of British Columbia, Vancouver. She lives on the Flathead Indian Reservation with her husband and band of Huskies.

REFERENCES


Abstract
The Kapiolani Community College’s (KapCC) Science, Technology, Engineering and Mathematics (STEM) Program is introduced with particular focus on the Native Hawaiian (NH) student recruitment and retention strategies. The National Science Foundation’s (NSF) Tribal Colleges and Universities Program (TCUP) highlights that are described include peer mentoring and the Summer Bridge projects. These projects have been extremely effective in the development of the STEM program with over 200 current STEM majors (37 NH majors). The KapCC STEM program has transferred and/or graduated 55 NH students majoring in STEM programs at 4-year colleges.

Mole (Roots)
KapCC has a long, colorful history. Established in 1946 as the Kapi‘olani Technical School while Hawaii was still a U.S. territory, the school was administered by the Territorial Department of Instruction. Its first program at the Kapi‘olani Technical School was food service. By the time Hawaii obtained statehood in 1959, three additional programs had been added: practical nursing, business education and dental assisting. The technical school realigned its programs and became part of the open door community college system of the University of Hawaii in 1965 and was renamed Kapiolani Community College (KapCC).

Originally located on the corner of Pensacola Street and Kapi‘olani Boulevard in downtown Honolulu, KapCC's enrollment grew rapidly during the 1970s. So rapidly, in fact, that a move to larger quarters became a priority. In 1974, the UH Board of Regents provided for a phased transition and transfer of the Pensacola programs to a new 52-acre campus located on the slopes of Diamond Head crater. Occupying five temporary renovated buildings once owned by Fort Ruger, KapCC received the distinction of being the first two-campus college in the system.

Today, KapCC, the second largest of ten public colleges in the University of Hawaii (UH) system, is a two-year college providing extensive and high quality liberal arts and career
programs. The College bears the name of Queen Julia Kapi‘olani (seen here), whose motto, “Kulia i ka nuu,”—“To Reach for the Highest,” shapes the College’s vision as a learning-centered institution.

In the fall of 2010, more than 9,700 students will enroll in day, evening and weekend credit programs at the campus. An additional 25,000 students enroll through the extensive non-credit programs. The liberal arts program remains the largest, enrolling more than 6,000 students. Native Hawaiian students account for 13.7% of the campus population (N=1247), with the rest of the population representing a cross-section of Hawaii’s overall population.

**Loa‘a (Resilience)**

The STEM program began in the fall of 2005 with only four Hawaiian students enrolled. With support from a Tribal College and Universities (TCUP) implementation grant from the NSF and additional funding from other State and Federal sources, the program has grown to more than 360 NH STEM students this year (see figure 1). A large number of these students (~70%) are enrolled in pre-college mathematics and will require six or more semesters to transfer to a 4-year college as a Junior.

![STEM Student Enrollment](image)

**Figure 1. STEM Student Enrollment**

In the spring of 2007, the college opened the KapCC STEM Center. The STEM center provides TCUP and other STEM students with “a sense of place” on campus and is staffed with mostly Native Hawaiian Peer Mentors who work with students as tutors, counselors, advisors and friends. The KapCC STEM Center is a place of sanctuary for many STEM TCUP students and a gathering place for students and faculty with similar goals and interests. The kuleana (responsibility) of the mentors is to provide the necessary academic resources and share their experiences. A peer mentor provides constant support both academically and personally to the other students.
The success of our program at KapCC can be seen in the increased *ikaika o na`au* (inner strength) and academic growth of each student. To date, 87 Hawaiian STEM students have worked as *alaka`i* (TCUP Peer Mentors) and 378 Native Hawaiian STEM students have taken advantage of the Peer Mentoring program.

The STEM Center is full of resources available to all students who are taking STEM classes, especially those that may need extra assistance. The center encourages individual, paired and/or group study by providing versatile computer furniture and hardware that accommodates different learning styles. Students can bring their own laptops to connect to the KapCC wireless network, borrow a tablet laptop from the STEM center or use a desktop computer with monitors that are on articulated arms that allow students to view their work in a group setting. The space in the STEM Center was renovated to provide faculty offices within the center itself, which allows the students to have direct access to the faculty that are currently teaching STEM courses. These features have made the center a lively, collaborative, STEM-centric hub of activity on campus.

In addition to embracing and promoting STEM academic excellence, the STEM center is the *hale* (home) of the TCUP ohana (family) and is an important focal point on campus for Hawaiian cultural activities, such as the TCUP Pa`ina (gathering). At these gatherings, students learn how knowledge is acquired, exchanged and valued. The TCUP faculty, staff and students come together to “talk story” about the STEM program, STEM careers, college transfer opportunities in Hawai`i, summer internship experiences, as well as other programs.

The scheduled Pa`ina’s also allow the students to reconnect with important Hawaiian cultural influences. Students have the opportunity to attend workshops by Kupuna (elders), who combine traditional knowledge with modern technology. For example, the students were taught how to locate Heiau (ancient spiritual sites) through the use of Global Positioning Systems (GPS) and Geographic Information Systems (GIS). TCUP students also had the opportunity to visit Kaho`olawe (the forbidden island - used by the United States Navy for bombing practice for over 50 years) and help in the restoration efforts that are taking place on the island reserve. The students assisted in the planting of native plants that flourished on the island many years ago. This was a rare opportunity for the STEM students to grow academically and culturally.

The TCUP students also learned of the importance of *loko i`a* (fish ponds). They learned about how the ponds were engineered to provide a sustainable food source for the surrounding communities. In addition, the students studied the ‘aina (land) that provided the *lo`i kalo* (taro patch), the staple crop of the early Hawaiians. The TCUP students joined a KapCC botany professor to work the taro patches and learn how to grow taro, as well as the nutritional and economic value of this vital Hawaiian crop. This type of interdisciplinary learning helps to integrate cultural knowledge with modern science:

> “*O Ka Mole Koa Ke ‘Ike I Ke Po’ohala*” – *The confidence of every native Hawaiian student is the result of societal encouragement that all indigenous people are scientists.* - *olelo no’eau*, by Keolani Noa

Another essential retention strategy for minority students, particularly at a community or tribal college, is to provide these students with a “clear academic goal.” In an effort to clearly identify and track STEM students at the college and throughout the UH system, the college has
invested in the creation of a new college degree called the Associate of Science in Natural Science (ASNS) degree, with concentrations in either physical or life sciences. The new 60-credit degree consists mainly of preexisting core courses, with more advanced math, science and engineering courses filling out the elective option. ASNS enrollment has grown from zero when approved by the University of Hawaii Board of Regents in 2007 to over 250 students today. Fifty-five (55) Native Hawaiian students have graduated and/or transferred to 4-year colleges in STEM majors. ASNS enrollment is still increasing and the degree continues to be the fastest growing degree at KapCC.

**Hiki (Reach)**

The KapCC Summer Bridge program continues to be a vital part of TCUP. The Program hosts 60 Native Hawaiian high school juniors and seniors who participate in two separate 3-week summer bridge programs. The programs run daily from 9:00am to 4:00pm with rigorous math review and lectures or team building activities. The students re-examine their math skills on a daily basis for at least two-hours each day. The students are Pre- and Post-tested using the COMPASS placement exams at both the beginning and the end of the Summer Bridge program. The COMPASS program, which is used as a placement exam by all UH community colleges, is an adaptive computerized test that adjusts the difficulty of test questions to the level of individual students, removing items that are either too easy or too difficult.

The students work on improving their math skills using an online, self-paced math refresher course called Assessment and LEarning in Knowledge Spaces (ALEKS). ALEKS is a web-based, artificially-intelligent assessment and learning system. The online mathematics activities have made a significant impact on those native Hawaiian students who have the desire to become a STEM student. Since the program began, 163 students have participated in the Summer Bridge program using ALEKS intervention. More than 40% of these students were able to improve their score on the COMPASS placement exam to the point where they were able to move to a higher-level math course. In some cases, students were able to eliminate two semesters worth of math preparation courses en route to earning their STEM degree.

Summer Bridge afternoons are focused on a project-based STEM activities that are designed to make math and science fun for students with very little STEM background. The activities offered vary from week to week and are aligned with either the life science or physical science pathways. For example, the TCUP Summer Bridge program has focused on alterative sources of energy by
collaborating with the KapCC Culinary Arts department in a research experiment that involves the transforming of used cooking oil into bio-diesel. After being tested for quality by Hawaii Biodiesel, a Honolulu based company specializing in bio-diesel production; the final product made by the students was used to run a diesel tractor on campus. Further, students constructed a small, inexpensive underwater remotely operated vehicle (UROV), also known as a Sea Perch. The Sea Perch project was developed by MIT and includes a complete set of construction manuals and plans for the UROV. Students also learned how to wire control boxes to pilot the UROVs from the water’s surface.

The students learned how to use Global Positioning System hand-held units to measure the Polynesian Voyaging Society’s sailing distances, time required for sail, average sailing speed, prevailing winds and water currents. Students were then given the task of plotting their individual course by making a map of their movements using Geographical Information System software. Their mini voyage set sail from Kaiona Beach on a six-man wa’a (canoe) under the guidance of cultural navigators.

About the Authors

John Rand is a Professor at the University of Hawaii (UH) as well as the Science, Technology, Engineering and Mathematics (STEM) Program Director at Kapi‘olani Community College in Honolulu. With graduate degrees in both physical science (Physics, M.S., American University, 1988) and life science (Biomedical Sciences, Ph.D., University of Hawaii – John A. Burns School of Medicine, 1999), Dr. Rand has taught a wide variety of classes that range from the Science of Sleep and University Physics to Animal Physiology and Graduate Neurophysiology. He is the college’s Pre-engineering coordinator and representative to the UH College of Education’s Science Teacher Education Committee. Dr. Rand also is an Associate Director for the Hawaii Space Grant Consortium and holds a governor appointed seat on the Hawaii Innovations Council. Prior to coming to Hawaii, he worked for Optical Technologies Inc. in Herndon, Virginia as an optical engineer and laboratory manager designing, testing and constructing fiber optic sensor systems.

O Keolani Lindsey Noa is currently the Outreach Coordinator for Kapi‘olani Community College’s Science, Technology, Engineering, and Mathematics Program and coordinates the KapCC STEM Summer Bridge program. She has a B.S. degree in Business Management from the University of Phoenix. Mrs. Noa is active in community development and student affairs, and in facilitating cross-cultural awareness. She is certified in specialty education with the Schools Attune program, Oli, Ho'oponopono, and Religious Studies. Prior to joining KapCC, Mrs. Noa taught Hawaiian Studies and Health at a private school in Honolulu. She received the Ellison Onizuka National Award from the National Education Association and was recently inducted into the NEA’s National Women’s Historical Biography. Mrs. Noa was born and raised in Kuli'ou'ou Valley on Oahu, the ahupua'a where her family has lived for seven generations.
Facilitating Student Transition from a Tribal College
to a Four-Year Institution

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Understanding the contextual environment of how and when tribal colleges were established helps frame the issue, “How do you help students transition from a tribal college to a four-year institution?” First, one ought to understand that tribal colleges were:

“...created in response to the higher education needs of American Indians and generally serve geographically isolated populations that have no other means accessing education beyond the high school level. TCUs have become increasingly important to educational opportunity for American Indian students and are unique institutions that combine personal attention with cultural relevance to encourage American Indians—especially those living on reservations—to overcome the barriers they face to higher education.” (AIHEC website, 2010)

Secondly, many of the tribal colleges are including four-year programs (and some graduate programs) to fill the vacuum not provided by four-year institutions and are looking at servicing those students that transfer out, only to return, because the “fit” of the four-year program just was not meeting their needs. Cheryl Crazy Bull, President of Northwest Indian College (NWIC) states that many “tribal people don’t want to mainstream,” and, therefore, tribal colleges help to create a “comfort zone” and an institutional environment that provides a “family experience for our (tribal college) students.” (Giegerish, 2008)

Although little transfer data was available on tribal colleges credit goes to AIHEC for understanding this vacuum and they will increase their research agenda concerning tribal college students by utilizing American Indian Measures of Success’ (AIMS). This is a landmark data collection initiative, which will define measures for tribal colleges and universities (TCU) success that are relevant to the colleges and their communities. Many of the missing data for tribal colleges will eventually be addressed by AIHEC’s research component and will eventually provide empirical evidence of their plight, their story, and their accomplishments.

Yet, in spite of the many programs that tribal colleges provide, many students do transfer and face a multitude of issues in the process, both good and bad. There are several concepts that cause a disruption in a smooth transition to a four-year institution as well as there are many avenues to make the transition go smoothly. I will also incorporate the six universal questions utilized by journalists: “who, what, where, when, why, and how?” In some cases, one may need to use these questions to outline the initial question presented, facilitating tribal college students into four-year institutions.

Beginning with the smooth transition route, and understanding how it proceeds will, on the other hand, help frame the difficulties one faces when transferring to a four-year institution. In the report by American Council for Education (ACE, 2004), Patricia McDonough (who is a
leading scholar on how students, schools, and colleges manage this critical transition) reports on the challenges and prospects so that institutions can help schools (and colleges) prepare disenfranchised students (and families) for success in higher education. McDonough states three disparities that hinder college access and they are “preparation for, knowledge of, and attitude toward college.”

Therefore, if these transitional issues are addressed early, there ought to be a smooth transition for tribal college transfers. Since preparation is an issue, when and where should one begin in preparing for college and the eventual transition from a two-year institution to a four-year institution? A research study by Educational Testing Services already shows that there are precursors that help students, and one begins in the pre-school era (Carnevale and Desrochers, 2003) and continues throughout the early high school days (Hossler, Braxton, and Coopersmith, 1989). The precursor to college enrollment is referred to as “aspirations.” However, when one looks at college aspirations for low-income students, minority students, and, in this case, tribal college students, college aspiration is not thought of in the same sense because many of the tribal college students are from first generation families, are more into the ‘here and now,’ and current time and place seems to resonate versus long-term visions. This is akin to understanding the complex thinking of indigenous peoples versus the linear track of most Western thought (Barnhardt and Kawagley 1999).

Thus, aspirations need to be cultivated earlier to get a smooth transition when transferring so that students better understand how to fill their occupational and educational goals early in the process. The question now is, where and when do aspirations form within Indian families, especially for the college bound individual, that adequately take into consideration what it takes to get to that occupational position (i.e., to become a scientist)? How can academic support staff help in framing this dilemma so that it takes into consideration the cultural environment of both the student and institution?

A new paradigm can be developed earlier in this process for tribal college students that focus around individual aspirations that include culturally sensitive time and place and Western linear thinking about the future. This will help address the anomaly and perhaps help encourage earlier interventions. The responsibility of addressing these issues will rest with both parents (and in many cases grandparents) and school district staff to help understand what preparations are necessary to meet the end goal.

Having aspirations is great, especially if one understands what is necessary to get to the end goal. However, since higher education is expensive, many tribal college transfer students are not fully aware of the financial barriers that exist in transferring from tribal colleges. For example, according to the National Center for Educational Statistics 2010, the average cost of attendance in 2007-08 was:

- $12,000 for public two-year institutions (and presumably tribal colleges)
- $19,400 for public four-year institutions
- $37,000 for private institutions

There is a significant increase in cost of education in transferring, an eye opener for many tribal college students, who currently pay lower tuition and fees versus what they will pay at
public, four-year institutions. Therefore, thinking about college costs at an earlier stage in life helps with minimizing the stress that goes with financing your college education. This includes knowing the deadlines in applying for all kinds of scholarships (tribal educational grants, institutional scholarships, federal financial aid deadlines, etc.) and to apply on time to meet the deadlines. Thinking about transferring earlier helps in the planning stages not only for getting into the four-year institution, but in meeting all of the many deadlines. Applying to transfer at the last moment creates all kinds of problems (most important is the availability of financial aid; housing availability; college course selection more than likely will be minimal; and transcript reviews need to take time).

Both preparation (academic and personal) and financial assistance are two of the barriers that cause conflict in transferring to a four-year institution. Adelman (1999) verified that the quality and intensity of high school academic preparation was one of the most important variables in completing a four-year degree and, in helping to transfer from a community college to a four-year institution. Tinto (1993) mentions that it is important to have financial support if one is to be successful in college, with both verifying the importance of preparation and financial assistance in transferring from one institution to another.

As mentioned earlier, if preparation is not there, then the transition becomes problematic and can lead to frustration, dropping out, and a bad taste in the student’s mouth about the institution. The completion rates are somewhat longer for transfer students for several reasons, two of which include financial aid availability to complete degree and the possibility that students might change majors, which adds to the number of credits needed for a degree. And, of course, the interruption of stopping out only to re-enroll at a later date also extends the time to earn the degree. The National Center for Educational Statistics (Special Analysis, 2008: Community Colleges) reported that the bachelor’s degree eight-year completion rate for students starting at community colleges is far lower (17%) then students going right into four-year colleges (57%). There is some indication for community college transfer students (and maybe tribal college transfers) that the bachelor’s degree completion rate is lower, 44%, in 6 years versus 63% for students who started at a four-year institution (NCES-2003 data). (Data not available for tribal colleges.)

With the multitude of research, data analysis, and both anecdotal and empirical research information, there are ways to overcome the many disruptions that might take place in transferring. Some are institutional commitments to providing a better environment at the transfer point, others are special programs designed to making the transition a lot easier.

For any transfer to take place seamlessly, institutions need to have a good relationship with both the K-12 system as well as the tribal colleges. The K-12 system can be a partner in making change if they too knew what the difficulties were, especially in academic preparedness. If tribal colleges are experiencing poor mathematics preparation of their incoming students, and have to provide remedial programs to get students ready to take STEM courses, then the high schools need to look at revamping their process, working closely with the tribal colleges. Thus, encouraging schools to refocus on their college preparatory mission with focus on instruction, their counselor orientation for college preparatory training, and on financial aid at the earliest possible year to include both student and parents (guardians) will ensure success.
Of course, the four-year institution needs to review their teacher training programs and form partnerships with reservation-based high schools that lead the discussion on academic preparedness and how they can provide assistance. Some institutions (e.g., The University of Montana and Montana State University) have dual admissions programs whereby tribal college students are dually enrolled in both their tribal college and the university and have access to advising, transferring help, campus tours/library usage, as well as access to key staff that work closely with tribal colleges. This helps in advising, financial aid issues, orientation to the four-year program and campus, and the opportunity to identify transfer obstacles early in the process.

Some of the special transition programs are funded by the National Institutes of Health (NIH) through their Bridges to the Baccalaureate Program, to help tribal college students navigate the process of achieving a baccalaureate degree in biomedical sciences. This program provides tribal college students with a taste of the four-year curricula, the campus environment, and opportunities to network with scientists, program administrators, instructors, and fellow students. The intent is to make their transition into the campus as smooth as possible, improve their academic competitiveness, and to be part of the scientific research team. (NIH website, 2010)

Another program that helps in the transition, much before one considers transferring, is the Department of Education TRiO Upward Bound Program. Students from tribal communities attend summer sessions/programs that provide them with improved educational opportunity and access to higher education. A sister program of Upward Bound is the institutional TRiO Student Support Services, which offers a range of services aimed at increasing the success rate of students once the students get on campus and serves primarily first generation college students. Both of these programs recognize the important role that academic preparation, awareness of opportunities for college, and assistance in completing the college application process play for low-income students whose parents are not college-educated.

At the tribal college level, many colleges have received support from the National Science Foundation (NSF) through the Tribal Colleges and Universities Program (TCUP). The intent is to enhance the quality of science, technology, engineering, and mathematics (STEM) instruction and outreach programs at tribal colleges (NSF Program Solicitation NSF 04-602, 2008). Collaboration is a key component of TCUP grants and many of their tribal college students continue at mainstream institutions. This program helps students to outline their continued programs as they transfer to four-year institutions.

So, the pathways of transition have many avenues of service, all with the intent on helping students be their best and ultimately graduate with a degree and perhaps consider a graduate degree as an option after their undergraduate program. Is there a role for tribal colleges in this process? Of course, even if research shows that if one starts at the four-year institution they are more likely to get their degree within six years. The caveat for tribal college success is to have the right amount of support, the connectivity to four-year institutions, and a clear pipeline process with all of its support services intact. With the NSF support (and other science based programs) to develop student-based STEM skills, and helping to develop the creativity needed for scientific inquiry which eventually helps to promote active learning and stimulate student interests in STEM.
Tribal colleges can, and do, deliver support to help students through this process. As Cheryl Crazy Bull indicates “We re-create the family experience for our students…” (Giegerich, 2008) and that seems to be a key aspect of keeping tribal college students on track to complete the two-year degree. There are two other key components that tribal colleges have that four-year institutions are seeking to replicate and that is the integration of tribal traditions into the campus climate and to have inclusion into the academic curriculum.

Montana has done some amazing things to promote cultural inclusion by passing Article X, Section 1(2) of the Montana Constitution that reads, “The state recognizes the distinct and unique cultural heritage of American Indians and is committed in its educational goals to the preservation of their cultural integrity.” The Montana four-year institutions are utilizing this language to also help promote the unique cultural heritage of American Indians. So the process of inclusion begins at pre-K and continues on into the four-year programs.

In 2003, Drs. Iris Heavy Runner, Jim Shanley, and Janette Murray, with the assistance of colleagues and friends and the support of W.K. Kellogg Foundation funding, developed the Family Education Model (FAM), to help meet the needs of American Indian students and to help with retention challenges. The goal was to create a process on “thinking about how higher education can improve access for students and can provide more effective support for student persistence and degree completion.” Because female students represent a larger percentage of all tribal college students (52%) (AIHEC website, 2010), and many have families, the FAM is a timely piece of information that will help four-year institutions understand the needs of tribal college transfers and, will help tribal college students to understand issues before they matriculate.

Now for the practical process of facilitating student transitions to four-year institutions comes from my past experience working for STEM activities for 20 years and in directing a multiple-state effort in promoting STEM for American Indian students and tribal colleges. Here are some activities that seem to work in this process:

- Start early, have some kind of collaboration efforts with K-12, tribal colleges, and four-year institutions that form a solid and lasting partnership with equal representation. Develop a comprehensive plan and share it widely.
- Formulate articulation agreements on STEM courses that transfer to four-year institutions. If there are some weaknesses in either tribal college or four-year curriculum, then work together to provide input to solidify the articulation agreements.
- Provide early orientation sessions on criteria for success at both tribal the college and when they transfer, to include academic standing criteria, financial aid procedures, environmental changes from one institution to another, and strategies on handling stress, racial tensions, and homesickness.
- Be ready to see matriculated students return to the tribal college and be prepared to offer assistance to provide a holistic approach to completing their degree and help transition them back into four-year programs to complete STEM degrees.
- Early in the process, establish mentorships with students, both at tribal colleges and at four-year institutions about the process of transferring and academic standards. This allows the student to “learn the ropes” while still at a tribal college and creates ties to both institutions.
Arrange networking meetings for students at the local, tribal, state, regional and national levels. Getting students involved in meeting scientists, researchers, and faculty allows them to see what activities are occurring at each level and to meet professionals.

Tribal colleges need to have follow-up sessions with their graduates not only for reassurance to maintain academic programs but to get feedback on how they can improve their programs for future students.

Utilize four-year institutions’ summer programs to get a taste of the institutional climate and to meet campus support individuals.

Establish a four-year timetable with dates, deadlines, opportunities, connections, and follow-up activities. This helps to make sure financial aid opportunities are not missed, that application dates are adhered to, and planning for the next step is outlined so that the process is seamless.

Four-year institutions ought to have tribal college exposure, to meet the potential students on their turf. This will help faculty to understand the support that tribal-college students receive and what the differences are between tribal college and mainstream environments. According to AIHEC’s Learning Pyramid, the average retention rates for tribal college students by presentation methods are: lecture-5%, reading-10%, practice by doing-75% and teach others and/or immediate use-90%. (AIHEC website, 2010)

Four-year institutions will need to develop early transition programs for tribal college students and their advisors. Sharing information before matriculating eases the frustration and provides valuable contacts at host institution.

Four-year institutions will need to have clear and updated articulation agreements with tribal colleges. This helps in making sure the academic pipeline is seamless when students transfer.

Both institutions can start sharing “best practices” that impact college achievement and academic success.

Overall, the most successful avenue to a bachelor’s degree starts early with solid academic preparation and personal goals outlined (Kinnick and Kempner-1988). Research shows that these individuals, no matter what background, tend to complete a four-year degree within six years. Nevertheless, there are pockets of tribal college transfer students that show high academic success in the transferring process and do complete their bachelor’s degree and continue on for a graduate program. There is anecdotal evidence when talking to tribal college faculty, and they are proud to list those students as “one of theirs,” yet here is no research to verify this.

Personally, I can attest to at least four tribal college students who matriculated to a four-year institution, graduated within five years, have gone on to terminal degrees, and all the while maintaining at least a 3.5 GPA. And, for the most part, they have never severed ties with their tribal community, have actively participated in cultural activities and are acknowledged by their institution, by native organizations (Montana Indian Education Association), and all plan on returning to their reservations to serve and create change. So there are pockets of success in student transition from a tribal college to four-year institutions.
About the Author

Patrick Weasel Head is the former Director of the Office of American Indian Student Services at the University of Montana-Missoula (UM). He currently serves as Cultural Consultant to the UM Graduate School’s Sloan Scholars Program. Dr. Weasel Head worked in Native American Studies on two previous occasions and also has worked at both community colleges and universities in Oregon as well as in Montana. His past positions include serving as Project Director for the Tribal College Rural Systemic Initiative, a five-year NSF-funded grant to Turtle Mountain Community College. Dr. Weasel Head is very knowledgeable about the efforts of federal agencies to support minority-serving institutions in STEM areas. He also has served as a consultant to the W.K. Kellogg Foundation’s Native American Higher Education Initiatives.

Dr. Weasel Head is a “community builder” and is aligned with two Montana tribal groups, the Blackfeet Tribe and the Gros Ventre Tribe. He has spent most of his career working on systemic change in “Indian Country” and in promoting STEM activities for disenfranchised students. Dr. Weasel Head received a bachelor’s degree in Business Administration from the University of Montana-Missoula, and a master’s degree in Guidance and Counseling as well as the Ph.D. degree in Higher Education Administration from the University of Oregon-Eugene.

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Strategies for Culturally Responsive Mathematics in Distance Education

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Abstract
Success in mathematics is essential for success in higher education. The Interior–Aleutians Campus of the University of Alaska Fairbanks has responded to this need by making an effort to create a culture of learning about and doing mathematics. Providing and improving place-based education through distance learning for required university mathematics courses and respecting personal and cultural values is making a difference. Mathematics faculty have researched and adopted technology to improve the mathematics learning experiences for the students, and also have adapted teaching design in response to the cultural needs of rural and Alaska Native students. Research data indicates that increasing mathematics success increases student persistence for future Alaska Native educators. Grant money provides additional support to these students, including bringing them together to work face-to-face. Qualitative data also includes survey responses from students about the meaning of the term “culturally relevant.” Strategies for Culturally Responsive Mathematics Education & high expectations for success also will be shared.

Success in mathematics is essential for success in higher education. Mathematics faculty at the Interior–Aleutians Campus adapt course design to support the needs of rural and Alaska Native students. “Becoming a culturally competent educator is a constant learning process that requires flexibility and adaptability on the part of the educator depending on the particular students and contexts with which they are working” (Castagno & Brayboy, 2008, p. 947). Efforts to improve success in university mathematics classes for rural Alaska Native students have created a response to culture, time and place. Each semester teaching methods are reviewed, and ways to adapt the design of the class to meet student needs are considered. This article describes current teaching strategies that seek to improve mathematical success for students in university courses. For future Alaska Native teachers, grant resources provide financial and academic support in reading, writing and mathematics, including bringing students together to work face-to-face, creating personal connections among students and university staff. Student perspectives on the meaning of the term “culturally relevant” are shared.

Culturally Responsive Math classes include opportunities for cooperative learning, visual learning, connecting learning to the students’ everyday lives, a holistic approach to explaining mathematics, presenting and reminding students of the big picture before working out the details, not putting a student on the spot to solve a problem if they are uncomfortable with it, increasing wait time between questions and answers, and allowing flexibility in due dates in response to unexpected events in village life. Strategies to improve mathematics learning include building
trust, encouraging an intrinsic motivation for learning math, and setting high expectations for mathematical performance. Mathematical explanations during class include solving problems, making mistakes, and learning to check one’s own work to know if it is correct or not. This is a powerful concept because, rather than waiting for an outside source of authority, the student learns to justify his/her own mathematical strategies, thus building the student’s self-confidence as someone who can do mathematics.

Academic challenges related to the preparation of Alaska Native college students must take into account the K-12 preparatory education of rural Alaska Native students themselves. The high teacher turnover rate of educators from outside Alaska, the necessity of rural teachers to teach more than one subject to more than one grade, and the lack of “highly qualified” teachers has led to gaps in student educational backgrounds. Mandatory placement requires many rural and Alaska Native students to take several developmental mathematics courses before they take the 100 level mathematics class required to earn a degree. For some students these courses review basic knowledge, but for many, it is the first time they are learning the mathematics (which corresponds to Algebra I and Algebra II at the high school level).

TEACHING STRATEGIES

Distance education at the Interior–Aleutians campus includes Audio-Conference and Internet-based classes. The telephone has been one of the most reliable forms of communication for Alaska, and students have been calling in to conference call classes since the 1980’s (Hahn, Lehman, Dupras, 2007). The university employs the Blackboard online course management system, which gives access to Elluminate Live, a synchronous online classroom where professor and students meet. There is an interactive whiteboard, a chat window for questions, and polling features where students can raise their hands or choose solutions to multiple-choice problems.

Mathematics faculty at Interior–Aleutians Campus convene class both over the phone and online in the Elluminate Live classroom. Students who do not have Internet access during class time or who are traveling can phone in to class. Also, on any given class day, the Internet is not working properly in some part of the state. The phone line gives these students the option to attend class via the phone. Since offering Elive classes, the majority of students meet online where they can see, hear, and interact with the rest of the class. These classes are also recorded, and students that miss class or need to review can rewatch a class any time.

One adaptation in response to the culture of rural Alaska is how assignments are turned in and how students receive graded work. Faxes have been used for years. It became essential to create bigger and bold fonts on exams and quizzes, so it was readable after being faxed back and forth. When graded homework or quizzes were faxed back to students, the student received a black and white copy, making it challenging for them to figure out the difference between the grading comments and the marks from the student’s original work. Campus upgrades to communication equipment gave access to a machine that faxes and scans. Now, graded work is scanned, turned into a PDF, and emailed to the student. Students maintain privacy of grades (oftentimes students had faxes returned to them at the school or tribal office, where others could see their graded work), and now students can see different color marks on the paper. Also, students can view it on the computer, without needing paper and ink for printing, supplies that sometimes run out, and are expensive in rural Alaska.
Students may resubmit quizzes and exams and earn back half of the points that they missed. Grading comments include questions to students about their problem-solving process and suggestions on how to solve the problem correctly. This gives students a chance to build on their own work. Some students understand the big picture of the problem, but multiply two numbers wrong or forget to write down a negative sign. Good news in this scenario is that students understand the higher-level mathematics, and gain confidence when they realize they just need to be more careful with details. Students who make systematic errors, like \((2xy^3)^4 = 8x^4y^{12}\), learn to recognize their mistakes. Students who did not get it the first time have an opportunity to learn it.

Homework is accepted in both the traditional format (worked out by hand and faxed in), and now in an online format. Traditionally, the homework process takes several days. Students complete the work and travel to a fax, instructor receives the fax, reviews it, then gives the student feedback and faxes it back. The online benefits are that it provides instant feedback to the students about whether they are solving the problem correctly or not, and that it addresses multiple learning styles. Students can see and hear video lectures by the author, view problems solved step by step, and watch animated mathematical explanations of challenging topics.

Many students say that they are visual learners, and the online homework gives that opportunity. In addition, when students are stuck, they can access hints, and view examples of problems solved correctly. Drawbacks are for students who are not very technical and have problems registering, logging in, and setting up the computer on which they are working. Internet access is improving for rural Alaska, but many villages have limited access (like the school and tribal office), and many do not have Internet access at home. Some students are resistant to technology. DVD’s of the video lectures and selected examples are available for the students who do not have Internet access.

**SUPPORT FOR FUTURE ALASKA NATIVE TEACHERS**

There is a need in Alaska for more rural and Alaska Native teachers. Many Alaska Native students perform poorly on standardized mathematics tests in K-12 education and enter college at a remedial level. Many potential educators have given up on their goal of becoming a teacher because they could not pass the required mathematics classes or have not passed a basic skills high-stakes test required for entry into the teaching profession. In Alaska, 25% of the student population is Alaska Native, but only 5% of the teacher workforce is Alaska Native and teacher turnover in rural Alaska is at 22% (Hill & Hirshberg, 2006, 2008). The presence of Native teachers in classrooms with high numbers of Native students can have a positive impact. Native teachers serve as role models in the community, and share cultural characteristics such as language, belief systems, and traditions.

Since 2005, the Interior–Aleutians Campus (IAC) has offered academic, financial and moral support to future rural and Alaska Native teachers. Grant monies provide tuition for required mathematics and English courses, including tutoring services, airfare, lodging and per diem once a semester to travel to Fairbanks to work face-to-face with professors and other students, and academic and financial support as well as preparation for students to take the high-stakes test, Praxis I, required for entry into the teaching profession.
The majority of students are female (92.3%) and Alaska Native or American Indian (92.3%). The students represent non-traditional age ranges: 20-29 (15.4%), 30-39 (33.3%), 40-49 (20.5%), 50-59 (28.2%), and 60-69 (2.6%). Eighty-one (81%) of the students have worked or are already working in schools as head start teachers, associate teachers, teacher aides, special education aides, tutors, school board members, an acting principal, and Native language specialists. See Table 1.

<table>
<thead>
<tr>
<th>Why do I want to become a teacher?</th>
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<tr>
<td>“I want to become a teacher to educate students in my region. I feel it's really important to provide elementary education so they can feel more comfortable and at home with me. I've been employed with my school district for over 20 years... I feel I am qualified to teach students but it requires a certificate.”</td>
</tr>
<tr>
<td>“I want to become a teacher because it has been one of my life's goals since high school. I would love to have a job teaching within my community ... Growing up in the village, there were very few Alaska Native teachers. I was fortunate to have two Native teachers. I think that the local kids will work harder and set more goals for themselves when they see one of their own succeeding as someone who grew up with almost the same circumstances as themselves. It would be my way of giving back to my community.”</td>
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Among the challenges for these students are passing their required mathematics classes, and passing the high-stakes test, Praxis I. Over the years, these obstacles have stalled many potential teachers. Of these students, 28.2% have completed all required university coursework for becoming a teacher, but have not passed at least one of three parts of the Praxis I. Of those stalled, 38.5% are still actively trying to meet this requirement.

Most semesters, 70–100% of students who attend face-to-face mathematics workshops during the semester have passed their required mathematics classes, and moved forward in the sequence to the next level. Students who come to Fairbanks establish a personal connection with the professor, meet their classmates, are more likely to ask questions in class when they return home, and are creating a community of rural and Alaska Native educators.

A long-term goal is that students build a strong foundation in mathematics and English, and return to teach in their communities. Native teachers are role models, and in a position to incorporate Native ways of teaching and learning, local language and cultural knowledge into the curriculum. For individuals to “see” the mathematics occurring in the world around them, they need to understand the mathematics behind it. Since the term “culturally relevant” is such a buzz word, and the notion is that Alaska Native teachers will be more likely to be able to teach in such a way, IAC thought it was important to find out what the students’ understand about this term (see Table 2).
### Table 2. Future Alaska Native Educators’ Definitions of “Culturally Relevant”

<table>
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<th>Definition</th>
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<tr>
<td>- I believe the content needs to be focused and applied to a social group in which it is most relevant to meet their needs and understanding.</td>
</tr>
<tr>
<td>- Someone who understands and knows his/her culture and environment.</td>
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<tr>
<td>- To me, it means the subject fits into the background of my life.</td>
</tr>
<tr>
<td>- It is important to have culture in everything that we do.</td>
</tr>
<tr>
<td>- Praxis and/or education and the way we teach should be taught to students based on their culture.</td>
</tr>
<tr>
<td>- It is relevant to my culture or to someone else? Bridging the Gap is culturally relevant!</td>
</tr>
<tr>
<td>- That there is a first language besides English and another way of communication involved.</td>
</tr>
<tr>
<td>- Taking knowledge from what we know.</td>
</tr>
<tr>
<td>- Dealing with culturally relevant</td>
</tr>
<tr>
<td>- We, as Alaskans are culturally diverse because we live in our own rural setting.</td>
</tr>
<tr>
<td>- &quot;My culture&quot;</td>
</tr>
<tr>
<td>- It pertains to one's environment or native/natural heritage.</td>
</tr>
<tr>
<td>- How can we better relate to another culture through reading, writing math “borrowing” ideas from a specific culture.</td>
</tr>
<tr>
<td>- How is my math connected to our culture</td>
</tr>
<tr>
<td>- In this regard, it is instructing in ways that provide insight into real-life math applications.</td>
</tr>
<tr>
<td>- Activities that you are already aware of, that relates to your life or the environment in which you live</td>
</tr>
<tr>
<td>- Activities in your culture and applying that to mathematics?</td>
</tr>
<tr>
<td>- Material or information used based on a specific culture</td>
</tr>
<tr>
<td>- (Things) having to do with my culture.</td>
</tr>
</tbody>
</table>

**In summary**, IAC is making efforts to create more culturally responsive place-based educational opportunities for rural and Alaska Native students. Mathematics course design has adapted to meet student needs, and improve the teaching and learning experience. Additional financial and academic support has been given to future rural and Alaska Native teachers to help them with their mathematics and English classes.
About the Author

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ABOUT THE QEM NETWORK

The Quality Education for Minorities (QEM) Network was established in July 1990, as a non-profit organization in Washington, DC, dedicated to improving education for minorities throughout the nation. It is the successor organization to the MIT-based QEM Project that was funded by the Carnegie Corporation of New York. With initial support from Carnegie and MIT, QEM began its operation as a focal point for the implementation of strategies to help realize the vision and goals set forth in the QEM Project's January 1990 report: *Education That Works: An Action Plan for the Education of Minorities*.

QEM seeks to put into practice the recommendations in the QEM Action Plan by working with minority and non-minority individuals, organizations, and institutions around the country to help coordinate and energize efforts to improve the education of minorities, particularly in STEM. The QEM Network engages in activities designed to:

- Promote, and disseminate information on, promising research results on the education of minorities, and serve as a resource in evaluating educational programs and projects;
- Stimulate and assist in the development of programs to increase the number of minorities in science and engineering fields;
- Implement a series of workshops in areas of special interest such as the under-participation of minority males in STEM and concerns of women STEM faculty at Hispanic-serving institutions;
- Provide technical assistance to faculty and administrators at minority-serving institutions (particularly Historically Black Colleges and Universities, Tribal Colleges and Universities, and Hispanic-serving Institutions) in the development of their proposal ideas into competitive proposals for submission to: cross-directorate programs at NSF such as CAREER and Major Research Instrumentation; programs in the Foundation’s Education and Human Resources Directorate such as Math and Science Partnerships, Innovation through Institutional Integration, Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), and Tribal Colleges and Universities Program (TCUP); and programs in NSF Research Directorates;
- Assist new STEM project directors through workshops and campus visits in the successful implementation of their funded multi-year projects, particularly during the initial years; and
- Strengthen the leadership capabilities of STEM faculty, staff, and students at minority-serving institutions, particularly at HBCUs and Tribal Colleges and Universities, to help ensure greater diversity in the leadership of campus-based STEM projects. Pathways to leadership development have included Leadership Development Institutes for STEM faculty at TCUs and HBCUs; Health-focused Student Summer and Academic Year Internships; Summer Student Science Internships and short-term Academic Year Faculty Appointments at NSF; and Research Appointments at major NSF-funded Research Centers.

This unique array of opportunities and approaches has enabled QEM to establish an extensive network of STEM faculty, administrators, and students and to successfully engage in a range of institutional and individual capacity-building activities. Strategies employed and lessons learned in the implementation of one project inform approaches in other projects. With the assistance of experienced STEM consultants and evaluators, QEM offers high quality technical assistance, encouragement, and follow-up support to chief academic officers, STEM faculty, and STEM students at a range of minority-serving institutions as well as underrepresented minority faculty at non-minority institutions.