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Nation Building in STEM Through Relationships, Education, and Research

AARON THOMAS AND SHANNY SPANG GION

Higher education has a role in the nation building of Indigenous People and their associated communities, particularly in STEM areas. Two Native STEM scholars offer their reflections working in academia in research, education, and relationships with Indigenous People. Efforts are being made to support Indigenous students in higher education, both undergraduate and graduate students; supporting Indigenous faculty in STEM disciplines; building relationships with tribal communities; and promoting collaborative, meaningful research within Indian country. The framework of these efforts is centered on the five Rs of respect, relationships, reciprocity, responsibility, and relevance.

Background

American Indian and Alaska Native (AI/AN) students are severely underrepresented in science, technology, engineering, and mathematics (STEM) disciplines in higher education and in the STEM workforce. Numerous researchers have called attention to the root causes of Indigenous marginalization in STEM, noting there exists inherent epistemological conflict between mainstream STEM educational context and Indigenous identity, traditional knowledge, and native ways of knowing (Aikenhead & Ogawa, 2007; Bang et al., 2009; Cajete & Pueblo 2010; Miller et al., 2012; National Academies of Science, Engineering, and Medicine, 2016; Page-Reeves et al., 2017). The insufficient pool of Native American candidates for advanced professional training is alarming and negatively impacts tribal communities' ability to exercise self-determination over a number of critical areas affecting their quality of life, education, health, and natural resources. (Mills et al., 2019). A different framework is needed to support Indigenous students and Indigenous interests and desires in STEM, one that recognizes and incorporates the unique traditional knowledge, sense of place, identity, rights

of sovereignty, and culture of Indigenous Peoples. We also recognize that academia is a settler-colonial construct in which Indigenous People are actively pursuing decolonizing methods, curricula, and pedagogies toward more inclusive education standards, research, and curriculum. This article examines the underrepresentation of AI/AN students in STEM and the climate of higher education in relation to tribal communities through a nation-building lens and offers insights and reflections from our experience as Indigenous faculty members in STEM fields. Specifically, we seek to engage in dialogue about the importance of how both Indigenous and non-Indigenous scholars/researchers/faculty can and do actively participate in nation building through a variety of actions within academia and with tribal communities.

While academia offers many areas or fields of study, from an Indigenous perspective, there remain fundamental, culturally appropriate practices and approaches, increasingly defined by Indigenous scholars. Indigenous practices and approaches are becoming more widely adopted in terms of how to approach research, learning, and teaching in higher education. These epistemological and structural understandings are the lenses through which we will discuss STEM education and research: Indigenous research methodologies and tribal nation building.

Brayboy et al. (2012) have defined four Rs of Critical Indigenous Research Methodologies—*respect, relationality, reciprocity, and responsibility*. Other scholars have previously contributed to these axiological and ontological frameworks in higher education by including *relevance* (Kirkness & Barnhardt, 1991). We, as a tenured STEM faculty member (Aaron) and a visiting tribal scholar faculty member (Shanny), find the five Rs framework reflective of how we navigate academia within STEM fields and with tribal/Indigenous People and communities. Specifically, we are keenly aware of our moral obligations as Indigenous persons and uphold the five Rs above as living Indigenous epistemology, ontology, and expression of Indigenous axiology to guide our work. We understand this framework with the following tenets that can guide academic practice:

One should **respect** each other's ideas, knowledge, worldviews, bodies, spaces, and traditions by acknowledging the value of these for each person and community.

One should acknowledge being **responsible** to each other and to the knowledge that is put in one's trust.

One should take time to develop **relationships** with partners in these tribal communities and value these interactions as worthwhile including relationship with human and more than human relatives.

The work conducted should be **relevant** to the partner's experiences, perspectives, ways of knowing, and issues important to their communities.

One should **reciprocate** for the mutual benefit of all partners through a concerted effort to give back to the partners in thanks for being entrusted with their time, sacred knowledge, and contributions.

Native nation building, as defined by the University of Arizona's Native Nations Institute, "is the process by which a Native nation strengthens its own capacity for effective and culturally relevant self-government and for self-determined and sustainable community development" (Native Nations Institute, n.d.). We generally accept this definition of nation building but also add that in the context of academia, and specifically, within the context of STEM fields, nation building requires a conscious strength-based approach to Native knowledge, while giving much thought and effort in avoiding deficit-based approaches to our work. Tribal people also reside, work, and contribute to their people outside of their respective communities and sometimes in isolated environments where they may be the only Indigenous person in their position. However, they are still very much a part of their communities. We propose contributions to sustainable community governance, and development through academia takes many forms.

Both the five Rs and nation building are foundational in working with Native students in STEM fields and working within tribal communities on STEM-related research. The following are perspectives in higher education and research practices.

Indigenous Students, STEM, and Higher Education

Native people have a fundamental understanding of mathematics and science that has been used for generations. Experience has been passed for generations to elucidate scientific facts that support traditional practices and have been validated through continued practice with reproducible results. Mathematical concepts that center on probability, statistics, geometry, and basic counting were integral to everyday life and survival (Stevens, 2021). Mathematics and science are infused seamlessly into the culture along with language, art, and music. Today, Native people are having to adjust to a new way of living while holding onto traditional practices. Colonization has introduced money, schooling, businesses, tribal governance, and other Western issues while being confined to reservation communities that require learning a new set of knowledges and practices.

The focus of the following sections is on higher education and the role institutions have had in providing education from a Western-based approach while providing ideas to best support nation building in STEM fields with Indigenous students, faculty, and tribal communities. It is acknowledged that disparities exist in STEM education within K-12 through underfunding, systemic discrimination, extensive teacher turnover, and disregard for Native ways of knowing that exists in schools serving Indigenous students across the United States. While these issues are incredibly important in the development of Native students in STEM before post-secondary education, this paper more closely examines the challenges and opportunities affecting nation building within a higher-education setting.

From Native Student to STEM Faculty

We offer our reflections and resources to the discussion of tribal nation building through STEM fields from the perspectives of a Native temporary faculty/rising scholar contemplating the professoriate, as well as from that of a Native STEM faculty member involved in engineering and Native STEM education research. Prior to our current roles, we were Native students in STEM education. As academic research has the habit of “otherizing” Native people, we want to self-locate ourselves in relation to our communities, work, and research, to humanize what is often presented in abstraction. As co-authors, we each introduce ourselves and situate our roles in STEM work.

Positionality Statements

Shanny Spang Gion I begin with and offer a positionality statement as a means to intentionally connect with the reader and to give further context to my upbringing, values, and education toward practicing and embodying relational accountability (Wilson, 2008) and axiology in academia.

I am an Indigenous woman who embraces all parts of my heritage, coming from many tribal nations including the Northern Cheyenne, Crow, and Pawnee in addition to being of German immigrant heritage. I grew up primarily on the Northern Cheyenne Reservation, attending public schools most of my life. I am an enrolled member of the Northern Cheyenne Tribe. I am a mother, a wife, an auntie, a sister, and a mentor. I am both a knowledge seeker and knowledge holder, with careful consideration that I am still on a learning journey. Humility is

central to the way I approach knowledge and research, resulting from my grandparents' teachings, who helped raise me and taught me the cultural values and belief systems of my tribes. From their example and teaching, I know the importance and centrality of relationship and responsibility to the natural systems of this world, spiritual places, and more-than-human relatives. These teachings directly informed my Western education goals, pursuing STEM degrees in environmental science (undergraduate) and a Master of Science in Interdisciplinary Studies (geological sciences and technical communication). I also hold experience in working for the Northern Cheyenne tribe in varying positions that tend to water. I recently began a new position as a visiting tribal scholar in the College of Natural Resources where I am involved in curriculum and programming changes to help Native students and communities thrive. My learning, philosophy, and value system arise from my upbringing on Northern Cheyenne, my experience as a tribal environmental professional, and continued learning in academia.

Dr. Aaron Thomas I am Diné and grew up in and call Albuquerque, New Mexico, home. Although I grew up as an urban Indian, I often visited my grandparents (shinálí) on the Navajo Nation near Tohatchi, New Mexico. They lived in a hogan, without electricity or running water, and spoke very little English. My father was a first-generation college student who earned a degree in welding engineering, and he, along with my mother, inspired me to attend college. I am now a chemical engineer who is currently a faculty member at the University of Montana (UM), teaching, doing research, and having administrative duties as director of Indigenous Research and STEM Education. I have been in higher education for 20 years, combined at both the University of Idaho and UM. I have experience in many funding arenas including the National Science Foundation, National Institutes of Health, Department of Education, and National Aeronautics and Space Administration. My early research was heavily involved in fundamental chemical engineering research, but I have always felt a responsibility to guide and assist Native students in completing their degrees, especially in STEM. Further in my career, my research focus has shifted to more Native STEM education and making an impact among Native students and within tribal communities. I have been heavily involved in nation building not only among Native students and tribal communities in Montana, but among other institutions in other states through inter-institutional collaborations in Indigenous STEM education. In addition, Native ways of knowing has been a guide in working with UM in

bringing Indigenous knowledge into the institution's framework, into research, and into the curricula.

Mentoring Native Students in STEM Through Respect and Relationships

Native students can face a multitude of opportunities and challenges in adjusting to Western academic culture and associated expectations. University faculty frequently do not have experience or possess cultural understanding to support Native students in their academic journey. In our experience as Native students and faculty, we know Native students need faculty and other support services to be more proactive in helping Native students academically, socially, and culturally. Respect for Native students and the unique cultures and backgrounds they represent is integral to forming lasting and meaningful relationships with the students which can translate to academic success. This is especially important in STEM disciplines where notions of the way certain classes are taught and experiments are conducted are assumed to lie outside any cultural bias because they are just “math-” or “science-” based. Cultural objectivity is, of course, not accurate.

In classrooms where it is recognized that a Native student is part of the class, they are often singled out to provide a “Native” perspective on a variety of topics. Now, it is acknowledged that this often comes from well-meaning faculty who want to provide space for a Native voice, but it places an undue burden upon the student. Native students are expected to provide a viewpoint that is seen to represent all Indigenous groups, which is what the class will take away without knowing that there are a vast number of Indigenous cultures that would view the topic differently. The student can give their own view, but it is not intended to represent all Indigenous People.

However, the diversity of thought and approaches that Native students provide can be especially powerful and insightful to both the concepts introduced in the classroom and with other students in the class. When Native students are approached with respect to their culture and background, their non-Western worldview can introduce students and the professor to new ways of viewing the topic.

Research has found that making space for Indigenous ways of knowing within a STEM graduate-education context is possible and describes the challenges of realizing genuinely inclusive academic spaces for Indigenous knowledge (Anthony-Stevens & Matsaw, 2020; Page-Reeves et al., 2019). Indigenous students often attend graduate school

with the goal of researching areas that are important to their people or home community. This sometimes comes into conflict with the traditional graduate student who conducts research that is specific to their major advisor. Many faculty are uncomfortable, or unwilling, to adjust their research to integrate students whose interest is tangential to their work because of the community importance. However, faculty who have decided to broaden their work to involve Indigenous aspects and community-based work have learned unique ways to approach research and have viewed their own research from a different perspective. They have also indicated that they have viewed their relationships with other students differently than they have before by taking a more personal view of their students and families. These faculty demonstrate an adaptive capacity that reflect the values of respect (for the student, their worldview, knowledges, and culture), relationship (developing and fostering meaningful relationships with Native students and tribal communities), and relevance (considering and prioritizing interests/needs of Native students and tribal communities).

Many Native graduate students also experience “imposter syndrome” while they are in graduate school. Imposter syndrome is the notion of not belonging or being good enough to be in a graduate program (Sverdlik et al., 2020). This is often due to being the first family member to be in graduate school or completing any higher education, so they have never envisioned themselves in a graduate program. Setbacks in classes, in the laboratory, and with research, or with their major advisor or other students, are then amplified and reinforce their belief that they do not belong. Encouraging Native students and instilling confidence in their work is important for successful completion of their advanced degrees.

To address the disparities in mentorship, we highlight a program aimed at advancing Native graduate students in obtaining graduate degrees in STEM fields. As faculty (Aaron) and graduate student (Shanny), we both participated in a National Science Foundation (NSF) Alliances for Graduate Education and the Professoriate (AGEP) program titled Pacific Northwest Circle of Success: Mentoring Opportunities in STEM (PNW-COSMOS; McMurtry et al., 2019), which had a number of activities that focused on the major advisors of Native students to assist in mentorship and understanding. A few of the significant activities involved developing an Indigenous Knowledge Field Camp (IKFC) for graduate students and their major advisors to attend together, visits to the student’s home community with their major advisor, and an Indigenous Mentoring Program (IMP) aimed at improving relationship

and mentorship of Native graduate students in a culturally relevant manner. We both attended one or more iterations of the field camp in different roles. Shanny served as a coordinator during her graduate education, tasked with implementation of the IMP at Montana Technological University as well as providing insights and feedback to the PNW-COSMOS IMP team. Aaron, as faculty as well as director of the Sloan Indigenous Graduate Partnership program, served as a mentor and facilitator of conversations between students and their advisors.

The IKFC took Indigenous students and their major advisors to a camp based on the Nez Perce reservation in Idaho, which involved a rafting experience on the Salmon River. This week-long program has student/faculty pairs listen to stories from Nez Perce elders, introduction to language and traditional practices, and a visit to a tribally owned and operated fisheries station looking to save their traditional foods. The river-rafting experience in the wilderness of Idaho involved discussions on Indigenous research methods and Native ways of knowing in regard to STEM research in addition to strengthening relationships and understanding between student and faculty. This was an important start in initiating further conversation and understanding to alleviate some of the challenges Native students face.

Another feature of IKFC was visits by the major advisor to the students' homes. These visits were arranged to allow faculty to personally experience the land, culture, and important relationships of the students. It was an opportunity to see the motivations of each of these students for being in graduate school, and also the responsibilities that they have to their family and to their people. Often, faculty was able to see that their Indigenous students are often not obtaining advanced degrees for personal gains, but more to give back to and help their communities. Meeting mothers, fathers, aunts, uncles, grandparents, and cousins helps solidify the backgrounds of their students and reasons for their research interests and being in graduate school, all relationships that operationalize native nation building.

The development of IMP as part of the PNW-COSMOS project was a collaborative effort of faculty and researchers at Montana State University (MSU) and UM that was initially implemented at various institutions including MSU, UM, and Montana Technological University. The IMP consists of nine modules for faculty to complete that were aimed at developing faculty understanding of Indigenous research methods and methodologies, cultural humility, and Indigenous mentoring models, among others, toward the overall goal of increasing Native graduate student success in STEM fields.

Working closely with Native students through relational mentorship and respecting their individual cultures and backgrounds adds to their success, which can resonate through an entire community. Recognizing their unique needs and challenges and finding ways to foster the relationship between students, professors, advisors, and the institution as a whole is key in the retention and graduation of students in STEM disciplines.

Indigenous STEM Faculty Roles

The challenges throughout higher education do not evaporate once Indigenous researchers become faculty. Native faculty in STEM also have the challenge of balancing their responsibilities to the department and to the institution, the notion of “cultural taxation” imposed upon Native faculty, and the responsibilities to their people and communities. American Indian and Alaska Natives are 2 percent of the overall population of the United States but represent only 0.5 percent of the faculty members in institutions of higher education (Norris et al., 2012; Walters et al., 2019). Their low numbers lead to different challenges and barriers that many faculty do not face, even those from other minoritized groups. Some of the disconnect involves the need to give back to our community in ways that do not fall under the standard position description categories of research, teaching, advising, and service. Normally, working specifically within tribal communities through mentorship of students, participating in ceremonies, engaging in conversations and developing relationships, and recruitment of students typically fall under the service category that goes along with all other service, both internal and external to the department and institution, and typically represent only 5 percent of a faculty’s position description. Many Native faculty, however, feel the responsibility to serve their communities despite the small recognition of their time or weight given for promotion and tenure because of its importance.

For those who seek to integrate their research and scholarship with tribal communities, a time-scale issue can also be challenging. Relationships and trust first need to be developed within the communities where the work takes place. This will take time, even if a person is from the community. The first few years could simply be engaging in conversation and framing a project that is relevant to both the community and the researcher. Three- to five-year grants may not be enough time to gain the expected results from the funding agency if this relationship has not already been established. The tenure timeline might

also be a challenge, so a number of Native faculty first focus on projects outside these communities until tenure has been awarded and more time can be devoted to research that is more community based.

In addition, cultural taxation, a term coined by Amanda Padilla (1994), describes the extra work and unique burden placed on people of color as unofficial diversity consultants for their respective institutions without compensation for these tasks. This includes a number of items such as being asked to be part of several department, college, institution, and discipline-related committees so that certain representation is achieved. Faculty are also asked to be liaisons between different aspects of the institutions that are related to tribal communities, including Native students on campus. It is Aaron's experience that any institution initiative, questions, or challenge associated with Native Americans and STEM at his institution eventually come to him, which represents a large number of queries and requests for assistance. Overall, in addition to typical tenure hurdles, Indigenous STEM faculty face additional roles and responsibilities; Indigenous STEM faculty must achieve relational accountability to Indigenous People and communities, experience cultural taxation, and struggle with finding balance with giving back and serving Indigenous communities. Yet, there is opportunity for these faculty to achieve better balance by considering, practicing, and putting forth to their colleagues, colleges, and institutions as a whole, the five Rs framework.

Nation Building Through Relationships With Tribal Communities

Our work and the collective message from Indigenous scholars state that relationships with tribal communities to develop trust and begin collaborative efforts is foundational for nation building. As we propose, this work can be guided by the framework of the five Rs. Relationships are foundational in any endeavor with tribal communities and ought to be the top priority for both Indigenous and non-Indigenous researchers. Supporting nation building through reciprocal relationships often yields research that is relevant to the communities. As we transition to discussing practical opportunities to align nation-building goals in STEM research and higher education, we consider the challenge put forth by Potawatomi scholar Kyle Pows Whyte (2018). Whyte asks researchers to consider how research aligns to Indigenous Peoples' goals and desires. He describes two types of values Indigenous centered research has for Indigenous Peoples—supplemental value and

governance value. Supplemental value is defined as “the value of Indigenous knowledges as inputs for adding (i.e., supplementing) data that scientific methods do not normally track.” Governance value “serve[s] as irreplaceable sources of guidance for Indigenous resurgence and nation building.” Whyte (2018) states that too often, research done by Western scientists in conjunction with tribal communities holds only a supplemental value. For Western scientists to achieve governance value, “scientists need to understand how they may or may not fit in to emerging Indigenous governance in terms of resurgence and collective continuance” (p. 76). We believe this understanding, in Whyte’s view, applies to all scientists, Indigenous and non-Indigenous alike. Whyte’s work provides an example of how one can support tribal nation building by thinking critically of their role as researcher, their relationship to tribal communities, and whether their interests further and support Indigenous governance. It is in this context of asking hard questions around research and research ethics with tribal communities that STEM researchers can and must reckon with before forming any type of research agenda with tribal nations and communities.

In the context of STEM research and projects in tribal communities, our experiences have shown us that the lack of attention paid to tribal interests is detrimental to trust between tribal nations and higher-education institutions. In our time working either for a tribe or the academy, we have heard and read numerous stories and situations where tribal communities have been involved in research that has not worked out well. In fact, there have been instances where tribal communities did not even realize that they were written into a proposal. As a result, we have seen tribes refuse research funding and we have witnessed projects dissolved because expectations were not discussed beforehand, or tribes were not involved in decisions involving their work, people, land, and data ownership.

Through consideration and practice of the five Rs—respect, relevance, reciprocity, responsibility, and relationships—STEM faculty and researchers hold immense opportunity in building respectful relationships with tribal citizens, communities, and leadership. There are a few practical practices for respecting a tribal community’s tribal sovereignty and self-governance in supporting tribes to establish their own research agenda. First, conversations need to be initiated with tribal communities that are more than e-mail correspondence. Building relationships with a community must involve personal visits to the tribal community to begin conversations. It is important to first listen to the needs of the community as one may determine that the project,

program, or ideas that one had in mind needs modification based on these conversations. It is important that tribal communities benefit in some way from the project in a reciprocal manner. For example, this could be improved knowledge of challenges, public health education, or by hiring local community members to work on projects that directly deal with natural resources, infrastructure, or health. Working in partnership allows the preparation of a higher-quality proposal relevant to the tribe's needs, and consequently increases collaborative voice and leadership.

Significant to STEM research, another option for supporting nation building that directly outlines expectations, roles, and responsibilities of the university or institution in relationship with tribal communities is to develop a Memorandum of Understanding, or an MOU, with tribal communities one is hoping and planning to partner with on a project. This would involve putting together a joint document that explicitly outlines everyone's roles and responsibilities on the project. Having this document that is signed by all parties involved will clearly demonstrate the commitment on the project. It also ensures that a conversation has taken place on the project and will also alleviate any misunderstanding that may occur when the work takes place.

STEM research may not always be reviewed through a critical Institutional Review Board (IRB) process. Relationships should be sought for all research that occurs on or near tribal communities, even if an IRB is not required as some STEM-based studies are categorized. Be mindful that for all projects, the approval from all IRBs, or IRB equivalents, must be completed before any work begins. There may be multiple IRB approvals: one from the state institution, one from the tribe, and one from an associated tribal college or possibly the regional tribal IRB. Sometimes, there may be only one approval needed from the tribe, but there are instances where more than one is needed. Tribal IRBs may meet a limited number of times per year, such as quarterly, and if a researcher is working with multiple tribes, each tribe will have their separate applications and approvals. The process of research approvals takes time. Having an MOU established should greatly increase the likelihood of approvals from the tribal IRBs. It is ultimately the responsibility of the researcher to ensure that all approvals are received and appropriate methods/protocols are followed. Some of the projects that we have done with tribal communities have at times taken months to years to establish the relationship and develop the project. Engagement in the five Rs of the research process is certainly a professional and personal investment. However, this process will lead to less

misunderstanding between the work, the university or college, and the tribal and Indigenous communities. It will ultimately lead to more beneficial and impactful research for all involved.

The approvals needed for a portion of the research demonstrate the unique path a research journey can take while conducting research in an Indigenous community. Yet, the necessary approval from tribal communities is a direct demonstration of relational accountability in practice while conducting research in a high-context culture with complex communication styles.

An example of this approval process that is respecting the relationship with a tribal community is Shanny's IRB-equivalent approval process with the Northern Cheyenne Culture Commission (NCCC) for her graduate research, which involved synthesizing Western science approaches with Cheyenne knowledge to better understand water toward informing management decisions by Northern Cheyenne leadership and programs. Specifically, Shanny sought to understand flow paths of water in the portion of the Rosebud Creek drainage transecting present-day Northern Cheyenne Reservation lands by utilizing stable oxygen and hydrogen isotope tracing methods while simultaneously learning more about water from Cheyenne knowledge holders by employing conversational method (Kovach, 2010), including: spiritual knowledge of water, how water is valued, how those values are lived, and how that formed the knowledge holders' relationship to water. It was a goal of her research to better understand water from these ways of knowing, to improve understandings and make recommendations for further research, and tend to water in the largest watershed on the Northern Cheyenne Reservation. Being trusted with such knowledge is a huge responsibility and required great attention to respect and relationship, particularly to her community and to the knowledge itself. In fact, prior to any approval process with the NCCC, Shanny earned support from elders in her family and community to pursue research around water. She also gained leadership support from a number of the Northern Cheyenne Tribal Council members and had the support of her employer, the Northern Cheyenne Tribe Department of Environmental Protection and Natural Resources (DEPNR). In terms of time, the overall process took approximately nine months before final approval was granted by the NCCC. Shanny's perspective was believing things would happen when they were meant to happen.

Shanny attended two meetings with the NCCC to present her intention and research goals. In the first meeting, the NCCC generally expressed support for the project, to reframe how water is viewed and

tended to, using Northern Cheyenne knowledge in combination with a hydrological method. However, one NCCC commission member indirectly communicated that they needed additional time to consider the project. This member did so by addressing the NCCC chairperson and asked that, if a person had questions, could they have time to think about and consider the research. In any other context, a decision may have been pressed for immediately, but Shanny recognized that this particular commission member was asking for more time to consider the research before approving, even though it was not explicitly stated. It was then offered to come back to the commission in a few months for more conversation. In two months, Shanny gave another presentation to the NCCC, and after a brief discussion, the NCCC members voted unanimously to support and approve the research. After their vote, the NCCC expressed interest in and discussed with Shanny numerous matters related to water, from community water supply to water availability and water quality. In short, the second meeting was essential to one or more NCCC members becoming acquainted and comfortable with the researcher and to the research itself. The NCCC members communicated in a high context, meaning it was especially important to pay attention to the subtleties of their communication, such as body language, tone, and intent behind the statements they expressed.

While the IRB process and intent is well understood, there lies opportunity to support tribal nations in developing IRB or IRB-equivalent research-approval processes that are culturally relevant and appropriate for doing research with/within Indigenous communities. It is important to contemplate the extent to which a research-approval process is informed by tribal worldview, values, ethics, or Indigenous paradigms as opposed to simply adopting the Western framework, values, and philosophical foundations of an academic institution's IRB process. Essentially, there lies opportunity for Indigenous communities to carefully consider and reframe research-approval processes that are founded in tribal values to ensure relational accountability while avoiding an inadvertent fall into (and adoption of) colonizing practices, which can lead to manifestations of lateral violence or oppression, particularly for Native STEM faculty and scholars/researchers. The authors see the development of a more holistic research-approval process grounded in a community's traditional ways of knowing and being, especially in light of how we treat each other—how we tend to relationships—and how we hold ourselves accountable to and build relationships with the knowledge itself, as a direct expression of supporting nation building.

Inclusion of Indigenous Knowledge in Faculty Research

The methodologies used by Native faculty seeking to respect and integrate their culture, knowledge, and traditions in research often fall under a number of terms such as Indigenous research methods (Wilson, 2008; Smith, 1999), Traditional Ecological Knowledge (Berkes, 2012), Native ways of knowing, and community-based participatory research (CBPR). Native STEM researchers utilize one or more of these as a basis for their work where research is not done “on” someone, something, or a group of people, but rather in respectful collaborations. In addition, knowledge is not only found in books and scholarly journal articles, but also in traditional stories and other knowledge keepers such as the land, plants, and animals. The knowledges, knowledge systems, and values lived by and embodied by Indigenous Peoples have existed since time immemorial and transect multiple spaces that include the physical and spiritual worlds. When these knowledges are written about by both Indigenous and non-Indigenous People alike, the terms used vary from Native science, Indigenous knowledge, Traditional Ecological Knowledge, and traditional knowledge, to name a few. While some scholars have chosen to define what each of these mean in their work (Archibald, 2008; Berkes, 2012; Cajete, 2000), for the purposes of this article, we embrace the multitude of definitions of these terms and the commonalities amongst each—particularly that Indigenous knowledge is adaptive, ever-changing and includes values, spiritual beliefs, and philosophies that enter metaphysical spaces, and convey ways of living/relating that are sustainable, responsible, and reciprocal.

The successful integration, or synthesis of Indigenous knowledges and ways of knowing with traditional STEM fields of inquiry, has been demonstrated over decades by Indigenous and non-Indigenous scholars alike. Moreover, these works often hold direct, relevant value for communities in considering how use of Indigenous knowledges occurs as well as considerations for integration into policy and management decisions. Examples include those in climate science (Hatfield et al., 2018), fire for land management (Kimmerer & Lake, 2001), and bowhead whale management (Huntington, 2000). The nuances of how to respect, study, and apply Indigenous knowledges in academia to benefit Indigenous Peoples remains at the center of our work. While Indigenous knowledge sources do not easily fit academic norms, engagement with knowledge holders, such as community elders, should hold equal importance and validity in STEM fields. Respecting and upholding in

STEM research the multitude of ways in which Indigenous knowledge is utilized, kept, taught, and shared is a defining approach that directly reflects the governance value with which Whyte (2018) challenges us. By employing methods, methodologies, and paradigms unique to Indigenous worldviews, and being guided by the five Rs, Native faculty are actively practicing and living ways of being that further tribal sovereignty and self-determination. They do so by personifying values of consequence for tribal nations and not merely seeking research opportunities for individual benefit, promotion, or stature of their institution.

Elders as Faculty

Tribal elders possess invaluable knowledge, cultural perspective, and experience that holds unparalleled benefit within an academic setting. This can be especially relevant in STEM areas such as climate change, biology, natural resource management, and civil and environmental engineering, to provide a few examples. Their knowledge and experience extends far beyond the structures of Western education. As a result, their knowledge and lived experience does not, and should not conform to Western views and values of education (e.g., MS or PhD). Although tradition in academia usually values graduate degrees, elders/knowledge holders should still be afforded the opportunity to serve as faculty for the contributions that they would provide that no other would be able to contribute. They would be ideal instructors for Indigenous-specific classes in a variety of disciplines, could serve as graduate committee members, guide institutional policy and research agendas, be role models to both Native and non-Native students, and be a positive influence on the institution as a whole.

Nonetheless, knowing that elders/knowledge holders may understandably reject Western educational roles, elders/knowledge holders and other tribal community members who contribute their time and knowledge for various research activities or other services, compensation in various forms must be provided. The giving of gifts should become standard for showing gratitude toward tribal members who contribute to academic courses, research, and student support. Additionally, for services provided, some form of compensation should be given. However, complications arise as traditional university policies regarding gifts and compensation can be difficult to navigate. The use of honoraria, stipends, and consultant and vendor fees are business service offices' traditional payment methods, which often do not work as reciprocity and compensation of elders/knowledge holders. We see

a need for institutions to think beyond existing accounting infrastructure, allowing simpler methods to provide gifts and compensation that do not constrain compensations as occurs in the existing system, which often requires extensive paperwork to show appreciation to our tribal partners.

New Faculty and Staff Training

Equity among Western science-based knowledge and Indigenous knowledge is in critical need of faculty advocacy. Graduate students can and do face challenges with faculty not familiar with, for instance, Indigenous research methods. It has been Shanny's experience as a graduate STEM student that some STEM faculty, completely unfamiliar with Indigenous research methods or methodologies, were quick to attempt delegitimizing these methods/methodologies and openly displayed their disapproval/disdain by attempting to compare and belittle these methods with methods of their own expertise. These experiences were frustrating and very palpably presented themselves, particularly with faculty who practiced knowledge and research in an extremely specific and narrow sector of a STEM field. The behavior of STEM faculty described above had the impact of making Shanny feel othered, and by extension, not welcome in the STEM community. While she found great support in her STEM major advisor and graduate committee, we understand that other Native graduate students may not be as fortunate and can struggle with similar experiences throughout their entire educational journey.

Yet, there lies opportunity for institutions to implement practices that can develop new (and existing) STEM faculty who can provide the unique support to Native STEM graduate students, especially those seeking to synthesize utilization of the home community's knowledge(s). Faculty and staff who are new to an institution generally go through an orientation and training process. Institutions that are in regions with high populations of Native Americans, or that see the need to introduce new faculty and staff to Native populations, should have a training module specifically focusing on sovereign nations and the importance of developing relationships for those interested in research with tribal communities and for those working with Native students on their respective campuses. One example of a training program for both faculty and staff is the aforementioned IMP, developed by the PNW-COSMOS project. The IMP consists of a series of modules developed by Windchief et al. (2018) to introduce Indigenous ways of

knowing and provide practical guidance in working in tribal communities and with Native students, both undergraduate and graduate. The IMP is just one example of how higher education institutions can address faculty development toward cultural humility and understanding of worldviews, values, and knowledges different from their own.

Shifting Focus: Institutional Roles in Research and Education With Tribal Communities

It was briefly mentioned in the background section that K-12 institutions of higher education should operate alongside K-12 school districts, especially in tribal communities, to work together towards the advancement of students in preparing for higher education. Most institutions wait until a student steps onto their campus, assesses where they reside in math, science, and writing through various tests that vary from campus to campus, or ACT/SAT scores, and then uses that information to decide what classes a student is allowed to take. If a student tests into one or more remedial/no credit classes, then it is likely that a bachelor's degree that may have taken four years to complete, will now take five years or more, especially in STEM fields, unless a number of summer classes are taken. Many institutions place quite a bit of focus on these types of classes designed to "catch up" a student to the degree programs' standard curriculum. In turn, blame is then placed on the K-12 system for not preparing students properly for higher education. Instead, institutions should be more proactive and work to help prepare students for higher education, especially in STEM, instead of focusing on remediating students once they arrive. Some institutions do work with local high schools, but the reach should be further from their local community, and down to elementary and middle schools as well. It is especially imperative for Native students to be provided pathways into STEM and envision themselves as scientists, mathematicians, and engineers. Faculty from STEM disciplines are well-equipped to provide these pathways in these fields, especially Native faculty.

However, in Aaron's experience working with middle school students, he has heard comments, such as: "Why would the college invest in a sixth grader?" These comments are driven by a lack of an immediate return on investment by the institution of higher education, both in time and in funding. In addition, Aaron has heard from administration that the work put into K-12 is a "noble effort," meaning that is a noble thing to do, but is not important to the priorities of the college. Budget challenges, low enrollment, and research priorities at times

cause short-term vision to find solutions to current challenges. However, long-term investments not only provide access and opportunity to Native students, but also change the narrative of STEM education as a whole. Again, when position descriptions severely limit the amount of emphasis given to the service of faculty, the position descriptions and requirements for promotion need to be revisited to make this more of a priority.

Conclusion

Nation building, from the perspective of two Indigenous STEM faculty within academia, takes many forms in higher education, research, teaching, and research planning with tribal communities. Yet, at its core, it is foundational to begin and conduct this work by considering relationship—relationship with knowledge, with tribal communities and members, and amongst each other in academia. Moreover, the practice and embodiment of respect, reciprocity, relevance and responsibility focus and drive the ways in which we engage in academia.

The ethics in which tribal nations are involved with research and choose to utilize their own knowledges with both tribal members and non-tribal members is a question often at the forefront of any research endeavor, regardless of research field. Brayboy et al. (2012) offer a path forward in their work that describes critical Indigenous research methodologies. This framework is based in decolonizing theory (Smith, 2012) and truly centers tribal sovereignty and self-determination. Together, the frameworks and positions of Brayboy and colleagues (2012) and Whyte (2018) offer a way in which scientists/researchers and the academic institutions they represent, can ethically engage with tribal communities that upholds and supports tribal nation building.

STEM in higher education needs to be re-envisioned to include multiple viewpoints, especially when considering an Indigenous worldview that places importance on a different set of values when looking at science and math and within education and research. As Indigenous students navigate their way through different educational settings, a more individualized and proactive approach is needed to support and retain students, especially within STEM. Those who have navigated an undergraduate education and are now in graduate school are still vulnerable to seeing themselves as not fitting within the graduate program and the way research is conducted. Serving in and fulfilling a STEM faculty role as an Indigenous person in an academic institution comes with many challenges, added pressures, and opportunities, which can

and does take on deeper meanings of responsibility. Through thoughtful and deliberate processes, Indigenous STEM faculty can achieve a sense of meeting relationship responsibilities to both their institution and Indigenous Peoples and communities through applying a critical Indigenous research methodology framework from which flows multiple ways to honor and promote nation building. Moreover, when Indigenous knowledge is utilized in collaboration with tribal communities, there lie multiple ways in which this can be enacted through engaging tribal community members, especially tribal elders, and through training opportunities. This would include offering faculty positions to elders, developing and supporting policy to ensure sufficient payment for elders' time, offering new modules of orientation to Indigenous knowledges and mentoring to new faculty, and supporting nation building of tribal nations by taking a governance-value approach (Whyte, 2018).

While we acknowledge and hold onto hope for a future where our knowledges, values and worldviews are embodied, enacted and lived in academic contexts without constraint or otherwise attacked by others, we recognize that at present, we must remain diligent in our existing academic conditions to apply and uphold responsible ways of engaging our own knowledge systems toward productive nation building. We hold onto hope that in the future, likely beyond our own physical presence in this world, Indigenous diversity in academia will not be measured by a given percentage of Indigenous representation in any particular Euro-discipline, such as STEM. Rather, our hope is that Indigenous scholars in academia are measured by values of their own communities and at minimum, characterized as practicing, living, and embodying Native science/Indigenous knowledge, which reflects a more accurate intent and practice of true nation building and support of such in academia. It is with this hope that we continue down our current road and provide pathways for future scholars to further what we have learned to alter the landscape of higher education and research in ways that reflect Indigenous values and worldviews in the development of a sustainable community and in the self-determination of our people.

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Math and Science Program, which engages Native middle and high school students in STEM.

Shanny Spang Gion (Northern Cheyenne) comes from many tribal nations including the Northern Cheyenne, Crow, and Pawnee, in addition to being of German immigrant heritage. She is a mother, a wife, an auntie, a sister, and a mentor. She holds degrees in environmental science (undergraduate) and a Master of Science in Interdisciplinary Studies (geological sciences and technical communication). She recently joined the University of Idaho as the Visiting Tribal Scholar in the College of Natural Resources.

REFERENCES

- Aikenhead, G. S., & Ogawa, M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education*, 2(3), 539–620. <https://doi.org/10.1007/s11422-007-9067-8>
- Anthony-Stevens, V., & Matsaw, S. L. Jr. (2020). The productive uncertainty of indigenous and decolonizing methodologies in the preparation of interdisciplinary STEM researchers. *Cultural Studies of Science Education*, 15(2), 595–613.
- Archibald, J. A. (2008). An Indigenous storywork methodology. In J.G. Knowle & A.L. Cole (Eds.), *Handbook of the arts in qualitative research: Perspectives, methodologies, examples, and issues* (pp. 371–384). SAGE.
- Bang, M., Medin, D., & Cajete, G. (2009). Improving science education for Native students: Teaching place through community. *Sacnas News*, 12(1), 8–10.
- Berkes, F. (2012). *Sacred ecology*. Routledge.
- Brayboy, B. McK. J., Gough, H. R., Leonard, B., Roehl, R. F. II, & Solyom, J. A. (2012). Reclaiming scholarship: Critical Indigenous research methodologies. In S. Lapan, M. T. Quartaroli, & F. J. Riemer (Eds.), *Qualitative research: An introduction to methods and designs* (1st ed., pp. 423–450). Jossey-Bass.
- Cajete, G. (2000). *Native science: Natural laws of interdependence* (1st ed.). Clear Light Publishers.
- Cajete, G. A., & Pueblo, S. C. (2010). Contemporary Indigenous education: A nature-centered American Indian philosophy for a 21st century world. *Futures*, 42(10), 1126–1132. <https://doi.org/10.1016/j.futures.2010.08.013>
- Hatfield, S. C., Marino, E., Whyte, K. P., Dello, K. D., & Mote, P. W. (2018). Indian time: Time, seasonality, and culture in traditional ecological knowledge of climate change. *Ecological Processes*, 7(1), 1–11.
- Huntington, H. P. (2000). Using Traditional Ecological Knowledge in science: Methods and applications. *Ecological Applications*, 10(5), 1270–1274. [Doi:10.2307/2641282](https://doi.org/10.2307/2641282)
- Kimmerer, R. W., & Lake, F. K. (2001). The role of Indigenous burning in land management. *Journal of Forestry*, 99(11), 36–41.
- Kirkness, V. J., & Barnhardt, R. (1991). First Nations and higher education: The four R's—Respect, relevance, reciprocity, responsibility. *Journal of American Indian Education*, 30(3), 1–15.

- Kovach, M. (2010). Conversational method in indigenous research. *First Peoples Child Family Review*, 5(1), 40–48. [https://doi: 10.7202/1069060ar](https://doi.org/10.7202/1069060ar)
- McMurtry, J., Arouca, R. A., Thomas, A. (2019). Developing an Indigenous knowledge field camp. *New Directions for Higher Education*, 2019(187), 55–65. [https://doi: 10.1002/he.20336](https://doi.org/10.1002/he.20336)
- Miller, B. G., Doering, A., Roehrig, G., & Shimek, R. (2012). Fostering Indigenous STEM education: Mobilizing the adventure learning framework through snow snakes. *Journal of American Indian Education*, 51(2), 66–84.
- Mills, J. I., Thomas, A., Galindo, E., Hartline, B. K., Dhingra, A., (2019). Native pathways to science, technology, engineering, and math graduate degrees, new directions for higher education. *New Directions for Higher Education*, 2019(187), 41–54.
- National Academies of Sciences, Engineering, and Medicine. (2016). *Barriers and opportunities for 2-year and 4-year STEM degrees: Systemic change to support students' diverse pathways*. The National Academies Press. [https://doi:10.17226/21739](https://doi.org/10.17226/21739)
- Native Nations Institute. (n.d.). What is Native nation building? Retrieved August 13, 2021, from nni.arizona.edu/index.php/programs-projects/what-native-nation-building
- Norris, T., Vines, P. L., & Hoeffel, E.M. *The American Indian and Alaska Native Population: 2010. 2010 Census Briefs*. U.S. Census Bureau. Retrieved October 4, 2021 from <https://www.census.gov/history/pdf/c2010br-10.pdf>
- Padilla, A. M. (1994). Ethnic minority scholars, research, and mentoring: Current and future issues. *Educational Researcher*, 23(4), 24–27.
- Page-Reeves, J., Marin, A., DeerInWater, K., Medin, D. (2017). Broadening conceptualization of Native identity as foundational for success among Native Americans in STEM. *Anthropol*, 5(3), 187–198. [https://doi:10.4172/2332-0915.1000187](https://doi.org/10.4172/2332-0915.1000187)
- Page-Reeves, J., Marin, A., Moffett, M., DeerInWater, K., & Medin, D. (2019). Wayfinding as a concept for understanding success among Native Americans in STEM: “Learning how to map through life.” *Cultural Studies of Science Education*, 14(1), 177–197.
- Smith, L. (2012). *Decolonizing methodologies: Research and Indigenous peoples* (2nd ed.). Zed Books.
- Stevens, P. J. (2021). A woodcutter’s story: Perceptions and uses of mathematics on the San Carlos Apache Reservation. *Anthropology and Education Quarterly*, 52(4), 1–21. <https://doi.org/10.1111/aeq.12399>
- Sverdlik, A., Hall, N. C., & McAlpine, L. (2020). PhD imposter syndrome: Exploring antecedents, consequences, and implications for doctoral well-being. *International Journal of Doctoral Studies*, 15, 737–758. [https://doi: 10.28945/4670](https://doi.org/10.28945/4670)
- Walters, K. L., Maliszewski Lukszo, C., Evans-Campbell, T., Burciaga Valdez, R., & Zambrana, R. E. (2019). ‘Before they kill my spirit entirely’: Insights into the lived experiences of American Indian Alaska Native faculty at research universities. *Race, Ethnicity and Education*, 22(5), 610–633. [https://doi: 10.1080/13613324.2019.1579182](https://doi.org/10.1080/13613324.2019.1579182)
- Whyte, K. (2018). What do Indigenous knowledges do for Indigenous Peoples? In M. K. Nelson & D. Shilling (Eds.), *Traditional ecological knowledge: Learning*

- from Indigenous practices for environmental sustainability* (pp. 57–82). Cambridge University Press. <https://doi:10.1017/9781108552998.005>
- Wilson, S. (2001). What is an Indigenous research methodology? *Canadian Journal of Native Education*, 25(2), 175–179.
- Wilson, S. (2008). *Research is ceremony: Indigenous research methods*. Fernwood Publishing.
- Windchief, S., Arouca, R., & Brown, B. (2018). Developing an Indigenous mentoring program for AI/AN graduate students in STEM: A qualitative study. *Mentoring and Tutoring; Partnerships in Learning*, 26(5), 503–523. <https://doi:10.1080/13611267.2018.1561001>