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Situating Giving Back for Native Americans Pursuing Careers in STEM: "You Don't Just Take, You Give Something Back"

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Abstract

This article explores how a desire to give back influences Native Americans pursuing education and careers in science, technology, engineering and mathematics (STEM). We present analysis of data from 51 interviews with Native students and STEM professionals. Despite the compelling evidence of the core significance of a community orientation among Native Americans, insufficient attention has been given to thinking about the unique challenges faced by STEM professionals in devising ways to give back and how this relates to the continuing problem of under-representation of Native Americans in STEM. Here we propose strategies for universities and industry to honor Native ways of being by recognizing and embracing giving back as a value, and supporting STEM students and STEM professionals to overcome challenges to be able to give back to their communities. These strategies for situating giving back will promote expanded participation for Native Americans in STEM. This work provides insight for thinking about other under-represented populations in STEM.
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Keywords: Giving back, underrepresentation, STEM, Native Americans

Introduction

That's one of the things that I would like to do is to give back to my community…it's just for my particular degree, there really wasn't any potential for me to [come back].

We've always had to try to figure that out…. What do we do?… I don't know…. How are we going to use this education? It's like, I have no idea… And that's the biggest thing that I've been *struggling* with recently…. trying to *figure out how* this degree in mechanical engineering and my role as an aerospace engineer, how's that gonna be useful at all to [*my tribe*]?... And… if

I'm going to come back, there's not really going to be an existing job there for me to jump into. It has to be created out of something that doesn't exist yet….

You don't feel like there's an immediate, direct path back into the community workwise and that you're kind of going out, you're blazing that trail, you're trying to take a leap of faith and going out there and doing things.

—*Quotes from Native American STEM professionals*

An increasing number of Native Americans are going to college, getting a college degree, and pursuing graduate studies (Winkleby et al., 2009). However, despite these gains, Native Americans continue to be significantly underrepresented in education and careers involving science, technology, engineering and mathematics (STEM) (National Science Board, 2016; Ferrini-Mundy, 2013). As part of an effort on the part of universities, industry, and science sector funders (e.g., the National Science Foundation) to promote participation by underrepresented minorities in STEM, a wide variety of pipeline, internship, mentorship, and scholarship programs have been created. These programs offer Native American students opportunities for developing knowledge, skills, social connections, and interests that will position them to pursue a career in the sciences. These initiatives and investments are important pieces of the STEM education/career puzzle for students from underrepresented populations, but statistics on Native Americans in STEM demonstrate they have fallen short of hoped-for outcomes. Figuring out how to achieve greater gains in broadening STEM participation for Native Americans continues to present a challenge.

We propose that Native American underrepresentation in STEM requires consideration of issues that have not been sufficiently addressed by programming that targets STEM curricular, knowledge, social, and skill deficits, or educational financial barriers. Data we gathered while conducting a study about the factors that support success among Native Americans in STEM suggest that cultural dimensions of the choices that Native American students make regarding what discipline or career path to follow are of more importance than is generally reflected in the design of STEM participation initiatives. Elsewhere we discuss Native American identity as an important component of Native American success in STEM (Page-Reeves et al., 2017b). Here we consider how the value of "community" influences Native American STEM participation. Below we argue that a culturally sanctioned conceptualization of the need to use one's education to *give back* to the community[1] plays a significant role in the educational and career choices that Native American students make. Using one's educational achievement to *give back* to the community—to one's local or Tribal community, to the broader Native American community, or to society—is given a high priority and value.

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[1] In the anthropological literature, we understand that there are many types of Native American "communities." However, here, we employ the phrasing "giving back to *the* community" because this reflects the way that interviewees generally spoke about their relationship to "their community" or "the community" broadly defined as singular. In this usage, interviewees routinely conflated reference to their own Tribe with a broader pan-Native American identification, or even with broader social impact, and often they moved from one usage to another and did not make a distinction.

For many Native American students, it may not be immediately apparent how one could possibly use a STEM degree or career to *give back*. For example, becoming a physics professor or developing expertise in computational mathematics may not seem to have relevance or use in the context of a Native American community. As a result, although there is often a tendency to attribute low Native American participation in STEM to lack of capacity, many Native American students make a *choice*: it is not that they do not have STEM knowledge or interest, but rather, *they may consciously choose not to pursue a degree or career in STEM* in favor of other options that appear to offer a greater potential to achieve community-oriented goals and objectives that they value (e.g., teaching, social work, nursing, etc.). We suggest that a key reason for such a decision is that they cannot reconcile their understanding of STEM content/activity with the culturally defined value placed on community. Institutions and funders interested in promoting STEM participation for underrepresented populations have not sufficiently conceptualized the importance of this dynamic for Native American students. Moreover, the way that STEM subjects are taught in the mainstream classroom does not tend to incorporate attention to this issue in a meaningful way that would allow Native American students to imagine aligning their STEM educational and career aspirations with their community-oriented values.

Giving back as purposeful motivation

Having aspirations that go beyond personal and individual accomplishments has long been recognized as a potentially powerful motivation for individual academic attainment and persistence, and as promoting subsequent career performance and capacity. In studies by Yeager and colleagues, for example, students with a "transcendent purpose for learning" persisted longer when required to engage in a task that was considered "boring" and were less likely to drop out of college (Yeager et al., 2014), and those with "purposeful work goals" were found to derive more meaning from life and schoolwork (Yeager & Bundick 2009). In the education, career counseling, and community service literatures, this dynamic is often described as a desire to *give back* to the community. The desire of students to give back to their community has been shown to have an important influence on educational, career, and volunteerism dynamics in a variety of cultures and contexts, including among African Americans (e.g., Charles, 2005; Farmer et al., 2006), Chicanas (e.g., Bernal, 2001), Mexican-origin Americans (e.g., Vallejo Agius & Lee, 2009), Asian Americans (e.g., Chang 2004), and Samoan Americans (e.g., Borrero et al., 2009). However, among Native Americans, giving back has been identified as a foundational and unifying cultural construct, and as both a core motivation for and a defining feature of success (e.g., Guillory 2008, Guillory & Wolverton, 2008). For Native Americans, giving back has a deep meaning that relates to the specifics of their culture and historical experience.

The significance of giving back for Native Americans

The literature on Native Americans and the core cultural significance of giving back is compelling. Okagaki, Helling, and Bingham (2009) found that Native American individuals place great value on the need for their own education and

work to result in pragmatic benefit for not only themselves, but also for others in their families and communities. They describe this value as a "cultural orientation" (p. 171). Waterman and Lindley (2013, p. 147) write that, "community is at the core of the existence of Native American nations" and that in Native American communities, there is a deep "sense of obligation and responsibility to community well-being" reflecting culturally defined values that permeate everyday life. In a study by Guillory and Wolverton (2008, p. 75), giving back to the community was cited as a source of both encouragement and motivation for Native American college students. Commitment of students to family and community becomes a resilience factor that enables Native American students to overcome challenges and barriers in the "hope of making life better for their families" (p. 74) and cultural practices involving giving back remain "guiding forces throughout their lives" (p. 75).

Giving back and Native American nation-building

For Native Americans, the paradigm of giving back is more than just "do-gooding" or community service. In his delineation of Tribal Critical Race Theory (TribalCrit), a theoretical framework for understanding the complex reality and experience of Native American people and Native American communities, Brayboy (2005) highlights the relations of power that inform the structural and experiential landscape for Native Americans. Using a TribalCrit lens, giving back can be understood as essential for Native American self-determination. Guillory (2008) sees the community orientation of giving back as a mechanism for decolonization by nurturing the skills needed for "rebuilding that which [was] damaged" in the historical experience of cultural and physical genocide (p. 175). Kawulich (2008) explores how giving back builds leadership in Native American communities that has far-reaching implications for positive strength-creating community processes. Waterman and Lindley (2013) see the culturally defined dynamic of giving back as a form of community cultural wealth (p. 147)—a mechanism for maintaining cultural integrity that is necessary for Native American communities to continue as sovereign peoples (pp. 152-153). A nation-building perspective on giving back acknowledges the structural relations of power that operate to limit and keep Native American (and other individuals of color) out of spaces of STEM education and careers. Many individuals who might have interest in a STEM career are led *not* to pursue one by dynamics that exclude them, rather than merely the result of an individual choice. In this context, positive synergy between STEM and giving back can contribute to the strength of both the individual and the community. Giving back, then, is an integral component of Native American nation-building (Waterman & Lindley, 2013, p. 148).

Understanding giving back for Native Americans in STEM

Here we explore how the desire to "give back" to their community, to the broader Native American community, or to society influences Native Americans pursuing education and careers in STEM. We present analysis of data from 51 interviews with Native American students and STEM professionals. Our findings build on the work by Native American Scholars and others referenced above that has

begun to examine how the centrality of a relational ethic based on the Native American cultural value of community influences educational persistence and career trajectories for Native Americans and connects back with broader community and political processes. Our findings contribute further insights that help us think about nuances entailed in the giving back paradigm, including dynamics specific to Native American individuals pursuing education and careers in STEM. Despite the compelling evidence of the core significance of a community orientation among Native Americans, insufficient attention has been given to thinking about the unique challenges of giving back faced by STEM professionals and how this relates to the continuing problem of under-representation of Native Americans in STEM. Here we propose strategies for universities and industry to honor Native American ways of being by recognizing and embracing giving back as a value, and supporting STEM students and STEM professionals to overcome challenges to be able to give back to their communities. These strategies for *situating* giving back will promote expanded participation for Native Americans in STEM, but we believe that they also have implications for thinking about participation for African Americans, Hispanic Americans, and other populations that continue to be under-represented in STEM.

Methods

We conducted this study through a collaborative partnership between researchers at the American Indian Science and Engineering Society (AISES), the University of New Mexico (UNM), and Northwestern University (NU). Our research team includes both Native American and non-Native American investigators, and junior Native American researchers who were learning to conduct research. We developed the discussion presented here from our analysis of 1,926 pages of interview transcript data that we gathered through 51 interviews—30 interviews with Native American college students, and 40 interviews that we conducted in two iterative Phases with 21 Native American STEM professionals (21 in Phase 1 and 19 in Phase II). All participants provided signed informed consent. Interviews lasted one to two hours, and were audio-recorded and transcribed by a professional transcriptionist.

Student interviews were conducted by two junior Native American researchers (Cortez and Ortiz). Student participants were junior- or senior-level college students at UNM or Central New Mexico Community College (CNM) The student cohort of 18 men and 12 women was diverse in terms of Tribal affiliation, and included both STEM and non-STEM majors. The STEM professional interviews were conducted by an experienced anthropologist (Page-Reeves). STEM professional participants were a national cohort that we chose with an eye to diversity in relation to Tribal affiliation, geographic location, academic degree, STEM discipline, and work sector (academia, industry, government, Tribal government, private business). We followed the STEM National Science Foundation (NSF) definition of STEM disciplines which, in addition to the traditional physical sciences and math, include life sciences, environmental sciences, education sciences, and social sciences (NSF n.d.). Additionally, we also considered the category of medicine/medical research as

a STEM discipline. However, our participants were overwhelmingly affiliated with the traditional hard science, math, and engineering STEM disciplines (See Table I.)

Table I: Interviewee Affiliations and Characteristics

Discipline	Sector	Highest Degree
Aerospace Engineering	Government (2)	Ph.D. (7)
Chemistry	Government/Industry (1)	MS (5)
Electrical Engineering (3)	Industry (4)	MBA (1)
Environmental Engineering	Private Business (4)	BS (8)
Environmental Science/Hydrology	Tribal Government (3)	Medical Student (1)
Fish Biology	University (7)	
Forestry		
Manufacturing Engineering		
Materials Engineering		
Mathematical & Computational Sciences		
Mathematician		
Mechanical Engineering		
Medicine/Medical Research		
Nuclear Engineering/Physics		
Programming/Software Engineer/Computer Science (3)		
Small Business Owner/Retail		
Water Resources/Chemistry		

The STEM professional cohort was balanced in terms of gender (10 women and 11 men). Interviewees all strongly self-identified as Native American (Page-Reeves et al., 2017b), but were from diverse backgrounds that included urban, suburban, rural, and reservation experiences.

We posed questions in the interviews in a way that was designed to be open-ended to allow the interviewees to drive the direction of the interviews, and we derived questions in Phase II of the STEM professional interviews from our analysis of Phase I interview data. We were interested in understanding factors that contribute to success for Native Americans in STEM. We had five principle, underlying domains of inquiry: 1.) the types of experiences and relationships individuals have had that supported success in STEM (including mentors, teachers, family members, study groups, student and professional organizations, "discourse communities," social networks, and "protected spaces"); 2.) individual perspectives on the relationship between indigenous and Western science epistemological orientations, and how they describe their own ability to navigate between/within the two; 3.) the extent to which individuals see themselves or "people like them" as being involved in and having the capacity to be successful in scientific endeavors; 4.) how they understand and explain their own and others' success in STEM; and 5.) "counter narratives" regarding their own success or experiences or about science that challenge *status quo* thinking or images related to science or Native American participation in STEM. However, because our project design employed an anthropologically inspired approach (Madden, 2010), interviewees were encouraged to present their stories in a broad and open manner rather than being proscribed/constrained by *a priori* questions developed by the researchers, and for

the most part, interviews followed a more conversational structure than traditional interviewee/interviewer dyadic interactions.

We reviewed transcripts using a rigorous, disciplined approach to create an empirical analysis of the data according to Hammersley's (2008) criteria for qualitative research based on plausibility, credibility, and relevance. We followed Gläser and Laudel's (2013) framework for theory-driven qualitative content analysis. We reviewed the transcripts and identified conceptual categories and patterns related to the domains of inquiry, extracted data, and developed conceptual summaries. Following review and summary, we coded extracted data for systematic themes and their domains. We used "constant comparison" (Perry, 2003) to explore interconnections between theme categories and made connections with concepts we had identified in the literature by developing a holistic interpretation of the data that we present below.

Findings

Despite the diversity of the interviewee cohort, we identified a number of key themes in our analysis of the interview data. Elsewhere we discuss themes of *identity* (Page-Reeves, et al., 2017b), *wayfinding* (Page-Reeves, et al. 2017c), and *resilience* (Page-Reeves, et al., n.d.). Here we consider the theme of *giving back* in relation to five domains:

1) Duty, expectation, & reciprocity
2) Defining success in STEM in relation to giving back
3) Translating & bridging functions of giving back in STEM
4) Being a role model & blazing a trail in STEM
5) Giving back as a challenge in STEM.

Duty, expectation, & reciprocity

A primary motivation for interviewees to want to give back was because they feel a sense of duty, responsibility, and obligation that is in line with previous studies of giving back in Native American communities (e.g., Guillory 2008, Guillory & Wolverton 2008). For example, interviewees commented,

> My family was very supportive when I decided to go into…STEM…but in addition, they were always…reminding me of that *duty* to help the people and give back to the family. And, when we talk family, that's basically the community and not only our community but all Native American communities.

> There's a lot of things I want to do…But as a Native American, I'm *obligated* to…go work back with my community and to help out like the people where I grew up because it wouldn't feel right to just up and leave and not go back.

> I was doing [it] because I felt *bound and obligated* that I should become this person that all of the people before me were and that this is my path. And that you know this was the way that I would give back all of these gifts that I've been given…and…I would go back to the reservation and pass on my knowledge and that I would…try to help…other people from my tribe go to school and…show them the way.

> Oh, I think that's something that every Native American is taught. It's part of the culture…and it starts when you're very little. If somebody gives you something, you don't just take, you give something back…I remember. This was a story I was told and I passed it onto my little sister that even with Mother Nature, with Mother Earth, you don't just take, you have to give back. And how our ancestors were shocked when the White men came and just chopped down a bunch of trees and planted corn and didn't think about how to give back to Mother Nature, and you know, you don't take from Mother Nature without giving in return. And so…I think that it's the same then when you have a chance for an education, and you have a chance to do special things like science, that it's your *obligation* to give back.

Part of the sense of duty that interviewees expressed has to do with living up to the expectations of others. Expectation pushes them to live up to the obligation they feel; however, similar to experiences recounted in studies by Guillory (2009) and Makomenaw (2014), it also provides a source of strength to be able to confront educational and professional challenges. One interviewee said,

> There's a whole community of people and your elders that you're supposed to listen to. There's…a whole *expectation* of Native American people to…go out and get an education that's supposed to be to come back and help the people. And, and so it's not like you can go off and be selfish and study whatever you want. It's almost like you have that in your mind the whole time, that you need to find something that's useful. And…so, like even for me, I felt like I had other interests…but I stuck with engineering, even though I knew it was harder and even though there were parts that should have driven me away, because they weren't very fun or very interesting to me, but I stuck with it because I knew it was gonna be very useful in the end.

But the expectations of others have further implications. Charles (2005) found that African-American teens from an urban community see their own success as impacting a larger narrative about race. He reports that they believe that "If I don't succeed, they would say, I told you so" (p. 8). Similarly, because Native Americans are underrepresented in STEM, interviewees feel a sense of responsibility for making sure they stay on a straight path—that failure is not an option because it would only serve to reinforce negative expectations, stereotypes, and narratives about Native American ability. One interviewee described it as needing to make sure that he did not "drop the ball…an *expectation on ourselves* to…succeed and to not stray." Another said,

> We still hear it every day that we need more Native American scientists and engineers because there's just none. There's not very many. We have a very low representation in the STEM fields. So, I feel like *being one of the few, I have to perform well.* I have to do well.

Succeeding in STEM is, in itself, a form of giving back by proving that negative caricatures are not correct.

In addition to wanting to improve conditions in one's community or live up to expectations, the desire to give back contains an acknowledgement of a debt created

by personal benefit. Reciprocity, or the idea that individuals who have received something need to return the favor, is an important dimension of the giving back paradigm. Interviewees in this study said things like, "My main focus and goal is to have Native American children…*have the same opportunities like I had*," and "I feel like it's my responsibility to share that…*I learned it from someone else and now I'll have to teach someone else what I learned*." But reciprocity has implications that go beyond merely repaying a debt. Among Korean Americans, Chang (2004) reports that individuals who are understood to have gotten ahead as a result of support from the community then feel obligated to contribute time or money in return as a way of repaying the debt, but do so in a way that holds the community together in the face of economic and social forces that otherwise diminish community cohesion. Similarly, for Chicanas, Bernal (2001) sees reciprocity as a mechanism that reinforces collaborative ties between community members. She describes this as a form of cultural resistance. Among Native Americans, Brayboy, Solyom & Castagno (2014, p. 587) recognize the important role that the dynamics of reciprocity play in tribal nation building, and Minthorn, Wanger & Shotton (2013, p. 62) understand reciprocity to foster the development of leadership in the Native American community.

Defining success in STEM in relation to giving back

As indicated earlier, purposeful goals are not only a part of the giving back paradigm, but are associated with academic and career success (Yeager et al., 2014; Yeager & Bundick, 2009). The importance of having a strong sense of purpose has been identified as a defining feature Native Americans' determination to "give back" (e.g., Guillory, 2008). Interviewees see a sense of purpose as integral in their own career trajectories (Page-Reeves et al., 2017c). They described this as something beyond personal or professional success or as "a *purpose*, … that you're not doing this for yourself." It could be related to family: "I had a bigger *purpose* because…I needed to do what I could do best for my family." But they often saw it as part of their connection to a community. Interviewees commented,

> I would bring all our kids here…I spent the first eight, ten years here teaching them…all of these things that they need to know as people, to be good people first…and understand their *purpose* in life—that they have…individual parts in this larger mechanism, but that each one of them have an important *purpose*…and each one of them, working independently but together at the same time, to make things better…and…it goes back to that *purpose* thing.

And,

> I would always be available to help the community because we were a community and the only way that we would remain a community that we all did our parts to improve it or make oneself available... my dad would always put it in the context, remember you're not doing this for just yourself, you're doing this for your community and the good that comes from your dedication and the work will benefit not only you and your family, but your community….So…a *purpose*…kind of a thing, Yea…that…you're not doing this for yourself.

While we generally understand the concept of purpose in relation to doing something for others or for the greater benefit of the community, within the giving back paradigm purpose is often defined within a framework of cultural values and a spiritual ethic. Bernal (2001) found a thread of spirituality woven through the Chicana orientation to enhancing the community. "For these women their spirituality was connected to their commitment to their families and communities. They saw their educational journey as a collaborative journey not an individualistic one" (p. 634). In Charles' (2005) study in an urban neighborhood, the desire to give back to the community among African American teens was experienced as a moral obligation derived from their Christian faith. They have "an "immutable sense of 'stewardship' that can be found in the religious teachings of the New Testament" (p. 5). Similarly, interviewees in our study see a spiritual dimension and purpose to their work in science and the way they are able to give back. Speaking about her work in science, one interviewee said,

> *Creator* gave us this mind to dream big, but with *purpose*, and again always to give back to the community…to dream big but realistically and the whole intent and *purpose* of that ultimately is to benefit your larger community.

Another said,

> People have *purpose*. People have souls that we have to respect, so that when we pursue something, it starts with prayer, and I see the connectivity in my mind…there's a *spiritual* aspect. So rather than…separating in separate compartments, math, science, the environment, and whatever else, it's all connected so that the *spiritual* side is sort of the thread that holds all of these together.

Interviewee narratives suggest that this spiritual orientation enhances rather than encumbers their ability to do meaningful science:

> Having a *spiritual* component to life makes me, and probably others, a better scientist…observing nature…and…directing the human experience in a way that's harmonious and consistent with nature, what our ancestors were all about, and that's what we're facing today.

And, having a spiritual connection provides them with a framework of support:

> That's what got me through…going back to that and re-routing myself…with the prayer and the practices and the *spirituality*…that's what kept me going because…if we look back at our ancestors…they struggled, they survived, they withstood time…and I saw myself there too…and then I saw that happened to me and so I went back to…gathering myself together and going back to my *spirituality*, praying and re-centering and talking things out…just going back to my faith or gathering myself and picking myself up and understanding where I belong in the world…having a sense and place and knowing that I needed to be, [that I would] be an engineer, and sticking with it.

Spirituality, then, not only gives interviewees purpose, it gives them the strength they need to confront both philosophical and everyday challenges of pursuing a career in STEM, and ultimately becomes the foundation for giving back, reciprocity and the development of Native American leadership.

For Native Americans, conceptualization of giving back as a duty, an expectation, and a reciprocal obligation with a broader purpose and spiritual roots is the way that success is defined. Talking about their own personal careers in STEM, interviewees said things like, "I guess I really don't look at it as, as *succeeding*…in that sense…because I…think of it as just doing…my part or giving back," and, "I guess *success* for me…is not necessarily based on…the grants or the publications…it's really investing my time and helping [in the community]." Interviewees told us how they view success in STEM, in particular, as having a unique capacity for inspiring others (Page-Reeves et al., 2017c). These data from Native American STEM students and professionals support previous findings that for Native Americans, success is measured by how one's individual achievement contributes to the wellbeing of others and their community (Guillory, 2008; Juntunen et al., 2001).

Translating and bridging functions of giving back in STEM

For Native Americans pursuing a career in STEM, giving back has a particular importance because of the technical and scientific knowledge that individuals learn that has implications for benefiting Native American communities. Interviewees feel they have the ability to translate scientific concepts to make them more meaningful for people in the community who do not have scientific training or who might not understand the issues. For example, one interviewee, speaking about her own expertise, said she wants to

> *[help] people to understand climate change*…I have a better understanding of both [my tribe's] perspective and then the scientific perspective and then translating it into the language so that they can understand it. So, some terms may not be directly translated, like climate change…there's no word in [our] language that means climate change, but there are other concepts in [our] philosophy that allude to…a demise or an unbalanced time.

Another framed it as leveraging his position as a trusted insider to help community members understand scientific data that forms the basis of debates that influence Native American land and resources. He said that he could help

> [translate] *environmental-related* stuff that's going on, on their land, and if they have a person who's non-Native American coming on, then their…you know their tribal council's not gonna trust them, but if you have some Native American kid who grew up in that community, who knows how to you know understand what the data's saying and all that.

But the idea of translating is not a one-way process. A number of interviewees see their role as a bi-directional translator. They believe that they are developing skill and expertise that has implications for Native American communities, but that the synthetic perspective that they have developed—uniting Indigenous and Western ways of knowing—has benefit beyond the Native American community. One interviewee spoke about how this plays out in chemistry, saying,

> As a Native American chemist…you think about those things. You say, well, how is it going to affect our people? How is it going to affect our resources?… I think, indigenous science not only ties in the Native

American culture, but is also *providing substantial data and information to…the other worlds…*it's not a double-edged sword, it's an even plate…it's good all around… I think it's connected.

However, specific scientific knowledge itself is not the only way that interviewees think about their professional and STEM expertise in relation to giving back. Interviewees also described their role as one of bridging institutional and structural relations between Native American and non-Native American communities. One interviewee sees his individual role in working as a liaison. He said,

I'm definitely kind of...*working in that space like between tribes and like outside organizations* like…government agencies, labs, universities…lots of non-profits…[and] for-profit companies…that are trying to do work with...Indian country.

Another interviewee focused on the importance of being able to learn the rules of different systems and sharing that knowledge. He said,

I think being more open to other aspects of how society works or how cultural things work you *know if you can understand two different ways it's better than one* you know if you're in a classroom they're not gonna teach you in a traditional sense, well maybe like a, a Native American traditional sense you know, they're gonna teach you the way that they learned it from their professor who probably wasn't Native American right? *So if you can understand both ways* and how to, how to, learn how the professor teaches, how that's structured, and then be able to take what you learn and teach it to your community in a more, in a fashion that's more culturally appropriate maybe? *Then that's great, then you can transcend those two things.*

Yet another sees his role as helping his community to learn how to mobilize resources. He believes that he is

gathering other resources and knowledge…and then [you] return home…you…build your experience and career and bring something back home, not only yourself but these other resources…This is a holding place for us, we're gathering all our resources, but we have plans and visions to go back home…*learning how to do that, networking, knowing where resources are, and then connecting it back to yourself and then to the community and then tying it all together.*

Being able to bridge between Native American communities and non-Native American knowledge, institutions and resources is crucial to Native American health and wellbeing, and ultimately central to Native American nation-building.

Being a role model & blazing a trail in STEM

A key dimension of the giving back paradigm has to do with setting an example for others, especially for young people. Guillory (2008) discusses the importance of role modeling in the Native American conceptualization of giving back. Individuals who are successful become concrete evidence for kids that they have options,

breaking out of stereotypes or expanding kids' sense of who they can be (Page-Reeves et al., 2017c). One interviewee said,

> For me, I think…my impact comes from…those humble beginnings and dealing with…struggling in undergrad, and then getting through and succeeding. Like *that's the story I want people to know and have it be out there so that they can go and do [it too].*

Another said,

> Going back to the career…points of being a STEM major is that you're pretty much guaranteed to make more than you would in other fields. And you're able to use…those funds and take it back to the reservation. You can take your knowledge back to the reservation and help your community…And it would just help…the Native American community *to be able to show these other kids that it's do-able…like a role model,* right…I didn't really know…any Native Americans who were in the STEM field growing up. Most…all of the older people that I knew, they were all in the construction business and like my dad….it would definitely help our community and help the image as a whole.

In studies of giving back for a variety of populations, role modeling is often specifically discussed as a way to combat negative community dynamics such as drugs, alcoholism, teen pregnancy, and criminal behavior which can lead to prison time (*e.g.,* Bingham et al., 2014; Borrero et al., 2009). Our data suggest that while these things are a concern, interviewees are also interested in inspiring kids to love science and to feel joy in that. One interviewee said,

> What am I gonna do specifically for my community?…*maybe I've inspired others to sort of…take the STEM discipline*…it's hard to tell…that's what I'd like to think, but nevertheless…being identified as being successful…if people see me in that light, well, that's great, but how I would like to take advantage of it myself is to…not necessarily…try to…bask in any glory or something, but to try to use that…for some of the youth…to help *inspire* them.

Related to the idea of role-modeling, is the desire to have one's actual experiential knowledge be beneficial for others. Interviewees repeatedly used the metaphor of "*traveling a path*" to describe their experience. However, the path to becoming a STEM professional is acknowledged to be fraught with challenges. This is reflected the idea expressed by a number of interviewees that they are "*blazing a trail*" (Page-Reeves et al. 2017c) One interviewee discussed how difficult it is, saying,

> and that you're kind of going out, you're *blazing that trail*, you're trying to take a leap of faith and going out there and doing things…that's like…a lonely road, you know?... [Native American STEM professionals] *are truly…blazing trails.*

Interviewees see what they are doing is learning how to overcome obstacles so that they can pass that knowledge on. Interviewees said,

> So I want to give back and the reason I want to give back is to support the younger generation and *to make that path easier for them* because it was

> such a big learning curve for me and that just to let them know it doesn't have to be so hard if you go this way or that way.

Another said:

> [T]his value, this ethic for giving back... I guess how I imagined that to happen is more helping those who are coming behind…young people who may have endured or experienced the same kind of struggles, have the same…obstacles in their life, but how have a desire to do something different…*to follow this path* to be able to provide encouragement and…share my experience with them in a way that kind of helps them *move along that path*. That's kind of how… I've always internalized…that ethic.

Still other interviewees see this process as having more expansive implications. One interviewee discussed how he envisions the path he has traveled going to college, working in industry, and starting a business as a STEM professional as a cumulative process. He said,

> I look at my community …There's very few job opportunities … And I feel like the thing that will sustain us in the future and sustain us as a people and sustain our sovereignty is to have economic development in the form of jobs and employment and those kind of things which will allow us to stay in the community, allow us to have opportunity to make a living for ourselves economically an*d* allow us the ability to stay in our community and be connected with our traditional ways. But who's gonna make that happen? *It's those of us who are going out, getting our degrees, getting experience in the…in the larger world who can come back home and create opportunities*…I think being able to bring viable business opportunities to the community is huge…So many of our communities have a casino or a hotel or something…each generation going forward should have the…intent to improve upon with what they were given…you should always think about not only yourself but for those who come after…The destiny is within our hands…I think it has to be…a holistic approach…it's a slow, methodical process and it's… an accumulation process.

Role-modeling and trailblazing, like other dimensions of the giving back paradigm, operate on multiple levels. Role-modeling makes it possible for others to imagine becoming a STEM professional. Trailblazing makes the experience of becoming a STEM professional easier for others in the future. Both contain seeds of transformation to strengthen Native American communities and to enhance Native American sovereignty.

Giving back as a challenge in STEM

While giving back is a clearly articulated objective for Native Americans and as we demonstrate above, giving back has many dimensions of meaning, figuring out exactly what giving back entails is not as obvious (Guillory 2008, p. 170). This fact has significant implications for STEM participation—who decides to go into STEM. It also influences Native American STEM professionals in an ongoing way. A lack of appreciation of the cultural priority placed on giving back by Native American students exists in the orientation and goals of college administration and STEM

coursework. This lapse has been identified as a damper on Native American participation in STEM. HeavyRunner and DeCelles (2002, p. 8) write that "institutions fail to recognize the disconnect between institutional values and [Indian] student values; hence the real reasons for high attrition rates among disadvantaged students are never addressed." In a study comparing perspectives of Native American college students and college administrators, Guillory (2009) and Guillory and Wolverton (2008) found that ideas about what it takes to promote Native American persistence and academic achievement held by Native American students and those held by college administrators did not align. While administrators focused on tangible things like financial assistance and curriculum content, students' responses indicate that "family and giving back to tribal community [provide] the determination and desire to finish [college]" (Guillory 2009, p. 16). Students who are not able to connect their goal of giving back to a college education are less likely to continue their education. Smith and colleagues (2014) looked at this dynamic specifically for Native American STEM students. They identified a lack of "goal congruence" between the priority placed upon giving back by Native American students and a perceived individualistic orientation of careers in the sciences. This perceived individualistic orientation is generally supported by the way that STEM classes are taught and the nature of the knowledge conveyed, even if it is not necessarily indicative of all careers in STEM. Smith and colleagues believe that this lack of perceived goal congruence negatively influences Native American participation in STEM. They "contend that to the extent that Native American students highly endorse communal work goals, this goal endorsement will be associated with feeling that they do not belong in STEM and undermine their persistence in STEM majors" (p. 415).

Interviewees in our study discussed how the challenge to give back is a continuing struggle for STEM professionals. This was a pervasive theme in the interviews we conducted, and a dilemma for interviewees. They discussed a variety of things that make giving back difficult. One described it as a problem of proximity: "We talk about giving back to your Native American community and I don't have that opportunity because I don't live near my Native American community." Another described it as a function of infrastructure:

> I do think that science needs to come to the reservation. There's got to be a way that it can be implemented to really help things there and I'm still trying to figure out how that is. *There's not a good infrastructure* for engineers to come back and readily help the reservation. It has to be created from…nothing.

In the sciences, certain disciplines are easier to connect to giving back than others. Some of the interviewees in this study have expertise in water resources, forestry, or fisheries that have obvious implications and uses in Native American communities. But others who have degrees in physics, aerospace engineering, mathematics, or computer science find it more challenging to identify ways that the specific content of their scientific expertise can be mobilized in the service of community goals. Interviewees remarked, "That's one of the things that I would like to do is to give back to my community…*it's just for my particular degree, there really wasn't any potential for me to [come back],*" or "You don't feel like there's an immediate,

direct path back into the community workwise," or "It is a hard thing to understand how going into physics is ever going to help anyone," and

> The concept of giving back…that's the biggest thing that I've been struggling with recently…trying to figure out how this degree in mechanical engineering and my role as an aerospace engineer, how's that gonna be useful at all to [my tribe]?... And, and if I'm going to come back, there's not really going to be an existing job there for me to jump in to. It has to be created out of something that doesn't exist yet…I don't think I'm gonna be working in the same field.

Figuring out how to give back is a continuing challenge that clearly emerges from interviewee narratives.

Conclusion

A number of authors have proposed ideas about how to address the challenge of giving back for Native Americans. Brayboy, Solyom, and Castagno (2014) discuss this issue from the perspective of tribal nation building. They believe that the focus on individual merit and achievement by colleges and universities needs to be transformed to honor Native American students' cultural values. They see a need for a tribal nation building orientation at institutions of higher learning to not only promote recruitment, persistence, and retention among Native American students, but to facilitate Native American leadership development by specifically supporting a student's capacity to give back. Guillory (2009) suggests the need for colleges to create programs to allow Native American students to maintain a connection to their community and to have culturally sensitive career counseling. Guillory and Wolverton (2008) recommend creating collaborative programs between tribal communities and educational institutions. Makomenaw (2014) believes that service learning and volunteer programs could be created to allow Native American students to integrate their education with the cultural value of serving communities. Minthorn, Wanger and Shotton (2013) want, in addition to cultivating relationships with Native American communities for collaboration and service learning, to see colleges internalize the priorities of Native American culture and communities in a more structured way. This suggests that connecting Native American students with Native American faculty for structured mentorships that involve work in Native American communities would serve this purpose and would have the added benefit of further promoting leadership in Native American communities.

Situating giving back in STEM
Brayboy, Solyom, and Castagno (2014, p. 590) write that Native American students need more information about how "a college degree can (and to some extent should) add benefit and value from a Native American perspective." Writing about this issue with a specific focus on STEM education, Smith and colleagues (2014, p. 424) believe that a way to address goal incongruence between the STEM curriculum and Native American students' values is by incorporating culture in the curriculum. They suggest that first year curriculum courses in STEM could

emphasize the communal value of science and engineering careers, and provide real world applications. Our data suggest that this approach would be extremely valuable. We believe that interviewee narratives demonstrate the need to *situate* giving back specifically in relation to STEM. Elsewhere (Page-Reeves et al., 2017b) we have discussed how important it is for young people in Native American communities to understand that they do not have to give up their Native American identity if they pursue a career in STEM. We describe how interviewees explicitly indicated that they see our research as providing perspectives that can contribute to developing strategies to help Native American youth understand this fact. As Brayboy, Solyom, and Castagno (2014, p. 591) astutely point out, "institutions of higher education can help encourage students to believe that they do not have to choose between home community/culture and being a college student." We believe that this is particularly key in STEM, and has implications for thinking about giving back. We propose that in addition to strategies for universities to encourage and connect with Native American students' desire to give back, STEM industry employers and Native American organizations have a role to play.

In this article, we have demonstrated nuanced dimensions of the giving back paradigm as it relates specifically to careers in STEM. We did this through presentation of quotations from narratives gathered from Native American STEM students and professionals. We have 1900+ pages of transcript data. As should be evident from the extensive quotes we were able to weave into our discussion above, the narratives we gathered were rich, and interviewees—particularly, the professionals—were eager to speak about their experiences and share their ideas. We were incredibly inspired by their stories and their insights. All of them expressed the desire to give back, but the challenges are significant. Building specifically on ideas from Smith and colleagues (2014) for STEM education, and in line with broader insights from Brayboy, Solyom, and Castagno (2014), our data support the idea of a need for specific course content in STEM to help students understand how to connect their career aspirations to their desire to give back.

Students require information to guide them in understanding the ways that a career in STEM can be synthesized with their Native American values and identities (Page-Reeves et al., 2017b) and in figuring out how to think about orienting such a career path to giving back. This is particularly key for those careers that cannot be understood as immediately relevant to the priorities of Native American nation building (e.g., computational mathematics, laser science, or aerospace engineering). We propose that universities and industry could benefit from working with individuals like the interviewees in this study, and our partner, AISES—a national Native American nonprofit dedicated to promoting Native American participation in STEM and a partner on this research (Page-Reeves, et al. 2017e)—to develop course content, curriculum, workshops, and presentations to help students *situate* giving back into their own conceptualization of what it means to pursue a career in a STEM field. Universities could tap Native American STEM alumni to create these educational components. STEM industry companies could mobilize Native American employees and provide resources for work with universities on these ideas and to create professional contexts where this information could be shared for individuals who have completed their education in STEM and entered the work

world. AISES could be involved in a variety of ways, including by identifying Native American STEM professionals who are particularly interested in these issues.

We propose that Native American professionals who have been trailblazing a path in STEM education and careers have perspectives that are particularly salient for contributing to the development of messaging to communicate positive ideas about STEM to Native American young people. Many are the first Native American individuals to work as professionals or to receive advanced degrees in their field and they have personal experience connecting their professional career goals and activities with their Native American values in order to give back in a way that we have called *wayfinding* (Page-Reeves et al., 2017c). These individuals have unique experience and perspectives that can help universities and industry develop culturally appropriate materials and processes that can help Native American students see themselves *becoming* STEM professionals and self-identifying as scientists (Page-Reeves, et al. 2017b). But developing these resources requires a concerted and structured approach. If done strategically, coherently, and holistically, we believe that these strategies for situating giving back will promote expanded participation for Native Americans in STEM. However, because giving back has been demonstrated to resonate with individuals from a variety of populations that continue to be under-represented in STEM, we believe that *situating* giving back in this way could also have implications for thinking about similar strategies to improve STEM participation for African Americans, Hispanic Americans, and other populations.

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