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Conceptualizing a mentoring program for American Indian/Alaska Native students in the STEM fields: a review of the literature

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ABSTRACT

In order to address the disparity of American Indian/Alaska Native (AI/AN) doctorates in science, technology, engineering, and math (STEM), culturally congruent mentorship program development is needed. Because traditional Western academic paradigms are typically constrained to a non-Indigenous perspective, the authors question how American Indian graduate students in STEM can successfully navigate graduate education with their cultural identity intact. Our review and synthesis of the literature addresses this question by considering 60 data sources that include peer-reviewed articles, personal communication with professionals working in the field of AI/AN academic success, and professional training literature. Our synthesis demonstrates that there is a dearth of Indigenous participation in the STEM fields that needs to be addressed by instituting a bicultural paradigm. This paradigm includes incorporating traditional academic mentoring into Indigenous values and kinship structures. A conceptual model is offered that delineates information necessary to conceptualize and develop an Indigenous mentoring program.

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Introduction

The purpose of our literature review is to describe and introduce culturally attuned and congruent mentorship models using information extracted from literature, and conceptualize them in a way that has the potential to increase the number of American Indian/Alaska Native (AI/AN) students who complete science, technology, engineering, and math (STEM) graduate programs. This work is in response to the disparate representation of AI/ANs in these programs. Developing and implementing culturally congruent Indigenous mentoring programs for AI/AN graduate students in STEM disciplines requires considering circumstances that may

be unique to this population such as attention to place, meaningful relationships that start with committed mentors, navigating multiple institutional contexts, and students' Indigenous identity location.

Too often a deficit model discourse is applied when researching AI/AN populations. We hope this review will encourage institutions and the faculty who mentor AI/AN students in the STEM fields, to move beyond a model that places the onus of change solely on the students. The problem we address is that of institutions disregarding unique Indigenous identities and Indigenous relationship building, which may lead to low numbers of AI/AN's in STEM doctoral programs. According to data of the 2014 Survey of Earned Doctorates by the National Science Foundation the data shows that, although representing 1.2% of the U.S. population, AI/ANs earned just 0.19% of all doctorates in 2014. During the same period, foreign nationals, Hispanics or Latinos, Asians, Blacks or African-Americans, and Whites earned 29, 4, 5, 4, and 46%, respectively. Doctorates in STEM represent 59% of all doctorates; 0.13% were earned by AI/AN, 38% by foreign nationals, 3% by Hispanics or Latinos, 6% by Asians, 3% by Black of African-American, and 40% by Whites.

The nation as a whole is a stakeholder in AI/AN graduate STEM student success as the United States is committed to developing its human resources, particularly those who are underrepresented in STEM fields by employing them as researchers. The fact is that AI/AN students should be included as future researchers and scholars in these fields. To support this, one of the goals of the White House Five-Year Strategic Plan for STEM Education in 2013 (Holdren, Marrett, & Suresh, 2013) is:

[To] better serve groups historically underrepresented in STEM Fields: Increase the number of students from groups that have been underrepresented in STEM fields that graduate with STEM degrees in the next 10 years and improve women's participation in areas of STEM where they are significantly underrepresented. (p. viii)

Such goals could be accomplished through

Draw[ing] upon, relate to, and be respectful of the interests, knowledge, practices, and culturally relevant STEM experiences of underrepresented groups and demonstrate an understanding of targeted communities based on research ... and Build[ing] sustained relationships between participants and STEM partners (including continuous tracking and mentoring of participants). (pp. 117–118)

From the perspectives of their own communities, AI/ANs with doctoral degrees in STEM fields would be in an influential position to guide policies and practices that affect their resources. In particular those policies and practices related to tribal sovereignty and self-determination by making use of research that aligns with the needs of their own communities. These interests converge with National Science Foundation's commitment to broadening participation by preparing a diverse, globally engaged STEM professoriate.

In addition to the national push for broadening participation that includes AI/ANs, the global Indigenous community has shown, in both peer-reviewed literature (Coffey & Tsosie, 2001; Harding et al., 2011; Lomawaima, 2000; Lomawaima & McCarty, 2002) and at international Indigenous research conferences (He Manawa

Whenua, American Indigenous Research Association), a push for researchers to include in their studies that which protects cultural, human, and natural resources through responsible and ethical research for Indigenous peoples that align with Indigenous sovereignty and community self-determination.

Research is being discussed in a way that centers the Indigenous perspective on a global scale at the aforementioned professional academic conferences. The goal of these conferences is to re-imagine what comprises Indigenous research. For example, the Te Kotahi Research Institute hosts the He Manawa Whenua conference in New Zealand. Here, individuals who recognized that the heart, Indigenous knowledge is research (He Manawa, 2015). More locally, the American Indigenous Research Association conference challenges Western research views by ... acknowledge[ing the] relationship between researcher and data naturally ... as Indigenous research methodologies are powerful and worthwhile because they provide vital opportunities to contribute to the body of knowledge about the natural world and Indigenous peoples. (American Indigenous Research Association, n.d.)

These conferences show there are multiple spaces that support Indigenous research in the STEM fields and that these spaces are inclusive of an Indigenous reality.

We encourage inclusion of Indigenous paradigms in research and avoid excluding Indigenous researchers by placing them in prominent positions to lead the discourse. In order to accomplish this, we urge that institutions create Indigenous mentoring programs to *provide access* to education precisely to the STEM fields, so that Indigenous researchers have an opportunity to contribute to the body of research in a responsible way with their Indigenous identities intact or even strengthened. Mentors of Indigenous graduate students can become attuned to the unique individual and community needs of their students, while simultaneously providing access to graduate study in the STEM fields.

Given these considerations, Indigenous mentoring programs can be tailored to fit the geographic and ontological locations of Indigenous peoples, with mentors who have a vested interest in the local Indigenous communities. By being flexible and iterative, various institutional types and their unique infrastructures can be navigated, and students' lived experiences can be validated in their journey toward academic success. As a result, the following conceptual framework is offered and subsequently supported by the literature. In Figure 1, we depict the information necessary to conceptualize and develop an Indigenous Mentoring Program that is appropriate for the targeted (non-Indigenous) institution.

Research supporting the conceptual framework

Mentorship is a unique and necessary phenomenon in the realm of graduate education. In order to substantiate a mentoring program that is unique to, and can be refined for, AI/AN students in the STEM fields, the literature reviewed includes the broad (non-Indigenous) base of traditional mentoring in graduate programs, AI/AN

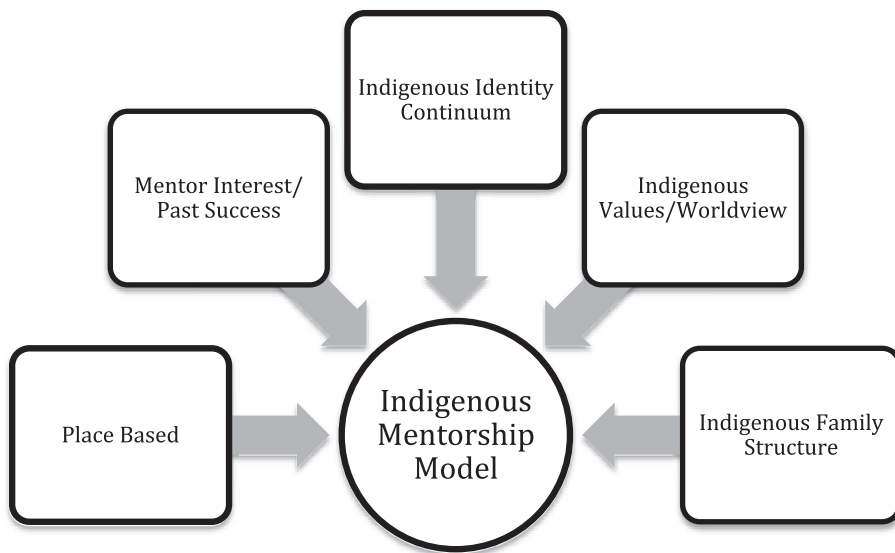


Figure 1. Indigenous mentorship model.

student experiences in higher education and finally drawing on both to focus on STEM graduate students who self-identify as AI/AN. There are many limitations in the empirical research and literature related to AI/AN populations, typically related to sample size (Barbeau, Krieger, & Soobader, 2004; Gloria & Robinson Kurpius, 2001; Morris, Wu, & Finnegan, 2005; Powers, Potthoff, Bearinger, & Resnick, 2003). These limitations are exacerbated when evaluating the literature that is connected to mentoring in an Indigenous context. However, there is substantive literature around the concept of cross-cultural mentoring that thoroughly communicates the importance of trust, issues related to racism, risks that faculty of color may encounter, power dynamics, and various ways mentoring is experienced (Blanchett & Clarke-Yapi, 1999; Johnson-Bailey & Cervero, 2002, 2004). Yet, as important as these issues are, the scope of the literature does not offer a model that serves AI/AN communities specifically.

Place-based

According to Peterson's© institutional types can include two-year colleges, four-year colleges and universities, public and private institutions, co-educational and single-gender institutions (n.d.). Within these delineations are institutions that have a special focus and include; liberal arts colleges, religiously affiliated colleges, and specialized mission colleges that encompass Historically Black Colleges and Universities, Hispanic Serving Institutions, and Tribal Colleges and Universities.

Issues of campus climate, defined as the existing positions, manners, and principles, of the institutional community concerning the amount of regard for diverse needs, abilities, and potential, are well researched and documented for students

who come from historically underrepresented communities in higher education. According to Rankin and Reason (2005), there are differing perceptions between how students of color perceive campus climate when compared to their majoritarian counterparts. These perceptions include but are not limited to increasing segregation, environmental implications of increased diversity, a lack of quality of interactions, sub-par institutional support, and unfriendly campus environments. These differential perceptions, based upon race/ethnicity of students often lead to episodes of racial microaggression and harassment (Harwood, Hunt, Mendenhall, & Lewis, 2012; Solorzano, Ceja, & Yosso, 2000). AI/AN students are undoubtedly experiencing a lack of cultural congruity when they attend doctoral degree granting institutions, due in large part to campus climate issues and barriers. For example, AI/AN students may be skeptical of the university environment, which increases their hesitancy to ask for help when it is needed (Gloria, Hird, & Navarro, 2001). As depicted in our proposed Indigenous Mentoring Program (see Figure 1), one way to improve AI/AN student experiences and learning is to stimulate faculty interest and encourage mentoring that helps students navigate issues related to adverse campus climates and institutional barriers.

Mentorship occurs within the context of the institution. Baker, Pifer, Lunsford, Greer, and Ihas (2015) studied faculty perspectives in connection to mentorship and found several supporting factors for faculty to become mentors. These factors included a supportive institutional culture, a variety of opportunities within the institution to mentor, individual motivators, and student and faculty financial incentives. Mentors can serve as safe spaces when matters of cultural incongruity arise.

Issues of cultural incongruity occur when students feel like they have to deny who they are, as indigenous people, in order to be successful in college and or graduate school leading to 'subtle assimilation' (Windchief & Joseph, 2015, p. 269). Tran (2011) stated that underrepresented students 'often feel invalidated, or alienated from the dominant academic culture, when they are forced to assimilate, compete against each other, and disconnect themselves from their past' (p. 14). Smith, Cech, Metz, Huntoon, and Moyer (2014) emphasized that many AI/AN students report strong community ties and value their ties to traditional culture. STEM fields are often incompatible with such communal values and goals, which in turn becomes a factor in AI/AN disparity in those fields. Smith et al. suggest in their study on AI/AN undergraduate experience in STEM majors that AI/AN students with strong sense of belonging and assurance in their tribal identity face challenges in finding a sense of belonging to STEM disciplines. However, when AI/AN students participate in AI student support programs, they often find staff and faculty mentors cognizant of their community context, which strengthens their ability to be included in STEM networks. On the other hand, feelings of invalidation and incongruity manifest in multiple ways, and begin early in one's academic career. These are often precipitated by deficiencies in the K-12 education system.

Academic preparation, or lack thereof at the K-12 level, impacts the participation rates for AI/AN in the STEM fields as graduate students. AI/AN students in STEM may not have the same access to quality preparation as their non-Native counterparts. The reasons for this include secondary school quality, time away from school, a lack of family emphasis on education, and an avoidance of rigorous course work (Guillory, 2009). This is similar to the experiences of self identified Black and Hispanic students, leading to the conclusion that academic preparation may be the difference in who chooses and subsequently persists in the STEM fields (Riegle-Crumb & King, 2010). Furthermore, psychosocial factors that elevate American Indian persistence in college include meaningful interactions with professors and professional staff, academic preparation, and aspirations of academic success (Brown & Kurpius, 1997).

Aspiring to improve the diversity of their faculty demography, UMass-Amherst has employed a mutual mentoring guide for early career and underrepresented junior faculty (Sorcinelli & Yun, 2010). There are important aspects of this model that relate to graduate students in the STEM fields. Sorcinelli and Yun explained 'mentoring in academia has been defined by a top-down, one-on-one relationship in which an experienced or senior faculty member guides and supports the career development of a new or early-career faculty member by taking him/her 'under his/her wing'(p. 3). However, this traditional approach does not account for the obstacles faced by underrepresented faculty, or even address the overall obstacles that all new faculty face, which includes getting oriented at the new institution; understanding research and teaching assignments; managing the expectations of the tenure process; integrating into faculty community; and balancing professional and family life.

The UMass-Amherst mutual mentoring model seeks to optimize the network of support for early career and underrepresented faculty through mentoring partnerships of a wide variety of individuals including peers, near peers, tenured faculty, chairs, administrators, librarians, and students; accommodating personal, cultural, and professional preferences for contact (e.g. one-on-one, small group, team, and/or online); focusing on specific areas of experience and expertise; emphasizing reciprocity of benefits between mentee and mentors; and regarding the mentees as the primary agents of their own career development (Sorcinelli & Yun, 2010). Based on the UMass-Amherst mentoring model and research (van Emmerik, 2004), we encourage similar development of *constellations* of mentors for AI/AN graduate students in STEM. There are other important aspects of the UMass-Amherst mutual mentoring guide that helped inform the development of an Indigenous Mentoring program for AI/AN graduate students in STEM. These aspects are described in the following section.

Institutional type and student level

Though graduate students are in a different developmental location there are aspects of the UMass-Amherst model that are important for AI/AN graduate students in STEM. Most notably, as students move into doctoral level study, they move from principally being consumers of knowledge and information to becoming primarily producers of knowledge and information. Consequently, the aspects that are important to consider are those that facilitate self-initiated professional/academic development, one of which is the phenomenon of peer mentoring. Colvin and Ashman (2010) noted that the peer mentors and the peers themselves benefit from this process though the benefits are reported differently for women and men providing relationships and better grades as the reported benefits, respectively.

Mentor interest and past success

Galbraith (2003) considered mentoring to be one of the roles that faculty members take on during their careers. Other roles included for college and university faculty include curriculum developer, researcher, lecturer, scholar in service, and other roles inherent to academic careers. According to Galbraith, a mentor must use various approaches to strengthen his or her relationship with students and establish trust. In mentorship, faculty are encouraged to offer guidance and information according to the specific needs of their mentee (Drayton, Rosser-Mims, Schwartz, & Guy, 2014; Lightweis, 2014; Treviño, Hite, Hallam, & Ferrin, 2014). Additionally, mentors need to understand how the connections between culture and successful mentoring relationships help meet students' challenges in a respectful way (Kochan, 2013). Mentors can motivate students using their own life experiences (Kobulnicky & Dale, 2016) and if done well, this can encourage positive role modeling by the students (Park, Behrman, & Choi, 2013). All of this occurs while inspiring students to take charge of their own futures as scholars. This is facilitated by helping mentors understand that student's participation in the STEM fields improves when students start to see themselves as scientists (Brenner, Serpe, & Stryker, 2014; Merolla & Serpe, 2013).

Tenenbaum, Crosby, and Gliner (2001) concluded that traditional (Western academic) support systems served to encourage student scholastic production and psychosocial support increased students' satisfaction and subsequently their entire academic experience. Further research found a significant association between the quality of a mentoring relationship and students' benefit (Chung, Dykes, & McPherson, 2017). 'Quality mentoring contributed to increases in learning skills, social support, and wellbeing. Specifically, close, dependent relationships with unrealistic expectations had the more significant associations with improvement in academic and social realms' (Tenenbaum et al., 2001, p. 1345). In order to develop this kind of relationship, Schwartz and Holloway (2012) mentors should

be engaged when meeting with students and show students they care by creating a safe learning spaces that clearly support and encourage student ideas.

The pairing of students and mentors is important. Students gain a more thorough understanding of their academic work when mentors create meaningful interactions (Comeaux, 2010; Schwartz & Holloway, 2012). In order to ensure a high quality mentoring experience researchers suggest that the creation of a mentoring relationship be taken seriously. This relationship begins with targeted student recruitment (Kendricks, Nedunuri, & Arment, 2013). Conversely, Barres (2013) suggested graduate students find mentors by considering a mentor's competency in their field (in this case STEM fields) and their ability to mentor. In either situation, (e.g. faculty recruiting student, or student seeking faculty), mentor relationships are personal and as a result, should not begin suddenly, or haphazardly. Furthermore, from the mentor's perspective, an empirical study revealed that benefits were person-centered; meaning students were inspiring mentors and they valued seeing the progress of the students they guide (Busch, 1985). Further, benefits to the mentors were related to their own career development including the incentive to keep oneself current in their field, which is valued by students and peers alike (Busch). More recently, researchers indicate that faculty who value diversity are more likely to be interested in serving as mentors of students who come from historically underrepresented groups (Morales, Grineski, & Collins, 2016) showing that mentorship has the potential to impact areas beyond the auspices of specific academic disciplines and serve to support diversity and inclusivity more broadly.

It is problematic when students learn too late that their mentors' advice had little to do with what the student perceives as important, for our purposed here, from a cultural standpoint. Mentoring can be experienced in many ways and can be problematic if it leads to academic 'cloning' (Blackburn, Chapman, & Cameron, 1981, p. 315). Specifically for AI/AN students, cloning may entail a sense of subtle and contemporary assimilation. As a result, academic mentors will want to consider that mentorship is performed differently across disciplines within graduate education. Institutional, personal, disciplinary, and other contexts must be considered in the socialization of all students, and for our purposes here, the lived reality of AI/AN students. In synthesizing the literature, we concluded that though extremely complex, good mentoring relationships are beneficial for both the student and the mentor if it is performed well, serving as motivation for mentoring while encouraging faculty and students to avoid the pitfalls of inattentive, poorly engaged mentoring relationships which can be the result of inappropriately essentializing an AI/AN Student's Indigenous identity.

Indigenous identity continuum

Indigenous students are presumably located differently along a conceptual Indigenous identity continuum (Personal communication with Darold Joseph, 2011). The description of state level Indian education policy (Starnes, Swaney, &

Bull, 2006) further clarified the concept as it relates to American Indian students transitioning to college. 'American Indians are located on an identity continuum from being deeply immersed in Indigenous ontological space, to being deeply immersed in non-Indigenous ontological space' (Joseph & Windchief, 2015, p. 92).

We speculate that one's position on this continuum is fluid in nature and are able to change positions through their relationships with other community members. There are multiple subgroups of students, including various generations of students, with varying levels of experience and interpretations of the concepts presented. As a result, we choose to view one's location on the continuum as a place of contribution to their community, by their definition, and include Indigenous Identity as an important component of the proposed Indigenous Mentoring Program (Figure 1).

There are several reasons that AI/AN students are kept from completing doctoral degrees, particularly in STEM, at the same matriculation and graduations rates as their non-AI/AN peers. One of these reasons is a 'crisis of relevance' S. Abbot (Personal interview, November 14, 2014) that Indigenous students experience within the campus climate at non-Indigenous institutions (NIIs). This can exacerbate the cultural incongruity within NIIs, contributing to a dearth of access to the same academic preparation. This is similar to students from other communities that are historically underrepresented in the STEM fields. *Crises of relevance* are experienced as feelings of intellectual isolation best described as what is being studied has little to do with their values, lived experiences, or community reality. Often students are in classes that don't speak to or teach about what is important to them in their own sociocultural context. Moreover, when evaluating what is being taught in public schools, one has to acknowledge the fact that Indigenous peoples have been historicized, exoticized, and marginalized in curricula as revealed in the literature. The academic community paid little attention in research and work on communities of color, to include AI/AN communities, particularly scholarship that offered positive portrayals and narratives of historically under-resourced communities (McGee Banks & Banks, 1995). Subsequently, AI/AN students are likely not connected to education in the same way that majority students are. At some point in time, AI/AN students may ask themselves, 'What am I doing here?' 'I am learning all about who I am not.' These self-reflective questions may increase AI/AN student's hesitancy to persist to graduation and calls for a unique type of mentoring that is couched in culturally relevant pedagogy (Klug & Whitfield, 2003), calling for community specificity.

Brayboy (2005) stated 'tribal philosophies, beliefs, customs, traditions, and visions for the future are central to understanding the lived realities of Indigenous peoples, but they also illustrate the differences and adaptability among individuals and groups' (p. 429). We intend that many of the concepts presented here can be applied to different subgroups in the identity continuum. Though there can be some overlap, Indigenous communities are culturally different and to think otherwise assumes that the lived experiences in AI/AN communities are monolithic.

Indigenous values

In order to construct an applicable model, we must consider Indigenous mentoring which comes in multiple formats that are place-based (Barnhardt, 2005; Davidson-Hunt & Michael O'Flaherty, 2007; Semken, 2005), consider mentor positionality (Mutua & Swadener, 2004), are influenced by institutional setting (Cobb, McClain, de Silva Lamberg, & Dean, 2003), and are attentive to student identity location (Dei, 2000). Furthermore, the importance of Indigenous values in the implementation of an Indigenous mentorship program cannot be overemphasized. These values are stated succinctly for the context of higher education by several authors (Ball, 2004; Cajete, 1999; Harris & Wasilewski, 2004; Kawagley & Barnhardt, 1999) and most purely stated by Kirkness and Barnhardt (2001),

- *Respect of First Nations Cultural Integrity* – to include customary knowledge, oral knowledge, and Indigenous knowledge that is often held by the community as opposed to any one individual (p. 9).
- *Relevance To First Nations Perspectives and Experience* – ('adopt a posture that goes beyond the usual generation and conveyance of literate knowledge, to include the institutional legitimation of indigenous knowledge and skills' (p. 9).
- *Reciprocity In Teaching And Learning* – (reciprocity is achieved when the faculty member makes an effort to understand and build upon the cultural background of the students, and the students are able to gain access to the inner-workings of the culture (and the institution) to which they are being introduced. (p. 11)
- *Responsibility* requires an institutional participation and commitment '...to finding ways to create a more hospitable climate for First Nations students' (p. 13).

These values call for examining the interaction between Indigenous values and higher education and must consider culturally congruent modalities. One such model is the family education model (FEM) (HeavyRunner & DeCelles, 2002). This model includes the development of the ability of family members to support student efforts, and engages family members in the mentoring process. This is accomplished by involving family in cultural and social activities. Including family in the students experiences in a holistic way can serve to create an environment that honors and includes Indigenous paradigms while nurturing appropriate institutional partnerships. This is accomplished by recognizing longstanding relationships based on respect. Modeling this respect in mentoring and other activities affirming student's Indigenous identities while making room for tribal/community variability.

In order to address the disparity of AI/ANs in STEM graduate education, institutions can address issues of campus climate by borrowing aspects of different mentoring ideologies. By implementing aspects of mutual mentoring, Indigenous

values as they relate to higher education, and the FEM; a culturally attuned mentorship program for AI/AN graduate students in STEM disciplines could be developed. If implemented, the proposed Indigenous Mentoring program (see Figure 1) has the potential to limit the crises of relevance and other dissuasive episodes that AI/AN students are likely to experience at doctoral degree granting institutions that don't have Indigenous community support.

Indigenous kinship structures

In a contemporary context, Indigenous kinship structures can be applied to improve graduate education success in the STEM fields for AIANs. There are multiple kinship systems throughout North America and the world. These have been studied in the field of anthropology for many years as noted by Read (2013);

The typology frequently used for kinship terminologies traces back to distinctions made by Lewis Henry Morgan, Robert H. Lowie, Peter Kirchhoff, Leslie Spier and George Peter Murdock. The typology is derived from difference in the ways that kin terms identify or categorize what are presumed to be primary genealogical relations. (p. 1)

This way of understanding relationship structures is a science in and of itself that extends beyond the scope of this manuscript. The important issue to understand here is that Indigenous kinship differs across contemporary Indigenous communities and can be applied to define responsibilities between people. Former president of the Fort Peck Community College speaks with Kenneth Ryan, who offers one example of an Indigenous Kinship structure.

Under the Assiniboine family model, one's father's brothers are called Father and one's mother's sisters are called Mother. Under this structure an individual always has more than one father and mother. It is not unusual to have a number of fathers and mothers. Father's sisters are called Auntie, and mother's brothers are called Uncle. To go horizontally in this model, all of one's mother's children and father's children are considered brothers and sisters. However an auntie's and uncle's children are all called cousins (Shanley, 1999).

There are multiple kinship systems beyond the Assiniboine example stated above, therefore there are multiple systems, which can be applied in the field. These applications are dependent on the cultural and ethnographic locations of the students and institutions that can potentially develop an Indigenous mentorship program.

Indigenous worldviews

Western scientific thinking has become the golden standard for what counts as scholarship in contemporary academic circles. Arguably, interactions between students and their mentors follow suit and a Western modality of mentorship is the norm. Alternative epistemologies and Indigenous methodologies have been largely discounted by majoritarian educational paradigms (Kawagley, Norris-Tull,

& Norris-Tull, 1998; Simonds & Christopher, 2013). This prompts us to consider mentor relationships based on Indigenous ways of thinking, being, knowing, and doing and merging them with appropriate Western Academic contexts.

According to Wilson (2008), relationships are key to Indigenous paradigms. Though he is speaking directly about research, given the aforementioned importance of relationships, it benefits Indigenous students and mentors to center mentoring relationships in what he terms relationality. In other words the importance of relationships as a collective or community cannot be understated and are more than between two people. This can be made pragmatic, but only if the community is included.

To develop an Indigenous mentoring program the construction of relationship is not merely between mentor and student, but, for our purposes here, it would include a sense of community constructed within the STEM degree program, the particular institution and academic field of the mentor and subsequently, the student. Ideally, this would include relevant Indigenous worldviews of the particular contemporized community (Hart, 2010), and Indigenous epistemologies (Meyer, 2013; Rundstrom, 1995), in ways that consider traditional concepts of mentorship in higher education, AI/AN student experiences in graduate STEM programs, multiple mentorship examples, Indigenous values, traditional and contemporary kinship structures, and worldviews.

Discussion and summary

We recognize that colleges and universities have different leadership structures and support services in place for AI/AN STEM graduate students. Institutions have different histories as they relate to Indigenous peoples. There is variability in funding sources, mechanisms and even missions as they relate to diversity. As a result, any mentorship program that is implemented would need to be framed appropriately within the institutional context.

Finally, mentors/advisors/principal investigators are typically receptive to andragogy, (adult learning) with a tendency to be self-directed and collaborative in learning (Pratt, 1988). Any program developed to prepare faculty members to mentor AI/AN students needs to incorporate their experience and input to program components to be problem-centered, and to connect content to relevance and impact on professional life (Knowles, 1984). The program should also capitalize in mentor interest or contribution to mentoring AI/AN students while understanding that they may be dependent on the student to learn the relational behaviors and kinship system norms within any given Indigenous community context.

We suggest, based on the literature, that the first step in developing an Indigenous mentoring program is to facilitate understanding and awareness of AI/AN student identity, and how it may complicate traditional conceptualizations of the mentoring relationship. Indigenous identity continuum location is to be considered in developing these relationships. On one end of the continuum, there

are students who are strongly anchored in their identity as an Indigenous person, they may be recognized as carriers of traditional knowledge for the community, speak their tribal language, know their genealogy, and serve as a cultural resource for the community. On the other end of the continuum, there are AI/AN students who do not have any idea about who they are as part of Indigenous communities. Though this is not their fault, however at this end of the continuum AI/AN Students' may not know the cultural intricacies of the community that they come from including the language, who their relatives are, and/or may not engage in community activities/ceremony due to assimilationist policies. Indigenous mentoring programs need to recognize that students are located everywhere on this continuum, and that their location on this continuum is not static.

Subsequently, mentors cannot assume that the students they will work with are on one end of the continuum or the other. Rather, to avoid assumptions, an Indigenous mentoring program would be designed to meet the students where they are on the Indigenous identity continuum, and include components proposed in our conceptual framework (see Figure 1) and supported by the literature reviewed in this paper. By being flexible and iterative, various institutional types and their unique infrastructures can be navigated, and students' lived experiences can be addressed and impact the development of the program.

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Notes on contributors

Sweeney Windchief is an assistant professor at Montana State University in the Department of Education. His research interests include the application of critical race theory in education, Indigenous methodologies in research, and finding cultural congruities between Indigenous ontologies and academic spaces, particularly in higher education.

Blakely Brown is a professor in the College of Education and Human Sciences at the University of Montana. Broadly, her area of expertise is behavioral and community health, with emphasis on diabetes and obesity prevention. The majority of her research focuses on understanding and impacting health behaviors related to preventing chronic disease, and improving food access and systems in underserved, rural and American Indian and Indigenous communities.

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