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Tribal College and University Research Journal

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Tribal College and University Research Journal

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The Tribal College and University Research Journal is published by the American Indian College Fund, with generous funding from the Henry Luce Foundation. The College Fund believes it is critical to support tribal college and university (TCU) faculty in conducting research that benefits Indigenous communities and disseminating research to both Indigenous communities and the wider research community. Lead authors on manuscripts conducted their research as faculty and staff at tribal colleges and universities. Manuscripts are reviewed anonymously by an editorial board of Indigenous scholars within a range of academic fields. The journal editors work with authors to prepare manuscripts for publication throughout the submission, review, and revision process.

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The TCURJ cover and logo design embodies concepts of Indigenous knowledge, community, and place. The design intentionally incorporates symbols to reflect the mission of the journal. Tribal colleges and universities (TCUs) are for the community and the research that comes from the TCU community is an act of strength and reclamation.

Tree - The trunk reflects the resilience and knowledge of the community. The leaves reflect the community being served by TCUs.

Land - The land reflects the place of higher education and TCUs. The land also resembles an open book for education.

Sweetgrass braids - The braids acknowledge language, songs, and dances.

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WELCOME TO THE TRIBAL COLLEGE AND UNIVERSITY RESEARCH JOURNAL

Cheryl Crazy Bull, President and CEO
American Indian College Fund

Mitakuyepi.

Greetings, relatives.

Research tells stories. I often think of that when I think of the research work done by the tribal colleges and universities and the American Indian College Fund. I think of the stories of experience, of opportunity, and of hopefulness.

All of those stories we tell come from evidence. Sometimes that evidence is narrative, sometimes it is numbers, and sometimes it comes from insights. I particularly appreciate that we have information – narrative or numeric – and insights derived from that information, leading to conclusions. Insights teach us.

For many years, earlier in my career, I taught a class in Reservation Economics. Two of my goals were for students to understand what happened to their families' land and for students to realize that we had economies rooted in production that were tied to what we needed for both survival and well-being.

Students researched the status of their family land. Native students often looked at what happened to their ancestors' allotments. Non-Native students explored what happened with the homestead acts, since many of them were descendants of the original farmers and ranchers who established themselves on Native peoples' lands once they were opened to settlement by Congress. The students collected stories, forming a narrative, and they saw numbers in western culture, because land has value. From that research, the students gained insights about what happened in the history of the Rosebud Reservation.

For me, Native research is about gaining and sharing Native insights, which are often overlooked in mainstream academic journals. Thus, our journal shares our stories through our research.

In a previous volume of this journal, I noted that the Lakota word of research is both a verb, *pasi,* and a noun*, wopasi*. *Pasi* is to follow or trace something, to inquire, or to investigate. *Wopasi* is research or investigation. Native peoples have words in our Native languages for the work that we are doing today – words that demonstrate that research has always been a part of our lives.

It is also the heartbeat of our tribal colleges and universities. When we share the work of faculty and students at tribal colleges and universities, we are telling our stories.

Wopila, thank you, for reading and sharing our research.

Introduction: Indigenous Research *for* and *with* Communities

Anna Lees, Editor
Natalie Youngbull, Editor
Tribal College and University Research Journal

Continuing the work of previous volumes, editors of the *Tribal College and University Research Journal (TCURJ)* are committed to disseminating research from tribal college and university (TCU) faculty across tribal nation regions. The *TCURJ* offers a unique publication outlet that is focused on research relevant to Indigenous epistemologies, ontologies, and axiologies within particular communities and across disciplines and methodologies. As an interdisciplinary journal, this publication is only made possible by the commitment of Indigenous and TCU scholars across numerous institutions. Volume 4 is the fifth issue of the TCURJ published by the American Indian College Fund and the seventh issue in the College Fund's *Tribal College and University Publication Series.* Each article underwent an external review process gaining anonymous feedback from experts in their fields. The authors then worked closely with the editors to complete a thorough revision process toward publication. We extend deep gratitude to our colleagues who have shared their time and expertise as reviewers in this volume of the *TCURJ,* their valuable and constructive feedback for authors was indispensable.

Nearly thirty years ago, Deloria's (1991) argued for "scholars to put something back into the Indian community" (p. 457) that they are researching. More recently, Coulthard and Simpson (2016) made a similar call in centering grounded normativity as a necessary construct for ethical research with Indigenous communities, stating "grounded normativity teaches us how to be in respectful diplomatic relationships with other Indigenous and non-Indigenous nations with whom we might share territorial responsibilities or common political or economic interests". Simpson (2017) expands at length on the notion of grounded normativity and the importance of considering tribally specific protocols and ways of knowing and being in any research endeavor. In fact, as we reflect on the important scholarship cautioning the ways research is enacted we must question the role of academia altogether as researchers of Indigenous peoples and communities.

Given the unique scope of the TCURJ to publish articles by TCU faculty, we are in a unique position to advance the calls of ethical research. The authors featured in this issue have reflected upon and discussed their positionality within the tribal nation community where their work is situated. The research these authors put forth is clearly connected to community interest and authors have thoroughly explained how their particular study is situated in relationship to the peoples, lands, and waters surrounding the TCU. As scholars we often examine our histories to envision a future we do not yet know that is more positive than our current reality (Battiste, 2001; Simpson, 2017). The articles in this volume of the *TCURJ*, depict current efforts to uphold positive change for Indigenous peoples. While each article offers a realistic portrayal of social, educational and environmental challenges, the authors depict their research endeavors as cause for optimism in seeing improvement through concrete and localized action. As editors of the *TCURJ*, we are deeply inspired by this work and delighted to share Indigenous research from TCUs that was conducted for and with tribal communities.

Opening this issue, Andrew T. Kozich, Valoree S. Gagnon, Gerald P. Jondreau, Erin E. Johnston, Trey A. Loonsfoot, and Max L. Rivas take on climate change and the impacts on a Great Lakes community.

In *Climate Change Perspectives and Policy Support in a Great Lakes Anishinaabe Community*, Kozich and colleagues utilized mix-methods research to depict Keweenaw Bay Indian Community (KBIC) community members' perspectives regarding climate change and their support toward developing long-term policy action to addres their concerns. The authors are thoughtful in their portrayal of the significant relationship with water in Anishinaabe communities and have interwoven western and Indigenous epistemologies. The article offers an important portrayal of both community voices and tribal leadership in considering localized and long-term action plans in preparation for and resistance toward climate change. The findings make clear that KBIC community participants are in favor of long-term action toward climate change and would support the allocation of tribal nation resources in such an endeavor. With a strong sample size and multiple data sources, the findings offer a strong foundation for communities wanting to address similar challenges.

In *The Effect of a Life Skills Curriculum on the Problem-Solving Abilities of Tribal College Students*, Monte Randall examines the impact of a life skills curriculum on TCU student problem solving abilities. Randall presents the context of education as one in great need of intervention and takes on the social crisis of Indigenous youth suicide. With these factors arguably plaguing all tribal nation communities, Randall's examination of a possible intervention is crucial for readers across disciplines. The life skills curriculum featured in this research was embedded into an already existing and required course at the TCU. The academic design of the intervention is particularly important as the implementation of the intervention did not require additional TCU resources, but rather a relatively simple curricular revision. Randall's findings illuminate significance with the life skills curriculum having a positive impact on student problem solving abilities. Thus, this curriculum holds the potential to foster better college experiences for TCU students and potentially a greater aptitude for navigating daily trials.

Also working to improve the educational experiences of TCU students through curriculum revisions, Janyce Woodard, Hank Miller, Beverly R. DeVore-Wedding, and Mark A. Griep have expanded on their established body of work in their article titled, *The Pathway to Chemical Literacy: A Resource Guide of Chemistry Courses at Tribal Colleges and Universities.* In this study, Woodard and colleagues examine both the offering of chemistry courses at TCUs across the nation and also what work has occurred to indigenize TCU chemistry course curriculum. The authors' dual focus in this research should not go under emphasized. They make a clear argument for why offering multiple chemistry courses at TCUs is important for student career potential and transfer opportunities and also address the need for offering culturally relevant classroom experiences. Importantly, this article discusses why entry to the STEM fields benefits TCU students, Indigenous communities, and the greater society in ways that move beyond a lens of economic gain. With findings indicating that only one TCU chemistry curriculum has shared examples for indigenizing the content, their research leaves the reader wanting to examine the authors' previous work in this area and also be sure their TCU is offering the appropriate number and type of chemistry courses to support TCU student entry to the STEM fields or further study.

Bringing us back to the environmental sciences, Kerry Hartman, Alexis Archambault, Ashly Hall, Tanya Sand-Driver, and Paul J. Johnson put forth *The Native Bees (Hymenoptera: Apiformes) Associated with Juneberry (Amelanchier alnifolia) on the Fort Berthold Indian Reservation, North Dakota.* This article offers insight to the diversity of bees near the Juneberry orchards on the Fort Berthold Indian Reservation, North Dakota and the possibility for those bee populations to enhance fruit production. The authors offer a clear depiction of the methodology and discuss the significance of this research to the local tribal nation community. They have made clear why fruit production of the Juneberry is significant and also offer insight to how the land has changed over time to result in reduced Juneberry fruit and bee populations. With frequent public discourse around concerns of bee extinction and the subsequent environmental impact, Hartman and colleagues offer an important in-depth look connected to a specific geographic region. Their research brings valuable clarity to the bee population in relationship to a culturally significant plant relative. The article depicts interdependence of non-human species and the impact of landscape change on such relationships that may otherwise be overlooked.

Again, the work put forth by the authors, reviewers, College Fund staff, and TCU community partners is tremendous and without their dedication this journal would not be possible. Significant institutional resources sustain the *TCURJ* with work from College Fund staff Dr. Natalie Youngbull, *TCURJ* Editor and former Faculty Development Program Officer, Dr. David Sanders, Vice President of Research, Evaluation, and Faculty Development, and Dr. Cheryl Crazy Bull, President and CEO. Drs. Lees and Youngbull are honored to hold the role of editors for this important publication and will continue to emphasize the significance of TCU faculty to engage research for and with tribal nation communities. Please take the time to read the articles in Volume 4 of the *Tribal College and University Research Journal* and share the findings from this research widely with colleagues and community. Chi miigwech and Néá'ésé for being a part of this important work of engaging interdisciplinary and localized Indigenous research.

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Author Biographies

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Natalie Youngbull (Cheyenne & Arapaho/Assiniboine & Sioux) is editor of the *Tribal College and University Research Journal* and Assistant Professor of Adult and Higher Education in the Educational Leadership and Policy Studies department at the University of Oklahoma. Her research interests include the experiences of American Indian Gates Millennium Scholars, Native/Indigenous student success, Native Nation Building, and intellectual leadership and capacity building within TCUs.

Climate Change Perspectives and Policy Support in a Great Lakes Anishinaabe Community

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In recognition of potential negative impacts to its environment, economy, and culture, the Keweenaw Bay Indian Community (KBIC) recently passed a formal resolution to develop a climate change planning initiative. This paper summarizes the second phase of mixed-methods research describing KBIC members' perspectives on climate change and their support for long-term policy actions. Through a quantitative mail survey we found that community members are acutely aware of climate change, are concerned about future generations of KBIC members, wish to prioritize traditional Anishinaabe culture in planning initiatives, and are supportive of mitigation and adaptation strategies. Our findings provide vital insight to KBIC leaders and adds to the broader literature by introducing Great Lakes Anishinaabe perspectives to discussions of climate change and environmental justice issues facing Indigenous cultures worldwide.

Key words: Climate change, Indigenous, Anishinaabe, Great Lakes

Introduction

The scientific community overwhelmingly agrees that global climate change is happening and that its negative impacts will be widespread (Intergovernmental Panel on Climate Change [IPCC], 2018; Melillo, Richmond, & Yohe, 2014; National Oceanic and Atmospheric Administration [NOAA], 2013; U.S. Environmental Protection Agency [USEPA], 2014). Environmental changes are occurring worldwide, but they are not evenly distributed; warming is most severe at high latitudes and the increase in extreme weather events varies across the globe (IPCC, 2018). Societies' ability to withstand these changes is largely based on economic resources, leaving some better-equipped than others to adapt and survive (IPCC, 2018).

Indigenous communities, who contribute relatively little to the causes of climate change, are disproportionally vulnerable to its negative impacts (IPCC, 2018; International Union for Conservation of Nature [IUCN], 2008; National Wildlife Federation [NWF], 2011; Whyte, Dockry, Baule, & Fellman, 2014). With many Indigenous communities already stressed by limited resources, the added burden of human-caused environmental changes represents one of the prominent environmental justice issues of our time (Cordalis & Suagee, 2008; Krakoff, 2008; Lynn, MacKendrick, & Donoghue, 2011; Maldonado, Shearer, Bronen, Peterson, & Lazrus, 2013; NWF, 2011; Thomas & Twyman, 2005; Tsosie, 2007; Wildcat, 2013; Whyte, 2013). Largely resulting from historical colonization and assimilation policies, many North American Indigenous communities are geographically isolated, rely heavily on natural resources and government assistance programs, have low per capita income, low educational attainment, and limited health and emergency services (Duerden, 2004; Lal, Alavalapati, & Mercer, 2011; Thomas & Twyman, 2005). These disadvantages are amplified for communities whose resources are already stressed by issues related to education, health, poverty, unemployment, or substance abuse (Cozzetto et al., 2013; Lynn et al., 2011; NWF, 2011; Weinhold, 2010). Historically, many Indigenous communities would respond to environmental changes by relocating, but legally-defined reservations and tribal lands (often associated with long-standing treaty rights) leave fewer adaptation options (Maldonado et al., 2013; Wildcat, 2013).

While economic impacts could be severe, perhaps more alarming are looming threats to entire aspects of many Indigenous cultures (Cochran et al., 2013; Cordalis & Suagee, 2008; Downing & Cuerrier, 2011; Lynn et al., 2013; Turner & Clifton, 2009; Whyte et al., 2014). Relationships between Indigenous peoples and their environments are typically very deep, with culture developing in conjunction with surroundings. Languages, traditional stories, survival strategies, and generations of accumulated knowledge are linked to the familiarity with (and sacredness of) homelands. Spiritual values and beliefs are intertwined with the natural resources of the area, such as water, geology, plant and animal species, and food sources (Lynn et al., 2013; Wildcat, 2013). While Indigenous scholars have noted the wide-ranging cultural impacts of climate change, they draw less attention than economic impacts in mainstream publications and climate change reports (IPCC, 2018; Kimmerer, 2013; LaDuke, 1999, McGregor, 2012; Whyte, 2014; Whyte et al., 2014; Wildcat, 2009).

The climate change vulnerability of Indigenous communities has only recently received attention in the U.S. scientific literature, focusing predominantly on three regions with relatively high Indigenous populations. Arctic communities are experiencing melting glaciers, reduced sea ice, thawing permafrost, and coastal erosion; impacts include diminished food sources, thawing of traditionally-frozen travel routes, and losses of homelands to the encroaching sea (Arctic Climate Impact Assessment [ACIA], 2004; Cochran et al., 2013; Cruikshank, 2001; Crump, 2008; Downing & Cuerrier, 2011; Duerden, 2004; Ford et al., 2008; National Tribal Air Association [NTA], 2009). Extreme droughts and heat waves in the already-arid U.S. Southwest are impacting traditional agriculture, reducing biodiversity, and intensifying invasions of non-native species (Cordalis & Suagee, 2008; Cozzetto et al., 2013; Finan, West, Austin, & McGuire, 2002; NTAA, 2009). In the northwest Pacific coast region, altered environmental conditions are impacting sacred salmon populations (Dittmer, 2013; Turner & Clifton, 2009).

Climate Change and Great Lakes Indigenous Communities

In the Great Lakes region, altered air and water temperatures, hydrological patterns, seasonal events, and weather patterns have been widely noted (IPCC, 2018; Melillo et al., 2014; Pryor et al., 2014; Schramm & Loehman, 2010). Ensuing impacts to forest, wetland, and aquatic communities are expected to include altered structure and species composition and invasions of non-native species (Pryor et al., 2014; Schramm & Loehman, 2010). While potential outcomes of climate change have drawn attention in mainstream scholarly literature, few studies have examined impacts to the region's Indigenous communities that rely on stable environmental conditions for the continuation of familiar lifeways. Instead, several inter-tribal initiatives have recently collaborated to produce rich reports intended to draw attention to cultural impacts and aid tribes in climate change planning (e.g., Inter-Tribal Council of Michigan, 2016; Tribal Adaptation Menu Team 2019; White et al., 2014).

Literature involving Anishinaabe[1] communities indicates concern about climate change and environmental changes, particularly involving water resources (Cave et al., 2011; Kozich, 2016; Kozich, 2018; Plummer et al., 2009). Water is particularly sacred to the Anishinaabe, as themes involving water are prevalent in creation and migration stories and many other enduring cultural traditions (Benton-Banai, 1988; Densmore, 1979; Kozich, 2018; Kozich, Halvorsen, & Mayer, 2018). Abundant wetland ecosystems provide critical habitat for manoomin (wild rice), a sacred plant that provides valuable nutrition. Additional sacred plant species, including giizhik (northern white cedar; *Thuja occidentalis*), rely on wetland habitats for their survival. Populations of manoomin and giizhik have already decreased in many areas, and further losses are feared as a result of altered hydrologic patterns (Schramm & Loehman, 2010). Significant cold-water fish species such as mookijiwanibi-namegos (brook trout; *Salvelinus fontinalis*) and ogaa (walleye; *Sander vitreus*) are at risk of habitat loss due to warming waters and invasion of non-native species (Michigan Department of Natural Resources [MDNR], 2015; NTAA, 2009; Nuhfer, Zorn, & Willis, 2015). Commercial and sustenance fishing that supports many Anishinaabe communities could be severely impacted.

Forest ecosystems include plant species used for traditional Anishinaabe medicines, foods, and utility items. For instance, wiigwaasaatig (paper birch; *Betula papyrifera*) is used for canoe-making, sap collection, and medicine. Baapaaggimaak (black ash; *Fraxinus nigra*) is highly regarded for making baskets and other goods. Ininaatig (sugar maple; *Acer saccharum*) is used for medicine, lodge poles, and supports the revered sugar-making tradition. These tree species are likely to be stressed by changing hydrological patterns, warmer temperatures, and the migration of competitive species (and invasive insects) from the south (Dickmann & Leefers, 2003; Pryor et al., 2014; Schramm & Loehman, 2010). If changes to the region's forest communities continue as anticipated, impacts to culturally-significant animal species that inhabit them can be expected to follow, affecting traditional hunting and trapping activities (Kozich & Kozich, 2015; Schramm & Loehman, 2010; Voggesser, Lynn, Daigle, Lake, & Ranco, 2013).

Generations of traditional ecological knowledge (TEK) could enhance understandings of past environmental patterns, interpretation of current conditions, and development of adaptation and mitigation strategies (Alexander et al., 2011; Berkes & Folke, 2000; Cochran et al., 2013; Vinyeta & Lynn, 2013; Whyte et al., 2014; Wildcat, 2009; Williams & Hardison, 2013). Many tribes view TEK as an important element of sovereignty and are now developing and adopting their own climate change adaptation plans, often in collaboration with other regional tribes (Inter-Tribal Council of Michigan, 2016; Tribal Adaptation Menu Team 2019; White et al., 2014). Scholarly literature on Great Lakes Indigenous climate change perspectives, largely based on interviews, symposia, or

[1] Often translated to mean "original people", Anishinaabe includes many culturally-related Indigenous peoples of the Great Lakes region such as Ojibwa, Potawatomi, and Odawa.

working group meetings, indicates awareness of environmental changes and concern about ramifications (Cave et al., 2011; Ford, et al., 2008; Kozich, 2016; Plummer et al., 2009; Smith, Liu, Safi, & Chief, 2014; Turner & Clifton, 2009).

Case Study: Keweenaw Bay Indian Community

The remainder of this paper describes climate change through the lens of the Keweenaw Bay Indian Community of northern Michigan (Figure 1). The Tribe[2] is federally recognized and a signatory to two treaties with the U.S. in recognition of their status as a sovereign nation (KBIC, 2013). The *1842 Treaty with the Chippewa* reserved existing rights of hunting, fishing, gathering, and other usual privileges of occupancy within more than 10 million acres of ceded land and water territory (7 Stat., 591:1842). The *1854 Treaty with the Chippewa* established the L'Anse Indian Reservation, containing approximately 59,000 acres of land (10 Stat., 1109:1854), primarily located in Baraga County at the base of Michigan's Keweenaw Peninsula. Legislation in 1934 created the Tribe's governing structure, including the council that is elected by Tribal members and tasked with the community's governance.

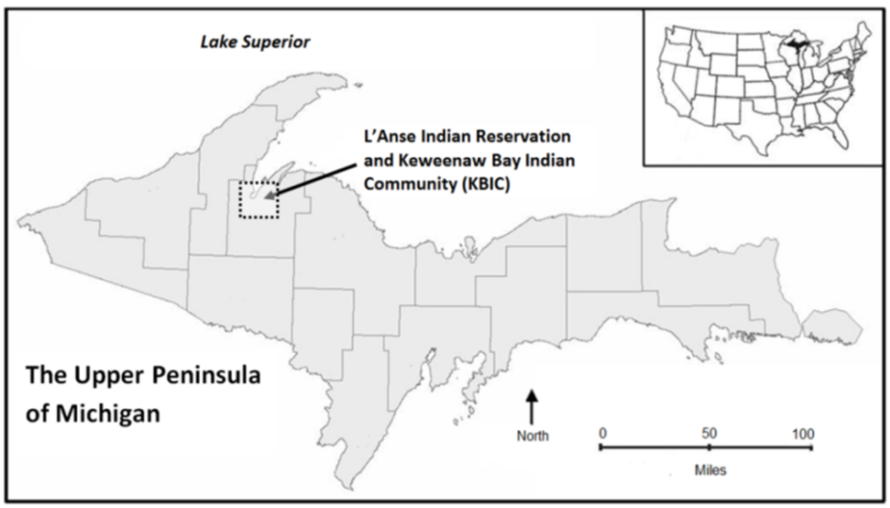

Figure 1. The L'Anse Indian Reservation in Michigan's Upper Penisula (Image: Kozich).

Resolution KB-016-2015, "To Establish a Climate Change Adaptation Initiative", was unanimously passed by Tribal Council in 2015. With this action the Tribe joined many others nationwide in recognizing that climate change poses substantial environmental, economic, cultural, and human health threats and that the development of mitigation and adaptation strategies is critical. The resolution instructs relevant Tribal departments to conduct a climate change vulnerability assessment as part of long-term planning initiatives and to advise Tribal Council on policy formulation. The resolution inherently addresses sovereignty and environmental justice through its concern for the natural resources to which the Tribe is guaranteed rights by the Treaty of 1842 (Gagnon, 2016). It also reflects the traditional "seventh generation" principle, in which decisions are made based on the knowledge of previous seven generations and with the utmost consideration of seven future generations (Gagnon, 2016).

[2] To align with community norms, Tribe, Tribal, and Tribal Council are capitalized in this article when referencing KIBC and are not capitalized when referencing other tribal nations or tribes in general.

The purpose of this study was to conduct quantitative survey research to provide insight to the Tribal Council as part of its climate change planning process, with a research team composed of Tribal college faculty and students, Tribal natural resource personnel, and university partners. An additional goal was to offer college students opportunities to enrich their educational experiences by contributing to the scholarly research process, earning internship credits and salaries, and making valuable contributions to their community. Building on previous qualitative findings (Kozich, 2016), our research objectives were to: 1) examine the community's awareness and understanding of climate change science; 2) synthesize opinions on potential ecological, economic, cultural, and human health impacts; and 3) assess support for various long-term planning strategies. Our rationale was that understanding community views is critical to policy formulation, and policy measures are likely to be effective only if supported by those they impact. Thus, the project was designed to simultaneously serve the community and enhance the scholarly literature involving Indigenous perspectives on climate change.

Methods

This research was led by full-time faculty and student assistants from the Keweenaw Bay Ojibwa Community College (KBOCC) Environmental Science department. Faculty previously conducted parallel interview-based research and gained community support for continued work. These steps ensured that we were trusted to continue interacting with the community and representing them in a good way as we conducted this work. A survey questionnaire and protocols were developed with insight from Michigan Technological University and Tribal Natural Resource Department partners. Students assisted with survey mailing, data entry, analysis, and public outreach.

In July 2016, we acquired a mailing list from the Tribal Enrollment Office containing names and addresses of all adult enrolled members residing in Baraga County. These 897 members served as our target population. We conducted a systematic random sample to select members to be mailed survey questionnaires (excluding Tribal Council members and individuals directly involved with the research project). The final list of survey recipients contained 370 names and addresses. Because the unit of analysis was the person and not the household, multiple individuals from the same household may have received (and completed) survey questionnaires.

The survey was carried out between July and September 2016, following established multiple-mailing protocols (Becker, 1998; Dillman, 1978). Survey packages for each mailing contained a cover letter, a questionnaire, and an addressed, pre-stamped return envelope. The only stimulus altered between the three mailings was the wording of the enclosed cover letter. No incentives were offered for completion of the survey. Nine survey packages were returned undeliverable (coded "non-contact"), resulting in an effective sample size of 361.

The 189 completed surveys yielded a response rate of 52.4%. Data were entered and analyzed using IBM's SPSS statistical software. Key demographic traits of respondents were fairly reflective of the target population (Table 1), including average age (44.8 versus 45.8), with 39.7% above age 55 (target population: 36.1%). Assigned gender distribution was 47.6% male and 52.4% female (target population: 48.5% male; 51.5% female). 51.3% of respondents lived in Baraga and 46.6% in L'Anse (target population: 56.8% Baraga; 42.0% L'Anse). In other instances, demographic attributes of the target population were unknown and therefore we cannot infer representativeness of our sample. For instance, 131 respondents (69.3%) completed a high school diploma or less and 112 (62.9%) reported an annual household income of $40,000 or less. Regarding political identification, 83 respondents (46.7%) described themselves as democrats, 67 (36.8%) as independents, and 23 (12.6%) as republicans. Most respondents were long-term residents, with 78.7% reporting having lived in the area for longer than 20 years.

Table 1
Demographic details of survey respondents (N=189 unless otherwise noted)

Category	Respondents (N)	% of respondents
Assigned Gender		
Male	90	47.6%
Female	99	52.4%
Town of residence		
Baraga	97	51.3%
L'Anse	88	46.6%
Other	4	2.1%
Years lived in Baraga County (total)		
10 or less	12	6.4%
11 to 20	28	14.9%
More than 20	148	78.7%
Size of home		
1 or 2 bedrooms	40	21.2%
3 bedrooms	110	58.2%
4 or more bedrooms	39	20.6%
Members of household		
1	25	13.2%
2	53	28.0%
3	36	19.0%
4	56	29.6%
5 or more	19	10.1%
Additional housing details		
Lives in Tribal housing	62	32.8%
Has air conditioning or central air in home	87	46.0%
Household annual income		
Less than $20,000	37	20.8%
$20,000 to $40,000	75	42.1%
$40,000 to $60,000	38	21.3%
$60,000 to $80,000	20	11.2%
More than $80,000	8	4.5%
Educational attainment		
Some high school	21	11.1%
High school diploma	110	58.2%
Some college	36	19.0%
Bachelor’s degree or higher	22	11.7%
Political identification (N=178)		
Republican	23	12.9%
Democratic	83	46.7%
Independent	67	37.6%

Most survey items were structured using 5-point Likert scales (1 = strongly disagree; 5 = strongly agree). For items asking respondents to rate their level of concern for various environmental topics, a 5-point ordinal scale was used (1 = not concerned; 5 = very concerned).

Table 2

Comparison of survey respondents and phone-contacted non-respondents

Demographic variable	**Respondents (N=189)**	**Non-respondents (N=15)**
Average age	48.4	47.4
Percent elder	39.7	40.0
Percent male	47.6	53.3
Most common educational attainment	H.S. diploma	H.S. diploma
Most common household income range	$20,000 to $40,000	$20,000 to $40,000
Percent democrat	46.7	43.9

We took several measures to test for non-response bias. Fifteen non-respondents were contacted by telephone and answered a sub-set of key survey questions. These individuals were similar across demographic variables to those who completed the mailed questionnaire (Table 2). Additionally, t-test examinations confirmed that their mean responses on the subset of survey items did not differ significantly from those who completed the mailed questionnaire. We then compared support for climate change planning based on survey response time, but no significant differences were found. As a final question for phone-contacted non-respondents, we asked why they did not complete the mailed questionnaire. The most common answers were that they “lost it” (40%), “did not see it in the mail” (33%), or “did not have the time to complete it” (20%); none remarked on the nature of the survey topic(s) in their reason as to why they did not complete the survey. Combined with our robust sample size and satisfactory response rate, these tests indicate that non-response bias does not exist and that findings are reliable and representative of the community as a whole.

Results

Analysis of survey results yielded important findings across four key thematic areas: 1) lifeways are intertwined with the environment, and environmental concern is high; 2) climate change is happening and is a major problem; 3) cultural values should be incorporated in planning; and 4) support for long-term planning is very high for both adaptation and mitigation measures. Findings from each theme are elaborated within the following sections.

Lifeways are Intertwined with the Environment, and Environmental Concern is High

The first section of the questionnaire contained broad questions intended to gauge respondents' general environmental values. We asked about participation in 13 specific outdoor activities to infer personal and cultural environmental connections. Ten of the 13 questions garnered participation from over 50% of respondents (fishing, swimming, boating, hunting, recreational vehicle use, camping, hiking, sight-seeing, gathering, and powwow attendance). Over 80% eat locally-harvested fish, wild game, berries, and maple syrup. More than two-thirds of respondents reported that they spend ten or more hours outdoors weekly. These findings indicate that outdoor activities are highly valued and that respondents are likely to personally observe environmental changes based on their degree of environmental engagement.

In another section we provided a list of 24 local environmental attributes that the literature indicates could be susceptible to negative impacts from climate change. Respondents were asked to rate their level of concern for these attributes in light of climate change. Using a 5-point ordinal scale (1 = not concerned; 5 = very concerned), the mean level of concern was greater than four for 20 of the 24 attributes listed. Table 3 lists respondents' concern for a sub-set of these attributes.

To test for internal consistency, we combined seven relevant item topics (air quality, water quality, lake levels, fisheries, wetlands, rivers and streams, and forests) into a multi-dimensional construct to assess respondents' overall level of concern for negative environmental impacts of climate change. The resulting Cronbach's alpha of .953 indicates an extremely high level of inter-correlations across these items and a degree of concern that is both deep and broad. Altogether these results indicate that respondents are very engaged with the environment, are well-positioned to notice changes, and through their concerns recognize many examples of potential negative impacts climate change could have on local environmental attributes.

Table 3
Climate change concerns for select environmental attributes (N=189)

Attribute	**Mean response***	**Std. deviation**	**Mode***
Water quality	4.57	0.864	5
Fisheries	4.46	0.855	5
Rivers and streams	4.45	0.907	5
Lake levels	4.42	0.888	5
Forests	4.38	0.842	5
Medicinal plant species	4.29	0.964	5
Sacred animal species	4.28	0.969	5
Wetlands	4.19	0.947	5
Traditional food sources	4.15	0.913	5
Hunting/game species	4.07	0.981	5

**1 = not concerned; 5 = very concerned*

Climate Change is Happening and is Major Problem

Respondents appear very aware of the existence and potential impacts of climate change. Ninety percent stated belief that climate change is happening, 92% reported personally observing changes in local weather patterns in their lifetime, and only 20% believe worries about climate change are exaggerated. Respondents were also generally clear on the causes of climate change with 80% reporting that it is human-induced and 60% identifying fossil fuel combustion as the leading cause. Trust in climate science was high, with 62% believing scientists understand the problem and 75% agreeing scientists should advise leaders on addressing it. However, trust in government efforts to combat climate change was low, with fewer than 18% believing politicians understand climate change and 9% agreeing that governments are doing enough to address it.

Based on previous findings among interviewees, the survey contained items asking respondents to indicate their level of concern for several non-ecological potential climate change impacts. Topics included human health, community infrastructure, heating/cooling costs, transportation costs, tourism-dependent businesses, and the Tribe's economy in general. Respondents expressed high and consistent concern for these potential impacts, regardless of threats that currently exist, indicating that perceptions of risk are widespread and encompass numerous contexts. The mean responses to all items in this section were greater than 4 on a 5-point scale (1 = not concerned; 5 = very concerned), with modes of 5 for all items (Table 4).

Table 4
Concern for potential non-ecological impacts of climate change (N=189)

Concern area	**Mean response***	**Std. deviation**	**Mode***
KBIC economy in general	4.30	0.911	5
Extreme weather events	4.26	1.006	5
Heating/cooling costs	4.23	0.895	5
Human health	4.15	0.999	5
Transportation costs	4.11	0.947	5
Community infrastructure	4.10	0.914	5
Tourism-dependent businesses	4.06	1.014	5

**1 = not concerned; 5 = very concerned*

The questionnaire contained several items related to indoor air quality, as air quality can decrease as ambient temperature increases. Over half of respondents (54%) reported that they live in homes without air conditioning or central air; under warming conditions these residents would be susceptible to increased problems related to mold, insects, humidity, and other threats that could compromise their health and comfort. Many reported already experiencing these problems. When asked to describe current conditions inside their homes, 68% of respondents stated that their home is already too difficult or expensive to keep cool during the summer. These findings should be particularly concerning, because many community members appear ill-equipped to adapt to climate change without substantial investments in housing improvements (as has already been noted through home inspections by Tribal departments). This is another example of environmental justice issues facing Indigenous communities; compared to affluent households, many residents could be at risk from heat-related issues because they lack the resources to adapt through home improvements.

Cultural Values Should be Incorporated in Planning

Across numerous survey items, respondents consistently expressed concern for climate change disrupting links between traditional culture and the environment. In response to separate questions, over 95% of respondents agreed that Anishinaabe cultural opportunities are important to maintain, cultural identity needs to be maintained in the community, and that culture is intertwined with the environment. Concern specifically for future generations of community members, a traditionally-sacred value, was well-expressed. Over 96% agreed that the Tribe needs to ensure a healthy environment for future generations, and 87% of respondents ranked concern for future generations in light of climate change as either 4 or a 5 on the 5-point scale.

Respondents articulated tremendous support for incorporating Anishinaabe culture in long-term climate change planning (Table 5). We asked respondents to rate their level of support for various policy measures the Tribe could potentially adopt. Over 90% supported prioritizing the survival of sacred plant and animal species in planning and managing forests and fisheries specifically to prepare impacts of climate change. Over 82% strongly supported the creation of a group of Tribal specialists to advise the Tribal Council in planning. Over 88% supported ensuring that traditional Anishinaabe knowledge has a key role in climate change planning.

Table 5
Support for climate change adaptation and mitigation measures (N=189)

Adaptation measures	**Percent support**	**Mean response***	**Mode***
Focus on ways to adapt to climate change	88.4	4.29	5
Manage forests to prepare for environmental change	90.5	4.49	5
Manage fisheries to prepare for environmental change	90.4	4.52	5
Prioritize the survival of sacred plant and animal species	89.4	4.52	5
Prepare for possible human health impacts	89.4	4.41	5
Mitigation measures			
Focus on ways to reduce human influence on climate change	85.2	4.28	5
Create initiatives for environmentally-friendly energy sources	91.5	4.61	5
Increase locally-grown food sources	89.3	4.44	5
Increase the availability of public transportation	74.0	4.12	5
Invest in home efficiency improvements for KBIC members	95.2	4.60	5
Offer incentives for reductions in energy use	91.5	4.54	5

**1 = strongly oppose; 5 = strongly support*

Support for Long-Term planning is Very High for Adaptation and Mitigation Measures

We asked two summary questions about Tribal leaders taking steps to address climate change. In response to the first item, over 86% supported the Tribe taking "as many steps as needed to address climate change in long-term planning." To test for consistency, a second item was reverse-structured and assessed support for the Tribe taking "no action at this time." Only 7.9% of respondents supported the no-action option. Respondents appear clear in their support for leadership action.

Respondents expressed strong support for a range of potential mitigation and adaptation strategies. We first asked respondents to rank their level of support through general statements such as "focus on ways to reduce human influence on climate change" and "focus on ways to adapt to climate change." Following each of these broad statements, a sub-set of additional items asked respondents to rate their support for specific actions, such as adopting alternative energy sources, and preparing for human health impacts. As Table 5 shows, respondents articulated strong support across all potential policy emphases, including adaptation and mitigation strategies. Respondents' support for the specific examples listed agreed with their support for the Tribe taking "as many steps as needed to address climate change."

Discussion

Our findings agree with previous work finding Indigenous communities to be very aware of and concerned about climate change (Cave et al., 2011; Ford, 2008; Kozich, 2016; Plummer et al., 2009; Smith et al., 2014). Our first key objective was to describe climate change perceptions among KBIC members; survey findings show a very high degree of awareness and the belief that it is already happening in the area. The finding that 90% of respondents believe climate change is happening is likely related to personal observations, considering the high degrees of outdoor recreation reported by respondents and the claim by 92% of respondents that they have personally observed changes in weather patterns during their lifetimes. These findings augment previous qualitative research in the community that contained in-depth stories and examples by interviewees about substantial environmental changes observed in the area (Kozich, 2016). Our findings also agree with previous studies concluding that Indigenous peoples tend to have a fuller awareness of the human causes of climate change compared to the U.S. public as a whole (Smith et al., 2014; Vaidyanathan, 2015). However, while 80% of our respondents believe human activities are causing climate change, only 60% identified fossil fuel emissions as the leading driver, indicating a possible need for educational outreach in the community to build support for some mitigation strategies the Tribe may choose to adopt.

Our second objective was to gain insight on perceptions of how climate change could potentially impact lifeways. Respondents expressed substantial concern for a wide range of negative impacts. Their high engagement in outdoor activities, including recreational and traditional cultural activities and sustenance harvesting, demonstrates that links between culture and the environment remain strong. Respondents identified potential threats to water resources, sacred plant and animal species, and traditional activities such as fishing and gathering. They also made astute links between climate change and numerous other facets of daily life that could be described as non-ecological and non-cultural, including human health, community infrastructure, tourism, and the Tribal economy in general. The potential impacts identified by respondents largely mirror those that scientists anticipate occurring in the region in the future (Melillo et al., 2014; Pryor et al., 2014; Schramm & Loehman, 2010). Interviewees in previous research in the community identified a similar range of potential impacts, but a higher proportion of survey respondents expressed concern for these impacts (Kozich, 2016).

Our final objective, perhaps relating most critically to future policy initiatives, was to assess support for long-term climate change adaptation and mitigation strategies in the community. Previous interview research found substantial interest in mitigation strategies, such as the development of wind and solar energy sources, with few mentions of adaptation strategies beyond the management of forests and fisheries in anticipation of environmental changes (Kozich, 2016). Survey respondents, by comparison, expressed strong support for adaptation strategies. Perhaps the focus on mitigation strategies by previous interviewees resulted from the fact that interview questions did not provide examples of possible policy actions, and interviewees gravitated towards familiar, visible actions such as the installation of solar panels or wind turbines (Kozich, 2016). Survey respondents, by comparison, were provided 12 specific examples of adaptation actions to consider, perhaps enlightening respondents on the variety of possible actions that would better-prepare the community for a changing climate. Regardless, Tribal leadership will benefit from knowing that all potential policy measures posed in the survey garnered strong and near-equal support among respondents.

Tribal leadership should also note that respondents expressed strong support for the involvement of scientists, collaboration across Tribal departments, and the development of community outreach programs to increase climate change awareness. Findings support the notion that traditional knowledge should play a role in planning. If the Tribe adopts policy actions, leaders will need to incorporate expected environmental changes into the management objectives of many departments besides natural resources, including housing, health, education, and public works. Many specialists will need to be involved. Based on survey findings showing respondents to be supportive of all potential policy actions listed in the questionnaire, leaders can be confident that their actions will largely be supported by those they affect.

Conclusion

The ability of KBIC leaders to take action on climate change reflects an assertion of sovereignty through self-management on critical issues. Although climate change is a global phenomenon, many jurisdictions are taking policy steps on their own in light of limited federal government action. The Tribe has the opportunity to join several other proactive tribes across the U.S. in the implementation of policy measures to minimize human influence on climate and prepare for inevitable impacts of it. In previous research, community members provided statements suggesting that Indigenous knowledge can lead the way on the important issue of climate change, and survey findings support that view (Kozich, 2016).

This work provides valuable insight at numerous scales. Building on previous qualitative research, survey findings provide robust quantitative data to confidently advise the Tribal Council on matters involving long-term climate change planning. Nationally, other Indigenous communities can benefit from Tribal perspectives as they consider adopting their own climate change strategies. As Great Lakes Indigenous communities are largely underrepresented in the scientific literature on climate change, our findings address a knowledge gap that follow-up work in other regional tribes can continue to fill to enhance recent inter-tribal efforts (Inter-Tribal Council of Michigan, 2016; Tribal Adaptation Menu Team 2019; White et al, 2014). Action on climate change requires international effort, but community-level actions, such as those being considered by the KBIC can serve as an example to create culturally-relevant and tribally specific policies for many Indigenous communities.

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The Effect of a Life Skills Curriculum on the Problem-Solving Abilities of Tribal College Students

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Enhanced Life Skills of tribal college students were examined to determine the effect on problem solving abilities. First time college freshmen students in both groups of a Life Skills and a non-Life Skills class were administered the Social Problem-Solving Inventory-Revised as a pre and posttest survey to measure changes in these abilities. This study confirmed the significance of Life Skills on the problem-solving abilities of tribal college students. Life Skills can provide students with a positive attitude of self-esteem and increase problem-solving abilities, thus providing them with the adaptive behavior to make rational decisions associated with functional problem solving.

Keywords: American Indian Life Skills, tribal college students, problem-solving abilities

Tribal colleges serve a population of students with unique histories and cultures. Many Native American students exhibit maladaptive behaviors in problem solving as a result of the historical trauma faced by their ancestors who were subjected to the United States' policies of assimilation and boarding schools (Lomawaima & McCarty, 2006). The purpose of this study focused on the modified implementation of American Indian Life Skills Development Curriculum lessons, created by LaFromboise (1996), into the Fall 2016 Orientation ORIE 1011 College Cornerstone course at a tribal college and university (TCU) located in the Midwest. Problem solving is a cognitive response of adaptive functioning to define problems, generate alternative solutions, decide, and act. Problem-solving abilities utilize a person's positive problem orientation and rational problem-solving behaviors, while diminishing negative problem orientation, impulsivity/carelessness style, and avoidance style behaviors as measured by the Social Problem-Solving Inventory - Revised (SPSI-R) survey instrument (D'Zurilla, Nezu, and Maydeu Olivares, 2002). According to D'Zurrilla and colleagues (2002), problem-solving ability contributes to social competence and psychological well-being, which enhances a person's ability to resolve everyday problems. Researchers have formally defined this ability as social problem solving, which is a self-directed cognitive behavioral process that a person uses to discover effective or adaptive solutions for everyday problem situations (D'Zurrilla et al., 2002).

Another common term for problem-solving abilities is life skills, which was defined by the World Health Organization (WHO) (1999) as the abilities for adaptive and positive behavior that enables individuals to effectively meet the challenges of everyday life. The problem-solving process is the act of realization of a solution which can be generalized for most problem situations (D'Zurrilla et al., 2002). Solutions are coping responses as a result of the problem-solving process (D'Zurrilla et al., 2002). An effective solution is described as one that achieves the desired goal with minimal negative consequences.

A study of first-time college students' success towards completion indicated that many students not only had difficulty in finding solutions to problems but were underprepared for college level course work (Greene, 2012). The issue of underprepared students became compounded when students were not only deficient in the course content, but also lacked basic life skills essential for success in college. Many students came to the institution underprepared for the critical thinking aspect of college level work due to their lack of life skills such as problem-solving abilities, particularly at open admissions colleges (Greene, 2012; Koruklu, 2015). Without the necessary problem-solving skills, many of these students were unaware of college procedures and resources that could assist them in successfully completing college.

Several studies have investigated the benefits of utilizing life skills lessons that include self-esteem and problem-based learning in developmental education (Germano, 2007; WHO, 1999). One particular study by Germano (2007) recommended that life skills be incorporated into an orientation course to acclimate first-time freshmen to the rigor of college courses and to provide support services. According to WHO (1999), every educational system has a duty to support the development of life skills in order for students to effectively function within the social and economic demands of society.

Research has indicated that the first-year college experience can have a major effect on student development and persistence towards graduation (Engstrom & Tinto, 2008; Tinto, 1993). The first six weeks of the first college year were the most critical for retaining first-year students as they struggled to adapt to a new environment and academic challenges (Engstrom & Tinto, 2008; Tinto, 1993). However, the difficulty lies in that life skills were not a standalone teaching subject and educators must integrate life skills in already established teaching processes (WHO, 1997). Contextualized curriculums utilizing real world problems faced in everyday college situations would benefit students' adaption to higher education.

Problem solving has historically been underemphasized in the assessment of a student's ability to be successful in an academic setting (Corda, 1991). However, examples of real-world problem solving occurred as Rotter (1966) suggested that those with a higher perception of self-confidence in their ability to control other aspects of their environment tend to be better problem solvers. Two of the most important problem-solving attitudes that affect a person's success were self-esteem and self-confidence (Gomes & Marques, 2013). Gomes and Marques (2013) examined the effects of a life skills training program on students' life skills and self-confidence expectations about academic achievement. The researchers indicated that students who received life skills interventions reported a tendency to be more optimistic and had higher expectations about academic achievement. In contrast to having self-confidence, TCU students with minimal life skills education lack problem-solving abilities and have difficulty being successful in higher education (Mainor, 2001). In order to support self-esteem and self-confidence, LaFromboise (1996) identified a need to develop a model for American Indian Life Skills Development Curriculum to introduce the population to strategies such as problem-solving skills to battle an epidemic of youth suicides among southwestern tribal school students. The Life Skills curriculum was crucial for bridging the gap between the disparities in problem-solving abilities and student success as defined as retention and completion for TCU students. The next sections will present a review of the literature that includes Native American historical trauma, Life Skills, and problem-solving followed by the methodology of the research, results and recommendations.

Review of the Literature

The review of the literature begins with a brief overview of the concept of Native American historical trauma which lends to the disparities of self-efficacy in this population. Key concepts focused on within this research include generational trauma, self-esteem, and dysfunctional behaviors. The Life Skills curriculum was discussed to introduce the intervention utilized in this study as the independent variable to address the generational trauma of low self-esteem. Problem-solving abilities were identified as the dysfunctional behaviors associated with historical and generational trauma of Native Americans and was the dependent variable of the study that was measured by a survey instrument.

Native American Historical Trauma

The impact of historical trauma on the Native American community has manifested in multiple challenges. Some of the challenges include loss of land related to economic disparities, a disruption in family continuity, and loss of languages. Historical trauma has been passed from generation to generation through extended family-child interactions and includes symptoms of poor emotional tolerance, psychic numbing, substance abuse, and depression (Brave Heart & DeBruyn, 1998; Evans-Campbell, 2008; Hawkins & La Marr, 2012).

Historical trauma was not exclusive to, but has been attributed to, the Native American boarding school era, which was one of the most devastating policies of the United States government specific to this population. It was the belief of the Bureau of Indian Affairs that Native American children would learn to be self-sufficient participants in the larger society if they were reared away from their homes in residential schools (Evans-Campbell, 2008, Tucker, Wingate, & O'Keefe, 2016). The Native American boarding school program, which began in 1879 and continued into the 20th Century, forcibly separated children as young as 5 years old from their families and sent them away for many years under the premise of promoting education, spiritual conversion, and other forms of settler-defined civilization (Grayshield, Rutherford, Salazar, Mihecoby, & Luna, 2015; Noel, 2002).

In boarding schools, Native American children were often harshly punished for speaking their language or practicing any of their tribal customs. During these events, traditional Native American parenting practices were severely compromised. Not only were these children denied the opportunity to be taught natural ways of living, they were also denied ongoing contact with their loved ones and opportunities to be nurtured through traditional childrearing practices. Sometimes children were welcomed by family members and sometimes after the separation and loss of language and culture family members did not know how to relate to them (Evans-Campbell, 2008). Disruptions in family living have produced generations of Native American parents with a sense of uncertainty about how children should be raised (Evans-Campbell, 2008). The effects of historical trauma on Native American people resulted in several disparities in their lives such as low self-efficacy towards resiliency causing low self-esteem. This study demonstrated that a Life Skills curriculum enhanced those deficient skills by providing a cultural protective factor. The next section introduces the framework for the Life Skills curriculum utilized for TCU students.

Life Skills Curriculum

A life skills curriculum that utilized a new paradigm for a specific cultural group was the American Indian Life Skills Development Curriculum (LaFromboise, 1991). The research was later developed and implemented as a culturally appropriate Life Skills curriculum for southwestern tribal school students (LaFromboise & Howard-Pitney, 1995). According to LaFromboise (1991) the community had experienced a high percentage of suicides and suicide attempts during the 1980s compared to the mainstream society. LaFromboise (1996) introduced an experimental research design in which the experimental group received the Life Skills curriculum while a control group did not receive the treatment. The hypothesis suggested that the experimental group would have better results in suicide prevention and problem solving than the control group. The study reported significant differences between the two groups regarding suicide probability, hopelessness, and depression at posttest (LaFromboise & Howard-Pitney, 1995). While the results did not indicate a posttest difference for problem-solving skills, behavioral observations did indicate better results with the students who received the curriculum than those who did not. The researchers concluded a cultural reasoning for this occurrence was that students may have reported lower scores for skills as a result of cultural humility which is a tendency to self-report lowers scores of confidence.

Low self-esteem among low-income ethnic groups encourages high risk behaviors which further contributes to destructive behavior among youth (LaFromboise, 2006). The American Indian Life Skills Development curriculum was a school-based, culturally sensitive, suicide-prevention program for American Indian adolescents. The curriculum was tailored to American Indian norms and values and was designed to reduce behavioral and cognitive factors associated with suicidal thinking and behavior. The curriculum was structured around 7 major units: "(a) building self-esteem, (b) identifying emotions and stress, (c) increasing communication and problem-solving skills, (d) recognizing and eliminating self-destructive behavior such as pessimistic thoughts or anger reactivity, (e) receiving suicide information, (f) receiving suicide intervention training, and (g) setting personal and community goals" (LaFromboise, Howard-Pitney, 1995, p. 481).

In order to assist student adjustment to college life, a study by Holland (2005) reported that over the last century, community colleges have adapted to the societal needs of its constituents. Many students enrolled at community colleges are the first in their family to attend higher education (Holland, 2005), and many community college students have low academic skills (McConnell, 2000; Schuman, 2005). Such academic challenges are attributed to both the lack of preparedness by the public school system and the experience of being first generation college students navigating an unfamiliar space with little guidance (Holland, 2005). In an effort to better support students who may be at-risk of not completing college, many colleges have created academic programs that incorporate life skills to support the needs of its students. However, there continued to be a need for more innovative approaches that could also be used as social strategies to assist with students' needs other than academics.

Life skills training has been described as one of the best-known programs to target the risk and protective factors of drug use by promoting social skills, personal self-management skills, and drug resistance skills (Botvin, Baker, Dusenbury, Botvin, & Diaz, 1995, Wurdinger & Rudolph, 2009). A decision-making skills measure of a study by Vicary and colleagues (2006) used five items that assessed the participant's ability to follow a logical decision-making strategy (get the information needed to make the best choice, make the best choice, and then do it, etc.). The results of the study showed that the life skills training program improved decision making, communication skills, coping skills, normative beliefs, attitudes, and assertiveness skills (Allen & Williams, 2012; Kivunja, 2015; Vicary et al., 2006). Skills such as decision making, communication, and assertiveness are a vital part of the problem-solving process.

Problem Solving

Samson (2015) indicated that creative problem solving was a teaching method that utilized student engagement to find answers to life's real world problems. An aspect of the creative problem-solving teaching method was self-directed learning (Samson, 2015). Motivation was also associated with this, in which the students took a more active role in their education by formulating goals, identifying resources, implementing strategies, and evaluating outcomes (Samson, 2015).

The term social problem solving was described by D'Zurrilla and colleagues (2004) as a process of solving problems in the real world environment. The social problem-solving model was identified as the most researched and assessed model through an instrument (Social Problem-Solving Inventory-Revised) that measured problem-solving abilities. The term social did not intend to limit the study of problem solving, but to qualify the adaptive functioning in a real-life social environment. As stated in the natural environment, problem solving was defined as the cognitive behavioral process whereby an individual identifies an effective solution for a specific problem encountered in everyday life. Problem solving was originally designated as either the concept of solving the problem or the solution implementation. However, the two processes were found to be different. Further research has concluded that problem solving refers to the process of finding solutions and solution implementation was the process of carrying out the performance. Furthermore, D'Zurrilla and colleagues (2004) redefined the model to include a five-factor model with two problem orientations and three problem-solving styles. The two problem orientations were identified as positive (adaptive functioning) and negative (maladaptive functioning). The three problem-solving styles were rational problem solving (effective problem solving), impulsivity/carelessness style, and avoidance style (dysfunctional problem solving). D'Zurrilla and colleagues (2004) also asserted that in research and practice it was important to not only assess problem-solving abilities, but to also define the strengths and weaknesses of each component.

Methodology

The review of the literature covered Native American historical trauma and how the impact of policies to educate and assimilate this population actually created the disparities of education seen today. The literature indicated this trauma was transferred from generation to generation and is reflected in the maladaptive problem-solving functioning. In response to the effects of historical trauma of Native Americans, a Native American Life Skills Development Curriculum was created as described in the Life Skills section of the literature review (LaFromboise, 1996). Specifically examined, was the students' abilities in the following key areas: positive problem orientation, negative problem orientation, rational problem solving, impulsivity/carelessness style, and avoidance style. In this research, the study group consisted of students in a freshmen orientation course who were administered a pre-and posttest SPSI-R instrument.

Research Questions

Aligned with the goals stated above, this study sought to answer the following research questions:

1. Is there a change in problem-solving skills from pretest to posttest for tribal college students who received the American Indian Life Skills Development Curriculum (Life Skills Curriculum) in a freshman orientation course at a TCU?

2. Is there a change in problem-solving skills from pretest to posttest for tribal college students who did not receive the American Indian Life Skills Development Curriculum (Life Skills Curriculum) in a freshman orientation course at a TCU?

In this study, one group of students received the Life Skills curriculum administered by the TCU, while another group did not. The independent variable was the Freshman Orientation course curriculum with two levels: those freshmen whose introductory course included the Life Skills Curriculum and those freshmen whose introductory course did not change from its previous structure. Table 1 shows the dependent variable was problem-solving abilities. The Life Skills curriculum was adapted from the American Indian Life Skills Development Curriculum book by LaFromboise (1996). The Life Skills curriculum was integrated into the regular curriculum of the Life Skills group's orientation classes.

Table 1
Variables of the Study

Group	Independent Variable	Dependent Variable
Life Skills	Orientation curriculum + Life Skills	SPSI-R Instrument Pre and Post Test
Non-Life Skills	Orientation curriculum	SPSI-R Instrument Pre and Post Test

Variables

In this study, one group of students received the Life Skills Curriculum administered by a TCU, while another group did not. The independent variable was the Freshman Orientation course curriculum with two levels: those freshmen whose introductory course included the Life Skills Curriculum and those freshmen whose introductory course did not change from its previous structure. The dependent variable was problem-solving abilities. The target population for this study was all students who were enrolled in each of the four sections of the Freshmen Orientation course during the Fall 2016 trimester at a TCU. As designated by the TCU, first time students are required to enroll in the orientation course. The four sections of the orientation course were taught during the Fall 2016 trimester to determine the effect of the Life Skills curriculum on problem-solving abilities. Orientation sections 02 and 03 were selected to use the Life Skills curriculum because all lessons were held in class. Whereas, sections 01 and 04 received the non-Life Skills curriculum because some class sessions were provided online and out of class due to scheduled holidays according to the fall academic calendar.

Each course section received the pre-and posttest survey instrument to measure the effect of the independent variable on students' problem-solving abilities. First-time freshmen students were advised by the TCU staff to enroll in the orientation course, but each student determined the section he or she enrolled in according to his or her schedule. The groups had homogenous characteristics, which included the following traits: students were in the first-time freshman cohort, Native American, average age of early 20s, and similar education levels (i.e. high school graduates) as verified by academic records.

Instrument

As a cross-sectional questionnaire, the SPSI-R was a self-report instrument that measures a person's ability to solve everyday problems. The questionnaire designer utilized exploratory and confirmatory factor analyses that led to the 52-item Likert-type response question instrument (D'Zurrilla et al., 2002). A 5-point response scale with a textual response continuum format ranging from "not at all true of me" (0) to "extremely true of me" (4) was used to identify the participant's problem-solving abilities. The questionnaire covered five key areas of problem solving: Positive Problem Orientation (PPO), Negative Problem Orientation (NPO), Rational Problem Solving (RPO), Impulsivity/Carelessness Style (ICS), and Avoidance Style (AS). The scoring system utilized a total score of all key areas.

According to D'Zurrilla and colleagues (2002), the SPSI-R assessed two constructive problem-solving areas (PPO and RPO) and three dysfunctional problem-solving areas (NPO, ICS, and AS). The SPSI-R has a large normative sample (N = 2,312), required a fourth-grade reading level, and is appropriate for males and females 13 years of age and older. The instrument measured maladaptive/adaptive functioning with an analysis of the total score. A lower score indicated maladaptive functioning such as psychological distress, poor interpersonal relationships, inadequate or ineffective performance, and self-defeating behaviors. Higher scores indicated adaptive functioning such as psychological well-being, good interpersonal relationships, adequate or effective performance, and self-enhancing behaviors.

The instrument originators conducted two forms of reliability tests for the SPSI-R, internal consistency and test-retest reliability (D'Zurrilla et al., 2002). Both tests of reliability were measured with four normative samples being: a) adolescents; b) young adults, c) middle-aged adults, and d) elderly adults. All five areas of the SPSI-R demonstrated adequate internal consistency (alpha) scores throughout the four samples. The test-retest reliability measures were taken from two subsamples over: a) 3-week period and b) 6-week period. The test-retest measured adequate (Pearson r) scores suggesting a stable instrument.

The validity of the instrument has been verified for structural, concurrent, predictive validity, and convergent and discriminant validity (D'Zurrilla et al., 2002). The structural validity has been measured with two separate samples using confirmatory factor analysis. The concurrent validity was measured with an assessment between the SPSI-R and the Problem-Solving Inventory created by Heppner and Peterson (1982). The predictive validity was evaluated by examining the relationship between the SPSI-R and measures of psychological distress. Finally, convergent and discriminant validity were determined by evaluating the relationship between SPSI-R and constructs that were believed to be related to and overlap with social problem solving to avoid redundancy.

Results

Two of the four Freshman Orientation courses at a TCU during the Fall 2016 trimester received the American Indian Life Skills Development Curriculum lessons. All four course sections were administered a pre-and posttest SPSI-R. The study sample included a total of 47 students enrolled in one of four Freshmen Orientation sections. Each student took the SPSI-R survey as a pretest during the first week of the trimester and then again as a posttest during the fifteenth week. The surveys were self-scoring instruments designed to provide raw scores for the two problem orientation key areas and the three problem-solving style key areas. The raw scores for these key areas were then summed to calculate the Total SPSI-R score which indicates problem-solving abilities.

A paired sample *t*-test was utilized to compare the change in SPSI-R Mean Scores from pretest to posttest for each group. Sections One and Three were taught using the Life Skills Curriculum while

Sections Two and Four received the existing curriculum. For each analysis, an alpha level of .05 was used. Results from the paired sample *t*-test were displayed in Table 2.

Table 2
Paired Sample T-Test Results for Change from Pretest to Posttest for Each Group

Group	**Mean Change**	**SD**	**SE**	**T**	**df**	**Sig. (two-tailed)**
Life Skills	6.35	8.76	1.96	3.24**	19	.004
Non-Life Skills	.19	11.70	2.25	.08	26	.935

$^{**}p < .01$

The Life Skills group Total SPSI-R mean score increased from pretest to posttest by 6.35 points, while the non-Life Skills group Total SPSI-R score increased from pretest to posttest by 0.19 point. The Life Skills group's mean change indicated a statistically significant increase in the Total SPSI-R mean score ($p < .01$). Results from the paired sample *t*-test indicated a significant difference between the Total SPSI-R mean scores from pretest to posttest for the Life Skills group. There was not a significant difference between the Total SPSI-R mean scores from pretest to posttest for the non-Life Skills group.

Summary of SPSI-R Statistics

The study was designed to first determine whether there was a significant difference in the pre-and posttest Total SPSI-R mean scores for both the Life Skills group and the non-Life Skills group. Results from the paired sample *t*-test indicated a significant difference in the Total SPSI-R mean scores from pretest to posttest for the Life Skills group at the .01 level of confidence. However, results from the paired sample *t*-test did not indicate a significant difference in the Total SPSI-R mean scores from pretest to posttest for the non-Life Skills group.

Results from this study suggested the importance of having a Life Skills curriculum embedded in the curriculum of an ongoing college course (WHO, 1999). The Native American Life Skills Development Curriculum was embedded into the curriculum of the Freshmen Orientation course for 15 weeks during the Fall 2016 trimester at a TCU. Greene (2012) asserted that supplemental life skills training is needed to assist underprepared college students at open admission institutions. As a result of the effects of historical trauma, Native American populations have higher disparities from the general population in education, physical and behavioral health, and economic status (Brave Heart & DeBruyn, 1998). Because of the effects of historical trauma, some Native Americans required a culturally appropriate life skills curriculum to increase self-worth, community engagement, and problem solving (LaFromboise, 2006). The Native American Life Skills Development Curriculum utilized life situations recognizable to the tribal population it served (Koruklu, 2015; LaFromboise, 2006). As a result, TCU students received culturally sensitive Life Skills lessons that increased their problem-solving abilities.

Social problem solving is the process by which a person develops adaptive behavior to overcome problematic situations in everyday life social environment (D'Zurilla et al., 2002). Students who received the Life Skills curriculum were given tools to enhance their cognitive abilities, which in turn enhanced their self-esteem, ability to control emotional stress, communication and problem-solving skills, techniques to avert self-destructive behaviors, and vision to plan for the future.

The social problem-solving model was comprised of two general, partially independent components of abilities: problem orientation and problem-solving style (D'Zurrilla et al., 2002). Problem orientation was made up of two aspects: positive problem orientation and negative orientation. Problem-solving style was made up of three aspects: rational problem solving (adaptive functioning), and impulsivity/carelessness style and avoidance style (both maladaptive functioning) (D'Zurrilla et al., 2002). The Life Skills lessons were connected with the problem-solving instrument as self-esteem referenced a positive orientation and managing emotional stress limited the negative orientation. In addition, communication and problem solving contributed to a rational problem-solving model, while preventing self-destructive behaviors sought to eliminate impulsivity/carelessness. Finally, planning for the future intervened the avoidance style.

The Life Skills group created real life problem situations in which resiliency was strengthened in students by increasing self-esteem, engaging community involvement in the classroom, and developing problem-solving abilities. Wismath, Orr, and Good (2014) suggested that students needed to learn how to think, how to learn, and how to cope with changing situations. Methods included lessons created from shared experiences of the students such as cultural practices for healing and cleansing the mind and body. Teaching such life skills can be integrated into every aspect of the curriculum through problem based learning methods that include inviting student input in lesson planning, integrating peer tutoring into the learning process, and applying knowledge to real life problems (Cobo, 2013).

Conclusion

The effect of a Life Skills curriculum on the problem-solving abilities of tribal college students was the focus of this study. The results indicated the Life Skills curriculum had a positive effect on the problem-solving abilities of students enrolled in the two course sections that received the Life Skills curriculum. The curriculum was integrated into the course through a social constructivist approach by creating lessons based on life experiences (Vicary et al., 2006). The Life Skills curriculum increased the Total SPSI-R scores, which measured problem-solving abilities as a culmination of problem orientation and problem-solving style (D'Zurrilla, 2002). One of the non-Life Skills course sections increased its Total SPSI-R score only slightly and the other did not increase at all.

The Life Skills group pretest mean Total SPSI-R score was 4.63 points below the non-Life Skills group pretest mean Total SPSI-R score. Conversely, the Life Skills group posttest mean Total SPSI-R score was 1.53 points higher than the non-Life Skills group posttest mean Total SPSI-R score. The non-Life Skills group Total SPSI-R mean score increased by only 0.19 points. The students who did not receive the Life Skills curriculum maintained an average level of adaptive and functional behaviors of problem-solving abilities. However, the Life Skills group increased Total SPSI-R mean scores by 6.35. With the Life Skills curriculum, the students in this group increased their adaptive and functional behaviors, thereby increasing their problem-solving abilities.

The Life Skills curriculum demonstrated an effective positive increase in problem-solving abilities in students by strengthening the skills needed to make rational decisions. In addition, the curriculum was effective in reducing students' trends of poor decision-making. Overall, the Life Skills curriculum helped students reduce the negative aspects of problem-solving orientation and had a positive impact on the students' progress towards adaptive problem-solving abilities.

Recommendations for Practice

The following are recommendations for practice based on the conclusions and results of this study.

1. The negative problem orientation and impulsivity/carelessness style and avoidance style should be targeted as a primary area to be strengthened with students at-risk of not completing college in order to perpetuate success in college completion. Noting the positive increase in problem-solving abilities as a result of decreased negative orientation and maladaptive problem-solving styles in this study, it was important to focus on those two negative areas.
2. The study supported the positive relationship between Life Skills and problem-solving abilities. An increase in positive problem orientation and the rational problem-solving style increased the student's abilities to problem solve. It was useful to continue to encourage students to use positive self-talk and work through the steps of rational problem solving, which are: Stop—identify the problem; Options—generate alternative solutions; Decide—decision making, and; Act—solution implementation.
3. As demonstrated by the results of the study and as confirmed by Greene (2012), the Life Skills curriculum should be embedded into the curriculum of open admission institutions from orientation to completion. General Education courses that provide a foundation for core and specialization courses would provide the skills for decreasing maladaptive and dysfunctional behaviors. Exit level courses could provide real world situations to demonstrate positive problem orientation and rational problem solving.

Recommendations for Further Research

Further research was justified in order to strengthen existing studies and to identify more effects of life skills and other factors contributing to the enhancement of students' problem-solving abilities. The following are recommendations for further research based on the results of this study.

1. This study focused on the Freshmen Orientation course for the Fall 2016 trimester. Further research is needed on the longitudinal effects of the Life Skills curriculum on the freshmen cohort.
2. This study used the SPSI-R survey instrument to measure the problem-solving abilities of the students. Further research is needed to study solution implementation through a qualitative behavioral observation to support the effectiveness of life skills education.
3. Considering the disparities faced by low income and minority students attending open admission institutions, further research is needed to measure the effectiveness of life skills embedded throughout the entire program of study.

Higher education institutions, particularly those with open admission policies, have faced the issues of student populations who enter higher education underprepared for the rigors of college level work. These issues were complicated further when underprepared students also lacked the life skills to overcome the obstacles experienced in everyday life situations. This study confirmed increased problem-solving abilities of TCU students who received an embedded Life Skills curriculum. The Life Skills group had a significant increase in problem-solving abilities as measured by their Total SPSI-R scores. This study indicated a need, based on improved problem-solving abilities, to reinforce life skills that enhance positive adaptive and functioning behaviors, which in turn empower students to overcome problems faced in everyday life situations.

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Wurdinger, S., & Rudolph, J. (2009). A different type of success: Teaching important life skills through project based learning. *Improving Schools, 12*(2), 115-129.

Author Biography

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The Pathway to Chemical Literacy: A Resource Guide of Chemistry Courses at Tribal Colleges and Universities

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We surveyed the 38 Tribal colleges and universities (TCUs) for their chemistry courses, textbooks, and laboratory manuals searching for indigenized chemistry curricula. Thirty of the TCUs offered an introductory sequence of general chemistry, organic and biochemistry courses we identified only one indigenized laboratory manual, Turtle Mountain Community College's RISE Experiments, which was developed by students and Tribal faculty in North Dakota. To meet our needs at the two TCUs in Nebraska, we produced an indigenized chemistry laboratory for a two-semester general chemistry, organic, and biochemistry course sequence. TCUs building or revamping their chemistry programs may find our survey information useful.

Keywords: Chemistry, Indigenized Chemistry Curriculum, Textbooks, Lab Manuals

Introduction

This article summarizes the chemistry offerings at Tribal colleges and universities (TCUs) that we collected in our endeavor to develop an indigenized[1] two-semester general, organic, and biochemistry lab manual and an attempt to spark collaborations between the TCUs. Chemistry is an important part of the curriculum because it provides a base and gateway to science, technologies, engineering, and mathematics (STEM) and other career opportunities. Helmenstine (2018) lists multiple reasons for all students to take a chemistry course such as: a) assisting students' understanding of current events regarding fossil fuels; b) providing the tools to study the pollution in water and air; c) making informed decisions about household products; and d) understanding the nature of toxicity and the safe use of chemicals. In fact, chemistry as the study of matter and its transformation, is everywhere. Chemistry serves as a foundation for other disciplines because it is the

[1] In this article, indigenize will refer to connections to Tribal nations' cultural, traditional, and community knowledges. Tribal will refer to either the name of a college or combined with nation to specify a unique community or culture and its traditional knowledge. We will capitalize both Indigenize and Tribal when used as a noun and not when using it as a verb.

central science. For example, chemistry's atomic theory connects to everything from genetics to astronomy. But it is this very depth that makes the course such a challenge for students, which is why we need more discussions about the best way to encourage students to learn more chemistry (Van Doren & Duffy, 2016; Helmenstine, 2018). In this article, we focus on the information we collected regarding chemistry programs and courses at TCUs, as we have published our methods of indigenizing general chemistry, organic, and biochemistry labs (Griep, DeVore-Wedding, Woodard, & Miller, 2016, 2018).

Providing chemistry curriculum and instruction that is relevant, engaging, and appropriate to American Indian/Alaskan Native (AI/AN) students may be challenging. Connecting chemistry to students' interests and their world, not only increases their interest in STEM but may also increase their continuation in STEM courses and even careers (Burhansstipanov, Christopher, & Schumacher, 2005; Nicholas-Figueroa, Wall, van Muelkin, & Duffy, 2017; Helmenstine, 2018). Utilizing place-based projects, connecting to students' traditional values and knowledge, and relevancy of content increases AI/AN student engagement and success (Cajete & Pueblo, 2010; Nicholas-Figueroa et al., 2017). With more states adopting or adapting the Next Generation Science Standards (NGSS) for preschool-through-grade-twelve (P-12) public schools, (National Research Council (NRC) 2012; National Science Teachers Association (NSTA) 2018; NGSS Lead States 2013), students enrolling in post-secondary institutions may expect more authentic, relevant instruction which is our intent in indigenizing chemistry lab curriculum and instruction. NGSS complements our desire to indigenize chemistry offerings at two Tribal colleges in the mid-west to increase students' interest in STEM and STEM careers. We use the term, indigenizing instruction, to mean we are connecting the science and lab content to the Tribal nations' cultures and community knowledges which also falls into the realm of Ethnoscience (Deloria, 1992; Nelson-Barber & Estrin, 1995; Davison & Miller, 1998). Ethnoscience, as described by Deloria (1992), refers to the inclusion of "knowledge possessed by Tribal peoples about the world they lived in" (p. 12). Incorporating Ethnoscience curricula and instruction provides AI/AN students with an opportunity to share their traditional knowledge, providing them a space for a voice in science (Deloria, 1992).

Our interest in the chemistry courses at other TCUs emerged during the authors' collaboration to create a viable chemistry sequence at Nebraska Indian Community College (NICC). We wanted to know what other TCUs were offering in terms of chemistry courses and indigenized instruction to provide a sustainable chemistry program as well as introducing AI/AN students to potential STEM careers. NICC had not offered a chemistry course for five years and wanted to develop a sequence that attracted a sustainable enrollment of six students. We were successful at obtaining an NSF grant (#IIA-1348382 titled "Framing the Chemistry Curriculum") to establish a sustainable chemistry program. Over the past five years, the authors at NICC, Little Priest Tribal College (LPTC), and the University of Nebraska-Lincoln (UNL) have collaborated to develop an indigenized and sustainable chemistry course (Griep, et al., 2016, 2018). As we were framing our chemistry curriculum with Tribal nations' community lens, we wanted to know how other TCUs were connecting their chemistry, science, and math curricula to their students' traditional knowledge, culture, and communities. We chose to indigenize the lab curriculum after reviewing the RISE Experiments laboratory manual (Turtle Mountain Tribal College (TMCC), 2006) which would uphold the integrity of the lecture content while enhancing the laboratory experience. Thus, we focused on developing an indigenized two-semester general, organic, and biochemistry lab manual (Griep et al., 2018).

AI/AN students are underrepresented in all science and engineering fields (National Center for Educational Statistics (NCES), 2016; National Science Board, 2012; Smith, Stumpff, and Cole, 2016). This is problematic as the number of jobs in the United States that require STEM expertise has grown about 34% over the past decade (National Science Board, 2018). STEM workers who already have a four-year degree concur that their job required a minimum equivalent of a four-year degree training in STEM, which supports the need for providing STEM degree programs (National Science Board, 2018). AI/AN traditional content knowledge makes connections to the natural world through a long history of intimate, holistic observations and sharing of those observations within their communities (Cajete & Pueblo, 2010; Nelson-Barber & Estrin, 1995). AI/AN interactions with their natural environment starts at an early age, observing and learning from their elders, daily incorporating critical thinking, problem-solving skills which complement STEM learning and careers (Kim, 2017). Nicholas-Figueroa and colleagues (2017) found that applying Indigenous knowledge to research and authentic problem-solving added to the value of AI/AN education and research programs as well as increased student achievement. Integration of Indigenous traditional knowledge with the relevancy of STEM into college curricula and instruction may increase AI/AN students' interest and participation in STEM education and careers (Kim, 2017; Nicholas-Figueroa et. al., 2017).

For TCUs, their charge is to provide culturally relevant academic and vocational postsecondary education opportunities for AI/AN students. Higher education via TCUs was conceived as a safe, positive learning atmosphere for AI/AN students to honor and uphold Tribal traditions by providing opportunities to actively participate in their individual and communal education, to serve their Tribal communities, and for research and scholarship (Al-Asfour & Abraham, 2016; Boyer, 1997). Most TCUs were founded by Tribal nation councils to take control of their tribe's own educational journey while also meeting the needs of AI/AN students in their quest for a college education (Guillory & Wolverton, 2008). TCUs utilized an AI/AN approach that involved the entire community and incorporated the traditional knowledge of the students and communities they serve. For instance, Diné College, formerly Navajo Nation College, was established in 1968 as the first Tribal college (American Indian Higher Education Consortium (AIHEC), 2018). Today, there are 38 TCUs scattered across the United States with the densest collection of TCUs located in the northern Midwest (AIHEC, 2018).

Methodology

The four authors of this article are all Eurasian, and two teach at the two Nebraska Tribal colleges, LPTC and NICC. To provide authenticity and Tribal nations' communities and cultural lens (Miller, Kenneth, & Davison, 2001; Kim, 2017), we would need assistance from AI/AN science instructors as well as our AI/AN students. In the summer of 2016, we contacted the science instructors and academic deans at the 38 TCUs (Table 1) to ask for a list of their chemistry courses and curricular materials for both lecture and labs classes. Our project focused on the laboratory component so that information was of particular interest to us. The frequency with which these courses were offered was not part of this study. The response rate to the first email request was approximately one-third of those contacted. We supplemented this input with information from the student handbooks and course catalogs downloaded from TCU websites. When we finished tabulating the courses, we shared the list with each TCU again for verification. The enrollment numbers in Table 1 came from three sources, 1) Cappex (2018), a college comparison website, 2) AAA Native Arts (2010), and 3) TCU websites.

Table 1
*Number of chemistry courses and whether required for a degree or certificate**

Tribal College or University	Enrollment	# Chem Courses	Required?
No chemistry courses			
California Tribal College CTC	New TCU	0	
College of the Muscogee Nation (CMN)	197**	0	
Institute of American Indian Arts (IAIA)	325	0	
Keweenaw Bay Ojibwa Community College (KBOCC)	106	0	
Red Lake Nation College (RLNC)	104**	0	
San Carlos Apache College (SCAC)	New TCU	0	
White Earth Tribal and Community College (WETCC)	121	0	
Wind River Tribal College (WRTC)	49***	0	
One or two chemistry courses			
Bay Mills Community College (BMCC)	607	2	Yes
Blackfeet Community College (BFCC)	473	2	Yes
Little Priest Tribal College (LPTC)	148	2	Yes
Saginaw Chippewa Tribal College (SCTC)	153	2	
Sisseton Wahpeton College (SWC)	261	2	
Three or four chemistry courses			
Aaniiih Nakoda College (ANC)	214	4	Yes
Chief Dull Knife College (CDKC)	433	4	Yes
Fond du Lac Tribal and Community College (FdLTCC)	233	4	Yes
Fort Peck Community College (FPCC)	452	4	Yes
Haskell Indian Nations University (HINU)	958	4	
Ilisagvik College (IC)	288	3	Yes
Lac Courte Oreilles Ojibwa Community College (LCO)	489	3	
Leech Lake Tribal College (LLTC)	235	3	Yes
Little Big Horn College (LBHC)	410	4	Yes
Southwestern Indian Polytechnic Institute (SIPI)	531	4	Yes
United Tribes Technical College (UTTC)	600	4	Yes
Six or more chemistry courses			
Cankdeska Cikana Community College (CCCC)	220	6	Yes
College of Menominee Nation (CMN)	615	8	Yes
Diné College (DC)	2033	6	Yes
Navajo Technical University (NTU)	1019	12	Yes
Nebraska Indian Community College (NICC)	177	8	
Northwest Indian College (NWIC)	626	10	Yes
Nueta Hidatsa Sahnish College (NHSC)	215	6	Yes
Oglala Lakota College (OLC)	1752	8	Yes
Salish Kootenai College (SKC)	1158	9	Yes
Sinte Gleska University (SGU)	2340	8	Yes
Sitting Bull College (SBC)	314	8	Yes
Stone Child College (SCC)332	332	6	Yes
Tohono O'odham Community College (TOCC)	207	6	
Turtle Mountain Community College (TMCC)	969	10	Yes

*"Enrollment" is for TCU undergraduate AI/AN students from cappex.com (2018), **the college's own website, or ***AAA Native Arts (2010). "# Chem courses" are the number of chemistry lecture courses (many of which are associated with laboratory components). "Required?" indicates whether there is a TCU degree or certificate program that requires at least one chemistry course.

Results

Our goal was to learn what TCUs, other than NICC and LPTC, have done to indigenize their chemistry courses. To do this, we chose to characterize the current offerings of all the TCUs as a window to learn how a chemistry curriculum could be developed. To identify the chemistry courses, we used a combination of an email survey and a review of the 38 TCUs college bulletins, which list courses offered as well as a description of each course. A cursory examination indicated there were commonalities between the TCUs but also a great deal of diversity. To help us clarify the situation, we decided to simply count the number of chemistry lecture courses offered at each TCU (Table 1). From this, we saw that out of the 38 TCUs, eight do not currently offer a chemistry course, five offer one or two courses, eleven offer three or four, and fourteen offer five or more (Figure 1).

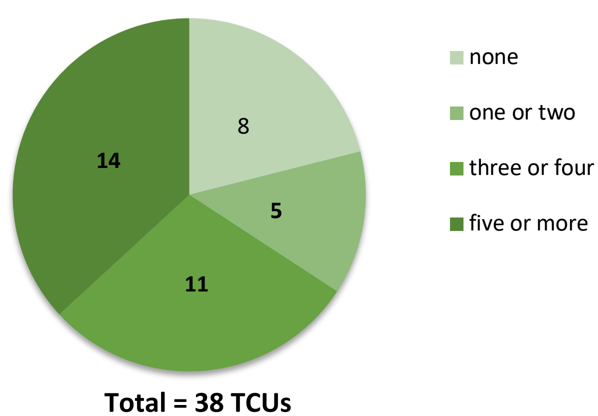

Figure 1. The number of chemistry courses offered by each TCU.

When separated this way, we noticed that the six of the seven TCUs with the highest student enrollment (969 – 2340) fell into the highest course offering category of six or more courses (Table 1). The eight TCUs with no courses have an average enrollment of about 200, those with one or two have about 300, those with three or four have about 600, and those with six or more have about 900. It is also clear that enrollment is not the sole determining factor as there are notable exceptions to these average enrollments, such as Nueta Hidatsa Sahnish College (NHSC) with an enrollment of 215 offering six chemistry courses, and NICC with an enrollment of 177 students offering eight chemistry courses.

The TCUs that offered a greater number of chemistry courses often required chemistry for a degree or certificate program (Table 1). The most common programs that required chemistry include health sciences, agriculture and natural resources, pre-nursing, pre-engineering, and environmental sciences. For instance, NHSC offers a bachelor's degree in environmental science that requires courses in advanced chemistry, environmental chemistry, and toxicology. Some TCUs have special requirements for enrollment in chemistry courses such as Chief Dull Knife College (CDKC) which requires their mathematics majors take one chemistry course. Another example is Oglala Lakota

College (OLC) that requires the two semester-sequence of introductory chemistry for their secondary physical education program.

Chemistry Courses and Program Requirements

Absence of Chemistry Courses. Among the eight TCUs (8/38) that do not currently offer a chemistry course, there are interesting strategies and developments underway. For instance, Red Lake Nation College (RLNC) incorporates chemistry content into their other science courses and beginning in 2020, they will offer an associate of arts degree in Environmental Science that will require a chemistry course. As mentioned earlier, NICC had not offered a chemistry course for five years prior to 2013 when we (UNL) started our collaboration with NICC and LPTC. Between 2013 and 2018, the authors collaborated to create a two-semester General, Organic, and Biochemistry (GOB) sequence that has been achieving a sustainable enrollment. Within the past year, NICC has created a total of eight chemistry courses and are in the process of finalizing their program requirements. General Chemistry I and II with labs are two of these eight courses which will correlate to similar courses at other higher education institutions. A third course, Applied Environmental Chemistry and Conservation Biology, provides experiential, Indigenous learning opportunities to introduce all students, science majors and non-science majors, to a broad spectrum of current science topics.

One-Two Courses. Among the five TCUs (5/38) that offer one or two chemistry courses, most offer a single preparatory course which prepares students to succeed in a general chemistry sequence. As such, they provide the students with options if and when they enroll in a TCU general chemistry course or transfer to a four-year college where most baccalaureate students take a chemistry course (National Science Board, 2018). LPTC currently offers a two-semester chemistry sequence which includes introductory courses in general chemistry and organic and biochemistry. Students enrolled in the Indigenous Science – Health program are required to take both chemistry courses. Students enrolled in the Indigenous Science – Environment program are only required to take the Introduction to General Chemistry course. However, these students will often opt to take the organic and biochemistry course as an elective. Students enrolled in the Liberal Arts program also choose to take one or both chemistry classes as elective courses depending on their intended major when transferring to a 4-year college.

Three-Four Courses. The eleven TCUs (11/38) that offer three or four chemistry courses have at least a two-semester general chemistry sequence or a two-semester GOB sequence (Table 2). Nationwide, GOB sequences are closely associated with pre-nursing programs which suggests that many colleges are focused on preparing students for careers in the health industry. One TCU in this group does not require chemistry for any of their degree or certificate programs, although it is recommended as an elective in their environmental science degree program. Leech Lake Tribal College (LLTC) requires one science course elective in their Early Childhood Education and their Indigenous Leader Associate of Arts degree programs, with chemistry as one of their choices.

Table 2
Chemistry courses offered at 31 TCUs.

Introductory and Preparatory Chemistry Courses (most with labs)
Applied Environmental Chemistry & Conservation Biology
Basic Chemistry
Chemistry & Environmental Sustainability
Chemistry & Society
Chemistry Concepts
Chemistry for General Education
Chemistry for Health Sciences
Elements of Chemistry
Environmental Chemistry
Forensics Chemistry
Foundations of Chemistry
Fundamentals of Chemistry
Inorganic Chemistry
Introduction to Biochemistry
Introduction to Chemistry Lab Equipment
Introduction to General Chemistry
Introduction to Organic Chemistry
Introduction to Organic & Biochemistry
Lab Equipment
Pre-Chemistry
Preparation for Chemistry
Principles of General Chemistry I, II, & III
General Chemistry Courses (most with labs)
College Chemistry I & II
General Chemistry I & II
Advanced Chemistry Courses (courses with chemistry prerequisites)
Analytical Chemistry
Applied Environmental Chemistry & Conservation Biology
Biochemistry
Biological Chemistry
Elements of Biochemistry
Environmental Chemistry
Environmental Chemistry & Toxicology
Fundamentals of Biochemistry
Fundamentals of Chemical Engineering
General Organic Chemistry I & II
Industrial Chemistry
Organic Chemistry
Organic Chemistry for Educators I & II
Petroleum Refinery Engineering & Petrochemicals

Six or more Courses. The fourteen TCUs (14/38) that offer six or more chemistry courses all offer a GOB sequence that is followed by a variety of chemistry courses, some of which are unique to the learning goals and emphasis of the specific TCU. For example, Navajo Technical University (NTU) offers a Bachelors of Applied Science in advanced manufacturing which requires a general chemistry course. NTC offers a degree in Chemical Engineering and provides courses in Chemistry Laboratory

Equipment, Industrial Chemistry, and Petroleum Refinery Engineering and Petrochemicals which may be of interest for those in environmental or other science programs.

Degrees or Certificate Programs. The TCUs with degrees or certificates requiring at least one chemistry course also offered the most variety of advanced chemistry courses, such as Analytical Chemistry (Sitting Bull College (SBC), TMCC), Chemistry & Environmental Sustainability (College of Menominee Nation), Forensics Chemistry (TMCC), Fundamentals of Chemical Engineering (NTU), Environmental Chemistry (NTU, OLC), Salish Kootenai College (SKC), Sinte Gleska University (SGU), SBC), and Environmental Chemistry & Toxicology (NHSC).

Overall, General Chemistry and GOB courses are often the minimum requirement for degree and certificate programs. These courses are usually transferable to other four-year colleges' and universities' degree programs. To ensure student readiness for a GOB sequence comparable to other colleges and universities, preparatory or introductory chemistry courses are offered at 27 TCUs (27/38) (Table 1; Figure 2). Preparatory chemistry courses often are the equivalent of high school chemistry courses (Society Committee on Education, 2015), whereas introductory courses fall between preparatory and GOB course content. Preparatory courses are frequently pre-general chemistry. However, for students who did not have a high school chemistry course or an interlude between their previous chemistry instruction and current TCU enrollment, a preparatory course may increase their success in general chemistry.

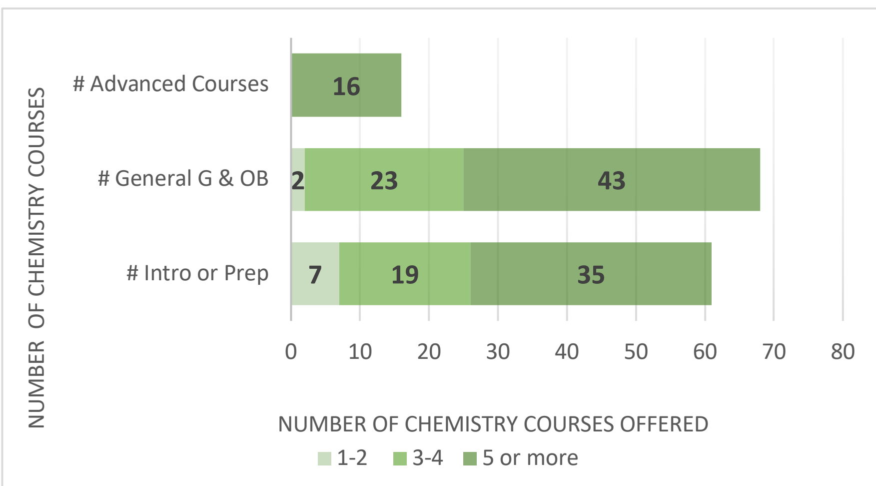

Figure 2. Types of chemistry courses compared with the number of chemistry courses each offered at each TCU.

Seven of the 38 TCUs offer Bachelor of Science degrees (Haskell Indian Nation University (HINU), NTU, Northwest Indian College (NWIC), NHSC, OLC, SKC, and SBC). Therefore, transferable chemistry courses are imperative for those majoring in sciences or other degrees at four-year colleges and universities that require some chemistry. Many of the TCUs have an articulation agreement within their states, such as the North Dakota University System Transfer Agreement which provides for general education coursework to transfer from North Dakota TCUs to any other North Dakota University. TCUs in Arizona, Minnesota, Montana, Nebraska, Washington, and Wisconsin have articulation agreements as well. Those who do not have articulation agreements state clearly in their catalogs and student handbooks that students should contact institutions they are transferring to for credit acceptance, which may not be apparent to first generation university students, of which many AI/AN students are. However, students who plan on transferring to a four-year college or university to complete their bachelor's degrees in a STEM field will meet introductory chemistry requirements at most TCUs.

Since mathematics ability is used at NICC to assist in placing students into the Pre-Chemistry course versus the Chemistry for General Education course, we examined the math prerequisites for TCU chemistry course descriptions. This is relevant because students with a background of higher levels of mathematics were found to be more successful in introductory college chemistry than those with less or lower levels of mathematics knowledge (Sadler and Tai, 2007; Tai, Sadler, and Loehr, 2005; Tai, Ward, and Sadler, 2006). Twenty-five of the 30 TCUs offering chemistry courses have a mathematics pre-requisite, ranging from basic mathematics to Calculus (Figure 3). Those TCUs that offered both preparatory and introductory courses, as well as general chemistry courses, may have different mathematical requirements for enrollment. The majority of general chemistry offerings required College Algebra or a Pre-General Chemistry course with a mathematical prerequisite. Pre-Algebra category includes Developmental Mathematics, Basic Mathematics, Introductory Algebra, Beginning Algebra, Elementary Algebra, and Intermediate Algebra. Only one of the TCUs required Calculus for their General chemistry course.

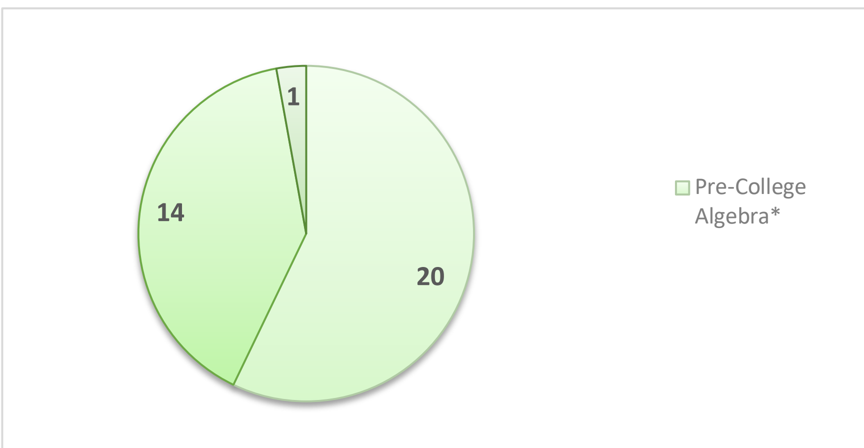

Figure 3. Number of TCUs chemistry courses requiring mathematics for enrollment in introductory or general Chemistry courses.

Textbooks and Laboratory Manuals

Textbooks. As much as the chemistry courses vary, the selection of instructional materials varies even more. There were no textbooks that explicitly incorporated AI/AN science themes or lessons for their introductory or general two-semester chemistry courses textbooks (Table 3). Imperiale (2018), Google Express (2018, December), and Best Review Guides (2018) provide lists of top-ranked chemistry textbooks for comparison. Contrary to popular thought that textbooks are seldom used by students, Pienta (2011) discovered that students at the University of Iowa in an introductory two-semester chemistry course relied on their textbooks more than any other component (lecture, discussion groups, laboratory, tutors, homework) as their primary source for information and assistance. While chemistry content is relatively standardized for introductory or general chemistry courses, presentation of the content can be varied to incorporate AI/AN knowledge. In reaching out to other TCU chemistry instructors, we hoped they would share their methods for indigenizing their curriculum and instruction. We found instructors who indigenized their instruction by researching the Tribal nations' communities of their students for a basic foundation of the Tribal nations' cultures, traditions, and unique topics that would integrate with the content as well as incorporate instructional strategies that are conducive to Ethnoscience methods, such as borrowing from place-based pedagogy and connecting to local topics and interests (Cajete, 1999; 2004; Johnson and Murton, 2007; Johnson, 2012; Nicholas-Figueroa et. al., 2017; Semken and Freeman, 2008). Cajete (2004) emphasized that traditional AI/AN systems depend upon intrapersonal, interpersonal, kinesthetic, and spatial learning using native oral language, actively including Tribal nation culture, values, and history. Including culturally relevant activities that connect to the chemistry content will engage and motivate not just AI/AN students but all students (Aikenhead, 1997; Davison and Miller, 1998).

Table 3
Textbooks used in TCU chemistry courses listed alphabetically.

Introductory and Preparatory

American Chemistry Society. (2015). Chemistry in Context - Applying Chemistry to Society. 8th ed. American Chemistry Society. ISBN 978-1259638145.

Bauer, R., Birk, J., and Marks, P. S. (2015). Introduction to Chemistry. 4th ed. McGraw Hill Education. ISBN 978-0073523002.

Burdge, J. and Overby, J. (2015). Chemistry Atoms First. 2nd ed. McGraw-Hill Education. ISBN 978-0073511184.

Corwin, C. (2011). Introductory Chemistry: Concepts and Critical Thinking. 6th ed. Pearson. ISBN 978-0321663054.

Hein, M. Arena, S., and Willard, C. (2016). Foundations of College Chemistry, 15th eds. Thomson Brooks Cole & Wiley. ISBN 978-1119231318.

Malone, L. J. and Dolter, T. O. (2011). Basic Concepts of Chemistry. 9th ed. Wiley. ISBN 978-0470938454.

McMullen, C. (2012). Understanding Basic Chemistry Concepts: The Periodic Table, Chemical Bonds, Naming Compounds, Balance Equations, and More. 3rd ed. Astro Nutz. ISBN 978-1479134632.

Montana State University-Bozeman. (n.d.). Introductory Chemistry with Study Guide and Student Solutions
Manual. 2nd ed. Montana State University.

Tro, N. J. (2011). Introductory Chemistry Essentials. 4th ed. Pearson. ISBN 978-0321725998.

General, Organic, and Biochemistry (GOB)

Armstrong, J. (2014). General, Organic, and Biochemistry: An Applied Approach. 2nd ed. Brooks Cole. ISBN 978-1285430232.

Denniston, K., Topping, J. J., and Dorr, D. Q. (2016). General, Organic and Biochemistry. 9th ed. McGraw Hill Education. ISBN 978-0078021541.

Seager, S. L. and Slabaugh, M. R. (2013). Chemistry for Today: General, Organic, and Biochemistry. 8th ed. Brooks/Cole, ISBN 978-1133602279.

Timberlake, K. C. (2014). Chemistry: An Introduction to General, Organic, and Biological Chemistry. 12th ed. Pearson. ISBN 987-0321908445.

Timberlake, K. C. (2016). General, Organic, and Biological Chemistry: Structures of Life. 5th ed. Pearson. ISBN 978-0321966926.

General Chemistry

Chang, R. and Goldsby, K. (2015). General Chemistry: The Essential Concepts. 12th ed. McGraw Hill Education. ISBN 978-0078021510.

Ebbing, D. and Gammon, S. D. (2012). General Chemistry. 10th ed. Brooks Cole. ISBN 978-1285051376.

Jesperson, N. D. and Hyslop, A. (2014). Chemistry: The Molecular Nature of Matter. 7th ed. Wiley. ISBN 978-1118413920.

Moore, J. W., Stanitski, C. L., and Jurs, P. C. (2014). Chemistry: The Molecular Science. 5th ed. Brooks/Cole. ISBN 978-1285199047.

Silberberg, M. (2006). Chemistry, The Molecular Nature of Matter and Change. 4th ed. McGraw Hill Education. ISBN 978-0073268088.

Advanced Courses

Caret, R. L., Denniston, K. J., and Topping, J. J. (1993). Principles and Applications of Organic and Biological Chemistry. Brown (William C.), CO. ISBN 978-0697137425

Eby, N. (2003). Principles of Environmental Geochemistry. 1st ed. Cengage Learning. ISBN 978-0122290619.

Hart, H., Hadad, C. M., Craine, L. E., and Hart, D. J. (2011). Organic Chemistry: A Short course. 13th ed. Brooks/Cole. ISBN 978-1-111-425562.

Masters, G. M. and Ela, E. P. (2007). Introduction to Environmental Engineering and Science 3rd ed. Pearson. ISBN 978-0131481930.

Mathews, C. K., van Holder, K. E., Appling, D. R., and Anthony-Cahill, S. J. (2012). Biochemistry. 4th ed. Pearson. ISBN 978-0138004644.

Stoker, H. S. (2000). Organic and Biological Chemistry. 2nd ed. Houghton Mifflin. ISBN 978-0618089352.

Laboratory manuals. We also asked TCU faculty to share the laboratory manuals they were using in their lower level chemistry courses (Table 4). The list includes commercially available manuals, plus one locally produced manual. Several instructors shared that they incorporated investigations from more than one source (Nicholas-Figueroa et al., 2017; Pansegrau, personal communication June 28, 2018). However, only one manual included Indigenous connections: RISE Experiments (TMCC, 2006).

The RISE Experiments manual was written by North Dakota Tribal college students and faculty under the leadership of Charmane Disrud, a TMCC faculty member with funding from National Institute of Health (Grant 1R25GM066064). The labs were written for an introductory organic chemistry course taught at TMCC and for use by the Tribal colleges in North Dakota (North Dakota State University Chemistry Department, 2002). We were looking for labs for a two-semester general, organic, and biochemistry course which led us to develop our own manual, *Lab Manual for Connecting Chemistry to the Tribal Community: Two Semesters of Chemistry Experiments and Teachings* (Table 4) (Griep et al., 2018).

Table 4
Lab manuals used in general and introductory chemistry, biochemistry, and organic chemistry courses.

Griep, M. A., DeVore-Wedding, B. R., Woodard, J., & Miller, H. (2018) *Lab Manual for Connecting Chemistry to the Tribal Community: Two Semesters of Chemistry Experiments and Teachings*, Keeper's Cottage Press. ISBN 978-1721129065.
Henrickson, C., Hunter, N. W., Byrd, L. C., and Denniston, K. (2007). *A Laboratory Manual for General, Organic and Biochemistry*, 6th ed., McGraw Hill Education. ISBN 978-0073226835.
Holmquist, D. D., Volz, D. L., and Randall, J. (n.d.). *Chemistry with Vernier, 4th ed.*, Vernier Software and Technology. ISBN 978-1929075843.
Majorski, S. A. (2012). *Chemistry 127 Laboratory Manual, 2nd ed.*, Kendall Hunt Publishing. ISBN 978-1465208781.
Majorski, S. A. (2012). *Chemistry 131 Laboratory Manual, 1st ed.*, Kendall Hunt Publishing. ISBN-13: 978-1465208774.
Majorski, S. A. (2012). *Chemistry 132 Laboratory Manual, 2nd ed*., Kendall Hunt Publishing. ISBN 978-0757570629.
Peller, J. (2003). *Exploring Chemistry Lab Experiments in General, Organic and Biological Chemistry, 2nd ed.,* Pearson. ISBN 978-0130477149.
Tyner, K. D. (2007). *Selected Exercises from Laboratory Exercises for Preparatory Chemistry, 2nd ed.*, McGraw Hill Education. ISBN 978-0073122649.
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Indigenizing the Curriculum and Instruction. The RISE Experiments laboratory manual written by North Dakota Tribal faculty and students provided a template for including community connections and Indigenous ideas that was particularly useful for the organic and biochemistry labs. While the survey of TCUs did not provide information regarding Indigenous curricula, it did provide information regarding a network of instructors who were individually indigenizing their courses. This sharing of strategies assisted us in our lab manual development and with our instruction.

After the first year of instruction at NICC and LPTC, we identified labs that covered standard chemistry content for an introductory chemistry, organic, and biochemistry two-course sequence that connected to the community topics identified by our advisory board[2] (Griep et al., 2016, 2017, 2018). Our own experiences as former teachers in rural schools, our AI/AN teaching assistants, and the research literature on place-based and Indigenous instruction also guided our work. Each lab presented the chemistry content and a community connection, as well as our AI/AN teaching assistants to guide discussions and to encourage students in sharing their typical laboratory protocols and safety concerns. Students were encouraged to share their own personal chemistry connections. We asked TCU instructors what culturally relevant connections they included in their courses, both lecture and lab, either from their own background or from the Tribal community the

[2] Advisory board was comprised of Tribal leaders, college administrators, faculty and students, Tribal liaisons to government offices, presidents of local public services, and Nebraska Commission on Indian Affairs (NCIA) representatives (Griep et al., 2016).

college served. We also wanted to know how they encouraged their students to relate their own culture and community to the courses. Our teaching assistants modeled this by sharing from their backgrounds culturally relevant connections to the course and lab content. To encourage the same type of sharing in the lab sections, we added a specific question to each lab, asking for students to share their cultural and community knowledge that related to the specific lab content. This may have included native plants and procedures or a Tribal nation tradition. Local events, newspapers, and community members became sources for relevancy and authenticity as well.

NICC offers a Pre-Chemistry course to assist students who have not previously had chemistry or have experienced a time gap between their last science/chemistry course. This course was laboratory based with approximately half of the lecture portion delivered digitally. The students were enthusiastic about the laboratory time, and we were able to tap into the individual students' Indigenous knowledge even more than during the general chemistry courses. Students were asked to demonstrate their knowledge by sharing an activity or research project with each other, local public schools, and even for an online STEM video promotion (Griep et al, 2017). We incorporated a case study, called a community connection, based on the importance of clean and available water. The overarching problem was for students to determine if their water supply was safe to drink and use for agriculture. To respond to this problem, students were to use information from their chemistry lectures, laboratories, and literature research for their conclusions. Discussion questions in the water community connection linked to more than one lab, such as both the water and soil quality labs, native plants used in the spectroscopy lab, and even in the density labs. The water community connection provided students with topics for further investigation, projects for the laboratory final assessment as well as mini investigations throughout the two semesters. Finally, we compiled our labs into a single resource, a lab manual for a two-semester introductory general chemistry, organic, and biochemistry (Table 4). This manual is available free from NICC, LPTCC, and UNL and may be downloaded as a pdf from their websites. An instructors' manual is also available by request only from UNL on Dr. Griep's research group webpage (DeVore-Wedding, Nicholas-Figueroa, Pansegrau, Woodard, Miller, & Griep, 2019). The instructors' manual provides instructions for lab materials and chemicals, safety considerations, and suggestions for further indigenizing of the curriculum, course, and instruction by encouraging students to use their native language in answering questions, share their personal and cultural histories that relate to the chemistry content, and to be aware of cultural values and traditions.

Conclusions

We wanted to know what other TCUs were providing in terms of chemistry courses for our framing of the chemistry curriculum work with NICC and LPTC. Our goal was to provide a sustainable and indigenized chemistry program as well as introducing AI/AN students to potential STEM careers. To sustain a chemistry program, students need to see the benefit of taking a chemistry course which means providing relevancy for the course. Yet, indigenized chemistry resources were scarce as we found no chemistry textbooks and only one laboratory manual that addressed Tribal nation knowledge and community cultural connections. The content in textbooks for a two-semester sequence of introductory general chemistry, organic, and biochemistry is basically the same so as to provide standardized curricula for such courses. In addition, the content for such courses should remain more standardized for students transferring to four-year colleges and pursuing careers in chemistry and related STEM fields. Though instructors for such courses can utilize Indigenous strategies for lecture instruction, the laboratory investigations provided more opportunities to include traditional knowledge and community connection topics. Therefore, we chose to indigenize our chemistry laboratory investigations. Our methods for indigenizing included adopting Ethnoscience strategies and drawing on the traditional knowledge of our AI/AN students, our colleagues at NICC and LPTC, and collaborating with faculty at several other TCUs (Griep et al., 2016, 2018).

We surveyed 38 TCUs regarding their introductory general chemistry, organic, and biochemistry course offerings and programs and to find what resources they were using for instruction. We discovered that 30 TCUs offer at least one chemistry course and that 24 TCUs require a chemistry course for a degree or certificate program (Table 1). We also discovered while standardized chemistry curricula were being used in these courses, both lecture and laboratory, a variety of textbooks and lab manuals were being used (Tables 2 and 3). A majority of TCUs offered some type of introductory or preparatory chemistry course (Figure 3) with GOB courses offered at almost all of the 30 TCUs (Table 1).

We also found individual instructors who were indigenizing their own curriculum, courses, and instruction. They shared their indigenizing strategies and resources with us for classroom and laboratory instruction. The development of our lab manual was enriched from their stories and provided a collaborative professional community for the exchange of future instructional strategies and ideas.

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The Native Bees (Hymenoptera: Apiformes) Associated with Juneberry (*Amelanchier alnifolia*) on the Fort Berthold Indian Reservation, North Dakota

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This project was intended to provide an initial documentation of the biodiversity of native bees in the vicinity of Juneberry (Amelanchier alnifolia) orchards and wild populations on the Fort Berthold Indian Reservation, North Dakota, document those bee species visiting Juneberry and performing pollination activity, and to evaluate which native bees may have potential to enhance fruit production in future studies. An inventory of native bee potential pollinators of Juneberry is reported. The bee fauna was numerically dominated by the silky-striped sweat bee, Agapostemon sericeus, at 38.8% of all bees sampled. The tricolored bumblebee, Bombus ternarius, comprised 20.2% of all sampled bees and about 49.6% of all bumblebees, and was the dominant bee active on Juneberry flowers. Native bumble bee diversity and abundance between wild and developed sites was highly significant, most likely due to massive anthropogenic landscape changes from large-field monocultural row crops, urban and rural development, and non-native plants.

Key words: Juneberry, bumblebee, Bombus, prairie, pollinator, Mandan, Hidatsa, Arikara

Introduction

The northern Great Plains biota has undergone considerable change in the past 150 years. Landscape and environmental modifications through combined effects of wide-ranging native ungulate, or hoofed mammal (e.g., bison, pronghorn, elk), replacement with regulated non-native ungulates (e.g, cattle, sheep, horse), tillage for crops, urban and rural development, fire management, and other factors have made significant impacts on the native biological diversity and ecosystem function. The pollinator guilds and communities in the region, especially those of native bees (Hymenoptera: Apiformes) respond negatively to the typical kinds of environmental change experienced in the region. These impacts occurred before the diversity, abundance, identity, and ecological roles of these insects were adequately documented (Buchmann & Nabhan 1997; National Academies Press, 2007). At present, there are few published resources available that will provide knowledge, information, and management techniques for the native pollinators or pollinator-dependent food crops for this region. Introduced pollinators, such as the European honeybee (*Apis mellifera* Linnaeus) and alfalfa leafcutter (*Megachile rotundata* Fabricius) are well-known and their plant association biology understood, but they are not reliable or effective replacement pollinators for early season pollination needs on native plants, such as Juneberry (*Amelanchier alnifolia* Nutt.; Rosaceae) (a.k.a., Saskatoon). Juneberry is a native shrub (Figure 1) in the northern Great Plains and is traditionally and extensively used by Indigenous peoples who use the fruit for nutritional and medicinal purposes (Hartman, 2008; Poelaert, Bergh, Hartman and Reese, 2010). Consequently, the use of native pollinators, such as bumblebees (*Bombus* spp.) (Figure 2) is better for meeting pollinator needs for flowering plants with early season flowering and optimized fruit production, such as Juneberry (Barney, Robbins and Fallahi, 2009; Flessner, 2001; St.-Pierre, 2005). Thus, the goals of this study are to provide an initial documentation of the biodiversity of native bees in the vicinity of Juneberry orchards and wild populations on the Fort Berthold Indian Reservation, document those bee species visiting Juneberry and performing pollination activity, and to evaluate which native bees may have potential to enhance fruit production in future studies.

Figure 4. Juneberry, *Amelanchier alnifolia*, in full bloom (Photo Kerry Hartman).

Figure 2. A bumble bee, *Bombus nevadensis,* on Juneberry flowers (Photo Kerry Hartman).

In order to meet the needs determined by land owners and managers, and investors, interested in growing and supporting Juneberry farming in the Fort Berthold Indian Reservation and to meet state, federal, and private interests in developing ecologically and economically sustainable and compatible farming protocols (Mader et al., 2011), it is essential that the native pollinator community in the cropping areas be determined and assessed for their diversity, relative abundance, and identity. This is necessary before potential use, augmentation needs, and conservation plans can be fully implemented.

Native pollinators are critical for natural reproduction of traditional food plants in the northern Great Plains, such as Juneberry. Yet, the pollinators and the cultures dependent upon them are under increasing threats of decreasing abundance, biological diversity, and sustainability. These threats come from the four basic anthropogenic impacts on natural environments (Sánchez-Bayo and Wyckhuys, 2019): 1) habitat loss and landscape conversion; 2) pollution, especially from agrichemicals (pesticides and fertilizers); 3) introduced non-native species and pathogens; and 4) climate change. Since Buchmann and Nabhan (1997) and the National Academies Press (NAP) (2007) report, we have seen a surge in studies on various pollinator species, especially native bees and their responses to habitat change along with documentation of anthropogenic impacts on their diversity and abundance (Ilha and Kremen, 2013; Nicholson, Koh, Richardson, Beauchemin and Ricketts 2017; Renauld, Hutchinson, Loeb, Poveda and Connelly 2016; Williams, Regetz and Kremen, 2012). However, reported pollinators of *Amelanchier* species are few (Robertson, 1928) and more recent studies are incomplete due to the relative novelty of regarding Juneberry as a commercial crop (Hartman, 2008, Poelaert et al., 2010). Further, the impact of pollinator loss by extensive landscape change on and around the Fort Berthold Indian Reservation, including ceded agricultural lands, has not been measured.

There are no known published studies explicitly on the pollinators of Juneberry, the diversity of pollinators visiting the plant, or their relative impact on fruit production. Historically, this plant has not been a major interest in pollinator needs so there is no published literature documenting pollinators in the northern Great Plains, or management recommendations regarding their impact on fruit production. Further, there are no published reports on the biodiversity of native bees in North Dakota or on the Fort Berthold Indian Reservation, or the impact on these insects from reservoir development and landscape conversions to commodity crops.

Figure 3. Overview of Missouri Canyon with overgrazed grassland in foreground, wild shrubs (including Juneberry) and trees across the middle, and Lake Sakakawea in the background (Photo Kerry Hartman).

Naturally, Juneberry typically occurs on well-drained mesic sites (Figure 3) that are wind protected, and tolerant of fire and moderate wildlife browsing and livestock grazing and trampling. Hartman (2008) reported that upwards of 80% of the natural stands on the Fort Berthold Indian Reservation had disappeared in approximately the past 150 years. Juneberry was once an abundant plant in the Missouri River Canyon prior to loss from flooding by Lake Sakakawea following completion of the Garrison Dam in 1953 (Hartman, 2008, Poelaert et al., 2010), which removed 152,360 acres (616.6 km^2) of productive bottomland, or about 94% of the tribal non-ceded agricultural land (Lawson, 1982).

Figure 4. Juneberry orchard at White Shield (Photo Kerry Hartman).

Re-establishment activities for Juneberry by faculty and students of the Nueta Hidatsa Sahnish College (NHSC) include the planting of four large orchards (Figures 4 and 5), and identification of 24 wild populations and numerous private stands that were available during the proposed project (e.g., Figure 3). The orchards were used as research sites each year of the pollinator project. These orchards were planted at anthropogenic sites and were adjacent to or surrounded by highly disturbed communities dominated by non-native grasses (e.g., *Bromus* spp.) and weedy broadleaved species, sparse small trees (e.g., *Fraxinus*, *Populus*), croplands, and development hardscapes.

Figure 5. Newly planted Juneberry orchard at Elbowood, New Town (Photo Kerry Hartman).

Juneberry is naturally self-pollinated, or self-fruitful, but this accounts for only about 20% of potential fruit production (Walden Hill Nursery 2018). Native bees provide increased fruit set and increased size for cultivars in the horticultural trade (Olson & Steeves, 1982). Olson (1984), after Church (1908), described the pollination pattern as "insect-mediated self-pollination." Spencer and colleagues (2013) noted that the floral structure is attractive to insects and encourages visitation, but that the flowers seem largely self-pollinated by the visiting pollinators, with little cross-pollination. The flowers of *Amelanchier* species follow the same basic anatomy and structural patterns of other insect pollinated plants (Olson, 1984). A higher percentage of seeds was noticed in cross-pollination (Walden Height Nursery, 2018), but were not quantified. Wild insect populations are indicated as of more importance to pollination than the honeybee, with reports of its disinterest in the blooms. There may be wind pollination involved as well, but limited to close flowers as the pollen is sticky and clumping (Walden Height Nursery, 2018).

In west-central North Dakota, Juneberry blooms during early spring, usually late-April to mid-May, and is variable by a week or 10 days by seasonal weather patterns, elevation, and site aspect. It is not unusual for spring snowstorms or high winds during peak flowering. Olson and Steeves (1982) noted the vulnerability of Juneberry flowers to frosts when buds are opening (anthesis), which can also interfere with pollination success from insect visitation. The flowering period typically lasts less than 14 days, depending on wind and other weather factors, with harvestable fruits available by late June.

The greater study area landscape is an undulating prairie pothole expanse incised by the 300 meter deep canyon of the Missouri River, with numerous stream-cut coulees draining the uplands to the river (Figure 3). The plateau is highly disturbed (see Figure 6) and variably cropped with wheat, canola, and alfalfa, heavily grazed, or developed for petroleum production, urbanization, and numerous scattered rural residences and businesses. Undeveloped lands are largely limited to steep slopes of canyons and coulees and tend to be variably grazed. The slopes of the canyon are vegetated with mixed native and weedy grasses and forbs on upper slopes, grading to shrubs and trees on lower slopes. Most slope and coulee habitats are lightly to moderately grazed, and none are tilled except in scattered small pastures, yards, and gardens.

Our prior observations indicated that native bees, particularly bumblebees (*Bombus* spp.) and sweat bees (*Agapostemon* spp. and *Halictus* spp.) appeared to be the primary pollinators. Thus, the goals of this study were to provide an initial documentation of the biodiversity of native bees in the vicinity of Juneberry orchards and wild stands on the Fort Berthold Indian Reservation, document those bee species visiting Juneberry and performing pollination activity, and to evaluate which native bees may have potential to enhance fruit production in future studies.

Materials and Methods

Native bees were explicitly sampled at six sites in the Fort Berthold Indian Reservation using standardized methods. Thanks to a decade of Juneberry reestablishment activities, NHSC has four large Juneberry orchards (Figures 3 and 4). Three of these were used and designated as Elbowood, War Coulee, and White Shield and are located on Figure 6. Elbowood orchard is located at the northeastern edge of the city of New Town, War Coulee orchard is part of a rural private property, and White Shield orchard is along the southern border of the town of White Shield. Twenty-four wild Juneberry stands (Figure 5) were used, three of which were selected for this project (Figure 6) and identified as the Baker, Hartman, and Wolf sites; each of these on undeveloped private property. The orchards were used as research sites each year of the project. Pollinators were observed, trapped, and net captured for identification, used for taxonomic training, biodiversity evaluation, and the establishment of a reference collection.

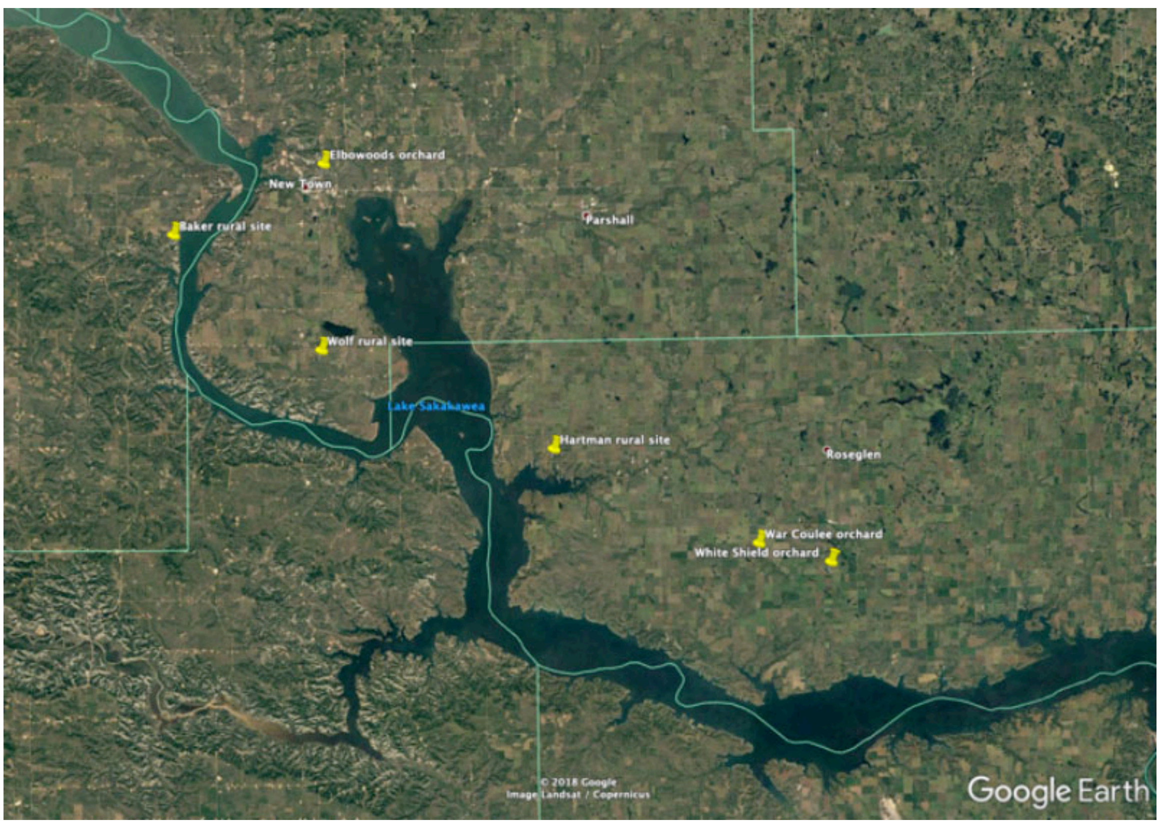

Figure 6. Locations mentioned in text of six study sites (yellow pins) on the Fort Berthold Indian Reservation. Map from GoogleEarth™.

Bee sampling was done using standard techniques with vane/bottle traps, colored bowl traps, and hand and net collecting as described by Droege (2010). Sampling was done daily to several day periods as weather permitted to coincide with Juneberry bloom periods each sampling season in late April or early May. Bees were sampled at each site with three yellow and three blue vane traps and blue, yellow, and white bowl traps. Hand and net collecting was done opportunistically and for supplementation of bee diversity data and observations. To meet long-term conservation goals, specimen-taking was progressively decreased during the project to an as needed-only basis focused on specimens that represented species not previously sampled. Thus, intensive sampling was conducted only in year one, from Juneberry bloom through the summer season to establish a biodiversity baseline. Sampling was reduced to a single trap of each type in year two. No traps were used in year three, with "samples" taken on a catch-and-release basis supplemented with photographs, such that bees were taken only on an as needed-only basis as project participants learned identification of the local pollinators so that only specimens that appeared to represent unknown species were collected. This was intended to help protect bee populations from excessive sampling and potential local extinction, especially bumblebees.

In the field, vane and bowl traps were each partially filled with soapy water to capture and temporarily preserve bees. Samples were retrieved frequently to reduce loss of specimens from decay. Samples returned to the lab were rinsed in clean water and ethanol and stored in 100% ethanol until further preparation. Specimen samples were subsequently sorted to bee taxa and to remove bees from non-target specimens and materials. Large bee specimens, such as bumblebees and leafcutter bees, were pinned and air-dried, while small sized bees were air-dried and glued to pins (Droege, 2010).

Bee specimens were identified by participating students that were trained in bee morphology and use of technical keys. Identifications were made to genus, and sometimes species, using online resources such as DiscoverLife.org and BugGuide.net, and published literature (Colla, Richardson and Williams, 2011; Mitchell, 1960, 1962; Williams, Thorp, Richardson and Colla, 2014). Specimens were determined to the lowest taxonomic level of identification, to the species when possible, or otherwise treated as morphospecies and simply numbered for recognition for future study. Taxonomic authors for each identified bee species are given in Table 1. The bulk of specimens will be retained in the Severin-McDaniel Insect Research Collection, South Dakota State University (SDSU), with representative vouchers in the biology labs of NHSC.

Each species of bee was tallied by taxon (Table 1). Bumblebees were separately tallied by taxon and location (Table 2). Because bumblebees were of greater interest due to their impact on Juneberry pollination, this data was subjected to a two-factor analysis of variance to estimate differences by location and species, which were treated as fixed variables. There were no interactions set to avoid influence of effects and errors. The data was common logarithm transformed based on Tukey's test of non-additivity. Species and location means presented here (Tables 3 and 4) were calculated from the original non-transformed data. Fisher's LSD ($p=0.05$) was used to test significance among means for species and location.

Results

A total of 2,012 specimens representing 27 native bee species (Table 1) were collected at all sampling sites. Native bees representing the families Andrenidae, Apidae, Halictidae, and Megachilidae were collected. The bee fauna was dominated by the silky-striped sweat bee, *Agapostemon sericeus* Forster, at 38.8% of all bees sampled. The tricolored bumblebee, *Bombus ternarius* Say, comprised 20.2% of all sampled bees and about 49.6% of all bumblebees. The highest taxon diversity was represented by bumblebees (*Bombus* spp.) (Tables 1 and 2), with seven species provisionally identified. The genus *Anthophora* was represented by four species. The highest relative abundances were represented by the sweat bees *A. sericeus* and an *Halictus* species, probably *H. ligatus* Say (Table 1)

Table 1.
List of native bees taken with vane and bowl traps at six sampling sites on the Fort Berthold Indian Reservation. Numbers for each species refer to the specimen count. Family names in bold.

Andrenidae
Andrena sp. 1 – 83
Andrena sp. 2 – 5

Apidae
Anthophora bomboides Kirby – 3
Anthophora sp. 2 – 6
Anthophora sp. 3 – 1
Anthophora sp. 4 – 1
Bombus bimaculatus Cresson – 31
Bombus borealis Kirby – 5
Bombus fervidus (Fabricius) – 68
Bombus huntii Greene – 71
Bombus nevadensis Cresson – 25
Bombus rufocinctus Cresson – 96
Bombus ternarius Say – 407
Bombus terricola Kirby – 88
Bombus vagans Smith – 31
Ceratina sp. – 11
Mellissodes sp. 1 – 14
Mellissodes sp. 2 – 3

Halictidae
Agapostemon sericeus Forster – 780
Halictus ligatus Say – 264
Lasioglossum sp. – 12
Sphecodes sp. – 1

Megachilidae
Megachile latimanus Say – 1
Megachile rotundata Fabricius – 3
Megachile sp. – 3
Osmia sp. – 11

Table 2.
*Counts and faunal percentage of bumblebees (Bombus spp.) from sampling sites on the Fort Berthold Indian Reservation. *Variance due to rounding.*

Species	Baker	Elbowood	Hartman	Voigt	White Shield	Wolf	Total	Faunal Percentage
B. bimaculatus	0	0	25	0	0	6	**31**	**3.7**
B. borealis	5	0	0	0	0	0	**5**	**0.6**
B. fervidus	16	9	13	2	0	28	**68**	**8.3**
B. huntii	18	3	31	3	0	16	**71**	**8.6**
B. nevadensis	0	0	17	0	0	8	**25**	**3.0**
B. rufocinctus	45	24	10	1	7	9	**96**	**11.7**
B. ternarius	186	21	103	21	0	76	**407**	**49.5**
B. terricola	4	3	52	0	0	29	**88**	**10.7**
B. vagans	25	0	2	0	1	3	**31**	**3.8**
Total Bees	**299**	**60**	**253**	**27**	**8**	**175**	**822**	**99.9***

Bumblebees were among the most prevalent native bees found during the study throughout the sampling season. They were usually the only pollinators found visiting Juneberry blooms, with all visitation observations being queens and early season workers of *B. fervidus* (Fabricius), *B. ternarius* Say, and *B. terricola* Kirby. The analysis of variance tests of the bumblebees showed highly significant effects among species means (Table 3) and location means (Table 4). In both instances, the statistical means are followed by a shift in identifying letters indicating significant differences. In the case of species differences, *B. ternarius* formed a distinct grouping indicating that the abundance of this species is significantly more than that of any other species. In the location differences, the Hartman, Wolf and Baker wild sites were significantly separated from the Elbowood, Voigt and White Shield developed sites.

Floral visitations by other bees seemed restricted to occasional visits by a native sweat bee (*H. ligatus*), and the introduced honeybee. Other Juneberry flower visitors observed included occasional early emerging specimens of the invasive cabbage white butterfly (*Pieris rapae* Linnaeus) (Lepidoptera: Pieridae), the native red admiral butterfly (*Vanessa atalanta* Linnaeus) (Lepidoptera: Nymphalidae) that overwinters as an adult, and an assortment of early season native and introduced flies (Diptera) of the families Bibionidae, Calliphoridae, Muscidae and Sarcophagidae.

Table 3.
Mean separations (FLSD, p=0.05) counts of Bombus by species.

***Bombus* Species**	**Homogenous Groups**	**Mean actual data**
ternarius	A	67.8
rufocinctus	AB	16
fervidus	BC	14.7
huntii	BC	11.8
terricola	BCD	11.3
vagans	CDE	5.2
bimaculatus	DE	5.2
nevadensis	DE	4.2
borealis	E	0.8

Table 4.
Mean separations (FLSD, p=0.05) counts of Bombus by location.

Location	**Homogenous Groups**	**Mean actual data**
Hartman	A	33.2
Wolf	A	28
Baker	A	19.4
Elbowood	B	6.7
Voigt	BC	3
White Shield	C	0.9

Discussion

Hurd (1979) listed 102 species of bee explicitly cataloged from North Dakota, of nearly 4,000 species reported from Canada and the continental United States. Though no summary of the bees of

North Dakota is available, the neighboring state of South Dakota with comparable physiography has approximately 400 species (Drons, 2012). A total of 17 species of bumblebee are recorded from North Dakota when combining data from Hurd (1979), Colla and colleagues (2011), Williams and colleagues (2014), and DiscoverLife.org (2018). We found 53% of the species recorded from North Dakota and regard the low number a result of relatively low habitat diversity and the high degree of landscape disturbance on the Fort Berthold Indian Reservation and surrounding areas. Of the nine species of bumblebee collected, our records of *B. bimaculatus* Cresson and *B. nevadensis* Cresson may be remarkable for the region as neither were listed from North Dakota by DiscoverLife.org (2018).

Based on sampling results (Table 2), *B. ternarius* was the most numerous and frequent bumblebee at five of the six sites and was exceptionally abundant at the Baker and Hartman sites. No specimens were taken at White Shield. The Baker and Hartman sites are rural and the least disturbed. They were located in shallow coulees above the Lake Sakakawea reservoir, and have relatively low intensity livestock grazing, no tillage, and very low development intensity. These sites include Juneberry growing with or adjacent to populations of wild plum (*Prunus americana* Marsh.), chokecherry (*Prunus virginiana* L.), buffaloberry (*Shepherdia argentea* (Pursh) Nutt.) and a wide diversity of native prairie and weedy flowering plants that provide additional season-long nectar and pollen resources to *B. ternarius* and other pollinators. Nevertheless, *B. ternarius* also seems to have the highest tolerance for habitat and landscape disturbance of native prairie associated bumblebee species of any of the seven species collected. The White Shield site is within the boundaries of the village and surrounded by areas of urban development, weedy non-native vegetation, and expansive monocultural commodity crops. This site was extremely poor for bumble bees, with only eight specimens representing two species. This likely indicates a probable distinct impact of relative development away from natural conditions for explaining the reduced diversity and abundance of bumblebees, given that the developed sites are surrounded by lands that are upwards of 90% disturbed by row crops, and the wild sites are surrounded by lands that are upwards of 70% disturbed by heavy grazing.

Given the high degree of landscape disturbance on the Fort Berthold Indian Reservation the higher diversity of bumblebees and abundance at the Baker, Hartman and Wolf native sites (Table 2), the residual wildlands with Juneberry appear to provide the best retention of native bee biodiversity. In contrast, bumblebee diversity and abundance (Table 2) is lost in the developed areas of Elbowoods, Voigt, and White Shield. At none of the sites are agrichemicals known to be extensively used. The low takings of honeybees at all sites suggests that this introduced honeybee is not a major competitor against native bumblebees, at least on early blooming Juneberry. Of the "loss drivers" for the insect fauna as defined by Sánchez-Bayo and Wyckhuys (2019), this leaves habitat loss and landscape conversion, and climate change, as providing the most impact on Juneberry pollinators. The empirical data of this study clearly indicates that habitat loss and landscape conversion is likely the leading negative impact on biotic integrity and biodiversity on the Fort Berthold Indian Reservation. The general pattern of bee occurrence, including that of *B. ternarius* is likely a result of native bee populations being negatively impacted by massive anthropogenic landscape changes (Figure 6) due to enlarging crop fields, flooding of the Missouri River canyon, urban and rural development, non-native plants, and petroleum and natural gas extraction (Figure 7).

Figure 7. Petroleum pumping and storage platform near New Town, Fort Berthold Indian Reservation, North Dakota (Photo Kerry Hartman).

Among other bees listed in Table 1, *Agapostemon sericeus* and *Halictus ligatus* were the only other abundant species. These widely distributed and common species and others of these genera are notable in that they often have a high tolerance for landscape disturbance and shifting habitats. And in addition to a wide variety of native plants, they readily use flowering crops and common weeds as nectar and pollen sources. As such, they can be the most abundant native bees found in urban, suburban, and developed rural sites, and can take advantage of relatively small habitats such as weedy fields, road right-of-ways and verges, field borders, and other untilled vegetation. Many of the other bees sampled, such as species of *Andrena* and *Mellisodes* have lesser degrees of tolerance for disturbed habitats and will use flowers of certain crops such as sunflower, canola, alfalfa, and a variety of common weeds. As seen in Table 1 most of the other native bees were sampled in very low numbers, suggesting poor habitat conditions involving vegetative structure and limited or absent preferred floral resources. Many of these bees have specialized nest requirements. The majority of species sampled are ground nesting species that often have specific soil and vegetation condition needs for successful brood production, in addition to floral resources. These conditions relate to soil composition, drainage, compaction, slope, aspect, and exposure, with different bee species having their own particular combinations of traits. The *Ceratina* species is a stem nester, requiring woody to semi-woody stems with a pith core, wild roses and blackberries are examples of acceptable nesting hosts. The other exceptions are the bumblebees that require soil or plant crown cavities for nesting, especially those remaining from abandoned small mammal nests at the bases of bunch grasses, such as deer mice (*Peromyscus* spp.), prairie vole (*Microtus ochrogaster* Wagner), or burrows and holes of the plains pocket gopher (*Geomys bursarius* Shaw), the thirteen-lined ground squirrel (*Ictidomys tridecemlineatus* Mitchill), or Richardson's ground squirrel (*Urocitellus richardsonii* Sabine).

Bumblebees were often the only flower visitors when the weather was cooler in temperature, overcast, or with light breezes. All of the other pollinators noted are low incidence and fair-weather visitors, except for some flies, and none of these are specialists on Juneberry. Thus, only the bees seem to be effective pollinators of Juneberry. Regardless, the cumulative impact of these occasional visitors should not be dismissed without further investigation to their natural potential for augmenting pollination and fruit production even by accidental transfer of pollen for Juneberry.

Although numerous examples of the introduced honeybee were also collected during the survey, very few were trapped or observed on Juneberry blooms and only when weather conditions were relatively warm. Usually, weather conditions are cool and breezy during Juneberry bloom periods in mid-April. Since this species is not native and is unreliable as a Juneberry pollinator it is not considered a reliable potential pollinator.

Our results demonstrate that the bumblebee, *B. ternarius*, was likely the primary native pollinator of Juneberry on the Fort Berthold Indian Reservation. *Bombus ternarius* queens and early season workers were relatively abundant in the early spring at each rural site, but was uncommon at suburban sites, probably due to a lack of nesting sites and significantly reduced floral resources. The presence and abundance of *B. ternarius* and bumblebees in general must be taken into account if Juneberry cultivation can enhance fruit production using native pollinators.

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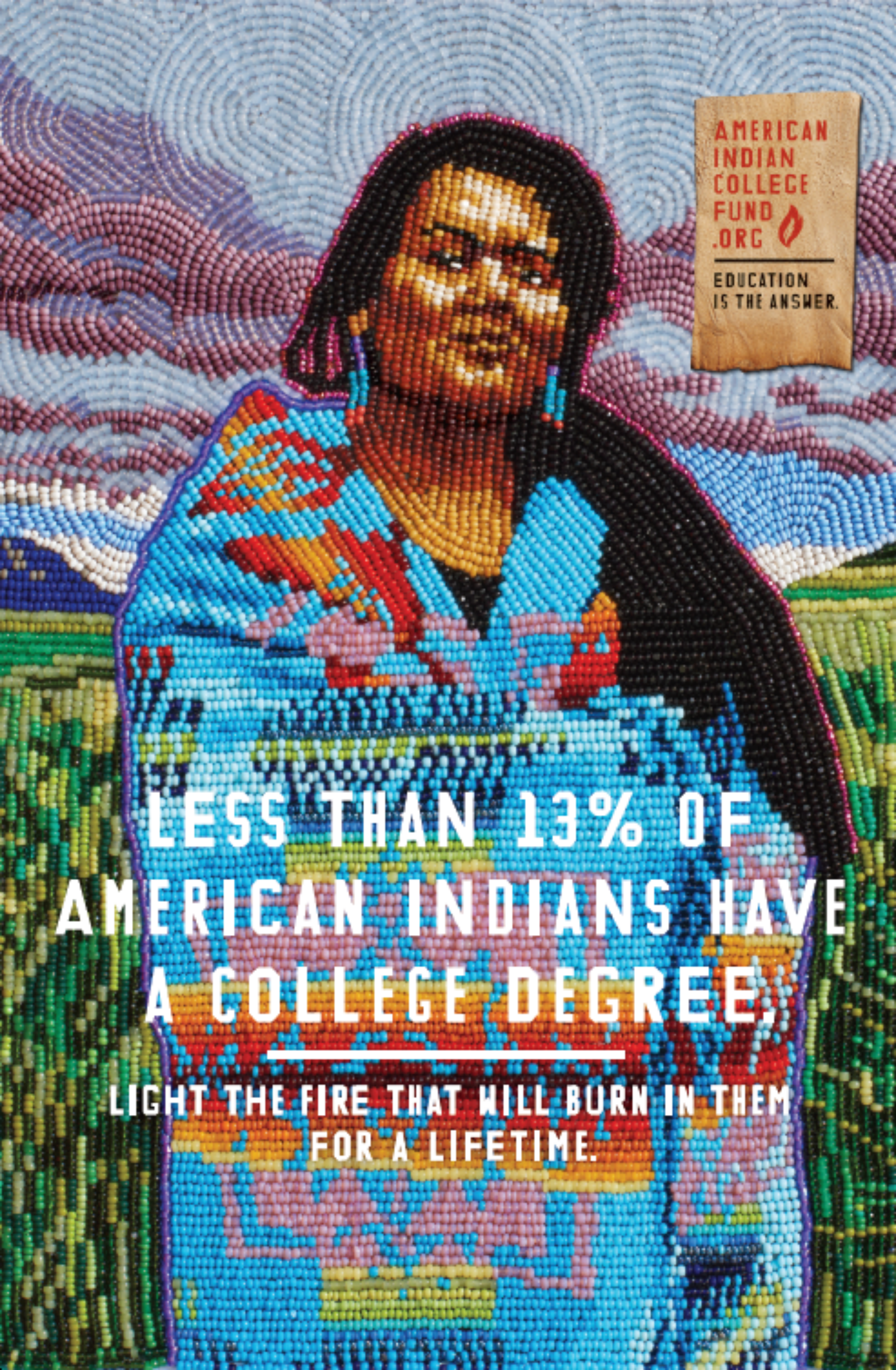
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