

Journal of Indigenous Research

Full Circle: Returning Native Research to the People

Volume 10 | Issue 2022

Article 10

January 2023

Weaving Together Indigenous and Western Knowledge in Science Education: Reflections and Recommendations

Zoe Higheagle Strong

Washington State University, zoe.strong@wsu.edu

Landon James Charlo

Washington State University, lcharlo@wsu.edu

Francene Watson

Washington State University, fwatson@wsu.edu

Paula Groves Price

North Carolina A&T State University, pgprice@ncat.edu

Kimberly Christen

Washington State University, kachristen@wsu.edu

Follow this and additional works at: <https://digitalcommons.usu.edu/kicjir>

Recommended Citation

Higheagle Strong, Zoe; Charlo, Landon James; Watson, Francene; Price, Paula Groves; and Christen, Kimberly (2023) "Weaving Together Indigenous and Western Knowledge in Science Education: Reflections and Recommendations," *Journal of Indigenous Research*: Vol. 10: Iss. 2022, Article 10.

Available at: <https://digitalcommons.usu.edu/kicjir/vol10/iss2022/10>

This Article is brought to you for free and open access by the Journals at DigitalCommons@USU. It has been accepted for inclusion in Journal of Indigenous Research by an authorized administrator of DigitalCommons@USU. For more information, please contact digitalcommons@usu.edu.



Weaving Together Indigenous and Western Knowledge in Science Education: Reflections and Recommendations

Cover Page Footnote

We express our deepest gratitude to many Tribal elders, culture and language specialists, and educators from three communities who dedicated their time and heart, even in the midst of the pandemic, to help find creative strategies to integrate Indigenous knowledge into science education in order to better serve and teach Native American students. Two elders passed away during this time, and their legacy will truly live on.

Weaving Together Indigenous and Western Knowledge in Science Education: Reflections and Recommendations

Although researchers have shown that Traditional Ecological Knowledge (TEK) has the potential to enhance motivation and self-esteem for Native American students (Bang & Medin, 2010; Kant et al., 2018; McKinley, 2005) in STEM, many Native American students are primarily taught from a Western science model (Baker, 2003; McKinley, 2020) that may devalue their own cultural knowledge and belief system. In a recent memorandum from the Executive Office of the President of the United States (Lander & Mallory, 2021), Indigenous TEK is recognized “as one of the many important bodies of knowledge that contributes to scientific, technical, social, and economic advancements” (p. 1). Despite the importance of TEK, it is rarely included in science education in K-12 settings, and Indigenous knowledge keepers are often not represented as “science educators.” This omission discounts how Indigenous knowledge contributes to the understanding and management of the natural world.

Indigenous science includes collective decision-making, flexible notions of time, holistic relationships, long-term perspectives, respect, reciprocity, and spirituality embedded in all elements of the cosmos (Kawagley & Barnhardt, 1998). Western science is often characterized by compartmentalized thinking, global verification, mathematical models, and hypothesis falsification (Barnhart & Kawagley, 2005). In efforts to shift the paradigm from teaching Indigenous students solely from a mainstream Western model of science education to integrating Indigenous knowledge systems in science education, the Culturally Responsive Indigenous Science (CRIS) project team from Washington State University (WSU) and three Northwest Tribes embarked on revisioning and developing Indigenous science curriculum and professional learning opportunities over a 5-year period. The purpose of this conceptual paper is to reflect

upon and provide preliminary recommendations on our process of weaving together Indigenous knowledge and Western approaches to science education and professional learning for educators. Although integrating technology tools within the curriculum design was a major accomplishment of the project, the focus of this paper is on the broader integration of knowledge systems among multiple Tribal communities and partners.

Brief Overview of the CRIS Project

The Culturally Responsive Indigenous Science (CRIS) project funded by the National Science Foundation (NSF Project No. 1720931) was a collaborative effort between three Tribal communities in the Pacific Northwest (Tribal language/cultural teachers/elders/science teachers) *and* faculty and graduate students from the WSU College of Education, College of Arts and Sciences, and the Center for Digital Scholarship and Curation. For the sake of confidentiality of our Tribal partners, we did not list their names. The project was designed to bring Indigenous and Western “knowledge streams” together to better “make sense of the world” with a focus on science education (Barnhardt, 2008, p. 122) for Native American students in grades in 5-9. Centering on land, language, and culture, the CRIS project had three main objectives:

1. Develop and implement culturally responsive science curriculum modules that integrate Indigenous knowledge, culture, and language with Western science and technology.
2. Conduct culturally responsive professional learning opportunities for teachers to effectively integrate science curriculum and technology into classroom instruction and assessment.
3. Provide supplemental hands-on enrichment programs for Native American students to engage with science projects and experiments outside of the traditional school environment.

Reflections on Weaving Together Indigenous and Western Knowledge

At the end of the 5-year grant project, members of the CRIS team gathered to reflect on the relationships built and the work accomplished. Our conversations consistently gravitated toward the process and nuances of bringing together people from various backgrounds, languages, and knowledge systems, also noting the unique benefits and challenges of collaborating with three different Tribal communities. The three Northwest Northwest Tribes are located in rural regions across three different states (Idaho, Oregon, Washington). Tribal enrollments range from approximately 2,100 members to 8,600 members, vary in cultural traditional practices, and two of the Tribes speak three different languages. The following themes capture preliminary core reflections.

Creating Relational Space for Cultural Values and Practices

The initial gathering for the CRIS project included Tribal elders, language and cultural specialists and educators, Western science teachers working in these Tribal communities, and WSU faculty and graduate students. The intent was to build relationships, identify professional learning needs, and define *mutual* goals, objectives, process, and timelines for curriculum development. The project's aim was to provide opportunities for teachers to collaborate across three Tribal communities, share knowledge, and build lesson plans grounded in Indigenous knowledge systems. The cross Tribal collaboration was rare prior to the CRIS project and was one of the highlights expressed by Tribal teachers, language, and cultural specialists. It did, however, become evident that the Western science teachers felt more confident discussing lesson planning and curriculum development, whereas Tribal educators expressed that they did not label or think about their work as science, until this project. Because of the confidence and experience with developing curricular units within mainstream school settings, Western science teachers

initially directed the conversations and planning sessions, which often had the effect of pushing Indigenous knowledge to the margins contrary to our original intent.

Recognizing this tension, the project team shifted the focus of discussion away from the technical aspects of lesson planning and curriculum development to center language and cultural values—the initial goal of the project. Tribal elders, language, and cultural specialists were encouraged to think of the cultural values in their traditional languages that they believed should guide the work. The result was a major shift in how all the project partners saw the integration of traditional knowledge and Western science. The three Tribes each agreed on five core concepts which they expressed in their own languages: 1) Lifeways/way of life with Creator/spirituality, 2) Good heart/kind heart, 3) Honoring and respecting life, 4) Stewardship and being protectors, and 5) Sharing knowledge. Each Indigenous language had a different word or phrase that represented these concepts. The richness of the languages, accompanying stories, and explanations given by Tribal experts could not possibly be fully captured. The authors also decided to leave out the explicit language terms because there is ongoing debate in some language groups depending on the speaker. Ultimately, these are best understood orally. Furthermore, we believe it was not our story to tell.

As we engaged in conversation regarding the seasonal aspects of Indigenous TEK, Tribal educators, and cultural and language specialists shared rich stories about traditional practices such as harvesting berries, traditional indicators of water health, and root gathering. Although the Tribal communities shared these similar traditional activities, their seasonal calendars and cultural practices or ceremonies surrounding these activities tended to vary. In this process, the conventional Western standards-based framework typically used to structure lesson plans were

replaced with a more intentional focus on Indigenous knowledge systems, the importance of relationship building, traditional stories, language, and nonlinear integrated learning.

Other major shifts from conventional Western practices occurred with dedicated time spent in Tribal communities thinking about place and land without the pressure of creating lesson plans. Tribal elders, and cultural and language educators remained engaged throughout the 5-years of the project to guide the work. The original conception of the project was a co-teaching model in the school setting, however, through attrition of Western science teachers (due to varying staffing situations at the schools) the cultural and language teachers took on the role of lead teacher—embedding the work within the Tribal community rather than the public school.

Indigenous Science Education Requires Many Educators with Diverse Expertise

The integration of Indigenous and Western knowledge in science curriculum required educators to come together to share their knowledge in a humble, flexible, and relational way. In some instances, the teaching and knowledge resisted “integration” and instead necessitated important conversations about the curriculum being taught from a cross-cultural framework (see Aikenhead, 2002). It was the project’s goal for each Tribal community to develop its own unique curriculum that was rooted in language, culture, and land— then make connections to Western science. To accomplish this, the Tribal partners led the direction of the project and invited an assemblage of diverse educators and knowledge carriers that varied depending on the subject.

When the full group began building the curriculum it was clear that there was no one person who held the knowledge in all of these unique areas. For example, one community chose the topic of Wildlife as the main subject of the curriculum. Within Wildlife, there were many learning outcomes across TEK, Western science, language, and technical and practical learning objectives. Within TEK, we had to seek out several diverse cultural experts who were

knowledgeable in distinct areas such as subsistence and traditional hunting practices, wildlife tracking, ceremonial importance of wildlife, traditional observation of wildlife behavior and migration, and traditional stories featuring wildlife. Similarly, with the Western science learning outcomes, we had to recruit a diverse group of Western scientists knowledgeable in wildlife identification, population dynamics, forest structure, and mapping. To complete the curriculum required successive group meetings and relational events to build trust and respect amongst the educators. The relationship-building process was important and ongoing throughout the 5-year project.

Respecting Tribal and Individual Autonomy and Timelines

The CRIS project worked to develop an Indigenous science curriculum and professional learning opportunities by adhering to and respecting Tribal expectations and values from each community while also respecting individual Tribal member's autonomy—this manifested in several ways. First, at the Tribal level, the WSU team consulted with each Tribal government and applied for respective permits and permission before the onset of the CRIS project. When working with Tribal cultural and language teachers, we were careful not to control the topics and direction of the curriculum development, rather we took a participatory approach and encouraged them to direct the content of each unit plan and timelines. Using this approach, all curricular content and educational resources originated within each Tribal community.

The ongoing COVID-19 pandemic impacted all three Tribal communities greatly and required the University team to reevaluate outcomes to respect the pace at which each Tribal partner was able to progress with curriculum development. This included reestablishing timelines and events with each community directly and working more individually with the Tribes. Core activities such as the teacher institute and youth field trips to campus were temporarily halted

and later rescheduled individually due to Tribal and state government mandates. After re-opening, each Tribal community had unique needs, priorities, and requests to complete grant objectives and activities. The team worked individually with each Tribe on developing curriculum according to their schedule and adjusted expectations for deliverables based on capacity and technological issues posed by the pandemic. Overall, we had to navigate and prioritize both Tribal and individual autonomy and rethink agendas, objectives, and timelines.

Remembering Who the Work is Meant to Serve

When Tribal elders, language, and cultural educators were asked questions about what motivated them to do the work of the CRIS project, the answer was always “the youth.” The deep care for youth brought all the CRIS team members together, motivating us to push past difficult barriers to educate Native American and mainstream students with the rich Indigenous TEK that contributes to our understanding and management of the natural world.

Despite strong culturally responsive and student-centered models emerging in regions across the country over the last two decades (Paris & Alim, 2014), Western approaches (e.g., teacher-centered, top-down) remain deeply ingrained in science education, even in Native American communities. The length of this project and the dedicated work with Tribal educators, community members, and students created space to critically reflect on ways we could embrace a more student-centered approach. For instance, one Tribal language teacher and a WSU Native American graduate student met weekly to plan lessons and implement the curriculum at the Tribal school while integrating students’ feedback and interests along the way. They utilized an interactive tool using iPads, which assessed students’ curiosity and engagement as they worked on an Indigenous science lesson. The technology tools also allowed teachers to dive deeper into

Indigenous science concepts with some students while other students engaged in self-directed learning with iPads.

Summary of Reflections and Recommendations

Over the 5-year project, we reflected regularly on our objectives and collaborative process. Ultimately, we saw that developing and implementing Indigenous science curriculum and professional learning opportunities is a communal and iterative process. As a result, we offer some recommendations based on our key learnings:

1. Intentionally create relational spaces for critical reflections and establish agreed-upon processes, values, and goals. Sometimes university researchers can focus too heavily on project objectives and grant-driven timelines for deliverables. The greatest product is knowledge sharing and the development of trusting relationships that ultimately leads to results that have a greater impact within communities (Welsh, 2008).
2. Emphasize collaboration with the communities, rather than only teachers or those who are labeled educators. Involving community members from adjacent fields and elders will broaden and enrich the knowledge base (Tynan & Loew, 2010).
3. Creating Indigenous science curriculum is community- and place-specific and needs to be created by many local experts. Adopting a community-based participatory approach throughout the entire project is needed to help ensure Tribal governments and members hold control of their knowledge systems at every level of project development (Bang & Medin, 2010).
4. Educators are often pressured to hold certain standards that may create a teacher-focused curriculum. Take time to critically reflect and create opportunities to gain feedback from

students which will encourage engagement and motivation, both among students and educators (Chandra, 2014).

References

- Aikenhead, G.S. (2002). Cross-cultural science teaching: Rekindling traditions for aboriginal students. *Canadian Journal of Science, Mathematics, and Technology Education*, 2(3) 287-304. <https://doi.org/10.1080/14926150209556522>
- Baker, D.R. (2003). Equity issues in science education. In B.J. Fraser & K.G. Tobin (eds.), *International Handbook of Science Education* (pp.869-895). Dordrecht, the Netherlands: Kluwer. <https://doi.org/10.1007/978-1-4020-9041-7>
- Bang, M., & Medin, D. (2010). Cultural processes in science education: Supporting the navigation of multiple epistemologies. *Science Education*, 94(6), 1008-1026. <https://doi.org/10.1002/sce.20392>
- Barnhardt, R., & Kawagley, A.O. (2005). Indigenous Knowledge Systems and Alaska Native Ways of Knowing. *Anthropology and Education Quarterly*, 36(1), 8-23. <https://doi.org/10.1525/aeq.2005.36.1.008>
- Barnhardt, R. (2008). Creating a place for Indigenous knowledge in education: The Alaska Native Knowledge Network. In D. Gruenwald and G. Smith (Eds.), *Place-Based Education in the Global Age: Local Diversity* (pp. 113-133). New York: Lawrence Erlbaum Associates. <https://doi.org/10.18251/ijme.v10i1.112>
- Brayboy, B. M. J. (2005). Toward a tribal critical race theory in education. *The Urban Review*, 37(5), 425-446. <https://doi.org/10.1007/s11256-005-0018-y>
- Brayboy, B. M. J. (2013). Tribal critical race theory: An origin story and future directions. In *Handbook of Critical Race Theory in Education* (pp. 108-120). Routledge. <https://doi.org>

/10.4324/9781351032223

- Chandra, D.V. (2014). Re-examining the importance of Indigenous perspectives in the Western environmental education for sustainability: “From Tribal to mainstream education”. *Journal of Teacher Education and Sustainability*, 16(1), 117-127. <https://doi.org/10.2478/jtes-2014-0007>
- Kant, J.M., Burckhard, S.R., & Meyers, R.T. (2018). Engaging high school girls in Native American culturally responsive STEAM enrichment activities. *Journal of STEM Education*, 18(5), 15- 25. <https://doi.org/10.3389/fpubh.2022.789994>
- Kawagley, A.O., & Barnhardt, R. (1998). Education indigenous to place: Western science meets native reality. Alaska Native Knowledge Network. <http://www.ankn.uaf.edu/EIP.html>
- Lander, E.S., & Mallory, B. (2021, November 15). Indigenous traditional ecological knowledge and federal decision making. The White House House. <https://www.whitehouse.gov/ostp/news-updates/2021/11/15/white-house-commits-to-elevating-indigenous-knowledge-in-federal-policy-decisions/>
- McKinley, E. (2005). Locating the global: Culture, language and science education for indigenous students. *International Journal of Science Education*, 27(2), 227-241. <https://doi.org/10.1080/0950069042000325861>
- McKinley, E. (2020). The Cultural interface tension: Doing Indigenous work in the academy. *Cultural Studies of Science Education*, 15(2), 515-621. <https://doi.org/10.1007/s711422-019-09963-6>
- Paris, D. & Alim, S. (2014). What are we seeking to sustain through culturally sustaining pedagogy? A loving critique forward. *Harvard Educational Review*, 84(1), 85-100. <https://>

[/doi.org/10.17763/haer.84.1.9821873k2ht16m77](https://doi.org/10.17763/haer.84.1.9821873k2ht16m77)

Smith, L. T. (2013). *Decolonizing methodologies: Research and Indigenous peoples*. Zed Books Ltd. ISBN:1-78699-812-2

Tynan, T., & Loew, P. (2010). Organic video approach: using new media to engage Native youth in science. *American Indian Culture and Research Journal*, 34(4), 31-40. <https://doi.org/10.17953/aicr.34.4.078377662754gg57>

Welsh, C.A. (2008). Making science education meaningful for American Indian students: The effect of science fair participation. (Publication No. 3330519) [Doctoral Thesis, University of Minnesota] ProQuest Dissertations Publishing.