

# Culturally Integrated Sustainability Education

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**Abstract:** Much of the teaching and learning happening within the environmental studies adopts a highly Westernized framing of the environment and humans' relationship to it, which has largely excluded the perspectives of Indigenous Peoples and the knowledge of Indigenous Science. In this paper, we outline how we are unsettling environmental sciences in institutions of higher education and building professional development (PD) for science educators in various contexts.

**Keywords:** Indigenous Science, Culturally Responsive Pedagogy, Professional Development.

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## Teaching for Tomorrow: *Unsettling Environmental Education*

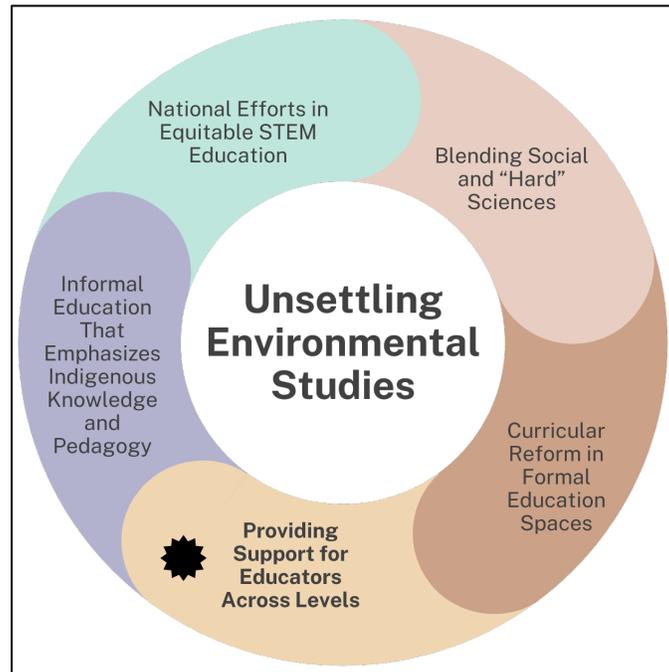
Waaban is Ojibwe for “tomorrow.” It embodies the Ojibwe philosophy of seventh generation planning. When making decisions and taking actions today, Ojibwe consider not only the immediate future, but also their impact on children seven generations hence. Similarly, holistic and long-term planning is imperative for the conservation and stewardship of the environment and natural resources. However, much of the teaching and learning happening within the environmental studies adopts a highly Westernized framing of the environment and humans' relationship to it, which has largely excluded the perspectives of Indigenous Peoples and the knowledge of Indigenous Science. In this paper, we outline how we are unsettling environmental sciences in institutions of higher education and building professional development (PD) for science educators in various contexts.

Western science, a dominant paradigm for knowing and learning about the world, is built on legacies of systemic racism and oppression. Among other global examples, settler colonialism in the United States effectively weaponized knowledge to exterminate and assimilate Indigenous peoples (Dunbar-Ortiz). By forcing Indigenous and Native people to surrender lifeways and knowledge systems, colonizers succeeded in positioning Western, Eurocentric ways of knowing and being in the world as the “right” way of knowing (Kimmerer and Artelle, 243). Western science remains wrought with exclusionary narratives of what counts as “intelligence” and whose voices are represented, a persistent phenomenon that pervades science education in the United States at primary, secondary, and post-secondary levels (Dewsbury, 169-170). College science teaching seeks to emulate the practices and processes of Western science, and, by extension, perpetuates inequities in similar ways (Barron et al, 1322). To date, Native Americans are the least represented group in science, technology, engineering, math careers and college education programs.

National calls for reform, however, are disrupting these legacies. Notably, the National Science Foundation recently supported the development of the Center for Braiding Indigenous Knowledges and Science (CBIKS) as a means of uplifting and affirming the rich knowledge systems held by Indigenous communities. Specifically, CBIKS seeks to utilize the inclusion of Indigenous knowledges as an approach to solving some of the world’s critical issues related to climate change. Related to college STEM education, the National Academies of Science, Engineering, and Medicine have convened a committee to develop a framework for effective and equitable undergraduate STEM teaching and learning, aimed at addressing inequity in

undergraduate STEM education. Efforts such as these are important in the work of unsettling *settled expectations* (Bang et al., 303) of what knowledge systems count as valid and whose voices are represented in STEM.

Environmental science and environmental studies remain highly settled spaces. In fact, programs labeled as *environmental science* tend to be inclusive only of the “hard sciences” while those labeled *environmental studies* tend to be those that take up issues of the human and societal dimension of the environment. Advancing our efforts in unsettling these spaces will require explicit recognition and incorporation of the socio-scientific nature of the environment, and adoption of new teaching practices and philosophies not just within environmental studies programs but also within the teaching of environmental science (Figure 1).



**Figure 1: Conceptual diagram demonstrating the multifaceted approach needed to continue unsettling environmental studies.**

Ultimately achieving the goal of establishing new ways of teaching about the environment within the Western Academy will require efforts across a broad range of educational settings and systems. Each of these facets of unsettling engage different stakeholders and leverage expertise across communities and disciplines, so it is imperative to engage in this work with thoughtful and reflective practices that align to the specific approach. To this end, our work here highlights our efforts to develop opportunities for systemic and sustained support for educators as they work towards integrating culturally sustaining curriculum and pedagogical practices into their spaces.

### **Unsettling Environmental Studies in Minnesota: A Model of Educator Professional Development**

Our work is situated within Minnesota, which provides important geographic, political, and cultural context for our work. Indigenous communities across Minnesota have a long history of engagement with environmental conservation and sustainability, yet much of the science that informs Minnesota's approach to environmental conservation does not include Indigenous knowledge. To create an environmentally literate society that is equipped to protect Minnesota's natural resources, we must create and implement educational resources and opportunities that are diverse, equitable, inclusive, just, and help learners make informed choices that support sustainable natural resource management. Through culturally responsive environmental education programming, we can engage students in practices that emphasize sustaining tribal heritage alongside scientific advancement. Our team was drawn together to further these efforts by developing sustained professional development opportunities for educators that promote environmental literacy and intercultural understanding and may serve as a model for others working towards unsettling environmental studies.

The authors work within these *settled expectations* and particularly in systems of higher education that train the formal education (teacher licensure) and informal education (youth work, youth development) workforce *and* in departments that provide specialized undergraduate instruction in related fields of science (Biology, Bio-Engineering etc) to formal and informal educators and science professionals. While our research and teaching has focused on integrating Indigenous Knowledge into various aspects of our work, recent changes to the State of Minnesota’s Science Standards for K-12 grades propelled this aspect of our work forward. Beginning in the 2024-2025 school year, the State of Minnesota requires students to meet a number of new benchmarks related to Minnesota Tribes & communities. These changes require teachers to provide opportunities for their students to “gather information about and communicate the methods that are used by various cultures, especially those of Minnesota American Indian Tribes and communities, to develop explanations of phenomena and design solutions to problems”.

The standards represent a significant step forward in ensuring that traditional knowledge and Indigenous ways of knowing are reflected in the teaching of science for Minnesota students, but few teachers have been adequately prepared to instruct their students on these topics. Minnesota teachers report a lack of knowledge, skills, pedagogical expertise and resources in addition to concerns about authenticity and misrepresentation (Wood-Krueger). Most have no formal training on Indigenous science philosophy, history, or methods, many report a lack of lived experience and a shortage of science-focused professional development resources and

opportunities to build skill, confidence and meaningful engagement with Native tribes and individuals (Roehrig, et al., 73-74).

All of these factors converge to make implementation of these new standards a significant challenge. To respond to this challenge, our project team designed an innovative model for educator professional development that specifically supports middle and high school teachers integrating Indigenous knowledge into the science curriculum using a *culturally sustaining/revitalizing* lens—teaching that perpetuates, fosters, and sustains linguistic, literate, and cultural pluralism in a democratic society *and* supports the sovereignty, self-determination and futures of Indigenous communities (Lee and McCarty, 61-82; Paris, 93-97).

Our PD model unites interdisciplinary scientists with science educators in Minnesota to promote environmental literacy and intercultural understanding. Through culturally responsive environmental education programming, we engage participants in practices that emphasize sustaining Tribal heritage alongside scientific advancement. Our work creates pathways for sustainable community engagement across cultural spaces to better connect educators to community assets and knowledge in ways that equitably value different knowledge bases rather than co-opt them. We aim to accomplish two key goals within our framework: 1) building science educator self-efficacy and 2) increasing students' conceptual understanding and critical thinking around sustainability.

Drawing on our existing knowledge and best practices in professional development (Hunzicker, 177-179), we designed and offered professional development learning communities (currently in

year 2) that include professional development workshops, professional learning communities, and sustained engagement. We describe each below and connect our work to implications for higher education STEM teaching and learning.

### *Professional Development Workshops*

We partner with Indigenous content experts to provide culturally-sustaining, 1-2 day professional development (PD) sessions to bridge the preparation gap for science educators with specific consideration of both Indigenous and Western scientific perspectives and pedagogical expertise.

To align with the new Minnesota Science Standards, we incorporate the three-dimensional learning framework that emphasizes *science practices*, disciplinary *core ideas* (physical sciences: physics/chemistry, life sciences: ecosystems, biology/evolution, earth/space sciences and engineering/tech/practices) and *crosscutting concepts* (National Research Council) integrated with Indigenous funds of knowledge. By explicitly integrating these aims and perspectives, we provide science educators with a more holistic knowledge base of both Indigenous Science and practical applications of the new science standards.

This foundational content is delivered utilizing pedagogical practices of the Tribal knowledge holders. Our workshops prioritize multimodal pedagogies that go beyond the books and classrooms that are typical to “science” education and into field laboratories, traditional harvesting grounds, waterways or sacred sites. For example, we have utilized traditional storytelling and public performance to introduce philosophical differences in resource management vs resource relationship models. We have explored botanical knowledge through hands-on cordage lessons, learning tribal language and harvest calendars, and collecting and demonstrating traditional foods and food processing methods. We have introduced tribal youth

leadership programs that mitigate invasive species and conserve/steward sacred places. We have investigated space sciences through tribal star maps, celestial names and stories and integrated field-based investigation of sustainability and water ecosystems in traditional watersheds. Teachers not only learn new content, but they do so in pedagogically innovative ways.

### *Professional Learning Communities*

To promote the integration of knowledge and pedagogy in the classroom, we establish Professional Learning Communities (PLCs) which provide ongoing, job-embedded mentorship and support to participants over the course of a year. With district and school-level administrative support, we continue to meet and support teachers over the course of the academic year via 3-4 virtual meetings. These communities are teacher-led but we engage in a variety of supportive practices: book clubs, facilitated dialogues, resource curation, development of mini-units, evaluation of student and teacher efficacy, consultation with master educators, ongoing learning opportunities and continued stakeholder engagement for future program iterations.

### *Sustainable Engagement*

Recognizing the need for sustainable engagement between teachers and Minnesota Tribes, Tribal departments (natural resources, historic preservation offices, education etc), community members, community-based Native American science educators and places (lands, waterways, more-than-human relatives etc) and statewide environmental learning centers providing Indigenous science opportunities, we explicitly create spaces to build relationship with these partners. In addition to our formal offerings, we invite teachers to attend public events and gatherings, forward relevant community resources and additionally invite district staff from

Indian Education units into our learning communities to build relationships, share knowledge and promote shared projects.

### **Preliminary Impacts**

In year two of our project, we have collected preliminary data that has given us insights into how our program model has impacted teachers. Two areas stand out: 1) science educator self-efficacy evolves over their time in the program, and 2) science educators grow in their awareness of Eurocentric, settled approaches of science and in their ability to identify colonizing practices in Western science education.

#### *Science Educator Self-Efficacy*

In one-on-one interviews with teachers toward the end of our first year, we asked them to reflect on their self-confidence over the course of the year and how, if at all, it changed as they learned more about Indigenous Science knowledge. Broadly, teachers moved from a space of “we don’t know what we don’t know” and “we are afraid to do or say the wrong thing” to a place of “we know where to go to learn more.” One teacher noted that the inclusion of Indigenous Science knowledge “feels like it lends itself better to learning about science” than they had originally perceived prior to working with their peers throughout the year.

Another reflected,

“That’s the conclusion we came to...you know, I could talk about science in a different way, like telling the story of science rather than just notes and facts. And I tried to incorporate [storytelling] a little bit and actually had the students tell us some stories. They loved talking about themselves.”

To make the leap from being concerned about misstepping to feeling confident enough to facilitate storytelling as a pedagogical tool is a distinct shift in self-efficacy. Across many of our educator participants, we observed similar themes of increased self-confidence and self-efficacy.

### *Awareness of Settled Approaches in Science Education*

We saw science educators grow in their awareness of settled and colonizing approaches in Western science education. A common misconception about Native American and Indigenous people is that they are historical. One teacher reflected that our program reinforced that Indigenous people “didn’t just live here in the past...they didn’t go anywhere.” They went on to discuss how the learning about Indigenous Science knowledge was transformative for the way they perceived science education, saying “Having that foundation for [students] is really important...because it’s really good science.”

Another participant reflected on the way Western scientists are dominant in the teaching of who discovered phenomena:

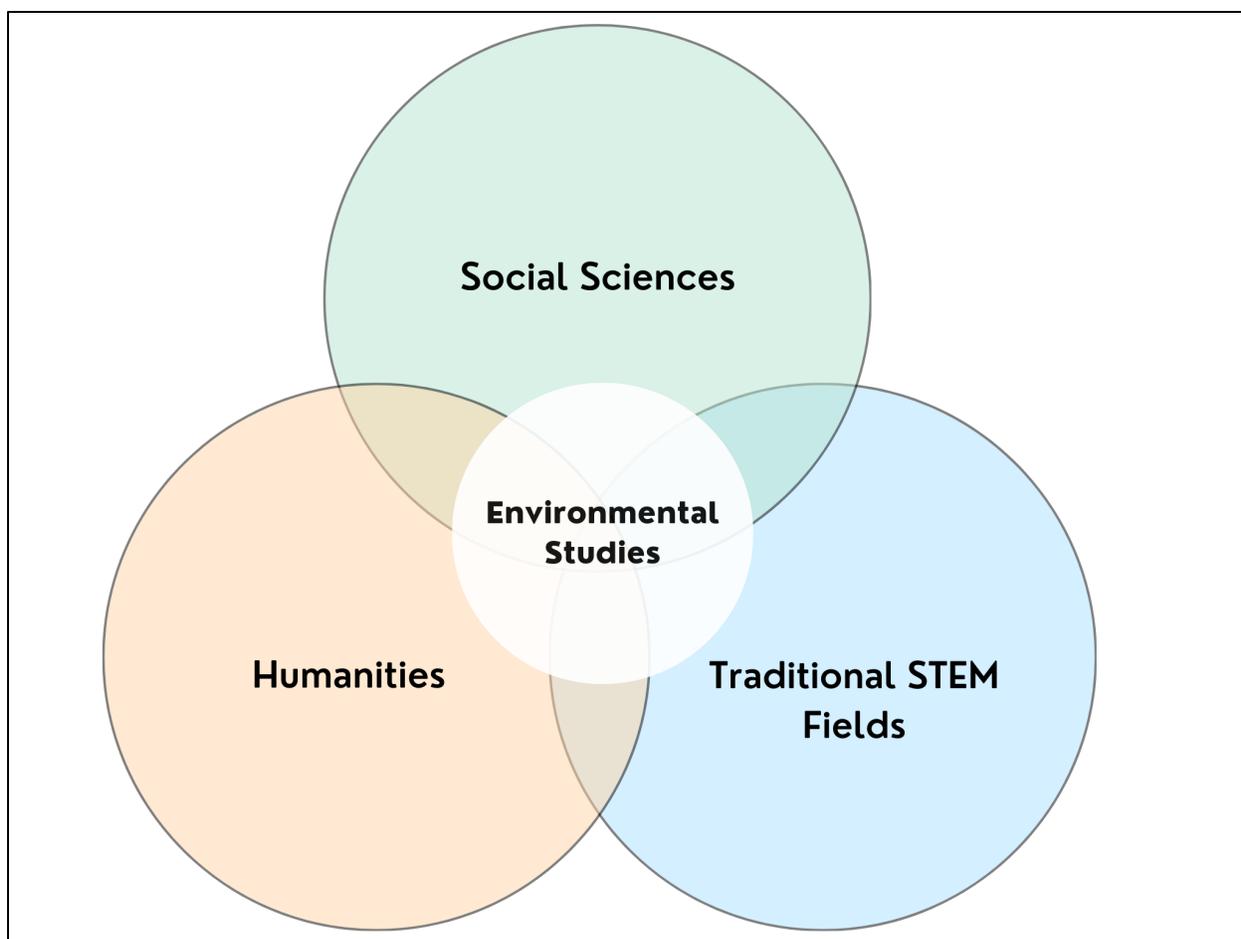
“Now I try to mention ‘You know this is one way that people did things’ or if we talk about Gregor Mendel, ‘This is one person who has studied [genetics], but people all around the world have [done] things like this, but who gets the credit for this?’ I’ve been trying to do things like that.”

Being able to both recognize settled structures in science education, and then also incorporate that into teaching practices is a significant theme that we are excited to continue to explore.

As we continue to collect data, we hope to better understand the impact of our model on *science educator knowledge and self-efficacy* as well as *increasing science knowledge and critical thinking around sustainability* amongst Native and non-Native student knowledge, identity development and interest in environment, science-based and natural resource management careers.

### **Implications for Higher Education**

Here, we argue that effectively unsettling environmental studies will require specific attention to unsettling the various disciplines that comprise environmental studies (see Figure 2). In particular, more attention is needed in unsettling the life and “hard” sciences that have comprised what has traditionally been referred to as the STEM fields. Despite the fact that major funding agencies (such as the National Science Foundation) include social and behavioral sciences under the umbrella of STEM, there remain distinct and siloed cultures that have effectively served to separate these disciplines from the life, physical, and chemical sciences (as well as fields of engineering and technology, which have major implications for environmental studies in their own right). Therefore, from an educational perspective, higher education remains a place of *highly settled approaches* to the teaching of environmental topics within the traditional STEM disciplines (such as physics, environmental chemistry, ecology, etc) because the culture of these underlying disciplines remain highly settled and those trained within these disciplines have largely been trained to think of their work as outside of or separate from the types of thinking in the social sciences and humanities that can be powerful tools for unsettling.



**Figure 2: Disciplinary Composition of Environmental Studies.**

Environmental studies is a multidisciplinary approach that draws on disciplines across the humanities, social sciences, and traditional STEM fields. Because of this, effectively unsettling environmental studies will require efforts that work to unsettling each of the disciplines that contribute to this multidisciplinary field. Traditional STEM fields have historically been hesitant to implement knowledge, philosophies, and methodologies from the social sciences and humanities that are powerful tools for unsettling. Our work aims to highlight the importance of unsettling within the traditional STEM fields as an aspect of unsettling environmental studies overall. In this way, our work aims to challenge educators within traditional STEM fields to incorporate Indigenous science within their classrooms, rejecting the notion that “Indigenous

ways of thinking should only be taught in social studies or history” that is commonly held by many STEM educators.

The benefits to students of incorporating an Indigenous-centered model of science teaching are numerous. Indigenous students whose instructors utilize an Indigenous sustainability-focused approach to science teaching will be more likely to see themselves in the science content they are learning. This builds student self-efficacy in science learning, as well as contributes toward building positive identities in science. When non-Indigenous students are exposed to Indigenous models of sustainability, they too are positioned to develop positive science identities that value inclusion of nature-culture relationality. However, in higher education STEM teaching and learning, the same impetus for change as we see in Minnesota does not exist. While there is a growing body of discipline-based education researchers (DBER) who are making strides in novel teaching practices, especially for inclusive and equitable STEM, DBER is not wholly represented across the institutional landscape. Additionally, there are no unifying education standards in college STEM classrooms and laboratories, aside from the traditional topics we expect to see across courses.

To meet the moment of the national shift in priorities outlined in our introduction, higher education STEM must pivot from dense, content-only focused instruction, to more holistic pedagogies that infuse and promote multiple ways of learning and knowing about the world. Our professional development model can be a guidepost for such work. We acknowledge that science educators in higher education STEM are often at capacity given their research and teaching responsibilities, and thereby emphasize the importance of all three facets of our model:

*professional development workshops* that aim to build community and provide a safe learning space, *professional learning communities* that foster collaboration, discussion, and growth, and *sustained engagement* that elevates the importance of the recursive development of the individual. In this regard, the model of professional development is as important as the focus, which is to affirm and uplift the authentic and respectful inclusion of Indigenous Science in our traditionally settled Western science learning spaces.

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**Hillary A. Barron** is an Associate Professor of Biology at Bemidji State University. Dr. Barron’s research focuses on creating equitable and culturally responsive science learning opportunities for students. She works with faculty and teaching assistants in academic biology to create teaching strategies that center culturally relevant pedagogy, funds of knowledge, and social justice science issues. Dr. Barron is a descendent of the White Earth Band of Ojibwe, and is passionate about blending Indigenous and Western Science.

**Katie Johnston-Goodstar** is an Associate Professor at University of Minnesota – Twin Cities. Dr. Johnston-Goodstar specializes in Indigenous youth studies, decolonization and systems transformation, youth participatory action research (YPAR), indigenous and participatory methods. Dr. Johnston-Goodstar has over a decade of experience in co-designing and implementing Participatory Action Research projects generating knowledge for Indigenous youth and community well-being. These have included projects on school transformation, revitalization of indigenous knowledge, environmental justice, sexual exploitation and data justice which have contributed to changes in policy, practice and systems.

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**Seth K. Thompson** is the Programs Director at the Freshwater Society, a nonprofit organization in St. Paul Minnesota that works to protect and preserve Minnesota's freshwater. He has a decade of experience designing and delivering programs that sit at the intersection of science and societal impact. He earned his PhD in limnology and oceanography in the Water Resource Sciences program at the University of Minnesota in 2019 and has worked on issues related to STEM equity and innovative science education.

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