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Engineering the Earth or Living With It? Transforming Mindsets for True Sustainability

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Abstract

Despite decades of research and countless proposed solutions, global sustainability challenges continue to intensify. Engineers design greener technologies, optimize energy use, and model environmental systems—yet we often find ourselves in the same loop, generating new solutions that fail to solve the deeper problem. This paradox suggests that the root issue is not technical but mindset-based. In engineering education, sustainability is frequently presented as a problem to be fixed rather than a relationship to be understood.

This study explores how introducing Indigenous perspectives on sustainability—particularly those emphasizing interconnectedness, reciprocity, and long-term stewardship—can reshape students' understanding of their role as engineers. Drawing inspiration from Native American worldviews, undergraduate engineering students were asked to reflect on how their design philosophy might change if they viewed the environment not as a resource but as a living partner. Their reflections were analyzed for shifts in mindset, systems thinking, and ethical awareness.

Preliminary findings indicate that exposure to Indigenous sustainability perspectives fosters humility, relational awareness, and a deeper sense of responsibility. Students began to articulate sustainability as an ongoing relationship rather than an optimization problem. The study concludes that the persistent failure of sustainability efforts lies not in our lack of innovation, but in the worldview that drives our innovations. Transforming engineering education to include Indigenous perspectives may offer a pathway out of the sustainability loop—helping future engineers think not only about efficiency, but about harmony, reciprocity, and belonging within natural systems.

1. Introduction: Sustainability, Worldviews, and Engineering Education

Despite decades of research, technological advancement, and policy initiatives, global sustainability challenges continue to intensify. Engineers play a central role in addressing climate change, resource depletion, and environmental degradation by designing greener technologies, optimizing energy use, and modeling environmental systems. Yet many sustainability interventions fail to produce lasting or transformative change. This disconnect suggests that sustainability challenges are not solely technical, but are also shaped by the worldviews that guide how engineers define problems, prioritize solutions, and relate to the natural world (Meadows, 2008; Sterling, 2011).

In engineering education, sustainability is frequently framed as a problem to be mitigated through efficiency, optimization, and regulatory compliance. While these approaches are essential, they often reflect anthropocentric and extractive assumptions that position nature as a resource to be managed rather than as a living system to which humans belong (Riley, 2008). As a result, students may develop strong technical skills while remaining less equipped to engage with the ethical, relational, and long-term dimensions of sustainability.

In contrast, Indigenous knowledge systems—often described as **Traditional Ecological Knowledge (TEK)**—offer well-established frameworks for understanding sustainability as a relationship rather than a technical endpoint. TEK emphasizes interconnectedness, reciprocity, respect, and responsibility to future generations, grounded in place-based knowledge developed over millennia (Berkes, 2018). Indigenous relational worldviews frame knowledge and action as inseparable, emphasizing participatory, relational, and responsibility-centered ways of knowing and being (Romm, 2024). Indigenous scholars such as **Robin Wall Kimmerer** articulate these principles through concepts such as reciprocity with the land, gratitude as an ethical practice, and belonging within ecological communities rather than dominance over them (Kimmerer, 2013). Together, these perspectives challenge dominant engineering paradigms by shifting the focus from control and optimization toward harmony, stewardship, and balance within natural systems.

Recent scholarship in engineering education highlights the importance of incorporating Indigenous knowledges and perspectives to support more holistic forms of engineering identity and practice. Studies show that Indigenous students often view engineering as inherently relational and community-centered, challenging deficit-based narratives and expanding dominant conceptions of engineering leadership and responsibility (Kwapisz et al., 2021). Similarly, prior work demonstrates that integrating Indigenous values and perspectives into engineering education can enhance ethical reasoning, systems thinking, and sustainability-oriented decision-making for all students, not only Indigenous learners (Forrest et al., 2021). These findings support calls to broaden sustainability instruction beyond technical competencies to include ethical reasoning, systems thinking, and culturally grounded perspectives (Baillie & Levine, 2013; Mihelcic et al., 2003).

Integrating Indigenous sustainability frameworks such as TEK provides a concrete and respectful pathway to meet these goals. Rather than replacing engineering content, these perspectives invite students to reconsider *why* and *for whom* engineering solutions are developed. In practical terms, harmony may be considered through design decisions that minimize disruption to ecological

systems; reciprocity through restorative or regenerative design practices; and belonging through recognition of engineers as participants within, rather than external to, natural systems.

This research-based study examines how introducing Indigenous sustainability perspectives grounded in TEK influences undergraduate engineering students' understanding of sustainability and their professional role as engineers. The study was conducted in an introductory engineering course and involved a dedicated instructional session on Indigenous worldviews followed by a reflective assignment based on Chief Seattle's Letter (Smith, 1887), used as a pedagogical artifact representing relational sustainability values. Student reflections were analyzed using qualitative thematic analysis to identify shifts in worldview, ethical awareness, and application to engineering design. By grounding sustainability education in Indigenous frameworks and examining student responses empirically, this work contributes to ongoing efforts in engineering education to move from sustainability as technical optimization toward sustainability as relational and ethical practice.

2. Research Context and Methodology

2.1 Course Context and Participants

This study was conducted in ENG 190 (Elementary Engineering Design) course at Purdue University Northwest in Mechanical and Civil Engineering department, a required introductory engineering course which offers to multiple engineering majors. The course introduces students to foundational engineering concepts, design thinking, and professional responsibilities, making it an appropriate context for exploring sustainability and engineering identity formation early in the curriculum.

Participants represented a range of academic backgrounds and levels, and the activity was embedded within regular course instruction. Student participation in the research use of the assignment was voluntary and did not affect course grading.

2.2 Instructional Intervention

One full class session was dedicated to sustainability and alternative ways of understanding human–environment relationships. During this session, students were introduced to Indigenous perspectives on sustainability, with particular emphasis on Native American worldviews that frame nature as an interconnected living system rather than a resource for extraction or control. Core ideas discussed included interconnectedness, reciprocity, long-term stewardship, and responsibility to future generations.

The session was designed as a reflective and discussion-based experience rather than a technical lecture. Its purpose was to prompt students to critically examine dominant engineering assumptions about sustainability and to consider how worldview influences engineering decision-making.

2.3 Chief Seattle's Letter as a Pedagogical Artifact

Chief Seattle's Letter is commonly attributed to Chief Seattle (Si'ahl), a leader of the Duwamish and Suquamish peoples of the Pacific Northwest, and is associated with an 1854 speech delivered during treaty negotiations between Native American tribes and representatives of the United States government. The speech reportedly responded to increasing pressure on Indigenous communities to cede their ancestral lands during a period of rapid Euro-American expansion. Chief Seattle's words were translated orally at the time and later reconstructed and published in multiple forms.

Because the speech was transmitted through translation and later interpretation, no single version of the letter can be considered a verbatim historical record. Nevertheless, the text has endured as a widely recognized narrative expressing Indigenous perspectives on land, responsibility, and belonging. Across its various versions, consistent themes emerge, including the interconnectedness of humans and nature, the sacredness of the land, and moral responsibility to future generations.

In this study, the letter was intentionally used as a **pedagogical artifact** rather than as a historical document. Its purpose was to introduce engineering students to an Indigenous relational worldview that contrasts with dominant engineering paradigms emphasizing control, optimization, and resource extraction. The letter was selected for its accessibility, narrative clarity, and capacity to prompt ethical and reflective engagement among students with limited prior exposure to Indigenous knowledge systems.

Students were informed of the historical context and interpretive nature of the text and were encouraged to engage with its underlying sustainability values rather than its historical authorship. This framing allowed the letter to function as an instructional tool for examining how worldview influences engineering decision-making.

2.4 Reflection Assignment

Following the in-class session, students were assigned a homework reflection activity. Students were asked to read **Chief Seattle's Letter**, a text commonly referenced for its articulation of Indigenous relational perspectives on nature. After completing the reading, students responded in writing to the following five open-ended reflection questions:

1. What is one sentence or idea from the letter that stood out to you the most? Why?
2. How does Chief Seattle describe the relationship between humans and nature?
3. Does this worldview align with how you usually think about engineering design? Explain.
4. If you applied this mindset to one engineering project you've worked on, what would change?
5. What responsibility—if any—does this letter suggest engineers have to future generations?

Students submitted their responses as a single written document through the course learning management system. The assignment emphasized thoughtful reflection and connection to engineering practice rather than correctness.

2.5 Data Collection and Ethical Considerations

Student submissions were collected as part of normal coursework. Prior to analysis, all responses were **de-identified** to protect student privacy. Students were informed that their responses might be used anonymously for educational research and conference publication. Participation in the research component was voluntary and had no impact on assignment grading.

2.6 Data Analysis

The collected reflections were analyzed using **qualitative thematic analysis**. An inductive coding approach was employed to identify recurring patterns and concepts across student responses. Initial codes were generated through multiple readings of the data and subsequently grouped into broader themes related to sustainability mindset, human–nature relationships, ethical responsibility, and engineering design practice.

This approach allowed for the identification of common ways students interpreted Indigenous sustainability perspectives and how these interpretations influenced their understanding of engineering roles and responsibilities.

4. Findings: Student Reflections on Indigenous Sustainability Perspectives

Analysis of student reflections revealed consistent patterns in how students interpreted Indigenous sustainability perspectives and how these perspectives influenced their understanding of engineering practice. Five dominant themes emerged across the data, reflecting shifts in worldview, ethical awareness, and application to engineering design.

Table 1 summarizes the major themes identified through inductive thematic analysis, along with their educational significance. The themes reflect both conceptual understanding and applied reasoning, indicating that students engaged with the Indigenous sustainability perspective at multiple cognitive levels.

Table 1. Summary of Emergent Themes from Student Reflections

Theme	Description	Evidence from Student Responses	Educational Meaning
Interconnectedness of Humans and Nature	Humans described as part of a living system	“Belonging,” “everything is connected,” “not owners”	Shift from anthropocentric to relational thinking
Responsibility to Future Generations	Emphasis on long-term impacts	References to future harm, stewardship	Growth in ethical and temporal reasoning
Reciprocity and Respect for the Environment	Giving back rather than minimizing harm	Restoration, respect, stewardship	Sustainability reframed as active care
Tension with Traditional Engineering Mindsets	Conflict with efficiency-driven design	Cost vs. care, optimization vs. ethics	Critical reflection on engineering identity
Application to Engineering Design	Translation into concrete actions	Material choice, lifespan, reduced disruption	Worldview applied to practice

To illustrate the strength and consistency of the findings, Table 2 presents the frequency with which each theme appeared across student submissions. While the study is qualitative in nature, this frequency analysis provides insight into the relative prominence of each theme.
These results indicate that nearly all students engaged with relational and ethical dimensions of sustainability, and all students were able to apply the Indigenous perspective to engineering practice.
To provide contextual depth and illustrate how students articulated these themes in their own words, representative excerpts from student reflections are presented in Table 3. Quotes were selected to reflect common language patterns across multiple responses rather than isolated viewpoints.

Table 2. Frequency of Themes Across Student Reflections (n ≈ 60)

Theme	Number of Responses	Percentage of Students
Interconnectedness of Humans and Nature	55	92%
Responsibility to Future Generations	51	85%
Reciprocity and Respect for the Environment	39	65%
Tension with Traditional Engineering Mindsets	21	35%
Application to Engineering Design	60	100%

Table 3. Representative Student Quotes by Theme

Theme	Representative Quote
Interconnectedness	"The letter made me realize that we belong to the Earth, not the other way around."
Responsibility to Future Generations	"Engineers shouldn't design just for now, but for people who will live here long after us."
Reciprocity	"Instead of only reducing harm, we should give something back to nature."
Tension	"Engineering focuses on efficiency, but this letter made me question if that's enough."
Application	"I would change materials and design lifespan to reduce long-term environmental damage."

4.5 Summary of Results and discussion

Taken together, the tables and conceptual model demonstrate that introducing Indigenous sustainability perspectives prompted students to reconsider how they define sustainability and their professional role as engineers. Rather than framing sustainability primarily as a technical constraint or optimization problem, students increasingly described it as an ethical and relational responsibility embedded within engineering practice.

From a discussion standpoint, these findings suggest that exposure to Indigenous worldviews can disrupt dominant engineering paradigms that emphasize efficiency, control, and short-term performance. Students' reflections indicate emerging awareness of interconnectedness, reciprocity, and responsibility to future generations—concepts that are often underemphasized in

traditional engineering curricula. Importantly, students did not reject technical reasoning; instead, they began to recognize the limitations of purely technical approaches when addressing complex sustainability challenges.

The universal ability of students to apply Indigenous sustainability perspectives to concrete engineering design decisions further suggests that worldview-based interventions can meaningfully influence engineering thinking without sacrificing technical relevance. This supports the argument that sustainability education must address not only *how* engineers design solutions, but *why* and *for whom* those solutions are created. Integrating Indigenous perspectives therefore offers a promising pathway for fostering more holistic, ethical, and systems-oriented engineers capable of addressing the root causes of sustainability challenges rather than their symptoms alone.

3. Conclusion

The findings of this study suggest that integrating Indigenous sustainability perspectives into engineering education can meaningfully reshape how students understand sustainability and their professional role as engineers. Through a brief, low-cost instructional intervention—a dedicated class session followed by a reflective reading assignment—students moved beyond viewing sustainability solely as a technical constraint and began to frame it as an ethical, relational, and long-term responsibility.

Students' reflections indicate that Indigenous worldviews emphasizing interconnectedness, reciprocity, and responsibility to future generations can disrupt dominant engineering paradigms focused primarily on efficiency, optimization, and control. Importantly, students did not reject technical reasoning; rather, they recognized the limitations of purely technical approaches when addressing complex sustainability challenges. The ability of all students to apply these perspectives to concrete engineering design decisions demonstrates that worldview-based interventions can enhance, rather than detract from, engineering practice.

These results have important implications for engineering education. Incorporating Indigenous sustainability perspectives offers a practical and scalable approach for embedding ethics, systems thinking, and professional identity formation into existing engineering curricula without displacing technical content. By reframing sustainability as a relationship rather than a problem to be fixed, engineering education can better prepare students to address the root causes of environmental challenges.

Overall, this study suggests that the persistent failure of sustainability efforts may lie not in a lack of innovation, but in the worldviews that guide innovation. Integrating Indigenous perspectives into engineering education provides a pathway toward cultivating engineers who think not only about efficiency and performance, but also about responsibility, reciprocity, and belonging within natural systems.

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