PROJECT REPORT

A Student Exploration on Advancing Multicultural Science through Ethical Indigenous Engagement

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The philosophy and perspective of Western science seeks to explain large-scale phenomena with a universal rule in which the observers are isolated from the subject they are studying (i.e., are on the outside looking in). Originating from Greek and Roman practices of creating law and order (Enache, 2010; Huntington, 1996), the Western scientific method has long been society's preferred process for understanding the world and the universe beyond. As issues surrounding climate change and resource extraction continue to become more urgent, many have begun to question whether this approach is sufficient to address the myriad of concerns facing the natural world. In addition, there is a growing understanding of how Western science's culture can perpetuate harmful colonial systems of oppression, environmental injustice, and loss of human rights. Multicultural science is an all-inclusive and holistic way of knowing that considers the ways people from all backgrounds collect information, create

connections, and expand the range and breadth of their knowledge. It has also been asserted that decentering Western science and adopting a multicultural approach are required to address the grand civic and environmental challenges facing our world (Held, 2023).

We are a group of Western-trained biologists (seven students and one faculty member) from diverse cultural backgrounds, who spent a semester exploring how we might complement our epistemological approach to addressing real-world problems by including possibilities outside the Western-scientific methodology. As our campus sits on the unceded territory of the Wiyot people, and has nearly one dozen contemporary Native American communities in our admissions and services area, our project focused on the ways Indigenous people have utilized Indigenous Science to manage natural resources since time immemorial. Indigenous Science, which includes Traditional Ecological Knowledge (TEK), is relationship-based, grounded in the living understanding of how the world works (Proulx et al., 2021; Lipe, 2023). Human and non-human entities in the environment are considered equal and are reliant on each other in both a pragmatic and spiritual manner (Kimmerer & Lake, 2001; Lipe, 2023). Information and knowledge acquisition is accumulated and transmitted across generations within specific cultural contexts. Not only does this ensure practitioners can build upon the knowledge of others; it is also a form of survivance, as it often uses traditional forms of knowledge such as oral storytelling, which simultaneously resist colonialism and disseminate knowledge to succeeding generations (Vizenor, 2008; Dunbar-Ortiz 2023). In the last decade or so, non-Indigenous Western scientific researchers and management practitioners have increasingly begun to include TEK in their studies, as evidenced by the application of Indigenous knowledge in peer reviewed publications related to the ecological sciences (Jessen et al., 2022).

Our study focused on how to move towards a multicultural scientific approach through the ethical, authentic inclusion of Indigenous Science. Our reflections were informed by literature review and conversations with Indigenous and Western scientists at various stages in their careers. We offer this project report not as experts, but as facilitators hoping to inspire future conversations that will broaden the definition of knowledge in our individual disciplines and refine professional codes of ethics to ensure respect and the dignity and sovereignty of all peoples. Though still a work in progress, our realizations include the following:

1. Valuable scientific knowledge has been derived from the contributions of scientists prior to the establishment of Western civilization. Roger Hooykass derived a set of criteria of what science is: "Science acknowledges no authorities … except the authority of nature.… Science is experimental" and is based on the "direct observation of nature" (Hooykaas 1987, p. 455).
Similarly, Arthur Clegg (1979) also constructs a list of criteria that define the key features of what science is: "[Science] is the habit of isolating a problem for observation … the use of experiment as part of the observational process … a logical structure of reasoning … a theory of knowledge … [and the] belief that something can be discovered and is worthwhile" (p. 186). Additionally, Clegg makes the insightful remark that although there is no evidence of scientific experimentation before the end of the 16th century, the earliest evidence for experimentation and its resulting contributions originated with the apprentices of merchants and craftsmen in medieval Europe (Clegg, 1979, p. 187). Through observation and "copying their masters," apprentices learned through "active experience" and through trial and error (p. 188). The contributions of pre-modern scientists produced valuable knowledge and information that is still used today. The history of science presented by Clegg and Hooykass has direct parallels to TEK and the production of knowledge through trial and error, direct experience, and the acceptance of natural laws.

2. The mere juxtaposition of Western and non-Western cultures for the purpose of comparing and extracting information does not serve as a conducive means for integrating knowledge systems. "Science contributes to culture by energetically proclaiming its own testable knowledge—not by denouncing additional sources of testable knowledge that may in fact have great legitimacy and value" (Gauch, 2009, p. 39). The idea that some knowledge is more valuable than others not only limits the perspectives available to current researchers, it creates engagement barriers for scientifically curious students

of diverse backgrounds. "The failure to appreciate the unique temporal, cultural, economic and political webs of social matrices that make up the immediate lives and environments of students' epistemological views only furthers hegemonic powers" (Zeidler, 2014). Cultural understanding must transcend mere translation of information to establish the equitable collaboration between cultures required for innovation and advancement.

3. The creation of a multicultural science requires Western scientists to acknowledge that all knowledge, no matter its origins, is relevant (Barsh, 2000). Scientists must unlearn the central fallacy taught to all Western-scientists-in-training—that the Western scientific method is infallible, unbiased, and unconcerned with identity and culture. Western science is deeply rooted in the notion that objectivity is a universal monolith, completely insulated from outside bias. The notion of objectivity, however, can be influenced by Western-based cultures, and therefore cannot be the main driving factor of science. Scientific convention is also a product of subjective cultural influence and can therefore not claim to be totally rational. This means that non-Western science and Western science are equally valid methods of knowledge production, and that both are inherently valuable.

4. To achieve multicultural science, Western scientists must first interrogate the multicultural aspects of themselves. Feminist philosophers were some of the first to argue that the standards for judging who deserves credibility and authority are social constructs that help to reinforce the political and economic status quo, and that when the perspectives of others are excluded, critical questions and perspectives are missed (reviewed in Meyers, 2014). As Western scientists, we must acknowledge the importance of how our personal identities as members of different communities and cultures are inherently molded by a Western worldview. We must think critically about parts of our perspective that we firmly believe to be true and must authentically challenge our own beliefs and understanding. This is easier said than done, as it requires each of us to behave with humility and to allow doubt to enter into our practice of science. Though it may be challenging, practicing humility and acknowledging our areas of personal bias and ignorance allows for us to interact with other people, whether they share our cultural identity or not, with increased authenticity and empathy. It is this humility that allows us to consider other perspectives and solutions that may work better than our own, where we truly have the opportunity to learn and solve problems in a more meaningful and hopefully more ethical and equitable way.

5. We must abandon the practice of extraction or "helicopter research," where researchers come to an area, conduct research, and leave without engaging the community. Engaging and actively sharing knowledge with local and Indigenous communities in research projects will deconstruct the disconnection and mistrust towards scientists. Engaging communities in research also carries the responsibility of integrity with regard to the knowledge that was gained from local peoples. What is often seen by one group as scientific knowledge may be the coveted cultural heritage of another. Therefore, preserving and respecting that knowledge in the wake of scientific studies is incredibly important if we are to avoid exploitation. Take the time to establish personal relationships. Take the initiative to learn about those you interact with, and unlearn reductive Western ideologies, if only to avoid inflicting further emotional turmoil onto others (Adame, 2021).

6. Remove and avoid scientific names that have discriminatory or exclusionary origins. Trying to categorize and classify the universe is deeply rooted in the practice of Western science (Gillman & Wright, 2020; Rummy & Rummy, 2021). Whether it be intentional or not, the creation and use of certain terminology has facilitated the colonization of language and culture. For example, binomial nomenclature, the practice of classifying organisms using a descriptive two-part name (i.e., scientific names) is useful to differentiate species but has historically been used to elevate the influence and prestige of white men. Interwoven with the history of scientific names is the erasure of Indigenous language and culture. The connection an Indigenous group has to a species, along with their values, knowledge, and the natural history of that species are lost in Western science (Rummy & Rummy, 2021). Just as research can be done with Indigenous input from start to finish, so can naming new species. This collaboration

between cultures and sciences will benefit science overall and expand our knowledge of the natural world.

7. As educators, we must value the knowledge and diverse experiences of our students and empower them to include their cultural capital in their approach to science. It is important to make connections between what is learned in school and life outside of the classroom. Information presented in a Western science classroom often lacks applicable meaning because it is presented at a global scale. Understanding through direct connection is an Indigenous practice that helps foster the idea of interconnectedness. For example, living in the same place as numerous generations of your ancestors emboldens the connection of a community with the land on which they live. Having knowledge of the land not only holds a profound cultural significance, but also holds a practical significance that is rooted in survival. Elder McDermott refers to the process of how elders teach the next generation about identifying medicinal plants: "…introduce them to the medicine tree…Hug it, taste it, smell it… spend some time with it" (Iseke & Desmoulins, 2015, p. 41). Elder McDermott continues by describing the process of making information directly relevant: "The ones who know what they are doing, … they didn't learn it from the book" (Iseke & Desmoulins, 2015, p. 42). Making direct connections with information helps learners understand the relevance of the task through firsthand experience. As we educate the next generation of scientists, we should empower them to include this cultural capital in their scientific approach.

8. To increase STEM interest among communities historically underrepresented in Western science, it is crucial to establish outreach programs that provide resources, information, and opportunities. By tailoring outreach efforts to the specific needs, values, and contexts of different cultural groups, schools can create a more inclusive and practical approach to promoting STEM education (Ong, 2011). It is essential to encourage the integration of cultural values and traditions into STEM fields to create a greater appreciation and understanding of the relationship between cultural heritage and STEM knowledge. This can be accomplished by initiating discussions on the harmonious coexistence of STEM knowledge and cultural heritage. Doing so can bridge the gap between these seemingly disparate areas and create a more holistic and inclusive approach to education and knowledge sharing. Schools can integrate cultural values and traditions by studying Native American history and by learning from Native American people and visiting their communities. Promoting the use of Indigenous languages and terminology in STEM education can strengthen inclusivity and cultural awareness (Ong, 2011).

In summary, considering either Western or non-Western systems as superior reduces our ability to understand the natural world. As individuals, we must explore the multicultural aspects of ourselves, abandon the idea of taking without engaging in a community, and reassess paradigms of scientific naming conventions that originated from discriminatory or exclusionary practices. As researchers and educators, we must acknowledge the voices, knowledge systems, epistemologies, and values from diverse perspectives and cultures and ensure they are included in our observations, experimental designs, analyses, and interpretations.

This project encouraged us to evaluate the ways we think, the kind of information we seek, the voices we include, and our approach to education and research. We find ourselves at various stages of increased awareness, understanding, intentionality, and implementation. The trajectory is non-linear, as each step elicits reflection and refinement of our approach to science. We are hopeful that through continuing conversations with scientists, cultural experts, and Indigenous communities, we can make progress towards advancing a multicultural approach to scientific exploration through ethical engagement with Indigenous people.

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About the Authors

Amy E. Sprowles is Associate Professor of Cellular and Developmental Biology at Cal Poly Humboldt and served as the facilitator for this course. A fourth-generation educator, her career has focused on inclusivity in STEM education. She currently serves as the Faculty Associate Dean for Undergraduate and Graduate Programs, the Director of the Cal Poly Humboldt HHMI IE'17 Award (Howard Hughes Medical Institute Inclusive Excellence Award), and the Director of the Humboldt/California Institute for Regenerative Medicine (CIRM) Bridges Training Program. Dr. Sprowles was the director of the Humboldt INCLUDES Planning Grant, is an 'IKE Alliance Member, SENCER Ambassador, and is a guest editor of this special edition.

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Jessica Jones has a master's degree from Cal Poly Humboldt. She is studying the behavior of northern red-legged frogs (Rana aurora) and northwestern salamanders (Ambystoma gracile). Prior to graduate school, Jessica worked at the Loveland Living Planet Aquarium in Draper, UT for six years as an outreach educator and then as a zookeeper. As an

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Noah Angell is a current master's degree student in the Fisheries Department at Cal Poly Humboldt. He earned his bachelor's degree from Colorado State University in fish and wildlife conservation biology. As a Latino with an Indigenous background he is very passionate about the representation and empowerment of people of color in science. He has participated and presented at multiple knowledge exchange events with local tribal nations and has been a program assistant with the Scientists in Parks program, which provides natural resource internships for students who have been traditionally underrepresented in science.

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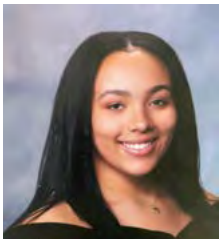

Elyse McKinney graduated from California Polytechnic State University, Humboldt with a Bachelor of Science degree in biology with an anthropology minor. She has a solid foundation in biological science and laboratory techniques, along with time management skills cultivated through college athletics. Elyse's accomplishments include Dean's List and Presidential Scholar honors, as well as serving as Team Captain for the Intercollegiate Women's Volleyball Team. With a strong passion for healthcare, she now seeks to advance her education in a medical profession, aiming to contribute meaningfully to the field.

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