

“These Different Ideas, Traditions, and Values Make My Thinking Unique and Creative”: Bringing Native Hawaiian Ways of Knowing to Engineering Education

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Abstract—Contribution: This article focuses on the study of Native Hawaiian student experiences in engineering education. Telling these stories illustrates the importance of legitimizing and appreciating different knowledge types in engineering as we move toward a more inclusive and sustainable field.

Background: Native Hawaiian engineering students live oppressive realities due to the history of settler colonialism and occupation that attempted to erase their culture and ways of knowing, including in engineering education. This study shows how students overcome these realities to enact their ways of knowing in a field where it is not always respected. Informing the field of ways to promote and respect the different knowledge types of marginalized groups can help to create a more inclusive and sustainable engineering field.

Research Question: In what ways do Native Hawaiian students bring their cultural ways of knowing into engineering education?

Methodology: We conducted semi-structured interviews with three undergraduate Native Hawaiian students using Manulani Aluli Meyer’s Holographic Epistemology as a theoretical lens to inform the questions and qualitative analysis. The analysis uses a combination of inductive and deductive analyses to create the hologram that Meyer outlines in her work.

Findings: The participants found different ways to enact their cultural ways of knowing. We interpret them through the Native Hawaiian values of *pono*, *kuleana*, and *hō‘ihi*. This illustrates how engineering educators, researchers, and programs can legitimize the knowledges of the students by promoting authenticity and reciprocity toward marginalized students and their ways of knowing.

Index Terms—Critical theory, epistemology, inclusivity, Native Hawaiian, race/ethnicity.

I. INTRODUCTION

KANAKA ‘Ōiwi are the native population of Hawaii, and they merit more focused consideration in engineering

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education research in the USA. Outside of the Pre-Engineering Education Collaborative (PEEC) that encouraged Native Hawaiian high school students to pursue engineering [1] and Nguyen et al.’s [2] work in identifying barriers obstructing Native Hawaiians path to becoming engineering professors, we could not locate other literature focused on Native Hawaiians in engineering.

Kanaka ‘Ōiwi bring a unique way of knowing that engineering can benefit from. Shawn Malia Kana‘iaupuni describes how “[t]he Hawaiian worldview stresses relationships first. It is spiritual, giving, and intimately bound to the land and Genealogy. This worldview is a source of resilience and strength” [3, p. 36]. Through this way of seeing and knowing that is bound to the natural world, Native Hawaiians accomplished and continue to accomplish major engineering feats, such as building *wa‘a kaulua* to navigate the Pacific Ocean without instruments and replicating aquatic ecosystems for sustainable agriculture and aquaculture that did not displace native habitats [1], [3]. The latter of these feats illustrates sustainable engineering that allowed the Native Hawaiian people to maintain a population of about 1 million people before Western contact in 1778 [4], [5].

Western colonization attempted and continues to erase the Native Hawaiian way of seeing and knowing that would be beneficial to the engineering field [6] as the ideologies of domination situated within settler colonialism live on in the Western engineering system [7], [8]. Consequently, Native Hawaiian students may experience historical and cultural tensions with engineering that erase or delegitimize their ways of knowing [9], [10], [11], [12]. We pose the following research question to shed light on how Native Hawaiian students resist colonialism by utilizing their cultural ways of knowing in engineering: In what ways do Native Hawaiian students bring their cultural ways of knowing into engineering education?

To address this question, we will describe the history and legacy of colonization on erasing cultural knowledge and creating an adverse reality in education that is unique to Native Hawaiians. Then, we will describe Manulani Aluli Meyer’s [7] Holographic Epistemology as the theoretical lens that we will use to illustrate and understand the Native Hawaiian way of seeing and knowing. We conducted three semi-structured interviews with Native Hawaiian engineering students in the

USA to understand how these students experience engineering education and bring in their cultural ways of knowing by balancing the three lasers of the Holographic Epistemology. We identified where and in what ways these Native Hawaiian students have used their way of knowing in engineering while also urging the field to provide more opportunities that allow for minoritized students to bring in their different ways of seeing and knowing.

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II. BACKGROUND

In this section, we will discuss settler colonialism and how that frames the history of colonization in Hawaii and the experience of Native Hawaiians. From there, we will pose the Western system of education as a place that reinforces settler colonialism and how that may be causing tensions with Native Hawaiian engineering students leading to the exclusion of their cultural ways of knowing. The way that different scholars approach these tensions will help to set up how the Native Hawaiian way of knowing is missing throughout education, especially in engineering education. The interaction of these concepts will help to situate the limited research on Native Hawaiian student experiences, which we argue is absent in engineering education research. This is the gap in the literature that we aim to address to illustrate the value of Native Hawaiian engineering students and their cultural ways of knowing.

A. Settler Colonialism and Hawaiians

According to most mainstream history books published in the United States, Hawaii was an independent nation that became a state within the United States of America in 1959. In contrast, from the perspective of many Native Hawaiians, the United States illegally occupied and continues to occupy the sovereign kingdom of Hawai'i through the settler colonial processes of annexation and statehood [14], [15], [16], [17].

Settler colonialism is a deliberate act of colonizers to take land away from native people and claim that land as their own [7], [9], [16]. Such colonization is not only about the taking away of land but also about taking away the main source of knowledge, spirituality, and identity from Indigenous people [9]. For Native Hawaiians, land and its teachings transcend time and space and connects people, nature, and culture [3], [6], [7].

In their work to create a space for a Kanaka 'Ōiwi Critical Race Theory or 'ŌiwiCrit, Erin Kahunawaika'ala Wright and Brandi Jean Nālani Balutski [18] identified five tenets. For the purpose of this study, we focus on the first tenet that explains how settler colonialism and illegal occupation are pervasive and sit at the center of issues of multiculturalism, tourism, and militarism that all contribute to the Native Hawaiian experience, including in education. We introduce this work and its connections to STEM education to illustrate how these

realities of education for Native Hawaiian students continue to erase or deligitimize their ways of knowing in engineering education.

B. Realities of Occupation in Education

The first issue Wright and Balutski identify in their tenet of 'ŌiwiCrit is the viewing of Hawaii and Native Hawaiian as multicultural taking away their Native Hawaiian identity representing a version of colorblindness [18]. One part of Hawai'i's occupation is the major immigration movements of the sugar plantation era (from the 1880s to the 1930s) when a variety of peoples immigrated to Hawai'i [16], [17], [18]. This era is filled with racial mixing and is one of the roots of the multicultural identities of Native Hawaiians [18]. In terms of race, Native Hawaiians today identify with multiple minoritized cultures [5]. This identification exacerbates issues of tokenization of diversity in education for Native Hawaiian students [11]. Native Hawaiian students may be used as poster children for diversity reinforcing that their worth is due to their multicultural and minoritized race rather than the ability that comes from their ways of knowing [10].

Multiculturalism does not affect just individuals who are Native Hawaiian, but also Hawai'i as a place. The islands of Hawai'i can be seen as a multicultural paradise [15], [18]. Hawai'i has become a symbol of diversity; however, seeing the islands as multicultural rather than as the land of Native Hawaiians continues to erase the Native Hawaiian identity of the land. This recognition of the islands as multicultural rather than as native homelands can lead to Native Hawaiian students struggling to recognize their own sense of place, a sense that is integral to their cultural ways of knowing. Losing their sense of place and home as related to the islands of Hawai'i can lead to students' difficulties in identity construction and negotiation [10]. Although multiculturalism can be positive in some forms of mainland education, a focus on multiculturalism in the Kingdom of Hawai'i continues to negatively effect Native Hawaiian students.

Along with multiculturalism, 'ŌiwiCrit identifies tourism and militarism, the two largest economic industries in Hawai'i, as power structures that reinforce the negative impacts of occupation over Native Hawaiians. Tourism acts as a proxy of capitalism by commodifying Hawai'i [18] through the appropriation of Native Hawaiian culture, the depletion of natural resources, and the imposition of economic constraints on Native Hawaiians. Militarism is one of the major reasons for the occupation of Hawai'i as it gave the United States a strategic position in the Pacific Ocean [18]. The military overrules many political and socioeconomic decisions in Hawai'i, often to the detriment of Native Hawaiians.

Both capitalism and militarism are inextricably tied to the structure and values of Western engineering [8] and to the settler control of Native Hawaiian land. Although many Native Hawaiian STEM students go into these fields to give back to their communities and resist illegal occupation [11], [12], occupation and settler colonialism remain tangible realities in education through their connection to capitalism and militarism. Allaire and colleagues [10] explain

how Native Hawaiian STEM students are seen as betraying their culture by enhancing the work of capitalism and militarism that then continue to oppress Native Hawaiians. Along with being in a place of tension with their culture, Native Hawaiian students may be unable to bring their cultural selves into their STEM education. When Native Hawaiian students try to bring their cultural knowledge into these fields, they are routinely ridiculed or have their knowledge discredited [11]. For Native Hawaiian engineering students, they may not be fully accepted by their Hawaiian community or within their academic community leading to feelings of isolation by living in this place of tension between their two communities [10].

Another tension occurs with the concept of place, as mentioned earlier, that is integral to being Hawaiian [3], [5], [7], [14]; improving the well-being of land and the place that raised them is one of the major reasons that Native Hawaiian students go into STEM and engineering [10], [12]. But the reliance on capitalism to structure professional engineering [8] pushes engineering students to see land as a commodity instead, threatening the relationship Native Hawaiian engineers have with place.

C. Overcoming Tensions

Some students are able to overcome these tensions of being between their cultural and academic communities and their outlook on place by remembering the motivation to restore the health and honor of their land and people. They see education as a privilege and some students want to use that privilege to help to empower their community and resist settler colonialism [10], [19]. Kerr and colleagues [12] describe how Native Hawaiian STEM students want to be the bridge between science and culture from a place of respect. This respect for the land and all of its inhabitants [6], [17] translates to their ways of knowing and pushes them to use their perspective, including the tensions, to heal their communities using engineering and STEM [10]. Investigating how Native Hawaiian students practice their ways of knowing in engineering education is the first step to enable these students to be the bridges that they want to be.

III. POSITIONALITY

The first author identifies as a multiracial man with his Native Hawaiian heritage and upbringing at the center of his identity, although only as of recently. His path through high school and undergraduate engineering education was defined by his assimilation and hiding his cultural ways of knowing to be successful. After diving into the world of engineering education as a current graduate student, he now recognizes the value of his cultural way of knowing as integral for the betterment of his people and engineering as a field. This new stance that he learned through educational hardship is what informs the study to create more spaces for other Native Hawaiians and minoritized peoples to see their ways of knowing as valuable and bring their ways of knowing into their work.

The second author identifies as a White woman with degrees in electrical engineering who has been in academia

and doing research in engineering education for decades. Her interest in studying and supporting underserved populations in engineering stems from her experiences of marginalization as a woman in engineering and a desire to change the culture of engineering to be more welcoming. Her experience as an instructor and advisor for some Native Hawaiian students also motivates her to learn more about their assets. Her perspective informs the presentation of this study to the IEEE TRANSACTIONS ON EDUCATION audience.

Together, we utilize these tools and experiential knowledge to begin the work of studying the student experiences of Native Hawaiians from a cultural and engineering perspective.

IV. FRAMEWORK—HOLOGRAPHIC EPISTEMOLOGY

A starting place to illustrate and explain the Kanaka Maoli way of knowing and how it differs from traditional Western engineering is through the Holographic Epistemology developed by Native Hawaiian scholar, Manulani Aluli Meyer. The Holographic Epistemology aims to find a way to balance the three dimensions of knowledge, the Mana'o'i'o or the body and objective dimension, the Mana'olana or the mind and subjective dimension, and the Aloha or the spirit and cultural dimension [7]. Body, mind, and spirit all work together to create a holistic and shared picture of knowledge [6]. Meyer suggests considering these dimensions as a hologram composed of three intersecting lasers. A hologram needs all three lasers to create a picture [6]. In a similar way, knowledge cannot be complete unless the body, mind, and spirit lasers of knowledge are in balance [7].

The first dimension of knowledge from the body deals with empirical knowledge that society and engineering education prioritizes [7]. The body laser focuses on the five senses and how humans experience the outside world. Notions of objectivity and measurements directly correlate with the body. This knowledge comes directly from physical experience but also includes the experiencing of emotions [7]. This distinction of experiencing emotions pushes engineering to recognize emotions as another part of empirical knowledge. Although those trained in a Western engineering mindset may be most comfortable with this dimension of knowledge, we encourage such readers and the field to go beyond this "objective" way of knowing and be more open to the other two knowledge lasers.

Second is the mind laser, or the knowledge that comes from thinking and reflection [7]. This laser is the knowledge that interprets and constructs an idea or concept based on the information provided through lessons and/or experiences [7]. The mind laser is conventionally assigned to ideas of relativism and subjectivity. Unlike the body laser, these thoughts are formed without the need of any of the senses and focus on reviewing ideas, finding patterns, and offering new understandings. Engineering should begin to recognize the mind laser as legitimate and omnipresent. For Native Hawaiians, the mind laser connects to the na'au or the place of wisdom that sits in the stomach, merging the experiences held in the head and heart [6].

The final dimension is perhaps the most challenging for those trained in a Western engineering mindset to comprehend.

The spirit laser does not necessarily have to be religious but it can be for some [7]. Rather this dimension envisions spirit beyond religion and as knowledge that transcends our bodies, time, and space to discover the relationships and connections between all things [7]. It is a knowledge of unification and interdependence shaped by the environment, other people, and cultures [7]. The spirit laser of knowledge is the two-way interaction of how we affect the world and how the world affects us, including our interactions with all the living and nonliving inhabitants of the Earth, the oceans, the skies, and other entities. It shapes culture and Meyer describes this laser as the “basic common sense” [6, p. 97] of all Native peoples.

Although Meyer [7] suggests the Holographic Epistemology as a way of knowing speaks to the realities and experiences of all people, we use it as a framework to understand the ways of knowing of Native Hawaiian engineering students [7], [12]. All of the knowledges, especially the spirit laser, are inherently tied to place and community illustrating the way of knowing of Native Hawaiians described earlier. Similarly, Native Hawaiian engineering students want to be the bridge between science and culture [11], [12] which can be seen as making knowledge whole by bringing in the mind and spirit lasers of their Hawaiian culture into engineering to resist settler colonialism and occupation.

V. METHODS

To understand how Kanaka Maoli engineering students bring in their ways of knowing to navigate engineering, we conducted one-to-two-hour semi-structured interviews over Zoom with three current undergraduate engineering students who self-identified as Native Hawaiian and acknowledged their Native Hawaiian culture as important to who they are. As few engineering students self-identify as Native Hawaiian, finding participants was challenging. The first author personally asked two of the participants within his network of colleagues who agreed to participate. We used a snowball sampling approach [20], where we asked the participants to identify other participants that meet our criteria of being an engineering undergraduate student that self-identifies as Native Hawaiian, to find the third participant.

Along with the difficulty of finding participants, another limitation of the study is that we conducted only one interview with each participant. To develop better rapport with the participants and gain deeper insight on their lived realities, we should have conducted multiple interviews. A final limitation is that we did not explicitly ask the students for their gender pronouns. For this reason, we will use the singular pronoun form of they/them for all students, and we did not consider gender in the analysis. Gender could have been helpful to understand the lived realities and complexities of the participants.

We framed the interview questions around the participants’ cultural and engineering experiences in their undergraduate education, both separately and together. After the interview, we assigned pseudonyms in ‘Olelo Hawai‘i or the Hawaiian language. Table I lists the pseudonym, the type of institution they attend, the year they are in, and the engineering discipline

TABLE I
PARTICIPANT INFORMATION

Pseudonym	Institution Type	Major and Year	Number of Racial Identities	Home Island
Hau‘oli	Private, Primarily Undergraduate	General Engineering (2 nd Year)	6	Kaua‘i, Hawai‘i, USA
Kahiwalani	Public, R1	Electrical Engineering (4 th Year)	12	Maui, Hawai‘i USA
Kekila	Public, R1	Civil Engineering (4 th Year)	6	O‘ahu, Hawai‘i, USA

they chose, as well as the number of racial identities they identify with and the Hawaiian island they call home. The participants are from different islands and attend universities scattered across the U.S.

We transcribed and deidentified each interview and qualitatively analyzed the transcripts in a three-step process that combined deductive and inductive approaches that represent the body, mind, and spirit lasers. For this study, we used the Holographic Epistemology to inform both our analysis approach and the lens for analysis. The three-step analysis process went in the order of body, mind, and spirit. First is the body approach of analysis where we coded the transcripts from the participants through a deductive approach using the lasers of the Holographic Epistemology. In this step, we wanted to see the ways the students physically and emotionally enacted the body, mind, and spirit lasers of knowledge in their engineering education journeys. For example, we identified quotes that represented knowledge gained from physical experiences in engineering education as the body laser. The same was done for the mind laser or knowledge gained from reflection or internalization and the spirit laser or knowledge gained from connecting or unifying other knowledges. Through this process, we identified that the knowledge gained from the body, mind, and spirit lasers connected to how the students experienced, internalized, and made sense of their cultural ways of knowing.

Analyzing these three lasers with this new understanding of the Holographic Epistemology as it applied to the experiences of our participants helped us to further develop this visual through the two inductive analyses. These analyses expanded on the deductive approach by taking the knowledge gained from the students and illustrated the ways the students used their knowledge gained to bring in their cultural ways of knowing to engineering education.

Second was the mind approach of analysis. We inductively analyzed the quotes related to the body, mind, and spirit to identify three themes of recognizing differences, motivation, and interconnectedness, respectively, across all three participants. These themes represent the ways that students reflected on their knowledge gained to recognize their own differences and the differences of others, to understand their motivation to continue in engineering, and to use their interconnectedness with others and the Earth to enact their cultural ways of knowing to persist.

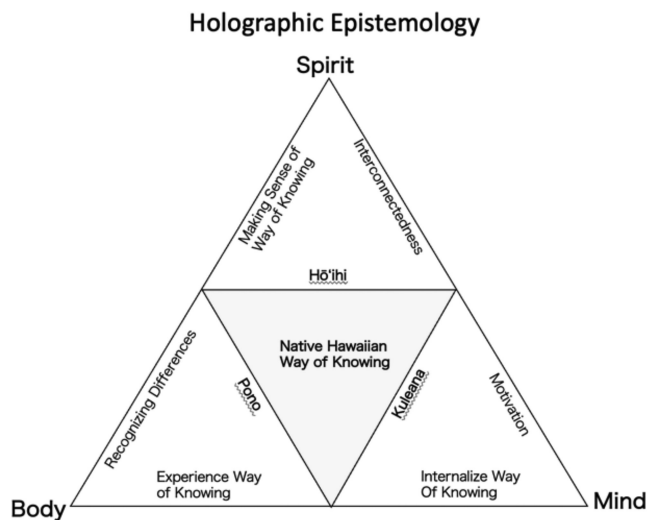


Fig. 1. Our conception of the Holographic Epistemology used for this study.

Although we could have stopped the analysis here, there seemed to be a cultural or spiritual portion missing from the analysis. Thus, we did a third analysis relating back to Native Hawaiian culture by identifying three Hawaiian values that correspond to the themes identified in each laser. We connected the body, mind, and spirit lasers to the Hawaiian values of *pono*, *kuleana*, and *hō'ihi*, respectively. These values will be discussed in depth in Section VI to develop and unite the relationships and larger picture between the identified quotes related to each laser, the connections from the knowledge gained in each quote, and themes that show how the students used their gained knowledge. Using the Holographic Epistemology as both an analytical lens and an analytical approach creates a more complete picture [7] of the meaning behind the ways that students brought in their cultural ways of knowing. The relationships between these concepts from each analytic step of the identified quotes are depicted in the “Body,” “Mind,” and “Spirit” triangles of Fig. 1. We will expand on the meaning of the center triangle in Section VII.

VI. FINDINGS

Each section of our findings will focus on explaining how the relationship between the connections, themes, and values to make up each laser of the Holographic Epistemology. Looking at all of these sections together as one story illustrates the benefit of having the Holographic Epistemology in balance to enable Native Hawaiian students to bring in their cultural ways of knowing.

A. Body—*Pono*

The three participants illustrated the body laser of knowledge through their physically experienced and emotionally felt ways of knowing that came about through recognizing their differences from their peers, their professors, and Western engineering culture. Hau'oli went through and is still going through an identity crisis due to their multicultural heritage when attending a predominantly White institution on the mainland United States away from their home.

I feel like I needed to be one ethnicity or I'd be looked at weird or people would doubt what I really am. A lot of people doubt me and they're like “you do not understand the struggles of people of color.”

Hau'oli identifies with multiple minoritized ethnicities, including Native Hawaiian and Japanese, but still faces a multicultural dilemma within themselves when others try to define who they are. Although this is a personal struggle for Hau'oli, they also see their multicultural heritage as their strength. Hau'oli explains that they “have all these different ideas, traditions, and values [that] make my way of thinking unique and creative because I am set apart from a lot of other engineering students.”

Kahiwalani arrived at a similar conclusion of their multicultural heritage as a strength but through a different mindset. When asked how their Native Hawaiian culture played a role in their education, Kahiwalani describes that their cultural heritage, especially their Native Hawaiian culture, taught them “the ability to be very confident and always sticking up for my right. I was prepared for college and how to adapt myself to new environments and people.” Their cultural way of knowing translates not just for their standing up for themselves, but Kahiwalani also speaks up for other minoritized groups.

Some people at my school assume that Asian students are good in class because they are Asian. Literally someone said that. I had to tell this person “why would you assume or say that” because I didn't understand where she was coming from at first. I understand now that she might not understand how that's offensive. I told her that “you're assuming that just because of his culture he is smart enough to be doing what is he doing rather than knowing that he is working hard like all of us to understand it.”

Not only did Kahiwalani stand up for another minoritized student but Kahiwalani also attempted to understand the upbringing of the person who was reinforcing the model minority stereotype [21]. Kahiwalani gives credit to their multicultural heritage to help them speak up and to be able to understand other people better, especially in an engineering education setting that they describe as “a White and male dominated field [in a] school that they say is diverse, but it definitely needs improvement.”

Kekila's experience with recognizing the differences of their way of knowing takes a culture level approach unlike the individual and interpersonal approaches of Hau'oli and Kahiwalani, respectively. Kekila compares the culture of engineering with Native Hawaiian culture through their coursework in both engineering and Hawaiian studies, especially their relationship with professors.

Most engineering professors are there to do research, so they do not really care about you. They're not really interacting with you. My most fond memories of classes was within my Hawaiian classes. The kumu [professors] actually care about you: who you are, what's your name, and where you come from.

Recognizing care and interpersonal relationships is an aspect of knowing that is integral to Native Hawaiian culture [3], [6], [22]. We will discuss this in more detail in Section VI-C, but this was a definitive moment for Kekila to see their cultural way of knowing as different from engineering. Kekila continues with this difference in culture when looking at accepted knowledges in engineering and Hawaiian cultures.

I can start to feel or see things that science cannot explain. I told my [engineering] professors some of the stories that I've seen or felt and they said "That's not possible. Science does not back it up." Hawaiian culture knows that there's a lot of stuff that science cannot prove and that makes our culture special.

Kekila recognizes the difference in legitimized knowledge between the two cultures and how their way of knowing continues to hold true to them and their community but is not accepted and often ignored in their educational experience.

All three participants have experienced their ways of knowing through recognizing their differences at various levels. We argue that the Hawaiian value of *pono* connects these different paths. Different scholars and community leaders define *pono* in different ways. In the Native Hawaiian dictionary, *pono* translates in English to harmony or righteousness [23] while Noelani Goodyear-Ka'ōpua introduces a different definition of *pono* from Native Hawaiian artist Kaumakaiwa Kanaka'ole that we see as a better fit [24]. Kanaka'ole describes *pono* as "not being righteous, but being the most authentic... neither right or wrong, both are acknowledged and both are valuable" [24, p. 19]. *Pono* as authenticity is how Hau'oli, Kahiwalani, and Kekila came to experience their way of knowing. The participants stayed true to their cultures and experienced the body laser of coming to their way of knowing through being authentically themselves despite their struggles within their selves, with their peers, with their professors, and with their cultural tensions.

B. Mind—Kuleana

If the body or *pono* laser focused on how the students physically-experienced or emotionally felt their way of knowing in engineering education, the mind laser represents how the students internalized their way of knowing. For the mind laser, we identified the theme of motivation and selected the Hawaiian value of *kuleana*. Many Native Hawaiian scholars incorporate *kuleana* into their work [24], [25], [26] spanning interpretations from "positionality and obligations" [24, p. 2] to "rights based on responsibilities" [25, p. 517]. The interpretation we chose that aligns with the experiences of the students comes from Jamaica Heolimeikalani Osorio who describes *kuleana* as "our interlocking authority and accountability to each other" [26, p. 129]. Osorio's interpretation centers positionality, relationality, and interconnectedness reflective of Native Hawaiian culture while challenging the idea of rights and domination in Western culture [26].

Similar to *pono* as the body laser, *kuleana* as the mind laser of internalizing their ways of knowing takes on different paths

for each of the students. For both Kahiwalani and Kekila, they could not reflect on a time where their engineering education allowed them to bring in their way of knowing but see *kuleana* as their motivation to persevere through the intensities of engineering education to bring in their way of knowing in the future.

I did choose a degree [electrical engineering] that it's hard to incorporate your culture compared to others. I've been very adapting rather than combining my culture because there were not many opportunities where I could mesh my cultural ideas. I think that will happen when I'm working and standing up for things that people at home would want to stand up for.
—Kahiwalani

[The curriculum] doesn't really tie in too much culture. I do wish that they did incorporate more stuff around situations-based off what happens here [in Hawai'i] for us to bring in our culture... I do feel like there's a lot of room to do better like I do not think [the institution] really tried to incorporate culture. Hopefully, if I understand and learn the stuff, I can give back to my community
—Kekila

This planning to help their Native Hawaiian community in the future demonstrates the participants' internalizing their way of knowing in engineering education and acts as motivation to persevere. Kahiwalani wants to show how "engineering is something [that] could better our people. I can help. One of my passions is to provide sustainable energy to low-income communities at home." Kekila recognizes that Native Hawaiians are not in engineering positions and "the things that are being built in our home are being built and run by people that aren't from here... that falls onto our shoulders to be in the position to do better for our culture and our home." They are internalizing their way of knowing by reflecting on their accountability to improve their island homes and communities representing their *kuleana*.

Hau'oli could reflect on bringing their way of knowing into their education by focusing their motivation and *kuleana* toward the environment. They describes their small department as a welcoming place, and their concentration for their major is sustainability. These factors may contribute to why they have more of an opportunity to practice their cultural ways of knowing that Kahiwalani and Kekila. Both Kahiwalani and Kekila discussed the importance of the land to them, but not in the way that Hau'oli uses it as the basis of their *kuleana*.

Growing up in Hawai'i and Hawaiian culture, you're taught to take care of the land and water... Sustainability is really important because of my roots and all the values instilled in me to protect the land. We have to respect everything, especially the land. I mean, we only have one Earth.

Hau'oli applies this perspective in all of their classes and they are looking at future work in renewable energy to use the power of the environment to improve their Native Hawaiian community. By centering their accountability toward the land, Hau'oli demonstrates how central land, water, and all of its inhabitants are connected in Native Hawaiian culture.

Therefore, they see their *kuleana* as the motivation to bring in their way of knowing to take care of and protect the land that will subsequently help their Hawaiian people and all living and nonliving inhabitants.

C. Spirit—*Hō'ihī*

Hau'oli begins to discuss respect which is the direct translation of *hō'ihī* [23]. Rather than using this interpretation, we chose to use Vaughan's interpretation of *hō'ihī* as "respectful reciprocity" [25, p. 517]. We believe that this interpretation represents the spirit laser of knowledge as it illustrates how the students combined the knowledges in the body and mind lasers to make sense of their experiences. Combining the students' ways of knowing or *pono* and the internalization of the students' ways of knowing or *kuleana* bring about the larger holographic picture or narrative of how these three students bring in their cultural ways of knowing to navigate engineering education. In other words, respectful reciprocity or *hō'ihī* is the underlying theme that ties together the other two lasers and represents interconnectedness.

Starting with *pono*, the students experienced their way of knowing after recognizing their individual, interpersonal, or cultural differences. All three students went through difficulties after recognizing these differences, and also became a more authentic version of themselves. Each of them had people in their lives that they consider instrumental to seeing their ways of knowing as valuable. We foreshadowed Kekila's teachers in Hawaiian studies and the exemplifying care toward Kekila through a reciprocal relationship.

Kekila gives credit to their high school kumu or teachers that created a "sense of we're all in this together. They are from [Hawai'i] and they actually know your name. The first thing they ask you is what's your name and where you're from to find some type of personal relationship." Kahiwalani also credits a high school kumu that "was a big very big influence on me being capable and believing I can do it. In college alone, I feel like you do not really get an experience with your professors." Hau'oli credits one of their professors outside of engineering that she identified as one of their fondest memories and inspirations in their college education. "I became really close with one of my physics professors. . . I didn't think I could grow up as intelligent and inspiring until meeting her and she continues to inspire and support me." Respectful reciprocal relationships among people are critical to sustaining well-being of land and people from a Native Hawaiian perspective [22], [26]. These relationships with teachers at different levels illustrate the support that come from others that are important for these students to recognize their authentic selves and legitimize their ways of knowing to motivate their *kuleana*.

With *kuleana*, the focus was on the responsibility of the students to give back to their community or land. Adding *hō'ihī* makes *kuleana* multidirectional where the students also are given the authority and accountability to do the work that they want to do. Kekila illustrates this with how their family

and culture is a relational form of perseverance through the intensity of engineering.

My parents and my grandparents raised me to be the best version of myself. That's not just my family, that's our culture. If we're gonna do something, we're gonna do it good and we're gonna do it the right way. That's what motivates me. I owe it to my parents to do the best that I can.

Kekila's responsibility is not just to their people out of their own merit, but because they represent more than that. Kekila represents their family and their culture, so their *kuleana* toward their community is uniting by connecting their family, community, and culture.

Hau'oli and Kahiwalani also represent the interconnectedness of the spiritual dimensions through *kuleana* while illustrating how adding *hō'ihī* as the spirit laser allows knowledge to transcend time and space. Hau'oli has the internal *kuleana* to protect the land and with the help of their physics professor they have a safe space to talk about their ideas to practice their *kuleana* to protect the land and all people.

I'm always talking to her about ideas and she gives me ideas. I just researched this one product, I cannot remember the name, that basically converts wave power into electricity because I think the ocean is so strong and powerful to help all people on Earth.

Hau'oli centers the land and understands that looking to the land for answers is another form of relational *kuleana*. From a Native Hawaiian perspective, the land supplies everything for humans, and in return, we must revere and protect it [22]. Through the connections of their home, mentors, and the land, Hau'oli creates a network of *kuleana* that transcends space.

Kahiwalani also shows a multidirectional flow of *kuleana* through reciprocal relationships with a focus on their future children to illustrate how *hō'ihī* transcends time.

I want my kids to know where they come from genealogy wise, who their ancestors were, who we really are as people. . . I would want them to learn Hawaiian and cultural aspects of the land, taking care of the land. We were lucky to be taught about the history of our land and the history of what plays a role in everything and as engineers, we have to take more consideration that these things have meaning. Our land is very special at home and I want my kids to learn this as I did.

Kahiwalani is exemplifying that they were privileged to receive an education that allows them to bring about Native Hawaiian ways of knowing into engineering. Their education is the *kuleana* that was given to them. In return, they have the *kuleana* to give back to their community with this education and to give a similar education to their children and future generations with a focus on helping them to better the Native Hawaiian community.

The multidirectional sharing of *pono* and *kuleana* occurs when these values are in balance with *hō'ihī*. *Hō'ihī* brings relationality and interconnectedness that allows knowledge to unite and transcend ideas beyond time and space.

This holistic knowledge is the strength of the Holographic Epistemology [3].

VII. DISCUSSION—HOLOGRAM

Looking through the *pono* or the body laser alone helped students to discover their way of knowing at an individual level. Similarly, *kuleana* or the mind laser alone illustrated the motivations of the students to care for and protect their community and the land. The respectful reciprocity that comes with *hō'ihī* or the spirit laser illustrated interconnectedness that helps to present the hologram of the ways that these three Native Hawaiian brought in their ways of knowing.

Positive role models that support these three students help them to accept their differences and enable their authentic selves creating the space and safety for these students to bring in their ways of knowing [2], [19], despite their realities in education from occupation and settler colonialism [18]. Engineering educators should be more supportive role models and create more open learning environments to allow all students with marginalized identities to bring their full authentic selves into the classroom. This is important for all educators, including those who are in the majority to truly change the culture of engineering, that is currently rooted in capitalism, militarism, and colonialism [8], [9]. Thus, we urge engineering educators to see beyond their frames of reference and begin to recognize how their own perspectives may be hindering their students' ways of knowing. This involves having conversations and learning together with Native Hawaiian, Indigenous, and other marginalized groups. These ways of knowing are continuously discredited or silenced [9], [10], [12] and will continue to be through the oppressive structures of engineering education unless engineering educators begin to learn with and about us inside and outside of the classroom to improve how students can experience their way of knowing.

The students internalized their way of knowing through their authority and accountability or *kuleana* that is given to them by everything they represent, their families, education, land, etc. In return, these students passed on their *kuleana* to their community, future generations, and back to the land to bring their Native Hawaiian knowing. We encourage students to find their *kuleana* or whatever motivates them from their experiences and use it to bring as much of themselves as they can into the classroom. These students illustrate that although it may be difficult or painful to be one's full self in the Western model of engineering education, one's full self can bring ideas to overcome cultural and academic tensions to persist.

To overcome these tensions, the participants found ways to bridge their two worlds through the spirit of knowledge that transcends time and space by understanding the interconnectedness of all things. These Native Hawaiian students engaged with *hō'ihī* or respectful reciprocity to create the full hologram. Each of the lasers contain three other concepts that we recognized through data analysis as integral to explaining each of the components and to create a holistic picture to answer the research question. The ways that students experienced, internalized, and made sense of their way of knowing as a form

of resistance to settler colonialism and overcoming cultural tensions connects to recognizing differences, motivation, and interconnectedness, respectively. Alongside the Hawaiian values, each of the lasers is connected creating a holistic picture created when balancing all three lasers of the Holographic Epistemology. *Hō'ihī* or the spirit laser brought the balance between the body, mind, and spirit lasers. This balance is the goal within the center triangle in Fig. 1.

In order for balance to occur, recognizing all three lasers as legitimate becomes imperative for the engineering education field to accept ideologies that may differ. For Native Hawaiians, the balance between the body, mind, and spirit lasers of knowledge was how these Native Hawaiian students brought their cultural ideologies and full selves into engineering. As a discipline, we want engineering education to promote and do more work with and around marginalized knowledges, such as experiential knowledge and cultural knowledge, to create a field that is more inclusive and open to all ideas. To accomplish this, work around diversity, equity, and inclusion must move beyond representation and toward allowing marginalized students and educators to bring in their full selves. Then, the field can diversify its knowledge through learning with other people and other cultures. However, this cannot happen until engineering education research and practice becomes open to different knowledges like the Holographic Epistemology of Native Hawaiians.

We note that *pono*, *kuleana*, and *hō'ihī* are some of the values that reside within Native Hawaiian culture and help to illustrate the experiences of these students, but these values do not always make up each laser. There are other values or concepts from multiple cultures that can fit into the Holographic Epistemology. The goal of this research is not to define each laser but to illustrate how balancing all three lasers creates a hologram in this particular study's context. Similarly, we also understand that the knowledges of different peoples may not fit with the Holographic Epistemology and hope that these people can begin to share what their knowledge looks like as we continue to challenge and expand the engineering education space to include more knowledge traditions.

Although each student uses their way of knowing and navigates engineering education in their own way, the connections of these lived realities are an important aspect that allowed us to construct a narrative to create our own version of the story that attempts to move the field to be more accepting of different knowledge types, including those that settler colonialism and Western engineering attempt to erase.

VIII. CONCLUSION

Native Hawaiian undergraduate engineering students are carriers of their cultural knowledge. Despite settler colonialism and the illegal of occupation of Hawai'i causing cultural tensions for these students, we illustrated how three undergraduate students were able to bring their cultural ways of knowing into engineering and use it to their benefit. Using the Holographic Epistemology and qualitative research methods, we connected each laser of the epistemology to Native Hawaiian values that are indicative of how the students experienced, internalized, and made sense of their cultural

ways of knowing. These translate to the body laser or the value of *pono* as authenticity, the mind laser or the value of *kuleana* as interlocking authority and accountability to each other, and the spirit laser or the value of *hō'ihī* as respectful reciprocity. The strength of centering the Holographic Epistemology is that knowing can be made whole with the spirit laser of *hō'ihī* being the connecting factor to illuminate the holistic experience of these students.

One area of future research to promote minoritized individuals to bring in their ways of knowing emerges from the fact that none of the students identified a positive role model within engineering. All the students critiqued the engineering education system as not helping them to develop respectful reciprocal relationships. Focusing on how to improve these types of relationships could be beneficial to Native Hawaiian students and other students from cultures that value relationality. Another area of future research should focus on how to legitimize and include a more holistic way of knowing in engineering education research and pedagogy from different groups. We should look at more opportunities to allow minoritized students to bring in their full selves, ideas, and knowledge types. As we move forward, we hope to continue challenging what knowledges are legitimate in engineering and exploring how to allow students to bring in their different knowledge types to enhance engineering and contribute to create a more inclusive and sustainable field.

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