

Ua lele ka manu (The bird has flown):**Science education from Indigenous/local/place-based perspectives**

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Abstract

Indigenous Hawaiian students are the majority in many rural schools where farming, fishing, and hunting build ecological knowledge but are underrepresented in science majors and careers. Native Hawaiian and Hawaii-born educators describe how they employ Indigenous knowledge as a foundation for student inquiry. Five themes emerge, four supporting and one impeding Indigenous inquiry in educational settings. Indigenous narratives, identity, sense of place, and connecting science to Indigenous practices supported Indigenous/local inquiry. Indigenous inquiry was found to be characterized by 4 elements: 1) Indigenous sense of place, 2) *mālama*, caring for places; 3) *kuleana*, recognizing that rights entail responsibility; and 4) conducting inquiry with appropriate protocols. School policies and teachers' lack of knowledge of place and Indigenous culture were barriers to place and culture-based inquiry. We propose a curricular planning framework for lessons connecting standards to culture, place, resources, and concerns and conclude with a call to reestablish *Mālama I Ka 'Āina*, Sustainability, a science standard applying Indigenous inquiry methods leading to systems thinking and active problem solving oriented to sustainability.

Introduction

More than one-fourth of students in Hawai‘i’s public schools self-identifies as Native Hawaiian. These students make up the majority of students in 17% of public schools, (Kekahio, 2007), many in rural communities in which farming, fishing, and hunting contribute to extensive knowledge of land, ocean, and sky that seldom connects to formal science learning. We explore this educational issue in science, emphasizing from the outset that in Hawaiian, there are no words that convey the western meanings of science, nature, or physical universe as separate from culture and identity.

We are Isabella Aiona Abbott, scientist; Michelle Kapana-Baird, Polynesian Voyaging Program teacher; Mahina Hou Ross, Lila Lelepali and Ka‘umealani Walk, Hawaiian immersion teachers; Sabra Kauka and Napua Barrows, Hawaiian Studies teachers; Moana Lee, archeologist/educator; Huihui Kanahale-Mossman, science teacher/administrator; and Pauline Chinn, Hawaii-born, Chinese-American teacher educator. Pauline is the “I” narrating the paper. Our paper includes reflections and stories about the ways *kanaka maoli*, those of Native Hawaiian descent, and long-time/Hawai‘i born residents, *kama ‘āina*, engage in inquiry: observing, accumulating, analyzing, sharing and developing knowledge informing decisions and action in the world.

First we discuss the title, provide a brief overview of major curricular ideologies that influence policies and practices in U.S. schools, introduce Indigenous Hawaiian ways of viewing and acting in the world, and then present our thoughts on indigenous science inquiry. We conclude with reflections on the title, implications for teacher education and curriculum development, and close with a call for the return of *Mālama I Ka ‘Āina, Sustainability* as a Hawai‘i State science content standard conveying a human in ecosystem perspective. .

Ua lele ka manu; The bird has flown

Dr. Isabella Aiona Abbott contributed the title “*Ua lele ka manu*; The bird has flown.” She said she often heard her mother this saying it as she searched for something missing, possibly still present but overlooked or not recognized. As we talked about its meaning, she said birds might be youth growing up ignorant right under our noses. I thought of the day I saw a small banana plant in a bucket in her laboratory. I was surprised as Dr. Abbott is renowned for her studies of marine algae. It was shortly before a NOAA research cruise to the North West Hawaiian Islands with Sabra Kauka and other educators. The captain had approved Dr. Abbott’s request to present it as an offering, symbolizing *Kanaloa*, god of the sea to notify the *akua*, gods, and *aumakua*, ancestral gods, associated with these places of the arrival of visitors. It was the appropriate cultural protocol, the proper thing to do; Sabra presented the offering as they approached the islands.

The title *Ua Lele Ka Manu* inquires if the bird has flown or is still here, under our noses. What is its current form and, like the banana plant shimmering between different meaning systems, can it be recognized? If so, can indigenous Hawaiian inquiry methods inform science education? This paper owes much to Dr. Abbott’s insights and experiences as a member of Hawaiian, scientific, and educational communities.

Trends in Curriculum Ideologies in Schools

US education is influenced by four major ideologies: *scholar academic* focused on acquisition of disciplinary knowledge; *social efficiency* focused on efficient preparation of learners to be productive members of society; *learner centered* focused on experience-based preparation for the future; and *social reconstruction* focused on problem finding and problem solving in an imperfect world (Schiro, 2008). Educational systems employing high stakes tests tend to follow *scholar academic* and *social efficiency* ideologies more appropriate to 20th Century models of resource-intensive economic growth. *Learner centered* and *social reconstruction* ideologies

recognize the need to prepare learners for rapid technological and cultural change during a transition to sustainability (Adams & Jeanrenaud, 2008; National Research Council, 1999).

Sternberg's (2003) research showed that a scholar academic orientation centered on mastery of disciplinary content had two undesirable outcomes. It favored the success of middle class, mainstream students, thus perpetuating the underrepresentation of marginalized minorities, and produced what he called *pseudo-experts* lacking practical, place-based experiences needed to develop critical thinking and real world problem-solving skills. These include critical and systems thinking, problem solving, creativity and intellectual curiosity; collaboration and self-direction; global awareness and civic literacy.

This transdisciplinary and transformative vision expects students to engage, evaluate, create, and effect changes in their lives and communities. It asks teachers to apply participatory, student-centered instructional approaches that address individual, cultural, and geographical diversity. Teachers' roles shift from that of curriculum deliverers to curriculum developers able to connect students' diverse experiences to meaningful, active learning about real world issues such as climate change and conservation that have both local and global impacts.

Viewing learning as authentic engagement requires teachers to establish working relationships with members of a range of discourse communities each having its own expectations and ways of communicating, behaving, and thinking. Fairclough (2006) holds that "people need resources to examine their placing...between the global and the local...and need from education a range of resources for living within socially and culturally diverse societies" (p. 151). Instruction helping students to understand their placing between the local and the global is guided by socio-cultural theories that view learning as developing through situated, context-rich, social interactions (Lave & Wenger, 1991). Gee, Hull, and Lankshear (1996) hold that "language, literacy, and learning can only be understood when situated in their social and cultural setting" (p.1). Learners

immersed in community-based discourse communities develop “common pools of knowledge—the knowledge commons—over which members of these communities labor to produce new knowledge” (p. 161, Waters, 2006).

Characteristics of Place and Inquiry-based Programs

Current educational views encourage preparation for multiple literacies, critical thinking, and awareness that individual actions have both local and global dimensions. Gruenewald (2008) provides a social reconstruction framework for designing place and inquiry-based science curricula: “What needs to be transformed, conserved, restored, or created in this place...[could] provide a local focus for socio-ecological inquiry and action that, because of interrelated cultural and ecological systems, is potentially global in reach” (p. 149). Woodhouse and Knapp (2000) found place-based North American school programs displayed 5 “essential characteristics” that establish each program’s unique, local nature: 1) natural and historical-cultural content specific to place; 2) multidisciplinary approaches; 3) experiential and/or service learning; 4) broader focus than preparation for a technological and consumer-oriented society; and 5) understanding of place, self, and community as part of a social-ecological system. Hall’s (2004) review of effective global adult environmental education programs adds the importance of revitalizing traditional and indigenous knowledge and practices and learning from elders.

Hawaiians already understood humans as part of a social-ecosystem in which actions had ethical consequences. In self-sustaining societies such as Hawai‘i’s, close observation, analysis, and thoughtful action based on evidence and knowledge gained over generations of living in a place informed a Hawaiian worldview oriented to sustainability. A human-in-ecosystem view recognizes interconnected social and natural systems as “complex adaptive systems where social and biophysical agents are interacting at multiple temporal and spatial scales” (Janssen & Ostrom, 2006, p. 1465).

Abbott (1992) notes that “Hawaiians did not belong to a village but rather to an *ahupua‘a*, a land division extending from the mountain heights to the sea” (p. 11) including at least one valley, its ridges, fresh water, and the sea to the depth of a man’s chest or edge of the reef. Hawaiians lived, married, and sustained themselves within *ahupua‘a*. Highly variable topography, soils, and microclimates led to hundreds of named cultivars of the staple crops, taro and sweet potatoes. People living upland, *mauka*, exchanged products with those living *makai*, seaward.

According to Maly (2001):

Hawaiian customs and practices demonstrate the belief that all portions of the land and environment are related, like members of an extended family...Just as place names tell us that areas are of cultural importance, the occurrence of a Hawaiian nomenclature for environmental zones also tells us that there was an intimate relationship between Hawaiians and their environment.

Pukui, Elbert, and Mookini (1974) and Clark’s (2002) collections of thousands of place names and their stories illustrate a Hawaiian sense of place, a valuing and cultural connectedness to specific places. A storied landscape enabled Hawaiian myths and nature gods to enter “into all the affairs of daily life” (p. 2, Beckwith 1970). *Mauka-makai* interdependence within *ahupua‘a* may have supported “an organized conception of form...where from lower forms of life emerge offspring on a higher scale and water forms of life are paired with land forms” (p. 3). The land-sea connection is seen in the names of organisms, e.g., pigs, *pua‘a*, (*Sus scrofa*) and triggerfish, the *humuhumunukunukuapua‘a* (*Rhinocanthus rectangulus*). Hawaiians employed binary nomenclature similar to the Linnean system: all triggerfish are *humuhumu*; the second name identifies a unique feature, its pig-like snout.



Figure 1. *Humuhumunukunukuapua 'a*. Photo: Maui Ocean Center

Kapu, Mo'olelo, 'Ōlelo No'eau: Indicators of Indigenous Inquiry

Beckwith (1970) notes that *mo'olelo*, legends, relating to the gods of fishing (*Kū'ula*) identify “authentic fishing grounds and stations for fishermen in island waters” (p. 20) and describe ways of establishing fish aggregation and spawning sites. *Mo'olelo* about the *'elepaio*, (*Chasiempis sandwichensis*), suggest close observation of the behavior of an insect-eating bird worshiped by canoe makers as the *kinolau*, bodily form, of a goddess. The *kahuna kalai wa'a*, priest of canoe-making, declared a tree free of boring insects if the bird explored the trunk but did not stop to peck and probe for insects. Abbott (1992) notes this as a rare case of men taking guidance from a goddess. She suggests that *kapu* forbidding women from contact or consumption of foods considered *kinolau* of the major gods *Kū* (coconut), *Lono* (pork), *Kāne* (taro), and *Kanaloa* (banana) may have contributed to gendered knowledge.

Chiefly and godly edicts were associated with fresh water, *wai*, a precious, life-giving resource that determined worth and value, *waiwai*. *Konohiki*, resource managers, supervised irrigation ditches, *auwai*, and equitable distribution of water: "A spirit of mutual dependence and helpfulness prevailed, alike among the high and the low, with respect to the use of the water" (*op. cit.* Perry 1912, p. 95; p. 28, Franco, 1995). Place names and *'ōlelo no'eau*, proverbs or sayings,

convey the importance of water associated with *Kāne*, “the great life-giver” (p. 15, Abbott, 1992), god of procreation, ancestor of chiefs and commoners, embodied in fresh water, sunlight, taro, sugarcane, and bamboo (Handy, Handy, & Pukui, 1972). The saying “*Hahai no ka ua ka ulula'au*; Rains always follow the forest” (405: Pukui, 1983) shows Hawaiians protected the watershed by cutting trees only as needed. Another, “*He ali'i ka 'āina he kauwā ke kanaka*; the land is a chief, man is its servant” (531) expressed the conservation ethic of active care (*mālama 'āina*) and respect/love (*aloha 'āina*) for the land that sustained life.

Indigenous Inquiry as Sustainability Science: Restoring Kaho‘olawe Island

Native Hawaiians and *kama 'āina*, (Hawai‘i born, literally, child of the land) create modern *‘ōlelo no ‘eau* conveying traditional values of sustainability. “The ocean is our refrigerator” cautions against taking more than needed. Meanwhile, recognition that “ecological and resource management issues...necessitate an approach that does not fit well with the conventional mechanistic, linear science of the Age of Enlightenment” (p. 84, Dudgeon & Berkes, 2003) leads to an appreciation for traditional ecological knowledge (TEK) based on “detailed observation of the dynamics of the natural environment, feedback learning, social system/ecological system linkages, and resilience-enhancing practices,” (p.85). The hope is that TEK can contribute to a new science of sustainability.

Cajete (2000) suggests that indigenous and western trained scientists collaborate in participatory research oriented to sustainability. In 1999, the US National Research Council identified 3 research and 5 action priorities for sustainability science. The following are relevant to Indigenous inquiry in Hawai‘i (pp. 10-13, NRC, 1999):

- Research Priority 1. Develop a research framework that integrates global and local perspectives to shape a "place-based" understanding of the interactions between environment and society.

- Research Priority 3. Promote better utilization of existing tools and processes for linking knowledge to action in pursuit of a sustainability transition.
- Action Priority 5. Restore degraded ecosystems while conserving biodiversity elsewhere.

From 1994 to its removal a few years ago following a review by outside consultants,

Hawai‘i’s Hawaiian content standard. *Mālama I Ka ‘Āina, Sustainability* supported culturally responsive, place and problem-based curriculum and pedagogy (Kaneshiro, Chinn, et al, 2005;

Chinn, 2006, 2008). Kanahēle’s (1986) explanation of the relationship between humans and nature resonates with Hall’s (2004) emphasis on indigenous knowledge and the NRC’s call for place-based research connecting environment and society.

If we are to be truly consistent with traditional Hawaiian thought, no one really owned the land in the past...The relationship was the other way around: a person belonged to the land...We are but stewards of the *‘āina* and *kai*, trusted to take care of these islands on behalf of the gods, our ancestors, ourselves, and our children (pp. 208, 209).

Kaho‘olawe, the smallest of the 8 main islands is a case study for indigenous inquiry methods. Following the bombing of Pearl Harbor in 1941 and the establishment of martial law, the island was used for military exercises and as a bombing range. In 1993 the US government returned it to the State of Hawai‘i as Kaho‘olawe Island Reserve, a status requiring that it and the surrounding two miles of ocean (<http://www.kahoolawe.info/history.html>) be dedicated solely to:

1. Preservation and practice of all rights customarily and traditionally exercised by the native Hawaiians for cultural, spiritual, and subsistence purposes;
2. Preservation and protection of its archaeological, historical, and environmental resources;
3. Rehabilitation, revegetation, habitat restoration, and preservation; and
4. Education.

The Kaho‘olawe Island Reserve Commission (KIRC) adopted Indigenous knowledge and practices for rehabilitation, revegetation, habitat restoration, and preservation. Sam Gon, III (2003)

describes the research that guided the planning process: “A review of Hawaiian traditional ecological knowledge and land management practices was undertaken...all stemming from chants and recorded practices of Hawaiians. [T]raditional approaches have much to offer the modern restoration effort” (p. 5). Looking to the past and acknowledging sources yields a genealogy of knowledge analogous to citations in a science publication (Chinn & Hana‘ike, 2010). Charles Kauluwehi Maxwell, Sr. notes that the saying, "*Nānā i ke kumu*, Look to the source” has a dual meaning, to seek the wisdom of elders (*kūpuna*) and the ancestral elder, nature: “One must study nature itself with all its wisdom that is portrayed in the forest and streams, the ocean with all its life and the air that keeps it alive” (<http://www.moolelo.com/nana.html>).

KIRC researchers fluent in Hawaiian and knowledgeable in cultural protocols interviewed elders, traditional practitioners, and reviewed the literature. “For wild-collected plants the rule was: Take some, but leave some: don’t take all. For those plants that could be propagated readily the rule was to replant when you harvest wild items” (p. 16, Pukui, Lee, & Haertg, 1972).

Researchers found 6 differences between Hawaiian and western culture views that could inform an Indigenous approach to inquiry (Gon, 2003):

- Relationship between humans and natural objects or living things (e.g., *‘aumakua*);
- Rights and responsibilities apply to all things in the natural world;
- Consciousness of the natural world and its elements;
- Humans may speak directly to those elements of interest;
- Environmental ethics include asking permission for resources;
- Giving something when taking anything of significance.

KIRC’s plan for the restoration and re-inhabiting of Kaho‘olawe includes maintaining special advisors in the role of *kuhikuhipu‘uone* (land experts), applying land practices known in other arid areas, applying traditional planting practices and protocols, developing *kapu* and protocol specific

for Kaho‘olawe, and reestablishing *kinolau*. Gon notes “some of great significance to modern Hawaiians (e.g., the *pueo*), should not be treated “merely” as biological elements, but with appropriate cultural protocol (p. 9). The plan suggests adaptive resource management, a process of “learning by doing” connecting research, practice, and decision-making “in the face of uncertainty with an aim to reducing uncertainty over time via system monitoring (http://en.wikipedia.org/wiki/Adaptive_management).

Indigenous Inquiry and Methods: Perspectives from Educators in Hawai‘i

To prepare for a place and culture-based professional development program, science teachers and an archeologist/educator exchanged ideas on Hawaiian indigenous inquiry and its methods for several months. Conversations were digitally recorded, notes were taken of informal and telephone interviews and emails were exchanged from November 2009 through April 2010. I transcribed the recording, reviewed notes from interviews, and organized responses into themes. Colleagues reviewed drafts and were invited to comment. Quotes may be edited for brevity but retain a conversational quality expressive of individual voices.

Five major themes related to Indigenous inquiry methods and K12 science education emerged. Each of the following themes is discussed separately in the remainder of this section.

1. Role of hula, chants, *‘ōlelo no ‘eau*, and *mo ‘olelo*;
2. Role of Indigenous identity and cultural expectations;
3. Role of place-based cultural practices;
4. Role of Indigenous knowledge and practices in curriculum and instruction; and
5. Institutional, cultural, and societal barriers to Indigenous inquiry.

1. Role of hula, chants, ‘ōlelo no ‘eau, and mo ‘olelo

Sabra, Moana, Huihui, and Ka‘umealani describe how cultural narratives provide a genealogy of knowledge that becomes a foundation for inquiry and conservation. Moana describes

her sense of loss when landscapes described in a hula no longer exist. Huihui, a science teacher/school administrator responds and elaborates:

Sabra: Legends inherited from our ancestors hold clues to our purpose and place in this world. Perhaps the most important is that of *Hāloa*, the first born *kalo* plant. When I teach the parts of the *kalo* those words carry meanings that go beyond the plant: ‘*ohā*, the offshoot of the main corm, forms the word ‘*ohana*, or family. The *hā*, or stalk, also means breath as in the word *aloha*, to be in the presence of the breath of life, or love. The ultimate lesson: if we take care of *Hāloa* as the elder sibling, it will take care of us; we will have food in perpetuity. Once we lose that plant, we too will be gone.

Moana: *Mo‘olelo* kept alive through hula are so much a part of indigenous research methods. There’s a red flower in a hula I was learning, and my auntie had to explain it to me because I’d never seen that explosion of red and the picture that language brings to your mind. That’s something I’d know intellectually, but never emotionally. What a loss that we still have our language but not the land to tie it to.

Huihui: That is the difference between scientists and Hawaiian practitioners—you both hear the song, but when we cannot see what is being referred to, it hurts us because our chants are also our genealogies. We hear songs about a certain kind of white *kolea* that does not exist anymore. We know a detailed list of living things from the *Kumulipo*, but half of those organisms no longer exist. Our sources of research are these living things in our songs and stories, as books, journal articles and research studies are sources of information for western scientists. Our sources of research are disappearing. Stories communicate past happenings. In the *Pele* and *Hi‘iaka* chant, *Polihua* is a beach on Lanai and *hua* is an egg, so this beach is probably a nesting site for *honu* (green sea turtles). So in this small section of a chant you learn the location of a beach that had a turtle’s nest and therefore know the characteristics of this beach. Information in the hula tells us why it is an important place to observe. Stories are important in teaching. When we were growing up we would only listen when my mother told stories. She is a *kama‘āina* so her stories were accurate. We learned about fishing holes and hammerhead sharks, things that would be different for people growing up in Hilo and Maui. When we go out and see these things and hear stories about them, we start thinking and begin to theorize. In the *Pele* and *Hi‘iaka* story, at Panewa (near Hilo) a

woman uses her skirt to fight a giant *mo‘o* (mythical water lizard). If you just tell that part to children from that area, they like it. They know all the place names and the weather, because that story is about the rain and *mo‘o* are found where it is wet.

Ka‘umealani, discusses an Indigenous geography program she is piloting with her immersion students.

I’m teaching geography as indigenous geography so our students feel good about looking through the lens of being Native Hawaiian. This is new, our school has never heard about indigenous geography. We want to take our students out and to apply indigenous ways of knowing. We’ve chosen water quality, so we when we revitalize a *lo‘i kalo* (taro pond field) we’ll have questions, “What do we need to do today, what did they do back then, how do we know we’ve done a good job, who do we answer to?” Those simple questions take us back to an indigenous methodology: who we answer to in order to maintain the integrity.

We really have to look at ‘*ōlelo no‘eau* as coded messages from the past: “*Ma ka hana ka ‘ike*; In working one learns.” We recognize different forms of knowledge, ‘*ike*, spiritual as well as intellectual/temporal ‘*ike*, and to be indigenous both have to be present. When we begin to see through that lens, we begin to see the full understanding of science. For example, I’m not a scientist, but I love science. So you know how our people believed everything is alive, everything has a spirit. People talk about energy and cycles. You can take a rock, that solid mass, and put it back in the *lo‘i*, and it’s going to turn into a different form. So systems on land coordinated with systems in ocean, they were coordinated with the lunar systems, and so forth. So that’s the science. It comes with *kuleana* (responsibility); and that ‘*ike* transferred from one generation to the next allowed us have the ‘*ōlelo no‘eau* in the ‘*āina*, waiting for us to recognize our *kuleana*, to carry on. I don’t think western science understands the pivotal understanding that both must be present.

2. *Role of Indigenous identity and cultural expectations*

Sabra, Moana, and Napua described how growing up in Hawaiian families shaped views and approaches to indigenous inquiry and research:

Sabra: Inquiry, asking questions whether they are silent or asked aloud, is a natural process. In Hawaiian culture it is often considered rude to ask questions. It is very cultural to observe, observe, observe, actually, not ask questions until you're ready. Being raised in a Hawaiian family I was always taught to *hāmau*, to be quiet, and *nānā*, to observe. We were called *niele*, or nosy, if we asked a lot of questions. "Be patient and wait," my *kupuna* (grandparent) would tell me. "The answer will be revealed to you when you are ready to understand." There was and still is the belief that the answers to all of our questions will be revealed to us when we are ready to understand them. To this day I try to look, watch and observe before I ask a question. Scan the environment first before asking a question that could be answered already. It took me a long time to figure out what they meant. I understand now and I am ready and many of the answers are being revealed.

Moana: I was not that person. My *tutu* (grandfather) had a favorite saying that carried over to my father, "If I tell you, will you understand?" And I didn't know how Hawaiian that is. It is something I eventually learned.

Napua Barrows, a teacher in the Hawaiian Studies *Kupuna* Program on Maui, describes how cultural expectations shaped her thoughts during an alien seaweed removal workshop.

Coconut Island is where I found my niche--at that workshop when we removed alien *limu* and I thought it should be restored. I work with *limu* restoring, replanting, since the area I live on Maui is where my *tutu* is from and I learned the family *mo'olelo*. She took me around, showed me all the lands and gave me the *kuleana* to take care of this family land--little did I know that it covered the whole area.

What I take care of at Waihe'e has extended to all of Maui and connected with other islands. I felt it was necessary for us to expand with our Hawaiian Studies Program. It has generated a lot of excitement--we work with the communities, get the kids involved. Now we're really trying to connect with the teachers, because in the Hawaiian Studies Program we're always separated even though we have tried to work with them. So we're trying to connect up, bridge that gap. It helps to reinforce our position in the schools and help teachers to recognize our *kūpuna* and make use of them.

So it's been exciting as we *kūpuna* network together to see what is happening with *limu* restoration. Of course, science has always been something that has always been way beyond, but we take it step by step. Now the young ones that come into the program are learning Hawaiian and Hawaiian culture. They see the science and how it works and see that elders are very supportive in what we're doing. They see that we are making that bridge and yet the culture is still so strong. The beauty of it is it helps to connect with the teachers and administrators, too, despite schedules and budget cuts. *Mahalo* (thank you) to everyone—it's exciting to go to all these different places to see what everyone else is doing. That has helped generate the desire to do something.

If someone had said this before, I would have said, "NO!" You just can't even imagine it, not until it bites you. When we get out to the land and start working it, it starts coming back. We were raised with some of it and we're ready to get back. And I can hear my grandmother. That's where the knowledge is, waiting there for us if we open that door. Then you have to go with it after that, you just can't drop it.

3. *Role of place-based cultural practices*

Interaction with and knowledge of place are culturally inseparable from responsibility, *kuleana*, and active care, *mālama*. For two decades Sabra Kauka and Moana Lee have worked to monitor and restore Nu'alolo Kai, a culturally significant site that "shows the longest continuous sequence of occupation on Kaua'i" (p. 10, Abbott, 1992). In 2006 several teachers and I cleared a small spring, counted goats, and surveyed plants. We submitted a plan to restrict goats, protect key native plants, and develop a plant nursery watered by the spring.

Sabra: Nu'alolo Kai chose us; in 1992 we took back our first re-interment as a result of the Native American Graves Protection and Repatriation Act (NAGPRA). These *iwi* (bones) came home and we took them back to their place of origin. The trail was only a goat trail, so overgrown you couldn't see very far, so the *kūpuna* led us there. We realized that we needed to begin to *mālama* that special 'āina, we had to clean and clear. State Parks archeologists led the early work teams to clean, clear and map the extensive rockwork. They were at the tip of the spear to poke it through the system, the bureaucracy.

Moana: The foundations and rocks are already there. What will be restored next is truly the restoration /recreation. The part I find interesting--other places are restored and people go there, learn things and there are caretakers, but you don't have the idea of it as having once being settled. But Nu'alolo Kai, maybe because we spend so much time there, you feel that you are walking in someone else's shoes, and this is why we return. Perhaps as we use it we evolve into who we are.

Michelle's alien *limu* removal program in Maunalua Bay is being taken up by students at her school.

Before I only took my class, then I thought, "What if they don't want to go—what if they all have sports one day?" So for the first time we invited kids from the leadership classes because guaranteed they're going to show up because they have to make their service learning quota. Then the marine science students, because they need to learn to take care of our island, too, and not just live in the lab. Then the kids started asking, "Hey Miss, when's the next one?" They started spreading the word, the basketball team started to come, then I talked to the Environmental Club. I said in one hour we cleared 3,850 lbs—and so the kids said, "OK, we'll come." It's getting to be more pleasurable and my kids don't feel over taxed. We've excited other kids who are willing to participate.

4. Role of Indigenous knowledge and practices in curriculum design

Michelle Kapana-Baird describes how she teaches an Indigenous method of locating sites in Maunalua Bay.

Recently our students were in charge of invasive algae cleanup. A member of the community organization came that day to help us. She asked, "What are your GPS markings?" I said, "I don't have one today." "So how do you know it's accurate? I knew she wanted to know how wide my area was that I cleared, what are the markings of my site, what are the points, how you do it, how you triangulate it. These things, it's all the science.

So I told my student, "Mele, Hawaiians didn't have GPS. This is what Ka'au told me when we use to sail into Kualoa. This is what I learned how to sail into the harbor. You'd find a

high land mark and a low land mark.” And I know the lady is listening to me. “How do you line it up and how will you see something that you will remember? What is a good landmark and what makes sense to you?” So I asked her to line it up with the *hālau*, (canoe house) a coconut tree, the Norfolk tree and the mountain. “Can you line that up with that little bump up there? So that’s your top landmark. And on the other side, do you see the water tower at the top of the mountain” “And what is down at the ocean level?” “The white mansion with the pillars.” “And what is the top of the mountain? So Mele you have the *hālau* and the trees and the mountain on this side and on the other side the dome and the mansion.” The lady came to me and said, “You triangulated your sights, I know you know what you’re doing.”

Huihui discusses how ancestral knowledge can be applied to indigenous place-based curriculum design and explains to Michelle how she can apply it to her Maunalua Bay setting.

If you look in the *Kumulipo* there are three different facets of science. *Papahulilani*, what’s above, rain, stars sun, moon, wind, clouds, measurement of vertical and horizontal spaces; *Papahulihonua*, the earth, ocean, caves, the study of natural earth, ocean, development, transformations and evolution by natural causes; and *Papahanaumoku*, things that are born, regenerate and procreate. There were schools and *kahuna* for these three things so we are looking at three different divisions of scientists.

Noho papa refers to something that has been in one place for generations (ordered and arranged like a feather lei), it means you start with the knowledge of the place and apply it to everything else. We recently did something for Hilo. Since social studies teachers are asked to do a place-based lesson we know the information that Hilo surprised us with and how we can connect that information to other things— *Papahulilani*, the hilo moon, star, winds; *Papahulihonua*, the Wailuku River, people are familiar with its dangers. *Papahanaumoku*, *nehu* fish (Hawaiian anchovy) congregate in Hilo Bay and *nehu* season starts the rain.

Huihui answers Michelle’s question about applying this approach to Maunalua Bay:

What you have asked has to do with landmarks just of your place, specific to your place. What does *Papahulilani* have to do with Maunalua, its stars, wind, rain? *Papahulihonua*—

what is it about the coastline, what do breakers look like there on a north swell? Where do we get our fresh water? What are the names of the springs? For *Papahānaumoku*, the birthing cycle of flora and fauna, where are the *mempachi* ('u'u, *Myripristis berndti*) holes, where are the *manō* (sharks), what about the birds? All this has to do with knowing your place.

Lila describes how indigenous inquiry methods develop cultural knowledge, sense of place, and questions needing further study.

Today we took our students to Punalu'u Valley to be taught on an ancestral 'āina by the *kupuna* (elder) who was born and raised there. It was an initial stage for our research in Punalu'u, to feel the 'āina. The *kupuna* taught them native Hawaiian plant identification and cultural practices in *la'au lapa'au* (herbal medicine). The students did land surveying and mapping and service learning. We learned that Punalu'u Beach was a source for *limu kohu* (*Asparagopsis taxiformis*) but none can be found today. *Honu* (green sea turtle) come into the bay seasonally. The *kupuna's* father fed the fish out on the *papa* (reef flat). Next month we will do science and geography research.

Mahina Hou Ross teaches science through Indigenous inquiry methods on Moloka'i. His immersion program is exceptional in its flexibility and use of educational technology.

Uncle Mac Poepoe of Mo'omomi says, "My generation, no can teach us, we're the one that took the fish. If you can teach the kids what the *kūpuna* taught us, we have a chance." So we've developed a traditional lunar calendar.

We have four sites we visit each quarter, Mo'omomi Bay and 3 fishponds. The kids actually see the health of the different parts of Molokai, more invasive *limu* along the south shore. The reef is not too healthy compared to Mo'omomi and further east. Today we were at a fishpond. Main focus, look at the organisms using the latest technology. We take students into the water, look at the fish and check what they've been eating. Like *kole* (*Ctenochaetus strigosus*), cut them open to check. They might look so similar but they taste different. To get the cycles and seasons for spawning, what time of the year, you've got to cut them open to find out. Then you've got to eat, so we fried them up.

We have the underwater camera and they're pretty good doing power points, I-movies, using Final Cut Pro software. They're going to do web pages. We have various scientists as resources, but I think the most important people are the teachers who have developed the program and made the connections with the community. Books are good to match what we catch, get the vocabulary. Drawings show the different parts; have the kids match them. But you've got to catch the fish. And the standards are going to be there, so show the learning is standards-based. Main thing is build the relationships with the students--they see the relevance of the curriculum when they go hunting, fishing, diving.

5. Institutional, cultural, and societal barriers to Indigenous inquiry

Teachers discussed barriers to place-based, indigenous methods of inquiry. In addition to familiar issues of school schedules and high stakes tests that interfere with fieldtrips and projects, obstacles to indigenous inquiry also included distrust of western science by some Hawaiians, degradation of familiar places, urban lifestyles disconnected from place, and the challenge of developing transdisciplinary curricula.

Moana: I started out as a scientist. About 25 years ago I was at a public meeting. One of the things being rejected by the Hawaiian community was science. Scientists are no good. Science was outright rejected because it had nothing to do with culture. I remember standing up. I was there to say something, as they were all rejecting science. My grandmother was a nurse, a healer. And you guys don't like science, but my grandmother was a scientist, she observed, she asked questions. She came to her conclusions out of her observations. If you think science is not Hawaiian, you're wrong. We would still be in the dark ages, we wouldn't even know how to sail the ocean. I was very unpopular.

Michelle: My son will never go to Kapena Falls and swing on the rope into the water because of the *leptospirosis*. So many things our kids will never do; so many things kids should do as science. When I was growing up and my dad said you're going Makapu'u!? I wanted to go there because the water's cleaner than Sandy Beach (site of a sewage outfall). It just passed on to another generation. There are some we have to give that experience.

Pauline: Many teachers are not from the place where they teach or haven't done place-based lessons, and they don't ask the kids, so they bring in outside experts. Teachers need to gain an understanding of the place in the sense that we've been talking about—from the people and land as key resources even if it is uncomfortable to move away from prepared curricula. What do I know of my place that I can bring to learning? The main thing is teachers can help kids to connect to land and community as resources for learning.

Sabra: Another challenge is combining science, education and culture. The Canoe Plants Project took about two years and required the expertise of three different people. An NSF fellow, provided scientific knowledge, a GK-12 graduate student wrote the lesson plans, and I provided the cultural component.

Discussion

Ua Lele Ka Manu as a search for a culturally responsive science education template

Ua lele ka manu. Has the bird flown or is it seen only by some? How can it be recognized?

Moana, the archeologist/educator thought indigenous inquiry might be a form of “cultural template.” Central to the notion of such a template is Moana's description of a Hawaiian sense of place connecting people to their storied landscapes from ancestral times into the future:

We keep track of landmarks because they can tell us something about the fishing spots in traditional times that can be brought into modern times. I'd like to say we're still doing it in the same way, like in *auana* (modern hula) we're still talking about the place. We recognize it is our template and we find ourselves within this template. This is what we're trying to provide to our students in an authentic way. We go to our *kupuna* to talk to them and do the sciencing but the students are collecting the data and they themselves have the *'ike* and they themselves are determining what to do with it.

Our study suggests a cultural framework for Indigenous inquiry and methods may be found in the practices of numerous groups in Hawai'i dedicated to caring for particular places and in the plans for restoration of Kaho'olawe Island. It also suggests a framework for culturally responsive

science education that situates standards in the contexts of place, culture and local concerns. A science teacher may apply this framework to develop a transdisciplinary lesson “that integrates global and local perspectives to shape a ‘place-based’ understanding of the interactions between environment and society” (p. 10, NRC, 1999).

Implications for Teacher Education and Curriculum Design

My research (2006, 2008, 2010) in Hawai‘i finds place and culture-based professional development has the potential to support teacher agency by linking Indigenous cultural roles to relevant science content and practices. A role informed by the roles and responsibilities of traditional *konohiki* or *papa huluhonua* could be reoccupied by teachers guided by core Indigenous values of *kuleana*, responsibility, and *mālama i ka ‘āina*, care for the land that feeds. As Bandura (2006) notes, “humans can create visualized futures that act on the present; construct, evaluate, and modify alternative courses of action to secure valued outcomes...To be an agent is to influence intentionally one’s functioning and life circumstances” (p. 164).

Sabra’s comments express agency informed by Indigenous inquiry and sense of place:

The survival of life on earth, let alone Hawaiian culture, depends on understanding how the natural world works. We have to heed the teachings of our ancestors and *mālama*, or take care of, the earth. If we do it will take care of us and future generations. If we don't it will be the end of us. We get people from all over the world at Nualolo Kai, we can't accommodate all of them. I tell them start where you are.

Sabra’s guidance to “start where you are” suggests that teachers whose primary training centered on standards-based science content can learn about their own places and issues to develop their own place-based lessons. Our study of Indigenous inquiry suggests a Hawaii-oriented framework with four process elements: 1) developing a Hawaiian sense of place, 2) *mālama*, caring

for/monitoring/restoring a familiar place; 3) *kuleana*, recognizing that the right to use resources come with responsibility; and 4) conducting inquiry oriented to sustaining a healthy social ecosystem. This framework can be adapted for other places, cultures, and issues. The following curriculum map shows how science standards can be taught through local historical, cultural, and ecological contexts to develop place-based understandings.

Table 1 Curriculum mapping to integrate global and local perspectives

Science Standard	Place	Culture	Resources	Issue	Action <i>mālama</i>
Science Inquiry	Local research, Field trip	Interview elders: environmental changes, practices, perspectives, values	Local agencies, colleges	Native and invasive species	Monitor, restore, communicate
Science/Technology/Society	Streams, ponds	Traditional vs. modern farming	Local agencies, farmers	Water quality	Monitor, restore, communicate

Science educators can prepare teachers with place and culture-based knowledge who are empowered to develop lessons incorporating local science-related resources, stories, places, and place names. Teachers who develop local expertise and culture-science networks in their community have more ways to engage diverse students' interest and more resources and venues for learning. Secondary sourced, text-based learning shifts to meaningful community-based learning relevant to students' present and future lives. Table 1 is also a road map for teachers to identify areas for their own professional development. Teachers who are interested in science-related issues in their own communities become life-long learners, continuously developing knowledge and designing lessons that address standards that are relevant to place, culture(s), resources, and local issues.

Resources for Hawai‘i’s teachers include groups caring for public places and courses providing place and culture-based science content and professional development. The revitalization of Hawaiian language and culture and Hawai‘i importance as a research center for earth, ocean, and space sciences support an extensive body of scholarship. The State’s adoption of Hawaiian for streets and place names; laws informed by indigenous practices related to ocean and forest access and water rights; restoration of significant places (*wahi pana*); and use of traditional land divisions maintains an indigenous, storied, eco-cultural landscape to educators ready to teach from Indigenous perspectives.

Conclusion

Ua lele ka manu, as a metaphor for Indigenous inquiry is still present, though more often in Hawai‘i’s communities than in its schools. Despite the rhetoric of active learning, inquiry, and critical thinking it continues to be relatively rare in school science due to policies that narrowly measure learning through tests. Western science now recognizes that Indigenous inquiry methods can play an important role in adaptive resource management and sustainability science. Science education faculty can prepare teachers to develop standards-based lessons that situate learning in local places, cultures, and issues.

The saying “‘*A ‘ohe pau ka ‘ike I ka hālau ho‘okahi*, All knowledge is not taught in the same school” (No. 203: Pukui, 1983) means that one can learn from many sources. In this light, the authors support the re-establishment of *Mālama I Ka ‘Āina*, Sustainability as a Hawai‘i State Science content standard as it expresses Indigenous/local perspectives on sustainability and supports development of systems thinking, problem solving, and civic engagement.

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