Science, Culture, Education and Social-Ecological Systems:

A Study of Transdisciplinary Literacies in Student Discourse in a

Place and Culture-Based Polynesian Voyaging Program

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Abstract

Social-ecological systems (SESs) linking human and natural systems have generally been studied by natural and social scientists from their separate disciplinary perspectives. Increasing rates of change in SESs have led to transdisciplinary approaches that recognize the potential for indigenous and local knowledge systems to contribute to societal capacity for adapting to change. This study of a transdisciplinary learning community led by a Native Hawaiian high school teacher applies discourse analysis to study student learning outcomes from a Polynesian Voyaging program dedicated to monitoring and restoring Maunalua Bay. Teaching and learning occur in the context of Hawaiian values, practices and place. Analysis of the student-made videotape of their 24-hour culture-science immersion shows students employ language suggesting concurrent development of literacies in scientific and cultural discourse. These outcomes suggest a significant role educators can play in developing societal capacity for understanding and adapting to changes in social-ecological systems.

1. Introduction

As the world’s most isolated islands with the highest number of endangered species per square mile anywhere on earth (Bishop Museum, 2003), Hawai‘i provides a unique setting for exploring questions concerning science, technology, and society. For reasons ranging from issues of health, safety, and schedules; to adoption of science curricula developed for national audiences; to science teacher education, relatively little of the science
students learn in school either relates to Hawai‘i or connects to students’ familiar environmental experiences and knowledge. Conventionally presented as a body of universal knowledge discovered through objective, impersonal, and culture-free experimentation, students perceive school science as largely unrelated to their places, practices, and personal knowledge.

1.1 Teaching, Learning, and Knowledge Building as Socially Situated

In reality, the doing of science is both a place-based and cultural activity as researchers take local contexts into account and communicate using the language and conventions of particular disciplines. Meyer’s (1998) interviews with Native Hawaiian elders about indigenous knowledge building led her to conclude that “Sites of practice, where the product, process and context were Hawaiian—that (sic) was where both information and practice synergized and strengthened the threads of cultural continuity” (p. 143). If the word scientific replaces Hawaiian and cultural, it becomes apparent that the ongoing development of science knowledge, the continuation of science as a culture, and the processes of incorporating new members are active social processes, situated in places where participants’ shared practices, tools, and language, i.e., Discourse (Gee, 2004, 2005) develop and sustain particular ways of understanding (Bourdieu and Passeron, 1977).

What are the connections among cultural and scientific knowledge building, cultural continuity, and social-ecological systems (SES)? Research in Hawai‘i suggests that transdisciplinary learning communities that include indigenous practices and knowledge are critical to building capacity to respond to ecosystem changes (Kaneshiro, et al, 2005). Folke’s (2004) overview of the role of traditional knowledge in ecosystem management notes that knowledge systems that develop through a community’s daily and long term ecosystem interactions address “interactions across temporal and spatial scales and organizational and institutional levels” and may provide models for adaptive capacity, characterized as learning
and responding during “periods of rapid change, uncertainty, and system reorganization.”

Davidson-Hunt and Berkes (2003) cite Folke et al’s (2003) synthesis of four principles for building adaptive capacity in SESs: “(1) learning to live with change and uncertainty, (2) nurturing diversity for reorganization and renewal, (3) combining different types of knowledge for learning, and (4) creating opportunity for self-organization.” Liu, et al’s (2007) synthesis of six coupled human and natural system studies across five continents underscores the importance of explicitly addressing “complex interactions and feedback between human and natural systems” to gain “unique interdisciplinary insights into complexities that cannot be gained from ecological or social research alone” (p. 1513).

This case study from Hawai‘i illuminates the complexities of one such coupled human and natural system. Until a recent revision, Hawai‘i’s science content standards included Mālama I Ka ‘Āina, Sustainability, incorporating a Hawaiian perspective on active stewardship. Kanahele (1986) explains its cultural significance, “If we are to be truly consistent with traditional Hawaiian thought…we are but stewards of the ‘aina and kai, trusted to take care of these islands on behalf of the gods, our ancestors, ourselves, and out children (pp. 208, 209).” Konohiki, a category of individuals with recognized expertise actively managed the SESs that sustained Hawaiian communities (Kumupono Associates, 2008):

Acknowledging the relationship of one environmental zone (wao) to another, is rooted in traditional land management practices and values…These traditional wao or regions of land, districts, and land divisions included: 1–Ke kuahiwi, the mountain; ...7-8–Ka wao ma‘u kele and Ka wao kele, the rain belt regions; ...10–Ka wao la‘au, the forested region; 11–Ka wao kanaka, the region of people below; ...14–Ka pahe‘e, the place of wet land planting; ...18–Ka po‘ina nalu, the place covered by waves [shoreline]; 19–Ke kai kohola, the shallow sea [shoreline reef flats]; ...23–Kai
Values of respect and care for nature that indigenous Hawaiians view as sustaining their existence are also found in American Indian and Alaskan Native cultures (Cajete, 1999, 2000; Kawagley and Barnhardt, 1999). Davidson-Hunt and Berkes (2003) describe how individual learning becomes part of community knowledge among the Anishinaabe, a First Nations people located near the border of Ontario and Manitoba, Canada. Among the Anishinaabe, social processes exist for incorporating individuals with new knowledge into recognized categories of holders of social memory. Through extensive life experiences that develop detailed, place-based knowledge, an individual may be recognized as especially competent and knowledgeable and become an elder, a socially designated role that recognizes certain individuals as a “source of authority and legitimate social memories” (p. 2).

The mapping of the Hawaiian social-ecological landscape into the 23 *wao* described above provided a cultural framework for constructing, organizing, and transmitting knowledge and values supportive of socio-ecological resilience. These knowledge-processing frameworks enabled individual and group memory to be consolidated into a dynamic body of cultural knowledge able to respond to changes in the SES. For example, the *Makahiki na o Lono*, an important island-wide, annual ritual dedicated to Lono, god of crops and bringer of rain began in late fall at the first new moon following the appearance of the Pleiades. For two months, war as well as fishing, planting, and other forms of work ceased as the island’s ruling chief, *mō‘i*, chiefly retinue and priests made a complete circuit of the island, visiting each *ahupua‘a* and receiving tribute. In effect, the *Makahiki* (meaning year, yearly) served as an institutionalized, annual island-wide monitoring of a range of SESs, enabling consolidation of cross-scale, cross-temporal information for resource management oriented to sustainability.
Abbott (1992) suggests the Makahiki’s biological significance lay in the “two-month period when the land could rest, plants could grow without being harvested, and the ocean could replenish itself” (p.22). When the Makahiki was not in force, lesser chiefs serving as resource managers, konohiki, in each largely self-sustaining resource unit, ahupua‘a, enforced appropriate behavior with strict sanctions, kapu, that structured the lives of all classes of society. In 21st century Hawai‘i indigenous ways of thinking about SESs continue to provide a framework for the responsible relationship of people to place.

1.2 Reconnecting School Science to Place, Culture, and Practice

Davidson-Hunt and Berkes (2003) warn that the loss of indigenous values and the institutions that authorized and legitimized construction and transmission knowledge can lead to loss of resilience that is both social and ecological in nature. Unfortunately, the perception of many science teachers that science is objective and culture-free contributes to insensitivity to the sociocultural contexts of teaching and learning (Greenfield-Arambula, 2005). The absence of authentic, personalized, experiential learning is a critical factor in successful schooling of Native Hawaiian students (Kawakami and Aton, 2000) and in the persistence of underrepresented females in college physical science and engineering programs (Chinn, 1999).

The gap between Hawaiian ways of learning that lead to transdisciplinary, situated, active knowledge and conventional school learning that lead to decontextualized science knowledge suggests that de-legitimization of traditional knowledge systems, values, and ways of learning may contribute to the underrepresentation in science of Native Hawaiians. Ten years ago, the goal of removing or narrowing this gap motivated the writer to design a science education course, EDCS 433 Interdisciplinary Science Curriculum, Mālama I Ka ‘Āina, Sustainability with a place, culture and inquiry-based focus.
Summer EDCS 433 courses allowed teaching and learning to be situated primarily in transdisciplinary, culture-science learning communities in which expert peer teachers, scientists, and community members provided models of place-based science programs. Course assignments asked teachers to view their communities as resources for writing lessons meeting the criteria of rigor (content rich, standards-based), relevance (significant issue, meaningful to learners), and relationships (learning community). When external funding permitted, overnight culture-science immersions in school and community settings provided opportunities for diverse participants to learn from and to teach each other. The teacher in the case study reported below developed her place-based program into an exemplary model with the support of several years of funding from Pīkoi Ke Kaula Kualena, Focus on the Essential Core, an award to the Consortium for Hawai‘i Ecological Engineering Education from US Department of Education, Native Hawaiian Education Act.

1.3 Theoretical Framework and Research Questions

The theoretical framework for this qualitative study is located in social learning research and theory associated with Bourdieu & Passeron (1977), Lave and Wenger (1991), Wenger (1998), and Gee (2004, 2005). Lave and Wenger’s (1991) theory of knowledge acquisition is based on studies of learning situated in communities of practice focused on specific outcomes. A community of practice (Wenger, 1998) has the characteristics of joint enterprise and mutual engagement among “people who engage in a process of collective learning in a shared domain of human endeavor.” The reciprocal and dynamic nature of teaching and learning is captured in the Hawaiian word a‘o, meaning instruction, teaching, doctrine, learning, advice, and counsel (Pukui and Elbert, 1986).

Social learning theories acknowledge the role of modeling, observational learning, subjectivity, intentionality, and a plurality of socio-cultural contexts productive of multiple
identities and literacies. Learning is viewed as a social process with implications for identity building occurring over an individual’s lifespan in formal and informal situations.

A sociolinguistic approach suggests that insight into learning may be gained in settings in which students use vernacular or home language and practices while learning and practicing academic and content area communication practices and skills. The analysis of Discourse, defined by Gee (2005) as “ways of combining and integrating language, actions, interactions, ways of thinking, believing, valuing and using various symbols, tools, and objects to enact a particular sort of socially recognizable identity” (p. 21) will be discussed below as way to study teaching and learning.

Gee’s (2004) critique of schooling relevant to equitable access to knowledge is based on the distance between “academic varieties of language connected to content areas” (p. 19) and the vernacular language of home and community. His research shows children from non-mainstream cultural backgrounds learn forms of language discouraged in schools while those from middle class homes learn forms that parallel academic speech valued in schools (e.g., providing explicit detail on a single topic). Gee thinks entry into a Discourse community with specialized language and practices (signified by a capital D) involves a trade-off between loss of vernacular, everyday language and gain of specialized language:

So a crucial question in science education, for example, ought to be: “What would make someone see acquiring a scientific variety of language as a gain?” …People can only see a new specialist language as a gain if: (a) they recognize and understand the sorts of socially situated identities and activities that recruit the specialist language; (b) they value these identities and activities…; and (c) they believe they (will) have real access to these identifies and activities….Thus science in school is learned best and most deeply when it is, for the learner, about “being a scientist” (of some sort) “doing science” (of some sort) (p. 93).
A view of learning as socially situated, supporting development of a new identity through the acquisition of an integrated set of language/knowledge/skills, and occurring in sites of practice provides a research agenda that looks for evidence that language, identity, and knowledge change as a result of this type of learning. Gee’s (2005) approach to discourse analysis is used to explore following questions:

- What socially situated identities and activities are enacted?
- What Discourses are involved?
- What relationships appear among different Discourses?
- How does intertextuality function in texts?

2. Study Setting and Participants

*Project Hoʻolohi* is a school-based Polynesian Voyaging program led by Michelle Kapana-Baird, a certified physical education teacher and canoe paddler associated for many years with the Polynesian Voyaging Society. She was motivated to study Maunalua Bay by Myron Thompson, a prominent educator and leader in the Hawaiian community and Polynesian Voyaging Society. He had remarked on the appearance of alien seaweeds in Maunalua Bay, where her students applied their learning with the support of the canoe club and Polynesian Voyaging Society. Michelle enrolled in EDCS 433 in 2002 with the goal of developing a plan to restore the bay.

Maunalua Bay is located in the Waikiki ahupua’a between the tuff volcanoes of Diamond Head, Leahi, and Hanauma Bay. Its name, Maunalua, two mountains, signifies its position between two mountains. The eastern section is connected by two dredged channels to the remnants of the largest precontact fish pond in Hawai‘i. In 1959 the 500+ acre fish pond was designated as private property in a landmark court case, permitting the development of a marina community designed for 50,000 but now home to 60,000 residents. Long time residents observe that the number of hammerhead shark pups found in the 200
acre marina has declined over the years. The development of a park, boat ramp, and a large parking lot on the ocean side of the marina support year round use by residents and tourists. Commercial activities include paddling, kayaking, jet and water skiing, SCUBA diving, coastal boat tours, snorkeling, and fishing. Michelle’s canoe club, Hui Nalu, houses its canoes on one side of a channel; a bird sanctuary is on the other.

Students in Project Ho‘olokahi learn and practice cultural protocols, Polynesian navigation, sailing and a core cultural value, caring for the land that feeds, mālama i ka ʻāina. Students are 15 to 18 years old and become life guard certified as a prerequisite to ocean activities. Most who enroll in this elective course are Native Hawaiian. As often found with courses that provide active, hands-on learning, special education students were overrepresented in Michelle’s class compared to their percent in the school. The culture-science immersion documented by students occurred during the 2005-2006 school year.

The author-researcher was born and raised in Hawaii. She used to fish and collect edible seaweed at Maunalua Bay, and taught science at Michelle’s school before becoming a university instructor. EDCS 433, an interdisciplinary, place and culture-based science curriculum course was underwritten by the Native Hawaiian Education Act, U.S. Department of Education.

3. Methodology

This qualitative case study seeks to understand how students in Project Ho‘olokahi construct meaning and express themselves through the journal excerpts and video clips they select as most important to telling the story of their culture-science immersion. Data sources include the videotape and transcript from Na Pua O Maunalua, The Youth of Maunalua. The researcher was a participant-observer during one of the three culture-science immersions, conducted site visits at the school and in the community prior to and following the immersions and attended the community meeting announcing the establishment of the non-
profit Mālama Maunalua. Michelle Kapana-Baird reviewed the paper to ensure cultural and interpretive validity (Cohen, Manion, and Morrison, 2007).

Discourse analysis (Gee, 2005) is applied to the transcript of a student-made video describing their 24 hour culture-science immersion. Analysis examines sites of practice, language, activities, actors and tools to detect Discourses that suggest learning and identity building; social languages associated with home, school, and disciplines; intertextuality of words as relating to words spoken by others; “and conversations” that relate to “themes, debates, or motifs that have been the focus of much talk and writing in some social groups….or society” (p. 21).

4. Results

Two years after beginning her culture-science program in 2003, Michelle led three community-based immersions at Maunalua Bay. The 24-hour agenda received by students and parents revealed extensive integration of culture and science. Students would learn from graduate students, US Geological Survey and Fish and Wildlife agents, science teachers, and a Master Navigator. Expertise spanned marine biology, GPS mapping, water testing, Polynesian sailing and navigation. Indigenous contexts for learning were seen in the frequent use of Hawaiian words and the following of Hawaiian protocol in pule, prayers or blessings that focus attention on the place, activity at hand, key participants and serve to connect natural, cultural, and spiritual worlds at key transition points. The agenda overall exemplified school Discourse while agenda content, Hawaiian and science words, tools and activities, exemplified cultural and science Discourses.

The author attended one of the three 24-hour culture-science immersions from morning through the early afternoon. Michelle had divided her class into three groups as the Hokulea, the voyaging canoe on which they would spend the night did not have adequate space. Students paddled out to the reef flat to remove alien seaweeds in the company of
botany graduate students and agency scientists. Each canoe held 6 paddlers, including an adult steersperson from the Hui Nalu Canoe Club. A small skiff towed by one of the canoes carried collecting bags, scoop nets, and other supplies necessary for site work. At all times students and adults were in close contact, working and learning together in various roles. The author observed an adult to student ratio of 1 adult to 3 students, in contrast to the 26 students to 1 teacher ratio in public schools.

4.1 Discourse Analysis of Transcript of Na Pua O Maunalua

Students’ journal entries provided the narrative of a five minute videotape of the October 2005 immersions. Students completed the 16 stanza videotape in May 2006. Different students spoke each stanza, defined by Gee (2005) as “sets of lines devoted to a single topic, event, image, perspective or theme” (p. 127). Selected stanzas are elaborated upon below to highlight the way situated, culture-science learning appears to support the simultaneous development of students’ cultural and scientific literacy. (See Appendix I for the complete transcript.) Stanza 1 introduces a key role model and program mentor, master navigator Nainoa Thompson, who in 1980 became the first Native Hawaiian navigator in many centuries to navigate a double-hulled voyaging canoe between Hawai‘i and Tahiti without instruments (http://pvs.kcc.hawaii.edu/finney80.html). With 11 Micronesians and 4 other Native Hawaiians Nainoa was inducted by Master Navigator Mau Piailug into the Weriyeng School of Navigation of Micronesia in 2007 (http://pvs.kcc.hawaii.edu/index/our_founders_our_teachers.html). The dominant Discourse is academic discourse, providing descriptive detail of a single topic, the 24-hour immersion.

Stanza 2 reveals the dual Discourses of school and Hawaiian culture that establish a Hawaiian context for the community-based activity. Using English at the beginning of the stanza to describe the purpose of the immersion establishes the activity as a school event but a shift to Hawaiian midway through emphasizes the cultural role of stewardship. The
impersonal label and role “environmental stewards” becomes the culturally contextualized haumana, students, who will mālama i ke kai o Maunalua, care for Maunalua, the area of the sea they know, use, and enjoy therefore must care for. The canoe club’s hālau houses canoes and gear and has served as their learning site since the project began. Hālau is also associated with meetinghouse and place of learning.) The final phrase “experiential learning” in English returns to school Discourse, but conveys place-based, purposeful, active Hawaiian ways of learning.

Stanza 3 is a hybrid of school, science/technology, and cultural Discourses. It opens with school Discourse (first activity of the day), then shifts into science/technology Discourse in describing the uses of Global Positioning System tools and its support for scientific data collection and communication. The only use of Hawaiian/local cultural Discourse is to introduce an agency scientist as Aunty Annie. This positioning of a scientist as a member of an extended family, ‘ōhana, establishes a pattern noted in succeeding stanzas that suggests the students’ familiarity with scientists as role models.

Stanza 4 shows the blending of informal discourse with school, science, and cultural Discourses. The overall format, detailed description of a single activity, clearing alien limu reflects school and science Discourse. “Quadrate, square meter, scoop net, floating fragments, because, generate, colony” representing the tools, terms, ways of seeing and measuring an objective world indicate students’ scientific literacy.

The Hawaiian word limu, seaweed, is used 4 times and kuleana, right/responsibility, is used once without elaboration in English. The ability of video to convey meaning through action of kuleana, a core Hawaiian ethic oriented to personal responsibility and sustainability indicate it would be well known to the audience. This is an example of Gee’s (2005) Conversations, themes that are generally known to particular social groups, in this case, Native Hawaiians, most residents of Hawai‘i, and those familiar with Mālama i ka ‘āina,
Sustainability, a former science content standard. Students’ voices and feelings are expressed in the words “amazing how much there was in one square meter” and “a big patch of alien limu.” Informal discourse recognizes the importance of affect, personal experience, and engagement in learning.

Stanza 5 continues the blending of school, cultural, and science Discourses. Aunty Kim and Aunty Dawn, botany graduate students, help students learn unfamiliar science in familiar settings and contexts. Alien limu shown in photographs taken by Michelle in Fig. 1(a) and (b) below are given informal and scientific names, linking everyday discourse to scientific and school Discourses. Students wear gloves as they handle the limu, following safety procedures used by researchers. (In Stanza 6, a student holds a bristly polychaete worm as the student narrator says: “Fire worms are the centipedes of the sea. Because when they sting you it feels like fire.”)

Fig. 1 (a) Gorilla ogo, Gracilaria salicornia  (b) Leather mudweed, Avrainvillea amadelpha

In Stanza 7 a student evaluates personal experiences in scientific, “Our class collected over 450 lbs of alien limu” and affective language, “It was awesome to do something that was good and benefited nature.” The student feels good that problem-based, active learning benefits a familiar social-ecological system. This Hawaiian way of learning produces active science literacy, “knowledge and understanding of scientific concepts and processes required
for personal decision making, participation in civic and cultural affairs, and economic productivity” (p. 22, National Science Education Standards, 1996).

Stanza 8 makes a direct connection between students’ reef monitoring activities and the practices of ancestors. As students paddle an outrigger canoe towards a coral reef the student narrator evaluates paddling as “hard work [that] brought many of us back to the routes traveled by our ancestors in ancient Hawai‘i.” The use of outrigger canoes as research vessels produces insights that support simultaneous identification with hard-working ancestors and scientists.

Stanzas 10 – 11 are particularly revealing of the co-construction of indigenous, school, and scientist identities. The video shows students, instructors, and community members conducting water tests for salinity, dissolved oxygen, and nitrates and using dyes to examine current flows. Participants wear informal beach clothes, are sun-tanned, and many appear to be of Hawaiian ancestry. In contrast to conventional school science laboratory activities with predetermined outcomes, participants are engaged in authentic science inquiry with outcomes of interest to their real world concerns. The phrase “Uncle Eric turned the hālau into a science lab” conveys the reality of culture-science identities, knowledge and practices co-existing in the same places and bodies.

These stanzas show that scientific Discourse, typically characterized by passive grammatical construction and tight connection of evidence, analysis, and possible outcomes may be situated in cultural and informal contexts. The claiming of science Discourse as personal/informal and cultural is seen in placement of the student-as-scientist into the text as “we” and “us,” the positioning of the science teacher leading the water and current tests as “Uncle Eric,” and the carrying out of science activities at the hālau. The visuals and text indicate that doing science in this way is meaningful and that anyone can engage in authentic science inquiry oriented to informed care for familiar ecosystems.
Stanzas 12 and 14 reveal that ending the day with a sail in Maunalua Bay, “the reward for all this hard work” of doing science is deeply cultural. “It truly was an honor” to sail on the *Hokulea*, learning to steer from “Uncle Nainoa,” the Hawaiian navigator famous for developing a non-instrumental way-finding system. In the video, several students grasp the steering sweep as the *Hokulea* sails in the open ocean. Steering the *Hokulea* is cultural work able to be simultaneously described in physics terms. Learning to be a Polynesian voyager is also “hard work” as the student reports “it was very challenging to keep control of the large steering sweep which weighs over 500 pounds.” The theme of learning as hard work occurs in stanzas 3 (twice), 8, 12, 13, 14, and 16.

Master Navigator Nainoa Thompson in stanza 1 has become Uncle Nainoa in stanza 14, suggesting a familial yet respectful relationship grounded in interpersonal, joint activity. As in other uses of “aunty” and “uncle” in the transcript, the terms represent relatedness, respect, and imply reciprocal responsibility instead of the distancing and status recognition expressed by formal institutional roles and titles.

In Stanza 16, language shifts from referring to instructors as aunties and uncles who shared thoughts and ideas, *mana‘o*, to “leaders” and “planners.” Positive evaluations of experiential learning are captured in the phrase, “This was one day that we all wished would never end.” The use of Hawaiian terms, cultural references, and final video footage, a lingering shot taken from the *Hokulea* of the sun setting directly over Leahi (Diamond Head) convey the message that new knowledge and experiences are firmly situated in shared place and culture-based learning activities.

A student recognizes that “By working together we developed a memorable experience that will last a lifetime.” “Working together” suggests the Hawaiian word *lokahi*, unity and harmony, a word found in *Ho‘olokahi*, the project’s name. Meaningful learning as “memorable experience that will last a lifetime” is constructed through working together, co-
planning, and willingness to share *manaʻo*, the thoughts, ideas, meanings, and theories presented that day. In positioning the immersion as learning to care for the sea and land, *mālama i ke kai a me ʻāina*, science learning is integrated with culturally responsive, place-based learning.

### 5. Discussion

A view of learning as socially situated looks for evidence that language, identity, and knowledge change as a result of this type of learning. Gee’s (2005) approach to discourse analysis is used to explore following questions:

- What socially situated identities and activities are enacted?

Michelle told the author a few years ago that she was initially put off by the first EDCS 433 classroom presentation that interpreted Hawaiian resource management practices through the lens of science. Her comments, echoed by other Native Hawaiian teachers indicate that *learning about* science has much less value than *doing science* in the context of problem-solving and application in the real world. She and her Native Hawaiian colleagues who knew from personal experience that human activities often had negative ecological consequences appropriately evaluated science knowledge and technologies through the lens of cultural relevance and utility.

Conducting science activities outdoors at the canoe *hālau* and from canoes serving as research vessels supports the simultaneous enactment and construction of science and indigenous identities. Students enact these identities through their use of science and Hawaiian terminology and appropriation of school, science, and indigenous Discourse patterns. The activities (*limu* identification, *pule*, paddling, sailing) and tools (GPS, quadrates, water test kits, canoes) allow multiple identities to develop and strengthen as participants with different knowledge and backgrounds teach and learn (*aʻo*) together.

Stanzas in which a student reports, “Uncle Dave taught us how to identify the fish and it was
neat to actually know their names” or in Stanzas discuss water tests and limu species suggest that doing science with scientists enables students to think about, experience being like, and even identify with scientists even as the cultural and place-based contexts of the activities support indigenous meanings and identities. (See Appendix for complete transcript.)

- What Discourses are involved?

Evidence from the videotape and transcript suggests hybrid Discourses of culture, science, and schooling are learned by students. Even when science Discourse dominates, a word or phrase, such as calling a science instructor “aunty” or “uncle” conveys a cultural Discourse. The overall language pattern of each stanza reveals academic Discourse in the description of a central topic. Possibly an outcome of revising journal entries during storyboarding, the process reinforces the use of academic Discourse as students learn to revise informal, expressive language towards the expected forms of disciplinary discourses.

- What relationships appear among different Discourses?

The context for Michelle’s science activities is the cultural imperative to study and care for (mālama) community resources for current and future generations. Thus the student transcript suggests both the wisdom of ancestors and western science are valued as providing tools for teachers, students, and community to learn about and care for the sea and land, mālama i ke kai a me ‘āina. Her program conveys and her students learn an adaptive cultural Discourse that includes scientific and academic Discourses as appropriate to the purposes of the activity and participants.

Through her situatedness in diverse settings over the years, Michelle has successfully established a transdisciplinary knowledge network that includes agency and university scientists engaged in conservation biology and community-based management. As someone with access to place, culture and community-based knowledge, her relationships with researchers appear egalitarian and collegial. She has developed a unique, science-based
understanding of Maunalua Bay and in 2006 won the Hawai‘i’s Living Reef Program’s Educator award (http://www.hawaiireef.net/awards/winners.shtml).

In the 713-word transcript, the number of terms associated with the Discourse of science and technology exceed those associated with Hawaiian language/culture/activities, which greatly exceed terms associated with school and classroom learning. The student selection of learning logs for the transcript suggests that they recognized the potential for science and technology to support and inform indigenous practices oriented to sustainability.

- How does intertextuality function in these texts?

The texts generated by students exemplify intertextuality in their borrowing of words and phrases from other Discourses. The first two lines in stanza 4 above show language associated with Hawaiian (limu, kuleana), science (quadrate), and academic (focus on a single topic) Discourses. It also contains informal, expressive discourse in the non-scientific description of “a big patch” of alien limu.

Intertextuality involving Hawaiian words functions to interrupt dominant Discourses and images of science in stanzas 10 and 11, giving science a Hawaiian voice and sensibility. Intertextuality in student writings thus connects cultural identity to emerging science and academic identities. Intertextuality also shows the origins of language used by students when words and phrases echo those used by the teacher, as in the use of “immersion.” Similarly, the student who spoke of voyaging in the “routes traveled by our ancestors” echoed Michelle’s words in her project overview which reflect the phrasing used in Polynesian Voyaging Society texts. The shaping of language through affiliation suggests the socially situated shaping of identities and construction and continuity of culture.

5.1 Implications for Teacher Education and Student Learning

Michelle modified the EDCS 433 model of a school and community-based culture-science program into a version appropriate to her site and Project Ho‘olokahi. The range of
participants and experts involved in her immersions showed she established a social network that shared her interests in monitoring and restoring *Maunalua Bay*. Analysis of student texts suggests that science done in the context of real world cultural and environmental issues is engaging and meaningful. Michelle’s original interest in incorporating science into her culture-based program is reflected in her students’ assessment of their learning and experiences.

This case study suggests that place-based professional development in science that is congruent with Native Hawaiian knowledge, values and practices has the potential to empower teachers as curriculum designers. Teachers who utilize the resources in their students’ communities in their lessons engage students in richly contextualized, personally meaningful learning that supports access to academic content. In Michelle’s program, co-learning with community members and scientists is central to this process. Participating in a transdisciplinary learning community composed of diverse participants who share a common purpose enables students to explore different Discourses in authentic contexts. Students recognize that learning to be a member of a Discourse community is hard but meaningful work. One of Michelle’s expectations is that her students learn in order to teach others who come to Maunalua Bay to help and to learn.

Gee’s (2004) position that learning science (or other Discourse) is noted as the gain of socially situated, specialist language and identity appears to be supported in this study. The transcript video, and researcher’s site visits indicated that students “recognize and understand the sorts of socially situated identities and activities that recruit the specialist language…and value these identities and activities” (p. 93). Some of Michelle’s students have entered into activities that indicate their experiences supported “real access to these identifies and activities” (ibid, p. 93). In 2008 I met one of several of her students participating in summer youth conservation programs.
The evidence from this study suggests that learning another Discourse need not involve loss of vernacular language and identity, but the gain of new languages and identities each appropriate to its Discourse community. Participating in a transdisciplinary learning community enables learners to become knowledgeable about, able to communicate with, and potentially to identity with and become members of multiple Discourse communities.

5.2 Implications for Adaptive Learning Relevant to Social-Ecological Systems

This case study of school and community-based management suggests that teacher education oriented to place-based curriculum development supports teachers as leaders in curriculum innovation. Two years after Michelle began incorporating monitoring and restoration into her Polynesian Voyaging program, and shortly after her series of 24-hour immersions, community supporters including the Polynesian Voyaging Society and Hui Nalu Canoe Club established a non-profit, Mālama Maunalua “dedicated to creating a more culturally and ecologically healthy Maunalua.” (See http://malamamaunalua.org for history and projects.)

Though this study reports on one teacher’s development of a diverse community of learners, other community-based monitoring and restoration programs have been initiated or strengthened by Native Hawaiian teachers following their participation in EDCS 433 (Chinn, 2006). Community-based efforts led by Native Hawaiians such as Uncle Henry Chang-Wo’s limu restoration efforts at on O‘ahu and former EDCS 433 teacher Alyson (Napua) Barrows on Maui are sustained by those who consider it their kuleana to respond to changes in their local ecosystems.

The 21st century presence of indigenous Hawaiian knowledge/practices/values and cultural frameworks connecting ecological information to real-time human behavior suggests that place and culture-based professional development in science can provide teachers with the tools to write and teach lessons that develop active science literacy.
However, challenges to place-based science education and teacher empowerment in Hawai‘i include a continued reliance on science texts designed to meet needs of large Mainland states, school policies and schedules that impede off-campus learning during the school hours, and accountability systems focused on narrow, test-based measures of student learning.

6. Conclusion

Discourse analysis reveals that transdisciplinary, place-based programs such as Michelle’s Project Ho‘olokahi help students to develop multiple literacies as they become familiar with the tools, language, values, and identities of scientists and indigenous ancestors. These findings indicate that situating teacher education and student learning in communities that incorporate indigenous, local and science knowledge supports educational, scientific, and cultural literacy.

Including indigenous and/or local, place-based practices and values in teacher education has the potential to prepare teachers with the situated scientific, cultural, and place-based knowledge to engage all students, particularly indigenous students who tend to be underrepresented in science in Hawai‘i as well as other states and countries, in meaningful academic and scientific Discourses oriented to adaptive learning in a time of rapid and uncertain ecosystem change.

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**References**


Appendix 1. Transcript of Na Pua O Maunalua Videotape

Completed in May 2006, the student videotape won second place award in a high school environmental video competition and has been broadcast on public access cable television. The following narrative, divided into stanzas read by different students, was compiled from student journal entries.

1. In October the Kaiser HS Ho‘olakahi Voyaging class began a series of 24 immersion sails with Hokulea master navigator Nainoa Thompson.

2. The purpose of this immersion was to help us become environmental stewards who mālama i ke kai o Maunalua. The haumana met at the Hui Nalu Canoe Club’s hālau to begin this experiential learning.

3. The first activity of the day was to learn how to use a GPS or Global Positioning System. Aunty Annie taught us how to track points on a map so that later on we would be able to tell others exactly where we had worked on the reef. The GPS sends a signal out every 5 seconds to a satellite that tells us where we are in the world.

4. We paddled out to a sandbar about 100 yards from shore to do a limu cleanup continuing the work we had begun last year. We placed our quadrate on a big patch of alien limu. Our kuleana was to clear the limu in our quadrate. It was amazing how much there was in one square meter. We used the scoop net to catch floating fragments of limu because the smallest piece could generate a whole colony of alien limu.

5. Aunty Kim and Aunty Dawn helped us to identify the different types of limu. One of the major limu that we had to get rid of was gorilla ogo, or Gracilara salicornia. Another is leather mudweed or Avrainvillea amadelpha, and Acanthophora spicifera. These are the alien limus in Maunalua Bay.

6. We also had to chart the fish and invertebrates. We found opaʻe, mantis shrimp and fire worms. Fire worms are the centipedes of the sea. Because when they sting you it feels
like fire. We also looked for crabs and sea cucumbers. We recorded the data of all the fishes and invertebrates that we found.

7. It was awesome to do something that was good and benefited nature. Our class collected over 450 lbs of alien *limu*. It felt great to clean up Maunalua Bay. The spaces that we cleared will become homes to native species of *limu* that we will plant in the future.

8. Then we paddled out to Blue Hole to do a reef check. The paddling experience was hard work and brought many of us back to the routes traveled by our ancestors in ancient Hawaii. Blue hole is truly a big hole of sand surrounded by a reef of very beautiful, low coral.

9. Uncle Dave taught us how to identify the fish and it was neat to actually know their names. Like *manini*, yellow tang, Moorish idol, surgeon fish, goat fish, and baby saddle wrasse. We also saw a spotted puffer fish.

10. After lunch back at the *halau* we tested for water quality at 3 different locations at the canoe site. Uncle Eric turned the *halau* into a science lab. The tests showed that salinity, dissolved oxygen, and nitrates were found to be at safe levels.

11. Bright green dye showed us which way the current was flowing since this can affect the growth of *limu*. We discovered that there were more than 5 different currents all flowing into one area of the bay.

12. The reward for all this hard work is that we got to sail on the *Hokulea*. It truly was an honor.

13. Aunty Catherine taught us the safety procedures before we sailed. Experienced crew members provided hands on training on how to open and close the jib and mainsail. As we worked with the ropes we learned about the bronco lines for the sails.
14. Uncle Nainoa taught us how to steer the canoe. If you pull to the left the boat goes to the right and vice versa. It was very challenging to keep control of the large steering sweep which weighs over 500 pounds.

15. We could see all the different *ahupua‘a* on shore. After Niu Valley we made a port tack and threw the escort boat a towline which took us back to Maunalua Bay.

16. By working together we developed a memorable experience that will last a lifetime. We are grateful to our leaders who planned this immersion and were willing to share their *mana‘o* to *mālama i ke kai a me ‘āina*. This was one day that we all wished would never end.