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# Decolonizing Methodologies and Indigenous Knowledge: The Role of Culture, Place and Personal Experience in Professional Development

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Abstract: This study reports findings from a 10-day professional development institute on curricular trends involving 19 secondary mathematics and science teachers and administrators from Japan, Malaysia, Indonesia, Thailand, Korea, Philippines, the United States, and People's Republic of China. Participants explored the roles of culture, place, and personal experience in science education through writings and group discussions. Initially, Asian participants tended to view indigenous knowledge and practices more negatively than U.S. peers. After a presentation on indigenous Hawaiian practices related to place and sustainability, they evaluated indigenous practices more positively and critiqued the absence of locally relevant science and indigenous knowledge in their national curricula. They identified local issues of traffic, air, and water quality they would like to address, and developed lessons addressing prior knowledge, place, and to a lesser extent, culture. These findings suggested critical professional development employing decolonizing methodologies articulated by indigenous researchers Abbott and Smith has the potential to raise teachers' awareness of the connections among personal and place-based experiences, cultural practices and values, and teaching and learning. An implication was the development of a framework for professional development able to shift science instruction toward meaningful, culture, place, and problem-based learning relevant to environmental literacy and sustainability. © 2007 Wiley Periodicals, Inc. J Res Sci Teach 44: 1247–1268, 2007

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In many nations public school science is shaped by policy makers who emphasize preparing and assessing students for an increasingly technological, urbanized, competitive, global economy. Driven by performance on standardized national and international tests such as Trends in International Mathematics and Science Study (TIMMS), curriculum becomes more uniform as nations compete on student performance (http://timss.bc.edu/timss2003.html). In the United States, educators in test-oriented public school systems generally turn to textbooks to provide

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science content meeting these objectives. The huge, profit-driven publishing companies that dominate the textbook market provide science materials shaped with one eye on policy and the other on their largest markets. When science curriculum is determined by concerns that reside outside of communities, especially those of nonmainstream or indigenous populations, the teaching of science tends to be separated from learners' experiences, local science issues, and traditional ecological knowledge (Kawagley, 1999; Snively & Corsiglia, 2000).

It may be argued that science education needs to focus more, not less, on real-world issues based in students' lives and communities. Science studies connecting science and society provide opportunities for personally meaningful, experiential, inquiry and place-based learning fundamental to scientific and environmental literacy. Teacher education focused on real-world science is appropriate from a learning standpoint and urgent from a societal standpoint as evidence accumulates that human activities are driving environmental and evolutionary change (Palumbi, 2001; Mapping Human Impacts on the Biospeher, www.globio.info/). In light of studies concluding that ''human activities have at least doubled the transfer of nitrogen from the atmosphere into the land-based biological nitrogen cycle'' (p. 146, Vitousek, Aber, Howarth, Likens, Matson, Schindler, Schlesinger, & Tilman, 1997), U.S. agencies call for research on how different societies respond to environmental change (Human Dimensions of Global Change, www.usgcrp.gov/usgcrp/ProgramElements/human.htm).

Emerging as a transdisciplinary field in education (Fain, 2004; Gruenewald, 2003), science learning associated with place develops the ecosystems knowledge integrating humans and nature characteristic of sustainable cultures (Cajete, 1999, 2000; Kawagley, 2001; Orr, 1992). Disinger and Roth (2003) stress the active, embodied, problem-finding, problem-solving, place-based nature of environmental literacy: ''Environmental literacy is essentially the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems.''

The following sections of this article discuss indigenous Hawaiian practices oriented to sustainability, the marginalization of indigenous/traditional/local knowledge in schools and society, and the ideology of Western Modern Science to set the stage for a study applying Habermas' critical communication theory. Nineteen international science and mathematics educators in Hawaii for a 10-day professional development institute viewed a presentation on indigenous Hawaiian practices related to place and sustainability then engaged in collaborative action research leading to recognition of the sociocultural and ethical contexts of education. Implications for professional and curriculum development oriented to sustainability and environmental literacy are discussed.

## Teacher Disempowerment and Test-Driven Curricula

Hawaii's students have a unique natural laboratory to explore fundamental biological questions involving evolution, adaptation, and interactions of humans and the environment on isolated island systems. But most learn classroom and text-based science, perhaps becoming literate in school science but not issues relevant to their own lives and communities. Thus, Hawaii's teachers, especially those in elementary programs that require only two semesters of science, are unlikely in either their K–12 or college years to gain the science knowledge and tools to integrate their own and their future students' familiar environments into their teaching.

Even when elementary teachers are knowledgeable about Hawaii-oriented science, the impetus to raise nationally normed, standardized test scores under the No Child Left Behind Act (NCLB) leads to administrative decisions to teach mainstream curricula. Teachers critique the emphasis on standardized tests as contradicting professional teaching standards (www.htsb.org/

standards/teacher_standards/teacher_index.html) and principles of learning emphasizing engaging students' prior knowledge (National Research Council [NRC], 2005) by ''Select[ing] science content and adapt[ing] and design[ing] curricula to meet the interests, knowledge, understanding, abilities, and experiences of students (p. 4, NRC, 1996). This standard empowers teachers as agents of cultural production connecting students' prior knowledge to science. Bourdieu, Passeron, and de St. Martin (1994) address the relationship between marginalized and dominant cultures: ''The more distant the social group from scholastic language, the higher the rate of scholastic mortality'' (p. 41).

As a third-generation, Hawaii-born, Chinese American female, a *kama'āina* (Hawaii-born) with public school science teaching experience spanning AP Chemistry to Plants and Animals of Hawaii, I designed my EDCS 433 Interdisciplinary Science Curriculum, *Malama I Ka 'Āina,* Sustainability course to address science content standards through familiar Hawaiian plants, animals, places and cultural practices. Two years after taking the class, a former student, a *kama'āina* with a master degree revealed disempowerment in the face of school policies that put scarce financial resources into textbooks unrelated to her elementary students' lives and experiences:

> Discussing woods such as oak or redwood is okay, but yet kind of silly because who has seen an oak or redwood tree, much less one in Hawaii?. . .There are a lot of great ideas from *Malama*. . .but I am afraid to do too much of it for fear that I would be accused of not following the curriculum (which they paid a lot of $$ for).

Allocating instructional time to preparing students for standardized tests translates to less time for real world field-based learning that builds environmental literacy. Sternberg (2003) criticizes this approach for producing *pseudoexperts*, ''students whose expertise, to the extent they have it, does not mirror the expertise needed for real-world thinking inside or outside of the academic disciplines schools normally teach'' (p. 5). His findings show that teaching ''relate[d] to real practical needs of students'' (p. 5) with elements of analytical, creative, and practical thinking enables students from diverse backgrounds to be successful learners. In contrast, the analytical approach of mainstream schools reduces the diversity of successful learners, leading to his concern that test-driven schools will not educate citizens and leaders with the experiences needed to make wise decisions in an increasingly complex, interrelated world.

## Culture, Ideology, and Education

The history of Western science as a cultural enterprise suggests that knowledge building and technological innovation are driven by the interests of dominant elites (Gould, 1993; Takaki, 1993). Science as a quest for knowledge developed in the historical context of Europe's search for new lands and economic resources. Shaped by 19th century New England missionaries who followed the whaling industry to Hawaii, schools were a vehicle for monoculturism, ''the practice of catering to the dominant or mainstream culture, providing second-class treatment or no special consideration at all to persons of non-mainstream cultures'' (p. 161, Hass, 1992). Speaking and writing in the Hawaiian language was forbidden in public schools after Hawaii was annexed by the United States, and from 1924 to 1960 oral tests selected a few students for academically superior English Standard schools (Stueber, 1964). Cultural, linguistic, and economic marginalization are factors contributing to statistics showing that Native Hawaiians, at 26% the single largest ethnic group in public schools, experience the lowest school success (Kanaiaupuni & Ishibashi, 2003).

But Hawaiian cultural practices and perspectives have much to contribute to current issues of environmental literacy. Prior to Western contact, most Hawaiians lived within *ahupua'a*, a land

division extending from mountaintop to the edge of the reef containing the resources necessary to sustain the population. Dependence on the resources of the *ahupua'a* produced long-term, detailed environmental knowledge revealed in place names of winds, rains, springs, and other environmental features (Pukui, Elbert, & Mookini, 1974). Continuous monitoring of the environment coupled with controls on human behavior supported a human-in-ecosystem understanding of the world. The Hawaiian proverb, *He ali'i ka 'āina; he kaua ke kanaka*, ''The land is a chief, man is its servant'' (p. 62, Pukui, 1983) reveals an environmental ethic of active care (*malama 'āina*) and responsibility (*kuleana*) oriented to sustainability.

From 1999 until its removal in 2005, a Hawaiian saying ''*Malama I Ka 'Āina, Sustainability*''(to care for the land that sustains us) was a state science content standard. Kanahele (1986) interprets what it means from a Hawaiian perspective:

> 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* (land) and *kai* (sea), trusted to take care of these islands on behalf of the gods, our ancestors, ourselves, and our children (pp. 208, 209).

In Hawaiian culture, humans are part of a world in which plants, animals, and natural features are alive with ancestral and spiritual significance. Western science methods of knowledge building that involve measuring, classifying, collecting, dissecting, and mapping of everything in an observable, material world are antithetical to a Hawaiian world view that understands humans and nature in a familial relationship. In contrast, Western, market-driven societies evaluate ecosystems in economic terms: the energy capturing, nutrient cycling, and environmental cleansing processes of natural ecosystems are framed as ecosystem services (Daily, 2003).

## Social Learning Theory: Culture and Perception of the Natural World

Sociocultural theory assumes that learning cannot be dissociated from interpersonal interactions located in cultural frameworks (Bourdieu & Passeron, 1977; Bourdieu et al., 1994; Cole, 1996; Gee, Hull, & Lankshear, 1996; Lave & Wenger, 1991). Socially situated learning recognizes that values, emotions, experiences, and cultural contexts are integrally related to learning. Recognition that cultural diversity is associated with diverse ways of understanding how people relate to each other and the world supports the explicit inclusion of culture in teacher education. If not brought to awareness, mainstream teachers may only become familiar with superficial, even contrived cultural elements such as the addition of pineapple to make a Hawaiian pizza.

Crosscultural research by Nisbett (2003) and his Asian colleagues yields insights into the role of culture in shaping views of the relationship of people and nature. Comparisons of Asian and American perceptions suggest that Asians are more likely to see humans and their surroundings as part of a complex system, while Americans tend to see individual actors. Nisbett suggests that *feng shui,* the study of how a structure relates to its environment, reveals Asians perceive the world as composed of complex relationships, while the American tendency to problem solve with a series of steps indicates rule-based, atomistic, universally applicable thinking. His results indicate that ''Westerners are more analytic, paying attention primarily to the object and the categories to which it belongs and using rules, including formal logic, to explain and predict its behavior.'' Nisbett warns educators that ''it might be a mistake to assume that it's an easy matter to teach one culture's tools to individuals in another without total immersion in that culture'' (The Geography of Thought, http://www.umich.edu/news/Releases/2003/Feb03/r022703a.html).

Cultural differences ranging from superficial to ideological provide a context for examining school success of students from different cultural groups. Hawaii's host culture emphasis on relational identity grounded in family and place contrasts with the dominant American emphasis on personal identity. The importance of language, place, and contextualized interpersonal experiences in learning and identity motivates indigenous peoples to shape their own education (Cajete, 1986; Kawagley, 1999; Smith, 1999; Smith, 2003). Personalized environments and authentic, experience-based learning are considered critical factors for success in the schooling of Native Hawaiian students (Kawakami & Aton, 2000), but in mainstream schools, science is associated with textbooks, individualism, and competition.

Influenced by Descartes' philosophy (Orr, 1992) and Isaac Newton's shaping of scientific communication (Bazerman, 1988), mainstream Western Modern Science (WMS) and its product, school science, portray science as the discovery of universal truths based on evidence gained through objective, reproducible experiments stripped of emotion, cultural contexts, and values. One outcome of being socialized in WMS is a tendency for science teachers to be less aware of issues of culture in education (Greenfield-Arambula, 2005).

Some scientists recognize the importance of grounding science in experiences and emotions leading to an ethical stance. Orr (1992), an environmental scientist, criticizes the ideology of WMS for separating people from the natural world:

> [Descartes'] philosophy separated humans from the natural world, stripped nature of its intrinsic value, and segregated mind from body. Descartes was at heart an engineer, and his legacy to the environment of our time is the cold passion to remake the world as if we were merely remodeling a machine.... A growing number of scientists now believe, with Stephen Jay Gould, that "we cannot win this battle to save [objectively measurable] species and environments without forging an [entirely subjective] emotional bond between ourselves and nature as well—for we will not fight to save what we do not love" ("Enchanted Evening," *Natural History*, Sept. 1991).

## Transformative Learning and Curricular Restructuring

If mainstream school science is viewed as immersion in the culture of Western science, perhaps immersing mainstream teachers in indigenous or sustainability-oriented cultures and communities holds the potential to help them teach a more complex, systems-oriented science that supports environmental literacy and recognizes the role of culture in learning. Over the past 6 years, support from awards under the Native Hawaiian Education Act enabled over 100 K–12 teachers to enroll in EDCS 433 Interdisciplinary Science Curricula, *Malama I Ka* '*āina, Sustainability*, a class that included overnight culture–science immersions at school and community sites coinstructed by Native Hawaiians, science educators, and scientists (Chinn & Sylva, 2000, 2002). Through this class, teachers developed and taught culturally relevant, place and standards-based curricula (see http://malama.hawaii.edu and http//pikoi.hawaii.edu).

EDCS 433 assignments asked students to interview their grandparents or other elders about their lives and to write about a personally meaningful place. A part-Hawaiian preservice teacher wrote the excerpt below that includes the joy of childhood experiences, the internalized voices of elders, Hawaiian place names and cultural uses of land, and a critique of changes. It suggested that asking teachers to reflect on personal places might shift views of teaching from delivery of universal science principles and laws towards experiential learning incorporating culture, local knowledge, and science to develop questions about the world that underlie scientific and environmental literacy.

> Hanalei has all the elements that remind me of my youth in *Pupukea* on O'ahu—beautiful bay to swim in, valley to explore and to [play] around in. My cousins and I would explore all over the back country and visit *Pu'u Mahuka* and clean up the trash up there for fear that if we saw the trash and didn't pick it up, our ancestors would punish us. We would head down the hillside into *Waimea* Valley and quickly find ourselves playing in the stream. We would look for any sort of creature to look at and float around toward the sea. The best was floating out to the ocean and being able to see the lush valley behind us. We are unable to do those sorts of things now because there are homes in the backcountry and there is ever-present danger of rockslides on the hillsides as well as *leptospirosis* in the stream that we used to play in. . . *Hanalei* reminds me of how things were in *Pupukea*, it has the beautiful lush valley with impressive and majestic mountains that surround it (one peak fascinates me, *Hihimanu*, the giant manta ray). There is the *Hanalei* River to play around in and it also flows into the *lo'i*, which is a reminder for me of what was important to my ancestors.

Place-based learning supported Hawaii's teachers in developing personal and professional connections to their place in their *ahupua'a* or *lifeplace*, defined by Thayer (2003) as the bioregion sustaining the unique human-natural community in which one lives and works. As teachers' knowledge of science connected to place developed, they began to use their immediate environments for interdisciplinary, experiential lessons expressive of the ethic of care and personal responsibility embedded in the science standard *Malama I Ka 'Āina, Sustainability.* Their lessons expressed transformative learning that develops a sense of place and connects with nature, recognizes the importance of biodiversity, builds social networks, understands power–knowledge relationships, learns from elders, and applies traditional practices (Hall, 2004). Exceptional teachers oriented their programs to sustainability and established long-term community collaborations to monitor and restore local ecosystems. Their highly diverse students grew native plants for school and community gardens, monitored and restored terrestrial and marine habitats, and were successful in their classes (Chinn, 2006, in press b).

## Connecting Culture and Science through Decolonizing Methodologies

Teaching that explicitly engages students' prior knowledge and understanding is relatively new in science education (NRC, 1996, 2005). My interest in science began with a science teacher father who took his children hiking, swimming, and fishing. This led to curiosity and extensive reading that seldom, if ever, connected to my formal science learning. The only Native Hawaiian in my college preparatory science classes was the son of a teacher. I did not recognize the irony of the absence of students from a culture sustained through active environmental literacy.

Isabella Abbott, the first Native Hawaiian woman to earn a doctorate in science became interested in botany not through science classes but through her mother's knowledge of plants and her principal's support of her interests (Chinn, 1999). Abbott (1992), whose *Lā'au Hawai'i*: Traditional Hawaiian Uses of Plants, is used as a text in EDCS 433, asks her readers to be researchers of cultural knowledge still alive in family stories:

> We Hawaiians have mostly lost our once-great talent for the oral transmission of culture, so if stories of the old ways still reside in your family, search them out and treasure them—and make sure they are preserved in written form (p. x).

Linda Smith (1999), a Maori researcher, describes 25 decolonizing research projects to recover marginalized cultural knowledge, practices, and identity. Decolonizing methods are critical communication strategies that engage participants in examining lives, society, and

institutions in ways that challenge dominant perspectives. Story telling, indigenizing, connecting, writing, representing, and naming are six decolonizing methods implicitly embedded in Abbott's suggestion to Native Hawaiians to seek out, treasure, and write their cultural stories. Gitari (2006), an indigenous science educator, suggests Kenyan teachers use similar strategies with their students.

Professional development with Hawaii's teachers suggested that learning science in the context of personal places and indigenous values and practices provided teachers' with both rationale and agency to restructure their curricula towards field-based science learning. But would a Hawaii-centric approach applying decolonizing methods be meaningful to teachers who were not Hawaii residents?

## The Study, Setting, Teachers and Research Questions

Nineteen experienced secondary science and mathematics teachers, 8 females and 11 males, from Japan (three), Malaysia (five), Indonesia (one), Thailand (one), Korea (two), Philippines (two), and the United States (five) participated in a 10-day Summer Teacher Institute ''Thinking in Math and Science: Making Connections'' described as a ''global learning opportunity for middle and high school teachers of math and science'' in Honolulu. Eleven also served as department head/chairs (five), deans and deputy heads (four), ''special science teacher,'' and science coordinator. The job titles of eight were associated with science, seven with math, and four with neither content area. My presentation on indigenous Hawaiian cultural practices oriented to sustainability was intended to enable participants to explore their views of indigenous knowledge and the role of place and culture in science education from a crosscultural perspective. I met teachers on the second and third days for 4 hours of formal professional development and 45 minutes of informal interaction at lunch. My workshop sessions took place in a small room with participants seated in front of computers along the classroom perimeter. Teachers could move their chairs to form small groups as needed.

In addition to my sessions, the institute involved all participants in a math pedagogy overview, presentations on assessment tools and new technologies in math and science, observations of math and science classes including online algebra, a visit to the Polynesian Cultural Center, a tour of Bishop Museum, and a visit to Hanauma Bay. Math activities included learning about manipulatives, Geometer's sketch pad, graphic and graphing calculators, Fibonacci, and combinatorial games. Science activities included a tour of the school's science center, an overview of GLOBE (Global Learning and Observations to Benefit the Environment, a hands-on, school-based science program), an introduction to the Manoa Stream project, inquiry based lab observations, a 2-hour middle school science presentation by two former EDCS 433 teachers, sharing of Web science resource, and science project work. Small teams were tasked with developing and presenting a lesson incorporating ideas and strategies acquired during the institute relevant to needs at their school. Due on the last day of the institute, the 15-minute minilesson presentations were to be taught with peers in the role of students. Teams could either integrate math and science or be discipline-based.

This study explored the following questions:

1. How would teachers evaluate traditional/indigenous knowledge and its role in curriculum before and after exposure to Native Hawaiian practices oriented to sustainability?
2. Would there be evidence of transformative learning defined as interest in developing place-based curriculum relevant to environmental issues?
3. Would place, culture, and prior experience figure in their lessons and evaluations?

## Methodology

Critical theory informed the design of a study in which 19 mathematics and science teachers engaged in repeated cycles of collaborative action research. Critical theory and critical educational research go beyond describing and understanding social phenomena and behavior in the intent to uncover underlying interests and agendas that shape them. In the area of education, critical research examines ''the relationships between school and society... the social construction of knowledge and curricula, who defines worthwhile knowledge, what ideological interests this serves, and how this reproduces inequality in society'' (p. 28, Cohen, Manion, & Morrison, 2000).

The critical methodology adopted for this study applies Habermas' communication theory as a framework for action research in which teachers individually develop writings to contribute to group and class discussions. This methodology assumes that teachers are social actors able to engage in *communicative action*, defined as ''that form of social interaction in which the plans of action of different actors are coordinated through an exchange of communicative acts, that is, through a use of language oriented towards reaching understanding'' (p. 4, Habermas, 1981; cited by Powell & Moody, 2003). Grady & Wells, (1985) note that the apparently objective statement ''The oven is at 350°'' is meaningful in the context of a speech community ''interested in recording relatively small differences in temperatures, able to control temperatures of enclosed spaces, familiar with a scale form measuring temperature, and skilled in cooking techniques that use stable temperatures to produce predictable results'' (p. 8). From a Habermasian perspective, communication based on participants' *lifeworlds*, the daily activities that make up individual existences, and intersubjective understandings of meanings establishes the contexts in which personalities, society and culture develop.

Decolonizing methodologies as described by Smith (1999) and applied by Abbott (1992) in her directions to readers may be regarded as critical communication strategies that explicitly engage participants in examining lives, society, and institutions through the lenses of marginalized (traditional, local, indigenous, sustainable) and dominant cultures (capitalistic, consumer oriented). A series of writing prompts (see below) elicited teachers' responses on selected aspects of their *lifeworlds*. I use these prompts in my teacher education classes to raise awareness of the socially situated, experiential nature of learning. Individual writings were shared in small groups, summarized, and then shared with the whole class. Through repeated cycles of collaborative action research, a shared body of information accumulated to be coexplored through the lenses of teaching and learning, culture, place, and environment. I collected writings from the first two exercises and took notes of discussions.

As the workshop leader, I played a role in establishing a learning environment in which participants felt comfortable in revealing personal information and critiquing powerful agents. The process of collaborative action research allows science and mathematics teachers to externalize and examine personal experiences, cultural values, and marginalized knowledge that might at first appear irrelevant to science and mathematics curriculum and pedagogy. These methodologies challenge the impersonal, ahistoric, acultural, stance of mainstream Western mathematics and science curriculum, and lead to examination of the sociopolitical contexts of education.

Five of Smith's 25 critical indigenous research activities were employed in this study: indigenizing, connecting, writing, and representing, and discovering:

1. *Indigenizing* refers both to the revisioning of cultural landscapes from the perspective of indigenous peoples and opposition to colonization through indigenous identity and practices. Writing prompts, ''I think indigenous science is _____,'' ''The role it has

in science curriculum is _____'' asked teachers to reflect on their knowledge of indigenous practices and to assess the role of indigenous practices and knowledge in school science. Following a presentation on indigenous Hawaiian practices and values oriented to sustainability, teachers were asked to write again to the same prompt. They shared their writings in small groups, synthesized their conversation into a brief written summary then contributed the main points for whole class discussion.

2. *Connecting* ''positions individuals in sets of relationships with other people and with the environment'' (Smith, 1999, p. 148). To elicit teachers' thoughts on connections of self to others, they wrote to a prompt that asked them to choose anything they thought they had learned well and to describe the stages of development to the point where they felt comfortable with their expertise: ''I am good at _____,'' ''I became interested through _____,'' and ''I became an expert by _____.'' To connect them to the environment, teachers were prompted to write about a personally meaningful place: ''My special place is _____.'' Individual writings were shared in small groups, synthesized into summaries, and reported out for whole class discussion.
3. *Writing*, and 4. *Representing* empower less powerful individuals to represent their realities, issues, and identity. Teachers were invited to write about and to discuss their lives as teachers and to identify topics they would like to develop into lessons relevant to their students and communities: ''An environmental issue in my community is _____.'' Through the course of the workshop, field notes on verbal and nonverbal speech and interactions were collected.
5. *Discovering* refers both to the ''development of ethnoscience and the application of science to matters which interest indigenous peoples'' (Smith, 1999, p.160). The writing prompt following the presentation on indigenous Hawaiian practices focused on the first aspect of discovering and provided an opportunity for teachers to express their views on indigenous science, its relevance to current situations and curriculum.

I did not meet again with teachers after the 2 days of my science workshop, but viewed the videotape of minilesson presentations and interviewed the institute organizer who filmed the presentations and was present throughout the institute. I had access to all evaluation materials including the original participant evaluations.

Three years after the workshop, I contacted three teachers from Philippines, Malaysia, and Indonesia by e-mail to ask if they had implemented place-based lessons in their classes. One e-mail was not current, another did not reply. I report the response from a female, biology teacher in Indonesia.

## Results

The first four sections present results from sessions where I guided teachers through collaborative action research and discussions. The final four sections present results from viewing a videotape of lesson presentations, reviewing written evaluations collected on the last day of the institute, interviewing the coordinator of the institute, and an receiving an e-mail from an Indonesian participant. More than 8 days elapsed between the end of my classroom-based session with teachers and their presentations and evaluations. Three years elapsed between the workshop and the e-mail.

### *Writing, Representing, Indigenizing, and Discovering Science Knowledge*

Before seeing a presentation on Hawaiian cultural practices oriented to sustainability, teachers wrote for a few minutes on the prompts: ''I think indigenous science is. . .'' and ''The role

it has in science curriculum is. . .'' Two Asian male teachers' pre- and postintervention writings were selected as showing the greatest shift in perceptions of indigenous knowledge and practices before and after the presentation on Native Hawaiian culture. Given their leadership roles in their schools, they potentially served as gatekeepers to curricular and pedagogical change and teacher agency. Teachers from the United States who were familiar with equal opportunity and antidiscrimination policies of the past few decades appeared aware of issues of cultural difference and did not show such shifts in their evaluations of the role of indigenous science in school curricula.

A Chinese male from Kuala Lumpur, Malaysia, with the job title of Deputy Head, Administration, wrote the following before seeing the presentation:

> Science has no or little place in (lives of) indigenous people—if at all they are used without being understood. Many herbal medications being used are passed down from generation to generation, knowing how to use but not why. The role it has in science curriculum is erroneous. Many traditional or herbal medicines required studies to have a full understanding and may have a great impact on modern medicine.

An educator from a school in Tokyo, Japan, who sent an all-male team composed of the math/computer skills teacher, math department head, and Seventh Grade Director/Associate Dean of Admissions wrote before the presentation:

> I think indigenous science is when catfish are nervous, big earthquake is coming. Every natural thing, tall tree, mountain, river, pond, large rock is house of Gods (spirit). Therefore we had 2,000,000 Gods all over Japan.

Immediately after they finished their writing, I presented a PowerPoint on traditional Hawaiian ecological practices related to farming and resource conservation. It presented the *ahupua'a* as a traditional resource unit within which inhabitants maintained a sustainable lifestyle through monitoring of resources and constraints (*kapu*) on exploitative activities and behavior. It mapped traditional practices and Hawaiian terms onto science terms and concepts such as nutrient cycling, conservation, hydrosphere, biosphere, and atmosphere. Following the presentation, teachers responded to the same prompts.

After the presentation, the deputy head from Malaysia wrote:

> It is about a balance between the mountain, the land and the sea—a diverse ecological balance. The role it has in science curriculum is to do things correctly and show the ways and means to sustain modern life.

After the presentation, the participant from Japan wrote:

> The idea of ''respect to the Nature'' was gone when Japan meets Western culture and they found Japan is way behind the West. ''Gods are gone'' for 100 years, 1867–1967. When we suffered serous air pollution, ''Gods came back'' through education. After 1960, ''environment'' and ''natural conservation'' became major issues in science education. If you talk to professional people, carpenters, engineers, mechanics, you will find their own traditional and very practical math and science which is not taught in school and it is very interesting.

The groups synthesized and developed generalized analyses of their discussions. The following writing is typical of group reports:

> The earth is our small and only livable planet. We should treat it with care so that the resources it provides for the human race are manageable and sustainable. Many traditional practices are invariably one way or another (related to) very effective ecological cycles one must pay attention to. The culture of indigenous people must be recognized and respected for its continued perpetuation.

These samples of individual and group writings suggest that participants were *discovering* new ways to think about, evaluate, apply and reapply traditional and indigenous practices to conventional curricular topics such as ecological cycles, sustainability, and resource management. They clearly recognized the linkage between local, place-based practices, and values and global environmental concerns. The group statement about the need to recognize and respect the culture of indigenous people is an outcome of applying Habermas' communication theory towards achieving intersubjective agreement, in this example, the group's recognition of the power–knowledge contexts shaping school-based knowledge and values.

### *Connecting to Others: Learning as Socially Situated*

The writing prompt to describe how personal expertise develops asked teachers to examine their own stages of learning from initial interest to expert performance: "I am good at _____," "I became interested in it through _____," and "I became an expert by _____." After writing for 5 minutes, teachers from different countries met in small groups to discuss their writings and look for similarities and differences. Groups then reported their findings for class discussion.

Although the skills described by individuals ranged from teaching to skiing to cooking to growing hibiscus, teachers recognized common themes emerging: (1) whatever was learned was important to one or more significant others in their lives; (2) learning was supported and encouraged by significant others; (3) practice, feedback, and encouragement were important for improvement; (4) enjoyment, interest, and other emotions were important to learning; and (5) active and hands-on learning complemented learning from books and lectures. Through sharing of personal experiences leading to expertise, the secondary science and mathematics teachers recognized and acknowledged the importance of positive emotions, feedback, and significant others in developing interest and supporting persistence in learning.

As small groups shared their personal stories of developing expertise, international teachers who had met each other only a few hours earlier began to relax, interacting with encouraging nods, smiles, and laughter at each others' stories. A room of adults that started off as silent and attentive individuals changed into actively interacting small groups engaged in sharing personal information that would help listeners understand each others lifeworlds. During whole class discussions they helped each other express their thoughts as fluency with English varied, and some were still uncomfortable speaking in front of the class.

### *Connecting to the Environment: Developing a Sense of Place*

The exercise gave teachers who may have been initially critical of indigenous peoples' spiritual and emotional connections to elements of the physical landscape an opportunity to describe and discuss their own emotional attachments to personally important places. As in the other exercises, teachers responded to a prompt to write for 5 minutes about a personally meaningful place: "My special place is _____." They shared writings in small groups and

reported similarities and differences to the whole class. The discussions are the basis for field notes.

Specific places with personal connections and meaning ranged from natural settings (American teachers) such as a beautiful beach or forest setting to being inside one's classroom (Asian female teacher), and a father's house (Asian female teacher). Meaningful places were recognized as sharing common characteristics. The places were described in emotional terms as being beautiful, comfortable, familiar, peaceful, and secure. Many were anchored in childhood memories, such as the garden in which a daughter learned to grow hibiscus from a highly skilled mother. The sharing of important places led to extended discussions among teachers and with me as they began to make connections between their personally important places and the lifeplaces where they currently lived and worked.

### *Curricular Critique: Implications for Change*

The final writing assignment employed the preceding exercises and discussions as a springboard for planning place-based, teacher-developed curriculum. Teachers were asked to think about critical environmental issues in their localities and ways that place-based topics could be incorporated in their curricula: ''An environmental issue in my community is _____.'' Their assignment was to develop lesson sketches to discuss the next day.

The assignment produced extended discussion, much of it critical of existing curricula. Asian teachers who initially had not favored inclusion of indigenous knowledge and practices in the curriculum now thought there was value, as noted in the group writing above, in teaching students to stay connected to elders and traditional knowledge. They commented frequently on the loss of respect for the elderly and the displacement of traditional knowledge by Western models of science and mathematics education. They thought their students would benefit if they learned about and valued their own cultures, remained connected to their environment through cultural beliefs and practices, and continued traditional sustainable perspectives that supported ''treasuring'' instead of exploiting local natural resources and raw materials. They regretted that children in their rapidly developing nations did not know how it used to be just a few generations ago.

Asian teachers faulted test-driven, national curricula they were given to teach for eliminating the ''joys'' of teaching and learning. They commented repeatedly on the way curricula were disconnected from real, pressing issues of their students and communities. They thought national science and mathematics curricula should not be generic across countries, and were of the opinion that individual countries should be proud of their own indigenous knowledge. As a group, the international teachers expressed frustration at the imposition and irrelevance of content and assessment adopted from Western nations identified as former colonial powers. They complained about feeling trapped in covering an extensive body of content. Both international and U.S. teachers agreed that test-driven curricula did not support independent thinking, encourage learning about traditional knowledge and practices, or address local environmental issues.

Although the brevity of my time with teachers did not allow further development of ideas into formal lessons, teachers identified issues of sustainability in their localities that potentially could be developed in problem-based, data-rich lessons to include in their curricula. The group discussed ways to incorporate these environmental issues into their curricula in the form of scientific studies to be reported to policy makers. Major issues were air pollution from unregulated vehicles and uncontrolled brush and forest fires (Malaysia), soil erosion and water pollution (Philippines), and dangerous driving behaviors on inadequate roads in their rapidly developing nations (Korea, Philippines, Malaysia). A woman from the Philippines spoke about exploitative

logging that left hillsides denuded and eroded and the people below vulnerable to landslides, flooding, and water pollution following heavy rains. Participants appeared fully engaged in discussions concerning identification of variables and experimental design involving students collecting and analyzing data and writing up results.

### *Videotaped Lessons*

The 45-minute videotape did not record every lesson fully or capture every participant. However, teacher introductions to lessons generally provided evidence of planning to engage students' prior knowledge, culture, or place. Two presentations were set in the context of what were now familiar Hawaiian settings. A science teacher from Malaysia presented a scenario of 2 *kalo lo'i* (*sic*) identical in number of plants, size, and exposure to sunlight but with different crop production by weight. Her place and culture-based lesson prepared students for exam questions requiring identifying and classifying relevant variables. A math teacher from the Philippines used maps of Honolulu streets in the vicinity of the institute to introduce his geometry lesson on intersecting angles. Three teachers mentioned the importance of connecting their lesson to students' prior knowledge before presenting a skit referring to water, wine, and apple juice in a lesson on acids and bases. They stressed that indicators are found in natural products, such as red cabbage, a familiar food. Three other teachers used spaghetti and Korean foods to introduce topics applying software used in the institute. A biology teacher used animals and plants in her lesson and referred to students' prior knowledge in designing the lesson.

Four male teachers did not make connections relevant to students' prior knowledge, places, or culture, although they might have when they were not being taped. Three U.S. science teachers addressing temperature and kinetic energy, states of matter, and gas laws had just asked participants to break into pairs when the video of their lesson segment ended. A teacher from Japan presented a math lesson in purely mathematical terminology, and did not engage participants' prior knowledge or employ active learning strategies during the taping of his lesson.

### *Interview with Institute Coordinator*

Two interviews with the coordinator, one via telephone and the other at the institute, were unstructured and informal. Questions involved her recollections of teachers' lessons. Her comments filled in some gaps as the videotape did not capture every lesson. She recalled the Filipino math teacher's geometry lesson using Honolulu streets, and said when he returned he planned to use streets on his campus as a place-based example. She commented on two teachers that were not on the videotape. The first was a female teacher from Indonesia whose lesson on corals was relevant both to Hawaii and her country. The second was a female, elementary Asian American teacher from the United States who was especially interested in teaching that addressed cultural contexts.

### *Comments from Final Evaluations*

Teachers wrote more than 80 comments related to questions on the program, assignments, improvements, extracurricular activities, growth or change as a result of the program, and implementation of strategies. A quarter of responses related to social and crosscultural aspects of learning showing they highly valued learning from peers and gaining strategies for active, hands on learning, and group work:

> I really enjoyed meeting and talking to teachers from around the U.S. and Asia. This was the richest part of the experience. I learned so much from my peers/colleagues here. They gave me a lot of concrete ideas and also got me thinking more globally about science/math education.
>
> My world focus now can include Southeast Asia due to the connections with the teachers here. Previously, my world view was not so inclusive al all parts of Asia and I was more oriented to Europe when thinking about ''overseas.'' I felt so validated to work with _____ and other teachers who came to the institute when it came to teaching from experience, giving kids more hands on engagement of the material!

Seven responses, including the two above were related to the importance of culture in teaching and learning: ''I will add a culture component to my chemistry classes to make my class more relevant to my students, I can hardly wait to do the lesson _____ and I formed for the final project,'' ''Take time to plan good lessons where culture and humour is (*sic*) present.''

Three participants specifically mentioned the presentation on indigenous culture: ''The more time I spent in Hawaii, the more I came to appreciate Dr. Chinn's lessons and discussions. The idea of indigenous science is truly a rich one,'' ''I found the information on indigenous science especially fascinating,'' and '' _____, Pauline and the Bishop were worth the trip all by themselves.''

Teachers enjoyed and valued place-based learning, ''Interesting, real original examples are the best teaching aids, even better at the original site,'' suggested longer and different field experiences, ''Perhaps also a trip into the mountains to the native rain forest?'' and planned to incorporate place-based activities into their teaching:

> A visit to the Bishop Museum, the stream and Hanauma Bay gave me an opportunity to really understand the works of nature and I think these should be available for the next group of teachers! I would like to have more field trips so the students are exposed to actual happenings around them. Our students lack hands on but as the saying goes, ''When there's a will, there is a way!'' I would try my level best to bring my students back to Nature at least three or more times in a year.

### *An Indonesian Biology Teacher's E-mail*

A key idea that participants took from science sessions was the ethical relationship between humans and the natural world and the role of embodied, active learning that supports knowledge oriented to sustainability. Three years later, I contacted three teachers who had developed place-based lessons to ask if they had followed up on their ideas to shift teaching into her students' lived environment. The teacher from Indonesia who presented a lesson on coral responded. An excerpt from her e-mail follows:

> P: Have you followed up with some of the environmental science ideas in your own teaching?
> A: No, not yet. But I'd love to know, and let me know what can I do about it. Because I'm a ''jobless'' now, I'm waiting for next month to pursue my master degree majoring ''education management.'' There, I hope I could find knowledge about how to educate, because my background was biology. And in the future, I have a dream to become a teacher trainer, sharing knowledge, and creating a local, needs-based curriculum for rural areas in Indonesia. If you look at the map, we're the maritime country, but we don't have

curriculum to develop the student skills about how to hatch fish, how to plant algae, etc. What they have been learning at school is the regular, high standards, biology, physics, chemistry, those sucks, boring, don't have any use, and caused the frustration to the kids. And believe me you have a contribution in bearing those thoughts into my mind. When I saw you guys spend a lot of time, making a field trip to the Hawaiian village, and learn their wisdom. Thank you for any help you can provide. Thank you for contacting me, for listening to my ''burden'' also.

## Discussion

Each section below addresses one of three questions explored in the study.

### *How Would Teachers Evaluate Traditional/Indigenous Knowledge and Its Role in Curriculum before and after Exposure to Native Hawaiian Practices Oriented to Sustainability?*

The results suggest that professional development designed from a critical Habermasian perspective enabled Western-trained science and mathematics teachers to connect their cultural and personal experiences to critical analysis of curriculum and pedagogy. Decolonizing methodologies supported collaborative action research and discussion leading to teachers' awareness of the way mainstream science curricula omits and thus marginalizes local, traditional, and indigenous knowledge. The presentation connecting Hawaiian practices oriented to sustainability to Western science concepts and terminology, for example, biosphere, hydrosphere, atmosphere, apparently provided an example that empowered teachers, especially those in the roles of administrators of science and mathematics departments to speak of the values of traditional and indigenous practices. Writings by Asian teachers that initially dismissed or devalued traditional practices shifted to critique of the dominance of Western science and marginalization of other ways of understanding the world.

The Malaysian Chinese deputy head first positioned indigenous and Western science as completely separated, with science in the superior position: ''Science has no or little place in (the lives of) indigenous people. . . The role it has in science curriculum is erroneous.'' After the presentation he recognized that indigenous knowledge could contribute ethical and ecosystems perspectives to science curriculum: ''It is about a balance between the mountain, the land and the sea—a diverse ecological balance. The role it has in science curriculum is to do things correctly and show the ways and means to sustain modern life.''

The Japanese director's initial writings about people seeing ''2,000,000 gods'' in rocks, trees, and mountains could be interpreted negatively from a Western science perspective. After the presentation his writing becomes more critical, suggesting Westernization separated people from indigenous beliefs and practices connecting them to their environment in a spiritual, ethical relationship. His comments to the effect that ''respect to the Nature (*sic*) was gone'' and ''Gods are gone'' while Japan industrialized to catch up with the West and ''Gods came back through education'' after Japan suffered from air pollution presents indigenous values and practices as a solution to foreign ills. Further comments that ''professional people, carpenters, engineers, mechanics'' still use ''traditional and very practical math and science which is not taught in school'' suggest that he thinks the national curricula should include ''very practical,'' ''very interesting'' indigenous math and science.

Participants' pre–postintervention writings and group conclusions about the need to recognize and respect the culture of indigenous people indicate applying Habermas' communication theory of cognitive rational discourse raised awareness of power–knowledge contexts shaping school-based knowledge and values. Beyond simply recognizing the overlaps between indigenous and Western science knowledge and practices that likely helped to legitimize the inclusion of nonmainstream knowledge in the curricula, final writings expressed an explicitly ethical stance. From a Habermasian perspective that critiques positivism and scientism's assumption that "valid human knowledge is restricted to empirically testable propositions arrived at through disinterested, value-free inquiry" (p. 17, Grady & Wells, 1985), the group's explicit inclusion of ethical and normative statements suggests the importance of intersubjective agreement obtained through "cognitive rational discourse. . . oriented toward truth but drop[ping] the fiction of impersonality that scientific and technical discourse maintain" (p. 8, Grady & Wells, 1985).

### *Would There Be Evidence of Transformative Learning Defined as Interest in Developing Place-Based Curriculum Relevant to Environmental Issues?*

As teachers shared personal stories about their lives and reached agreement on the wisdom and ethics of traditional and indigenous practices, they expressed many of the elements of transformative environmental learning listed by Hall (2004) including a sense of place, connecting with nature; revitalization of traditional and indigenous knowledge, learning from elders, and understanding of power–knowledge relationships. The 2-day workshop concluded with discussions on ways to bring specific environmental issues in their lifeplaces into their teaching.

This suggested applying Habermas' theory of communicative action leading to "intersubjective agreement. . . among rational, autonomous, responsible individuals" (p. 1, Grady & Wells, 1985) provided a context for these teachers to bring their personal experiences and cultural values to critiques of received curricula and discussions of power–knowledge relationships in their schools and communities. This critical first step, the recognition of the social contexts of supposedly objective science, discouraged in Western positivist thinking, reframed their perspectives on curriculum and pedagogy by extending the purposes of science education to serving the common good. The place and problem-based science and mathematics curricula they spoke of developing would connect meaningfully to their own and students' lives, respect alternate ways of knowing, and support critical environmental literacy oriented to long-term sustainability.

An Indonesian teacher's e-mail 3 years after the workshop indicates that professional development incorporating indigenous perspectives oriented to sustainability provided a model she could translate to science curricula relevant to Indonesian settings. Her "burden," the inability to teach what she recognizes as meaningful science for students and their communities, indicates the symbolic violence that silences and disempowers science teachers as curriculum developers. Her comment that "the regular, high standards, biology, physics, chemistry, those sucks, boring, don't have any use, and caused the frustration to the kids" echoes research in the United States that found "only about a third of lessons nationally are likely to have a positive impact on student understanding of mathematics/science concepts, and 16% are likely to have a negative effect" (p. 42, Weiss, Pasley, Smith, Banilower, & Heck, 2003, cited by Elmesky & Tobin, 2005, p. 808).

In the debate on national education policies oriented to globalization and teachers' desires to address culture and place-based environmental literacy, teachers are aligned with calls by

the U.S. Global Change Research Program (www.usgcrp.gov/usgcrp/ProgramElements/human.htm) for research that:

> Add[s] to an understanding of how humans contribute to changes in the global environment—why some societies are more resilient and others are more vulnerable to change, and how attributes of social and economic organization can make it either easier or more difficult to mitigate and to adapt to global environmental change.

*Would Place, Culture, and Prior Experience Figure in Their Lessons and Evaluations?*

The videotaped lessons and interviews with the coordinator showed that a majority of teachers were explicitly using strategies to engage students' prior experiences and knowledge in their lessons. Written evaluations emphasized the value of learning from others' experiences—a fourth of all comments were related to social contexts of learning, and two participants rated the opportunity to learn from culturally diverse peers as the best part of the institute. The recognition of the importance of engaging prior knowledge, if applied in their own teaching would help to connect students' lives to their learning of science and mathematics.

Teachers rated the field and place-based components of the institute very highly. A majority of teachers wanted to extend opportunities for personal place-based learning; one strongly expressed her determination to include field-based learning activities in her future instruction.

A third of the teachers commented on the importance of culture in teaching and learning. Teachers were focused on acquiring strategies to engage and interest students in their learning and thus valued hands-on, cooperative, place, and culture-based strategies. Minilesson presentations did not contain the explicitly critical, place-based aspects of their discussions from the second day of the science workshop, perhaps because they were developed by teams of teachers from different places with different environmental issues. In my work with EDCS 433 teachers, planning for place-based learning required multifaceted considerations spanning policy issues related to field trips, safety, access, and school resources to collaborations with researchers to develop research and reporting protocols. Only long-term access to their programs enabled me to follow and in many cases, support the development of community-based science programs (Chinn, 2006, in press b).

It can be concluded from evaluations, lesson observations, coordinator interviews, and an e-mail 3 years after the workshop that most participants took the necessary first steps of connecting students' prior knowledge to math and science topics and connecting topics to familiar contexts and places towards the larger project of developing place-based lessons oriented to active environmental literacy.

*Implications for Practice*

Professional development that prepares science teachers to locate inquiry-based science in their students' lives and communities addresses science teaching standards, research on learning in science (NRC, 1996, 2005), research on diversity of successful learners (Sternberg, 2003), and recommendations by indigenous science educators (Gitari, 2006; Kawagley, 1999). It suggests that science teacher education incorporate active learning situated in contexts and issues that recognize personal, sociocultural, and ethical contexts of science. Researching cultural aspects of

sustainability supports the inclusion of indigenous, traditional, and local knowledge in science and science teacher education, increasing teacher agency, knowledge diversity in science, and the participation of underrepresented minorities (Chinn, 2006, in press b; Manuelito, 2003). Cultural production by teachers and students and the role of ethics and praxis in science learning are areas of active theorizing and research (Barton, Aikenhead, & Chinn, 2006; Brown, 2006; Buxton, 2006; Chinn, 2006, in press a, in press b; Chinn, Hand, & Yore, in press; Elmesky & Tobin, 2005; Furman & Barton, 2006; Roth, in press).

Preparing teachers to develop locally relevant, inquiry-based lessons may be challenging in a climate of test-based accountability, but research shows teacher job satisfaction increases with greater autonomy (National Center for Educational Statistics, 1997), and that students are empowered in science, gain inquiry skills, and show gains in knowledge with inquiry-based instruction (O'Neill & Polman, 2004; Tal, Kajcik, & Blumenfel, 2006). Locating science learning in students' lives and worlds supports the goal of educating a scientifically literate society able to participate in decision making in an increasingly complex and interdependent world.

## Conclusion

At the start of the professional development institute, Asian participants from Asian nations tended to perceive indigenous knowledge more negatively than participants from the United States. Presenting indigenous Hawaiian practices and values as a cultural model oriented to sustainability led to a shift toward cultural respect and articulation of an environmental ethic. Decolonizing methodologies that engaged participants in cycles of collaborative action research and open communication led to recognition of the sociopolitical contexts that shape science and mathematics curricula. Discussions of participants' lifeplaces led to a critique of the lack of connection between Western Modern test-driven science and mathematics curricula and environmental problems affecting their lives and communities. Participants recognized that powerful interests lay behind globalization, exploiting of natural resources, national curricula, and marginalization of indigenous, traditional, and local knowledge and practices.

Critical views of test-driven, national curricula led to discussions of place-based curricula involving research to understand and address environmental issues. Final lessons were not explicitly critical but incorporated students' prior knowledge, familiar places, and elements of indigenous practices as the context for math and science learning. These professional development outcomes suggest the potential of critical methodologies to support transformative learning reconnecting Western Modern Science to culture, place, and community. For some of the 19 international science and mathematics teachers and administrators, a new respect for indigenous culture was a first step in that direction. For an Indonesian biology teacher, a critical perspective impels her repositioning as a teacher educator and developer of science curricula relevant to the needs of her country's rural communities.

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