

HE 'IKE PĀPĀLUA O KE AO ME KA PŌ: TEACHING SCIENCE IN A HAWAIIAN CULTURAL CONTEXT

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The purpose of this qualitative case study was to implement and document a Hawaiian culture-based science curriculum model bridging 2 knowledge systems, one based on the practices, beliefs, and pedagogical practices of the Hawaiian culture and the other based on Euro-centered (Western) scientific perspectives and pedagogy. Participants included K–6 educators and students at a Hawaiian language immersion school. Data sources included teacher surveys, classroom observations, semistructured focus groups, individual interviews with the teachers, student journal entries, analysis of student work, and student interviews. Teachers used the *Kumulipo*, a Hawaiian creation chant, an integrated unit plan with 5 perspectives, and an inquiry- and place-based curriculum to create this model. Data analysis revealed that content knowledge and interest in science deepened for participants.

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Hāllili: Multidisciplinary Research on Hawaiian Well-Being Vol.7 (2011)
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The classroom bustled with the sounds of 17 first- and second-grade students as their excitement centered on the theme for an art poster contest, “Ola ka wai” (water gives life). As the kumu (teacher) asked for possible ideas, the students yelled out, “Ola kākou i ka wai” (we live because of water) and “Hānai ‘ia kākou” (we are fed). As the kumu walked around the room, observing the drawings that transpired from the ideas generated by the class, she noticed one child with her picture of a huge cloud over a mountain. Curious, the kumu asked about the picture. The child responded that she drew Kūlanihāko‘i, the freshwater pond in the heavens that rains when it overflows. Such a cloud continues to sustain us, the child said. From the oli (chant) of the same name, students had learned about the different stages of germination from the planting of a seed to its full growth as a tree. At that moment, the kumu was convinced that these children got much more out of these lessons than she had anticipated. This child was coming from a place that was deeply and spiritually seeded from a chant taught earlier in the year when the students studied about plants.

This is one of many stories that resulted from the implementation of a culture-driven, inquiry- and place-based integrated K–6 science curriculum at Ke Kula ‘o Samuel M. Kamakau Laboratory Public Charter School (Kamakau), a Hawaiian language immersion K–12 program located on the island of O‘ahu in the State of Hawai‘i. The curriculum was implemented in response to teacher need for better pedagogical tools to teach what has been called “Western modern science” (Snively & Corsiglia, 2001, p. 7) through the lens of traditional Hawaiian values and scientific knowledge. A secondary goal was to create science curriculum from a student-centered, strengths-based perspective.

In this article we share (a) the rationale behind the development of the curriculum, (b) the essential steps involved in the development of the curriculum, (c) the components of success in the implementation of the curriculum, (d) the four key teaching strategies, and (e) participant perspectives at the end of the project. Developed over 2 years of working with the K–6 teachers, the curriculum uses the *Kumulipo*, a Hawaiian creation chant (Beckwith, 1951), as the major cognitive structure for framing the science curriculum. It also uses an inquiry- and place-based unit plan format that emphasizes five perspectives for each topic of study: historical, geographical, cultural, analytical, and human. The need for the development of this curriculum was urgent. The science standards mandated by the Hawai‘i Content and Performance Standards III (HCPSIII; Hawai‘i State Department of Education, n.d.) have been created from a perspective that often conflicts with Hawaiian beliefs, yet children and schools are held accountable

to them. As has often been the experience of teachers in other schools with a focus on nonmainstream curricula (Aikenhead, 2008; Jegede & Aikenhead, 1999; Stephens, 2001), it has been a challenge for the Kamakau teachers to know how to incorporate culturally responsive pedagogy and traditional knowledge into the required science curriculum.

THEORETICAL PERSPECTIVE AND RATIONALE

Our work is grounded in sociocultural learning theory whereby individual development and learning processes can only be understood in the context of the child's social world (Vygotsky, 1978). Learning comes from the interplay between the environment and the individual and occurs with the assistance of a more knowledgeable other. Knowledge, seen as actively constructed by learners, is mediated via the tools or symbols of culture (Hatano & Wertsch, 2001). Language is one of the most important of these tools. Because cognition is seen as predictably developmental in nature and dependent on the environment, both the process of going to school and the act of teaching, as it is done in school, become decisive forces in cognitive development (Scribner & Cole, 1973). As we worked on this project, we attempted to assess our holomua (progress) throughout the process as part of our role as educators.

EDUCATION IN A HAWAIIAN CULTURAL CONTEXT

Ua lehulehu a manomano ka 'ikena a ka Hawai'i.
Great and numerous is the knowledge of Hawaiians.

—'Ōlelo No'eau (Pukui, 1983, no. 2814)

Since the 1970s, there has been an ongoing interest and effort to create school programs designed to perpetuate the Hawaiian language and culture. Hawaiian language immersion (HLI) and Hawaiian culture-based (HCB) programs have

been established in the ‘Aha Pūnana Leo preschool system begun in 1983 (Kamanā & Wilson, 1996), K–12 public schools, and K–12 public charter schools (Hawai‘i Charter Schools Network, n.d.).

One goal of many HLI and HCB programs is to provide high-quality education taught from an indigenous framework of Hawaiian cultural values, practices, and pedagogy (Kahakalau, 2003). Educators use curriculum and pedagogical practices that are intended to be culturally congruent with the values and epistemology of Native Hawaiians (Kana‘iaupuni & Kawai‘ae‘a, 2008; Meyer, 2003; Schonleber, 2008). Examples include the use of modeling as a teaching strategy, multiage classrooms based on Hawaiian family structures, and a focus on the importance of place and a sense of responsibility to the community and the ‘āina (land).

Studies and test outcomes indicate that, overall, children in such schools have done as well or better than their mainstream counterparts (Kana‘iaupuni & Ishibashi, 2005) on standardized tests. Teachers and parents share pride in the progress of their keiki (children). Parents, both mothers and fathers, have been supportive of these schools, often spending time helping with classroom tasks, such as cleaning, making materials, and learning the Hawaiian language, to better support their keiki.

While HLI and HCB schools are promising in terms of student outcomes, an ongoing challenge for many teachers is in how to find and implement teaching strategies and content reflective of an emerging Hawaiian pedagogy. This can be especially true in the sciences, where there may be deep differences with regard to beliefs about the function and purposes of scientific knowledge and understanding.

Teaching Science in a Cultural Context

Research suggests that early exposure to a culturally responsive science curriculum is important (Britto, 2008; Klein & Knitzer, 2007; Spencer & Markstrom-Adams, 2008). When children do not relate to either science curriculum content or teaching methods from an early age, they will most likely not view the sciences as a possible career choice (Aikenhead, 2000; Fensham, 2008). For example, studies have shown that when children are asked to draw pictures of scientists, the pictures are often men of European ancestry wearing white coats and glasses. This is a picture children from diverse backgrounds may not relate to, and as a result, a career in the sciences may not seem either possible or desirable (Buldu, 2006).

As with many teachers in HLI schools, the teachers at Kamakau wanted their keiki to feel comfortable choosing a career in the sciences. They also wanted the students to be able to contribute in a meaningful way to their community, both locally and globally, because of their grounding in both Hawaiian values and Western modern science. In fact, some scientists in Hawai'i and other parts of the world today are integrating traditional indigenous knowledge with Western modern science in their work. One example is the Pacific Basin Information Node project (Fornwell & Masaki, 2006), which combines traditional Hawaiian knowledge with Western modern science in an attempt to reverse the degradation of the Hawaiian ecosystem.

Although many indigenous researchers have commented on inherent conflicts between indigenous and Western knowledge systems (Aikenhead, 2000; Castagno & Brayboy, 2008; Hermes, 2000; Schroder, 2006), teaching in a both/and context is often also described as possible and desirable. For example, Brayboy and Castagno (2008) argued for a relational view of this knowledge, grounded in a place-based pedagogy and informed by community practices. Snively and Corsiglia (2001) pointed out the differences in the worldview of what they called “traditional ecological knowledge” (p. 7) and “Western modern Science” (p. 8) but concluded that instructional strategies can bring a both/and perspective to science education, and they advocated for the inclusion of traditional ecological knowledge in all science curricula. Others such as Aikenhead (1996, 2000) and Michie (2004) suggested that it is the role of the teacher to act as a cultural broker in integrating and relating the two knowledge systems to their students. This presumes a depth of content knowledge in both systems.

A Need for Better Tools and a Strengths-Based Perspective

While the teachers at Kamakau felt competent to teach cultural practices based on indigenous science, such as planting and taking care of the land, they generally did not connect these practices to Western modern science or the HCPSIII. When the K–6 teachers knew their students would be held accountable for knowledge of the state science content standards, they wanted to create a bridge between the HCPSIII science content and the science embedded in Hawaiian cultural practices.

While an explicit goal of the science curriculum for the Kamakau K–6 teachers was to enable their students to meet state-mandated science assessments, another was to approach their work from a strengths-based perspective. As noted by Kana'iaupuni (2004), too often children of Hawaiian ancestry are viewed from

a deficit perspective, and their cultural strengths are not taken into account in assessments of their abilities. Teaching science content from a Hawaiian cultural perspective is one way to support the “funds of knowledge” (González, Moll, & Amanti, 2005) students from traditional Hawaiian families and communities may bring to school.

The purpose of this project was to develop and implement a science curriculum designed to enable the teachers at Kamakau to teach science from a Hawaiian perspective. The teachers’ goal was to teach science from a Hawaiian cultural perspective and to ensure that their students could pass the state-mandated science assessment.

METHOD

The notion of culture as integral to learning provided an overarching point of reference throughout the investigation. Researchers who subscribe to the notion that culture’s role in learning is of central importance (Cole, 1996; Ross, 2004) do not believe it possible to fully understand the functioning of the mind through the use of quantitative methods alone. They argue that qualitative methods and descriptive data are necessary to more fully understand the research situation and suggest that an analysis of both the processes underlying the data and the major themes and constructs embedded within the data are important aspects of the research process (Wolcott, 1994).

Setting

The project took place at Ke Kula ‘o Samuel M. Kamakau Laboratory Public Charter School, a K–12 Hawaiian language immersion school located in Keana, Kāne‘ohe, Hawai‘i. It has a multiage structure for Grades 1–2, Grades 3–4, and Grades 5–6. The school ‘ohana (family) is greeted daily by Kāne‘ohe Bay as a welcome mat, and instruction is delivered in old cabins once used by campers. Children play in the large field under the shadows and coolness of large monkey pod trees. Picnic tables are spread throughout the campus to provide additional space for outdoor learning. Often, teachers gather there with small groups of students to leave the limited space of the classrooms. Children are in their element being outdoors and see it as a classroom.

Founded in 2000, Kamakau's mission is to provide a culturally healthy and responsive learning environment that fosters success for all members of the learning environment. Similar to schools in other parts of the country emphasizing the culture and language of indigenous people (Lipka & Ilutsk, 1995; Settee, 2000), Kamakau is a place where the Hawaiian language and culture is being revitalized through the teachings of ancestral knowledge and practices. Named after an inspirational Hawaiian historian and leader, Samuel Mānaiakalani Kamakau, the school's educators continue to strengthen an educational program deeply rooted in the language and traditions of those who walked before them while equipping the students with the skills to survive in the 21st century and beyond. Following in the footsteps of Kamakau, the school's purpose remains to provide a quality family-based Hawaiian-medium education, emphasizing a holistic lifestyle of health and wellness, sustainability, and service to the community.

To achieve their goals, the teachers at Kamakau use a contextualized curriculum and pedagogical strategies such as hands-on and reality-based learning intended to be culturally congruent with values and epistemology of the Hawaiian language and culture (Meyer, 2003; Yamauchi, 2003). These practices are well aligned to recent research on common practices used by educators of Hawaiian children. Kawakami (2003), for example, found two elements commonly practiced by effective teachers of Hawaiian students: the provision of hands-on and experience-based activities based on culturally responsive physical and social environments. Schonleber (2008) found 10 key teaching strategies valued by Hawaiian culture-based educators. These included the use of silent demonstration or modeling, student-directed activity, the use of the natural environment, hands-on learning, multiage classrooms that replicate a traditional Hawaiian family structure, and a reality- and place-based curriculum.

At Kamakau, these teaching strategies and beliefs drive curriculum and practice. Education occurs both indoors and outside of the four walls of the classrooms in a real, experiential context. As is the case with other place-based programs (Knapp, 2005), this offers students authentic opportunities to problem solve while realizing their personal responsibility to their surroundings. In addition, classrooms are structured as multiage groupings designed to replicate traditional Hawaiian family social systems in which the *kaikua'ana* (older siblings) assume the responsibility for caring for the *kaikaina* (younger siblings).

Participants

The participants included six K–6 educators of Kamakau, the two authors, and the 60 students in the K–6 classrooms. All six educators and the first author have bachelor's degrees in Hawaiian studies or Hawaiian language; four have master's degrees in teaching. Among the educators and the first author, the average length of teaching experience was 10 years and the average age was 33 years. The students ranged from ages 5 to 12 years. Of the participating children, 92% were Hawaiian or part-Hawaiian.

The two authors have worked together for the past 12 years in various capacities and share a deep belief in education as a tool for social change. We were and are invested in the school and the teachers. The first author is the kumu alaka'i (elementary academic leader) of Grades K–6 at Kamakau and has been employed there for the past 7 years. The second author is a faculty member in the Department of Curriculum Studies at the University of Hawai'i–Mānoa and a Montessori specialist.

Procedure

DATA SOURCES. We collected data from the beginning of the project in October 2007 through its conclusion in October 2009. Data sources included reflective journals from workshops and observations, classroom observations, semistructured focus group and individual interviews with the teachers, student journal entries, analysis of student work, and student interviews. Interview questions are included in Appendixes A and B.

AN EXPLORATORY MEETING. We began with an exploratory meeting with the teachers to discover how best to proceed. This 2-hour meeting focused on the needs of the teachers, particularly around the topics of multiage and inquiry-based education. The purpose was to discover what the teachers knew and what they felt they needed to become more successful (a) as multiage teachers and (b) in their ability to use a more differentiated curriculum. The teachers raised many questions about curriculum planning for multiage classrooms and about how to implement an inquiry model. We asked the teachers whether they would be comfortable if we documented our work, and with their permission, this meeting was audio-recorded and transcribed.

FOCUS GROUP, CLASSROOM OBSERVATION, AND INDIVIDUAL INTERVIEWS. Based on the results of the first meeting, the second author conducted a semistructured focus group (Puchta & Potter, 2004) lasting 90 minutes and an individual observation of each classroom lasting 90 to 120 minutes. Each classroom observation was followed by an individual open-ended interview with each teacher that lasted from 60 to 90 minutes. The purpose of the focus group and interviews was to discover the specific needs of each with regard to teaching inquiry-based science. The purpose of the classroom observations was to discover the classroom setup and how the teachers were currently handling the multiage aspect of the classroom structure. Field notes of the classroom observations were taken using a running record format. Field notes were taken of the focus group and individual interviews.

LEARNING OPPORTUNITIES. Once we had more knowledge of what the teachers wanted and needed, we designed four initial learning opportunities to meet that need. They were (a) three workshops focused on how to create an integrated science-based inquiry framework, (b) release time for each teacher to conduct two full-day visitations to schools using an integrated inquiry-based curriculum in multiage settings, (c) three 60-minute individual consultations with teachers, and (d) three 90-minute debriefing/coaching sessions with the whole group. After each visit and workshop, teachers completed a reflective journal. Two of the teachers began pilot inquiry projects with the students. Field notes were taken of each individual consultation, and the debriefing/coaching sessions were audio-recorded.

A GRADUATE-LEVEL COURSE. In June another focus group with teachers led to a 45-hour graduate-level course on embedding science curriculum within a Hawaiian cultural perspective. The class included instruction in science content using the *Kumulipo* as a cognitive structure for the scope and sequence of the curriculum, a five-pronged unit plan based on the sciences and the HCSPSIII. Participants created individual unit plans and created a curriculum map based on Hawai'i state science standards and Hawaiian cultural values and knowledge. Teachers wrote reflective journal entries after each class session.

FINAL COACHING AND INTERVIEW SESSIONS. The teachers implemented the integrated units in the fall, and individualized coaching sessions were offered to the teachers. At the conclusion of the fall semester, children and teachers were interviewed in two separate focus groups. A final focus group was conducted in May 2009. Member checks were conducted at the conclusion of the data analysis.

Data Analysis

We used the constant comparison method described by Strauss and Corbin (1994) for the data analysis. Researcher notes, transcriptions of teacher interviews, focus groups, and student interviews, teacher reflections, teacher and student work, and classroom observation notes were coded by hand, first at the level of individual key words or open codes, and later, as patterns emerged, as themes.

As teacher needs became clear and as questions emerged, we reviewed the literature to provide a better understanding of the data and to guide the research process and emerging theories. Teacher work products, including unit plans and lessons, were coded and triangulated with the interviews, reflections, classroom observations, and student work. Procedures were further calibrated as new themes emerged and our understanding of student and teacher needs deepened. We concluded the data analysis process by conducting member checks with the teachers.

RESULTS

E lawe i ke a'o a mālama, a e 'oi mau ka na'auao.
*He who takes his teachings and applies them increases
his knowledge.*

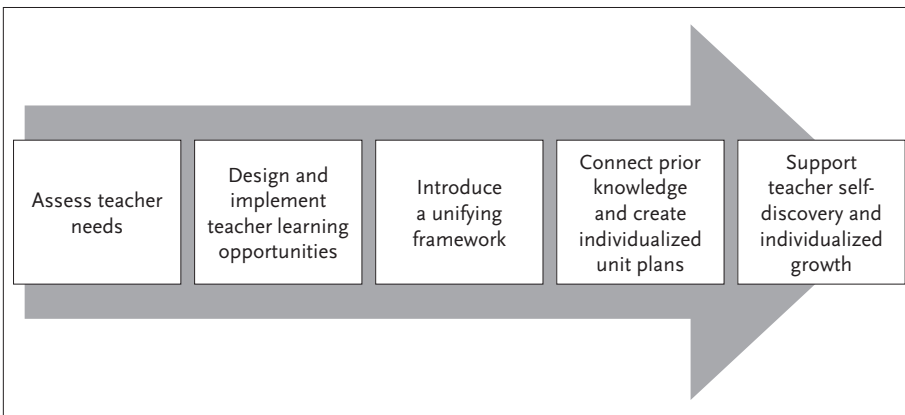
—*‘Ōlelo No‘eau* (Pukui, 1983, no. 328)

We analyzed our data from three perspectives. We first analyzed the process involved in the creation of this curriculum. We then analyzed the combination of teaching strategies that the teachers viewed as most relevant to their success. Finally, we analyzed the participant perspective with regard to lessons learned. In terms of process, we found that there were five essential steps and three key components that seemed to provide the framework for the success of the project. Four interwoven teaching strategies were viewed as most relevant to success in bridging the two knowledge systems and in creating higher interest in the sciences for the keiki. In terms of lessons learned, we noted a deepening of teacher and student knowledge and more confidence in the teachers' feelings about teaching science.

Process

FIVE ESSENTIAL STEPS. There were five essential steps that we felt contributed most to our success in this project. They are detailed in Figure 1. The first step was to stop and assess teacher needs before proceeding with what we felt they needed. Had we not taken the time to listen and learn, we would most likely not have obtained the same results. For example, as a group, the teachers were concerned about how to meet the state standards for two grade levels, and they mentioned this in each of the individualized meetings. This led to a focus on helping the teachers achieve their goal of meeting Adequate Yearly Progress on the state-mandated HCPSIII test.

FIGURE 1 Overview of essential steps in the process of creating the curriculum



The second step was to design and implement teacher learning opportunities. Teachers chose which classrooms they wanted to observe and were able to have individualized interviews in which they could share their concerns and needs in a more intimate forum than a group meeting. Teachers stated that they appreciated the opportunities to see firsthand how others were incorporating multiage and inquiry learning. An example of what the teachers learned was described by ‘Auli‘i, a self-described “traditional” teacher in the Grade 3–4 classroom:

Ma ka hana ka 'ike (in work one learns) sums up how this form of instruction relates to the objectives we strive for at Kamakau. It is important that we as teachers utilize a variety of learning materials and strategies to promote our culture traditions. Inquiry-based learning is a framework conducive to student-centered environments.

The Grade 5–6 teacher, Kēhau, took away this lesson from her second visit when she watched kindergarteners and their 5th-grade buddies interact as they learned about space.

Today, I enjoyed watching the older children interact with the kindergarteners on their space inquiry projects on planets. The older keiki felt important as they were looked up to for help in the younger children's reading and their organization of thoughts on paper. I'd like to coordinate a time for [our] older children to be mentors to the younger children in fulfilling their class projects and integrate valuable lessons of mālama [caring] and kuleana [personal responsibility].

The third step included the creation of a unifying framework during the summer course. The unifying framework was the combination of the Hawai'i state science standards and the *Kumulipo*. The *Kumulipo*, with 16 sections and over 2,000 lines (Beckwith, 1951), shares the belief that the earth started in darkness, and out of that darkness arose life from the sea. This life from the sea was followed by land plants, winged life, crawlers, larger animals, and, finally, humans. Described is the belief that everything is connected, with uniquely intricate, complementary relationships between plants and animals. This framework allowed the teachers to conceptualize any topic of study and to place it within a culturally relevant context that they could easily remember. It also allowed the teachers to create a curriculum map and to plan individual units of study from a common overarching structure.

The fourth step was to connect the teachers' prior knowledge and allow them to create their own individualized unit plans. This was a key component in the success of both the pilot units and the schoolwide units of study. Each teacher approached the project from a slightly different perspective, and each had "aha" moments at different times and places. For example, in the final interview, an "aha" moment for the teacher 'Auli'i was described as follows:

When they [the keiki] guide you to a different place. When you think you choose the best project to help their understanding and they give you a different idea. To be able to step back and go, "okay, the direct instruction is done and now they are self-guided, and what they have done was better than what [the teacher] could have done."

The final step was to support teacher self-discovery and individualized growth. As educators who work from a sociocultural perspective, we felt that it was important to work jointly as a group to create a shared product and to honor the fact that each teacher is an individual with her own perspective, experiences, and needs. An example of this comes from Kalaunuola as she reflected on her readings in the text:

I drooled reading about the organized classroom....I would like to implement the design consideration portion of this chapter and hone it to fit my needs. I also would like to scaffold and organize the other centers to reflect what my students are learning so that they may be more self-directed learners.

THREE ESSENTIAL COMPONENTS. The three components that we felt contributed the most to the overall success of this project are described in Figure 2. They include (a) ample resources, including time to collaborate; (b) a teacher-driven process that allowed teachers to connect practice to content; and (c) specific educational practices that, when combined, allowed teachers to bridge Hawaiian values and knowledge with Western modern science content.

FIGURE 2 Essential components of project success

Ample Resources	Teacher Driven	Specific Educational Practices
Funding for the project based on the following: <ul style="list-style-type: none"> • Time for teacher collaboration/professional development • Curriculum leader • Teacher release time • Substitute teachers • Continued teacher development 	Creation of curriculum created ownership Connects current practice to new content	Cultural practices based on Hawaiian perspectives and values—using the <i>Kumulipo</i> Integrated unit plan consisting of five perspectives Inquiry-based education Place-based

The first component was ample resources. A critical aspect of our success was the time to collaborate. Through the focus groups and the course, teachers expressed their gratitude for the time built into their day to plan and collaborate. This was possible partly because a grant funded the teachers’ release time for meetings plus the graduate course and all other professional development involved and also because of the structure of the class. A supportive administrator and a committed curriculum leader were also key resources. The curriculum leader was able to support the teachers on a daily basis, and because she did the work alongside the teachers, she was able to understand the work required.

The second component was that the entire project was teacher driven. The original meeting was based on goals the teachers had previously agreed upon, and each step of the process involved teacher input. For example, as the teachers began the course, they learned about Montessori’s cosmic curriculum, a curriculum model based on a cosmology suggesting that there is a fundamental unity to all of creation. The cosmic curriculum uses the natural sciences and what are called “great stories” (Duffy & Duffy, 2002) to describe the unfolding story of creation, from the unformed darkness of space to the arrival of humans and their gifts. Teachers could immediately see a connection to the *Kumulipo* and decided to use it as the scope and sequence for the science curriculum. They made it their own as they gained personal ownership by connecting their prior knowledge and experiences to the new content.

The third component involved the specific educational practices described in the next section. These practices were identified by the teachers as being keys to their success.

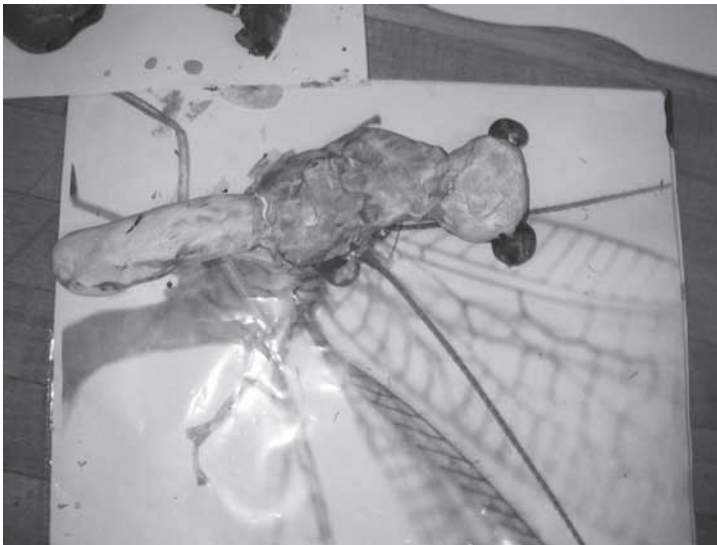
FOUR INTERWOVEN TEACHING STRATEGIES. The teachers identified four interwoven teaching strategies as critical to their success: the use of inquiry, place-based instruction, an integrated unit plan, and, as mentioned before, the use of the *Kumulipo* as an integrating device. These four strategies allowed for the use of cultural practices based on Hawaiian values and perspectives as well as the introduction of Western modern science content.

Use of inquiry. In the first strategy, the teachers began by learning about inquiry as a way to differentiate instruction. In an inquiry teaching and learning curriculum model, students learn to communicate and justify scientific procedures, evidence, and explanations within highly meaningful contexts within their place-based curriculum. Key goals for inquiry-based instruction include the following: (a) focusing and supporting inquiries while interacting with students; (b) orchestrating discourse among students about scientific ideas; (c) challenging students to accept and share responsibility for their own learning; (d) recognizing and responding to student diversity and encouraging all students to participate fully in science learning; and (e) encouraging and modeling the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science (Harlan, 2004). This model was of great interest to the teachers as they observed other classrooms using this mode of instruction. Here is what Joy, one of the resource teachers, observed:

I was reminded that as teachers, we need to guide our students on their path of learning and not to give them the answers right away, but give them the tools necessary in order to find the answer themselves. During our visit I was impressed with one student who did a mini research on William Penn and asked if it was his picture that was used on the Quaker Oats box. He and a partner went online for a few minutes and then reported back to the class that in fact the picture is not of William Penn but was modeled after him.

Much of the inquiry-based instruction in this study occurred when students were given the opportunities to investigate answers to questions that they were interested in. For example, in the study of animals during the third quarter, the first and second graders each chose a Native Hawaiian insect from the *Kumulipo* to further research. All students learned about the parts of an insect, their living environments, and their needs. Individually, however, students studied the unique features of the insects they selected, including colors, size, texture, wing designs, and so forth (see Figure 3).

FIGURE 3 A first grader's clay model of a pinao (dragonfly)



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Students in the Grade 5–6 classroom chose a constellation they were interested in researching as they studied Hawaiian navigation. Figure 4 is an example of a student's art project that resulted from the research.

FIGURE 4 A fifth grader's art project about Makali'i (Pleiades)



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Place-based instruction. The second strategy was the use of place-based instruction. This method of teaching and learning is often associated with education reform and focuses on using the local ecological and sociocultural setting as the organizing focus. It is used in schools as diverse as Montessori adolescent programs (Kahn & Ewert-Krocker, 2000) and rural education initiatives. It is reflective of a core value of Hawaiian pedagogy (Chinn, 2006).

Each unit was grounded in place-based education and told from a Hawaiian sense of place. For example, in the second quarter during the study of the earth, teachers told the story of Papahānaumoku, Earth Mother, and Wākea, Sky Father, from whose union was born the Hawaiian Islands. Student perspectives changed as they looked to the land as ‘ohana. The following saying was stressed daily in our teachings, “Mālama kākou i ka ‘āina, a mālama ka ‘āina iā kākou” (Care for the land, the land will care for us). Students in the various classes learned the stories and traditions of the ‘āina where the school now sits, as well as the stories of their own residence. Through these stories, students gained an increased sense of stewardship for the ‘āina and a renewed responsibility for its continued existence. Field trips to a neighboring Native Hawaiian plant nursery were taken to further expose the students in first and second grades to the koa bug in its natural environment. Students in the third and fourth grades took a day trip to Maui to visit ‘Īao Valley after studying about it. They also saw the value in visiting Lahainaluna High School, where Samuel Mānaiakalani Kamakau once attended as a student and later taught.

An integrated unit plan. A third strategy the teachers felt was important was the use of an integrated science-based unit plan. Here the teachers were reminded of an ‘ōlelo no‘eau, “He lawai‘a no ke kai pāpa‘u, he pōkole ke aho; he lawai‘a no ke kai hohonu he loa ke aho” (A fisherman of the shallow sea uses only a short line; a fisherman of the deep sea has a long line; Pukui, 1983, no. 725). The teachers realized they had been fishing in a shallow sea in their knowledge of science content, and as they began to do the research necessary to teach the keiki, they began to feel the need for a longer fishing line to deepen their knowledge of both science content and methods. They felt that they found their fishing line for deeper waters in the use of an integrated science-based unit plan with five perspectives. See Table 1 for a description of this plan.

TABLE 1 Integrated unit plan format

Perspective	Sample Activities
1. Historical/geological	Timeline of events: the story of the beginnings of a topic and history or genealogy Creation stories including indigenous and scientific perspectives
2. Geographical	Relationship of topic to place, location, climate Study of environments
3. Analytical	Parts of whole (i.e., parts of earth’s crust, parts of an animal, etc.) Needs of topic, whether living or nonliving Experiments
4. Cultural	Impact of topic on people Impact of people on topic Needs of people and reliance on topic
5. Human	Celebration of topic Inclusion of stories, songs, and dance

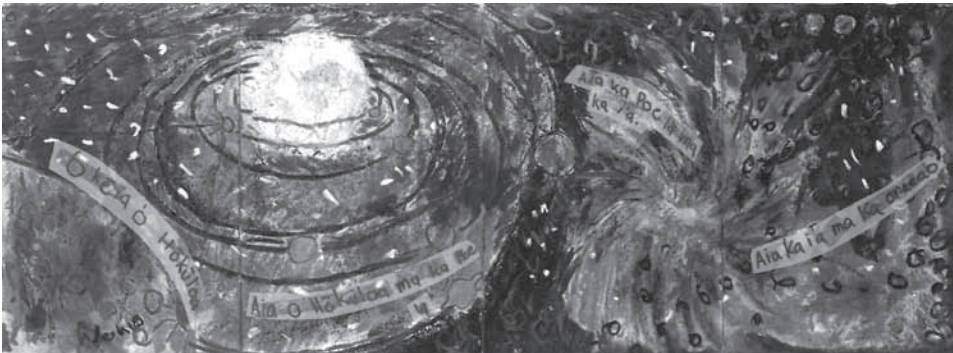
The integrated unit plan format required both teachers and students to view their topic of study through five different scientific perspectives or lenses. This allowed for a deep study of any science topic and provided a way for required state standards to be embedded within activities. It also provided for the use of place-based and inquiry-driven study. To get started, the children chose a topic of study

within the chosen theme. For example, in a study of the universe, kindergarteners chose to study the practical uses of the sun and moon, whereas fifth and sixth graders had chosen to study the constellations and celestial navigation. When they had chosen their theme, the children investigated their topic through the five lenses of the unit plan.

The first lens was a historical or geological perspective where the timeline or genealogy of the topic was made explicit. For example, when the kindergarteners chose to study the sun and moon, they learned, through both the *Kumulipo* and stories about the creation of the universe from the Big Bang theory, about its creation from darkness and heat.

Second was a geographical perspective where relationship to place, location, and climate was made explicit. The kindergarteners learned where the earth and moon are located in relation to each other and in relation to the sun. Third and fourth graders, on the other hand, learned where the sun is located in the Milky Way, and finally, where the Milky Way is located within the universe as currently mapped by Western scientists (see Figure 5).

FIGURE 5 A third grader's map of the Milky Way in relation to the universe



2008, IVY K. KELLING

Third was an analytic perspective, where the elements of the topic being studied were made explicit. Within this perspective, teachers had to deepen their own content knowledge to answer the questions arising from it. In the case of the

kindergarten children, the parts of the sun as defined by Western modern science were studied. Using hands-on materials, children made models of the sun, labeled the parts of the sun, and did matching activities to deepen their understanding (see Figure 6).

FIGURE 6 Kindergarten students learning the parts of the sun



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Fourth was a cultural perspective where the needs or interactions and impact of the topic on humans were made explicit. The kindergarten children learned that the moon was used as a calendar, revealing the appropriate times to plant and fish. The fifth and sixth graders learned about the importance of constellations to ancient navigation and how people could use the stars and elements to guide the way.

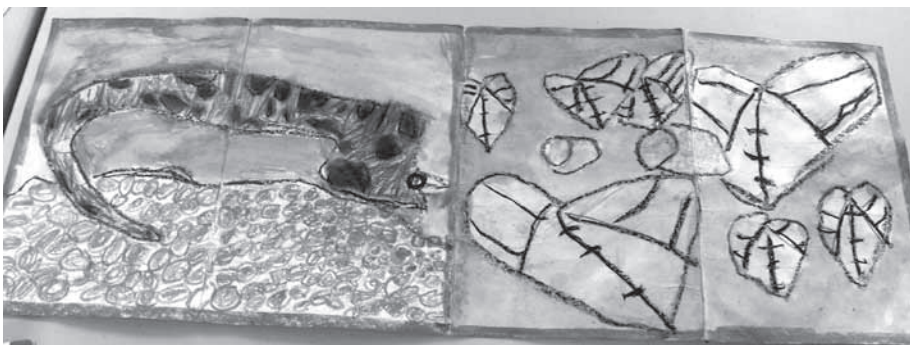
The final perspective was a human perspective where the students learned about the ways people have celebrated this topic. The third and fourth graders read stories about the Hawaiian constellations and learned of their cultural significance. Through oral communication with family members as well as written family histories, these students studied their personal backgrounds of mixed ancestry. They mapped the lands from which all of their ancestors originated and from those points created a “family constellation” that they felt best represented themselves

and their 'ohana. Many identified the most with their Hawaiian culture, as was evident with creative constellations that resembled their family's 'aumākua or deified ancestors. They then created their own personal stories and constellations that told of their family origins.

Using the Kumulipo to provide a scope and sequence. As the fourth and final strategy, the teachers chose to use the *Kumulipo* as the scope and sequence for their science curriculum. As the teachers worked with the *Kumulipo*, they could see that implicit in the chant were the ingredients necessary to include the state science standards. For example, the framework of the *Kumulipo* allowed the students in Grades 1–2 to study the relationships between sea creatures and plant life that arose in the second era of the *Kumulipo* and to learn of their interconnectedness as complementary partners. Using the strategies they learned in the summer course of inquiry-based education, the teachers allowed students to select a fish of interest and its partner plant life for further study. In the process, not only did the students learn a little more of the intricate sequence in which life arose through the *Kumulipo*, but they also met HPCSIII for learning about animal needs, life cycles, and living environments.

The teachers could also see that the *Kumulipo* would provide a scope and sequence for organizing the science curriculum. Following the description of the creation of life described in the *Kumulipo*, they decided to focus on a study of the universe in the first quarter, a study of the earth and the earth sciences in the second quarter, a study of life on earth in the third quarter, and a study of people and their needs in the fourth quarter (see Figure 7).

FIGURE 7 Artwork by a first grader depicting the laumilo (eel) and milo (portia tree) of the second era in the *Kumulipo*



2009, IVY K. KELLING

Lessons Learned: Teachers' Perspective

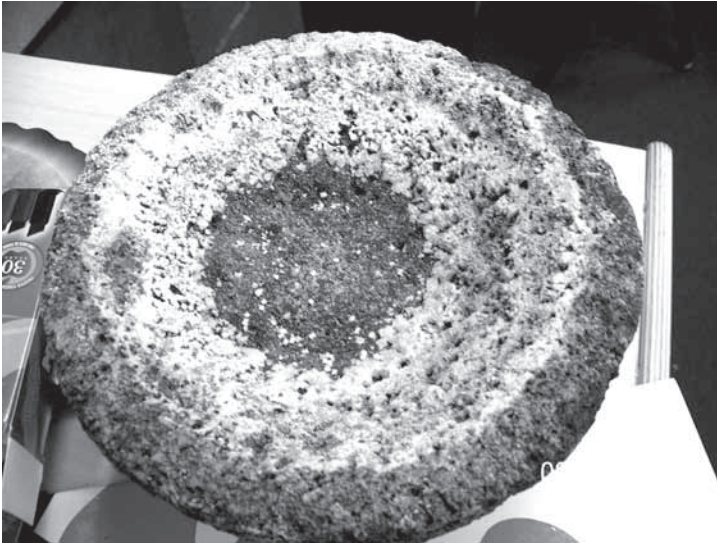
Four themes emerged from the teachers' descriptions about what they had learned from this project. They were (a) an increase in their perceived ability to bridge two worlds, (b) an increased sense of success in their ability to teach science, (c) a perceived increase in their willingness and ability to follow the interests of their students, and (d) an awareness that this curriculum allowed families to connect more deeply with their own ancestors.

HE 'IKE PĀPĀLUA O KE AO ME KA PŌ—DUAL KNOWLEDGE OF DAY AND NIGHT. Although two of the six educators were initially skeptical, by the end of the project, teachers were unanimous in feeling it was possible to create a bridge between what was described by one teacher, Kauai, as “two different ways of viewing the world.” Using the methodologies of inquiry- and place-based education to unfold the integrated curriculum model around the *Kumulipo*, teachers wove in traditional Hawaiian practices while teaching the state science standards. The following description provides examples of culturally based lessons that met state standards.

Keiki began the first year of implementation by learning about the creation of the universe and the existence of the heavenly bodies, earth, moon, and stars. They related this creation to their own place in the universe and on earth. Each grade level chose its own topic on which to focus. For example, as described earlier, the kindergarten children chose to learn about the sun and moon. As the units unfolded, teachers included hands-on and experiential activities for each of the five perspectives mentioned earlier.

These activities were designed to teach both Western scientific and Hawaiian cultural concepts while meeting the educational state requirements of the HCPSIII. One of the HCPSIII requirements is that kindergarten keiki will learn about the strength of the sun's heat. As an example of learning this concept through a scientific perspective, the kindergarten to second graders evaporated seawater using the heat of the sun to get sea salt (see Figure 8, and see Appendix C for a sample teacher's reflection on this unit plan lesson). They used this sea salt to clean and dry fish, a culturally important activity (see Figure 9).

FIGURE 8 Salt remaining in stone bowl after seawater evaporated



2008, IVY K. KELLING

FIGURE 9 Fish-drying activity to demonstrate the strength of the sun



2008, IVY K. KELLING

The first and second graders also studied the moon. Their teacher shared the cultural relevance of the Hawaiian moon phases as she taught the social studies standard of constructing timelines to sequence events. Students learned the sequence and names of the 30 moon phases. They learned that these moon phases coincide with the appropriate and inappropriate times for fishing and planting, a Hawaiian view. With the study of the moon, they also learned about its rotation around the earth and its relative sizes to the other planets, a Western view.

In the third- and fourth-grade classroom, the teacher and students decided to learn about the planets and stars. Students created their unique planet, studied the life cycle of stars, and understood the cultural importance of constellations. Through individual research, students were able to meet an integrated array of state standards, including language arts, science, social studies, and even math standards.

The fifth- and sixth-grade students wanted to learn about black holes and the constellations. Their teacher integrated the geographical and the cultural perspective to teach the standard on exploration, migration, and settlement. Students learned through hands-on experience aboard the double-hulled coastal sailing canoe Kanehunamoku with Captain Bonnie Kahape‘a Tanner and crew.

FEELING SUCCESSFUL. The teachers experienced a breakthrough during the 3-week graduate course as they worked to understand the connection between their current teaching strategies and this new way of planning and teaching. Kalaunuola, the Grade 1–2 teacher, described how she came to feel more empowered to teach science.

When [you] first showed us the “big picture” on how to plan from a science and social studies point of view, the light turned on really bright in my house! Aha! Seeing how the year was based off of science and social studies made my na‘au [seat of understanding, gut] maha [put to rest]. I saw the connections and not just separate parts! I couldn’t wait to use the unit plan I worked on with ‘Auli‘i [the Grade 3–4 teacher] and start planning.

The Grade 3–4 teacher, ‘Auli‘i, added the following reflection as a result of completing the graduate-level summer course:

The knowledge learned in this class will allow me to make constructive contributions to improve the quality of education I provide for my students. At the end of this class I can honestly say I feel that I am more equipped with learning strategies and materials.

Teachers shared that they felt prepared to teach science content as measured by the HCPSIII while simultaneously integrating Hawaiian cultural beliefs and values. As they learned the structure and process for planning and implementing an integrated and inquiry-based curriculum, they realized it could be used all year. A comment by one of the resource teachers, Kawehi, illustrated this:

It [the integrated format] involved all the learning opportunities that children need: multiple modes of learning, science process acquisition, language acquisition, peer tutoring, cooperative learning, socialization, linking the home experience or their prior experience to the school environment, and the opportunity to demonstrate their learning.

OBSERVING AND FOLLOWING INTERESTS OF STUDENTS. Teachers also discovered that they could feel secure in observing and following the interests of the students. This culturally important strategy for teaching (Schonleber, 2008) had been a challenge for teachers to use prior to implementing the inquiry-based science curriculum. Here is what ‘Auli‘i, the Grade 3–4 teacher, said:

The sessions have redirected my authoritarian teaching side (haha) to become more of a democratic facilitator for my students. Essentially, it is my job to initiate the first key experience; however, once the seed is planted...I become a resource rather than an expert. The objective of this type of

curriculum is to allow the students to tell their own story. The relevance of content to their own lives allows the novice student to become the expert, thus creating the transfer of knowledge that is needed for learning to take place.

CONNECTING FAMILIES TO THEIR PAST. At the end of the year, the classes had their annual hō'ike or sharing of knowledge. In their final interview, one teacher, Kalaunuola, pointed out that the science curriculum with its focus on the *Kumulipo* had an unexpected emotional impact on some of the families. In fact, Kalaunuola described this as her “aha” moment of the project:

It was in one of my conversations with one of my parents. Having her validate what you [the second author] do with [the two art teachers]. [The students] did a spiral about the universe, and her son took it home and showed her mom, and her mom started to cry...she realized that it was their genealogy. It was validating to [the keiki] that he knew what his tūtū [grandma] knows.

Lessons Learned: Keiki's Perspective

Through the focus group interview with the keiki and the teachers' informal observations shared during focus groups, three themes emerged: (a) The children realized they are part of a larger whole—this implies a greater responsibility to the whole; (b) the children liked knowing that they were all learning the same “big idea” content but with different focus areas during the same time frame; and (c) the children had a deepening understanding of both Hawaiian and Western modern science concepts. Their understanding and realizations are described here.

DISCOVERING THEY ARE PART OF THE WHOLE. Many of the keiki discovered their role as part of a larger whole. When interviewed about what they had learned from the project, for example, a first grader commented that the biggest lesson learned throughout the year was that “Pono e mālama iā Papahānaumoku i hiki ke ola ka'u mau mo'opuna” (We must care for Papahānaumoku, Earth Mother, so that my grandchildren can live). This child understood that we are responsible not only for ourselves in this lifetime but also for the generations to come. She was not alone

in her views. A third grader added, “Pili kākou a pau a pono kākou kekahi i kekahi” (There is a relationship between all of us [sky, earth, people, plants, and animals] in some way, and we all need each other). A fifth grader summarized the year’s curriculum with the following: “‘O kēia nā mea ko’iko’i e a’o ai i maopopo no ka wā e hiki mai ana. He wā ho’omākaukau kēia no ka wā e hiki mai ana” (All of this knowledge is necessary to learn. This is a time for us to prepare for the future).

LEARNING SIMULTANEOUSLY. Keiki discovered by accident that they were all studying the same general content. It happened on the playground when a first grader overheard conversations about the class work between groups of older students. He proudly proclaimed that he, too, was learning about the moon. The excitement and joy keiki displayed as they discovered they were learning the same topic touched the teachers deeply. In fact, when Kauai, the kindergarten teacher, saw that the keiki “realized they were learning the same thing,” this was her “aha” moment.

A DEEPENING UNDERSTANDING. Through the use of this curriculum, there was a deepening understanding of both Western science concepts and Hawaiian values and culture around those concepts. Keiki described what the alaka’i described as a “seamless understanding” of both Western and Hawaiian scientific and cultural explanations for the water cycle as they participated in the interview with her.

DISCUSSION AND CONCLUSION

The use of a place-based curriculum using the *Kumulipo* as an integrating device (Fogarty, 1991), the use of an inquiry-driven and science-focused integrated unit plan that fit well with the *Kumulipo*, and the underlying framework of Hawaiian cultural values and beliefs provided teachers and students with a way to bridge both Hawaiian and Western science beliefs, one of the original goals of the project. Further study and support for the teachers as they continue to implement this curriculum model would help to both validate the curriculum and refine it. For example, it would be worthwhile to analyze this curriculum from the perspective of what it brings to the students in terms of cognitive or psychomotor processes. We would like to further calibrate this model and better assess what the teachers are doing in their classrooms on a daily basis as they integrate the learning of science, place, and culture.

Although this project cannot be generalized as it is bounded by the particular circumstances of the situation, it would be useful to conduct longitudinal and comparative research on the effectiveness of the pedagogical practices delineated. Participants identified a number of specific practices for teaching Western science they felt were compatible with a Hawaiian approach to education. Discovering whether they make a difference in the academic and attitudinal outcomes of keiki could be helpful to other indigenous educators attempting to support students in bridging two knowledge systems.

From our own perspective, to be able to work with the teachers and provide a format for them to do their own learning as they worked together for the good of their keiki was inspiring. We observed that our role in providing resources, time, and the ability to collaborate was an important component in the success of this project. We also observed that one reason for the success of this project was that it was teacher driven. The outside “experts” were invited at teacher request and were based on perceived need and past relationships. These observations are borne out by research on school reform, with a growing body of research literature suggesting that it must be comprehensive, culturally congruent, and generated from within the communities, schools, and other stakeholders (Datnow, Stringfield, & Castellano, 2005; Tharp & Gallimore, 1991). Teachers, administrators, parents, and members of the community want to create their own models with the appropriate supporting materials, culturally congruent pedagogical practices, and ongoing training. Pedagogical strategies that are a good fit for the learning needs of students must be available. Structural support that facilitates culturally congruent and preferred pedagogical methods and strategies must be provided, and ongoing staff development must be offered (Bielenberg, 2000).

We began this project feeling unsure about how to implement a science curriculum that was both culturally relevant and reflective of the teacher goals and values as educators. We found that the teachers discovered that they could teach keiki about the natural world through the lens of Hawaiian cultural values and that they could enjoy teaching science and successfully prepare their keiki for state-mandated standardized tests without compromising their deeply held goals and beliefs about their culture. The teachers ended the project feeling so enthusiastic about the outcomes of our collaborative efforts that they spent precious resources to attend a week-long summer graduate-level course for teachers at the Colorado Springs Space Foundation (Space Foundation, 2009). As a result, they have become more confident in planning culturally responsive science curriculum preparing students to assume leadership roles in both Western and Hawaiian cultures.

Keiki appeared to appreciate the inquiry-based aspect of the work as they learned Western science content related to their personal interests through the lens of a Hawaiian cultural perspective. Many expressed that they felt empowered as they connected abstract science content to the Hawaiian values they were learning. This was evident in the way they began to describe themselves and the events around them. As one fifth grader said, when asked how she felt about being at Kamakau, “I feel like a shining star in the universe.” A shining star in the vast universe is an analogy to the maui, the life force that burns bright within each nurtured individual. This is the hope and prayer that we throw into the universe: to instill in all of our keiki the desire to carry on the burning flame of the school’s namesake, Samuel Mānaiakalani Kamakau.

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ACKNOWLEDGMENTS

Although the two authors wrote this article and participated in the development of this model, the results are of shared ownership with the following dedicated and passionate Kamakau teachers who contributed their 'ike and na'au throughout the process: Kupuna Kanoelani McGuire, Kauai Naniole, Kalaunuola Domingo, Joy Gallaher, 'Auli'i Hopeau, Kēhau Pe'a, and Kawehi Lucas. They have all dedicated their lives to educating Native Hawaiian children by building a strong cultural foundation. We mahalo Kahu Wai'ale'ale Sarsona, director of Kamakau, for her vision to foresee the hua o ka hana and for her support throughout this project. Mahalo nui loa to Miki Maeshiro and Meleanna Meyer, who have both worked in the Kamehameha Schools Literacy Instruction Support Division, for their inspiration and cultural wisdom to alaka'i many of the art and writing projects that are described in the article. We are grateful to all of our community partners who have and will continue to play a role in the building of culture-based education: Bonnie Kahape'a-Tanner and the crew of Kānehunamoku (Pualani Lincoln Maielua, co-captain, Rusty Oppenheimer, Mitchel Livsey, and Akoni Tacub), Hui Kū Maoli Ola, Paepae 'o He'eia, and Chaminade University of Honolulu. We also mahalo Tasha Wyatt, Monica Stitt-Berg, and David Jelenik, who read drafts of our work and gave valued feedback. This project was supported in full by the Native Hawaiian Education Program grant that funded Kamakau's Ho'okahua Project.

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APPENDIX A FINAL TEACHER INTERVIEW QUESTIONS

September 22, 2009

1. What was the biggest lesson learned as a teacher during the whole process? biggest successes?
2. What was the biggest “aha” moment?
3. What was different that they already knew? What did you think about the five perspectives?
4. What are some of the challenges you faced implementing such a curriculum?
5. What evidence did you have that the kids actually learned something?
6. Would you recommend an inquiry-based (five perspectives) curriculum to other Hawaiian-focused/immersion charter schools? schools in general?
7. If you could change one thing about this curriculum to best fit your student population, what would it be and why?
8. Have you continued to build upon last year, and are you continuing this curriculum this year?

APPENDIX B KA NINAUELE HAUMĀNA (FINAL STUDENT INTERVIEW QUESTIONS)

1. He aha ka mana‘o nui o ia mau mea ‘o ka ‘ōnaeao, ka honua, holoholona, mea kanu a me ke kanaka? Pehea lākou e pili ai? (What is the big/main idea of the units of universe, earth, animals and plants, and people? How are they related?)
2. He aha nā mea i makemake ‘ia? (What pieces/lessons did you enjoy?)
3. He aha nā mea pa‘akiki? (What was challenging?)

APPENDIX C

EXAMPLE OF A REFLECTION AFTER A UNIT PLAN LESSON

1. What happened?

I took the class outside and introduced the supplies I had: salt water (ocean), stone bowl. We discussed what was in the ocean water (responses—fish, salty, sand, crabs, etc.). I poured the water into the stone bowl and left it on a chair in the sun. I asked the keiki [children] to guess/predict what would happen to this water (responses—it will be gone because the birds will drink it, it will get hot from the sun, it will be salty, etc.).

We returned to the class and completed a bar graph (math) showing the number of keiki who said that the water will still be in the bowl tomorrow morning versus those who thought there will be no water left.

We started our daily observation chart. The keiki were asked to draw their observations in their journals, and the kumu [teacher] wrote their observations and predictions.

2. What did I like that happened?

Some of the keiki were thinking about the salt in the seawater, while others were using their previous experiences to guess that the birds will drink it, and so forth. This is just the start to making predictions/hypotheses, making observations, and explaining the results.

3. In what ways, if any, did the strategies I used help deepen Hawaiian values and beliefs?

They discussed the importance of the ocean water, and this will lead to the importance of the sun/salt to kānaka Hawai'i [Hawaiians].

4. What would I do differently next time?

Next time I would have the whole class discussion outside instead of moving back to the classroom after observing the water being poured into the stone bowl.

I would also prepare a template of the bar graph so that the keiki could be more involved in the process. Perhaps giving them each a small Post-it note to write their names and place under the appropriate category.

5. What did the students like about what happened?

The keiki enjoyed and felt a great ownership in this journal writing because these were their thoughts and ideas about what they thought would happen to the salt water if left in the sun until tomorrow morning.

6. What didn't the students like about what happened?

Since the bar graph was not as interactive as I would have liked, the keiki may not have fully understood the purpose (not all of them anyway). There were several of them who could answer my questions, "Which category had the most number of keiki?" while the others could not respond.