The Mo'olelo *(Story)* of Teachers Learning and Teaching Hawaiian Culture and Space Science: New Opportunities Through Minority Initiatives in Space Science (NOMISS)

Alice Kawakami and Nani Pai

This article describes a unique project that combined traditions of Hawaiian culture with astronomy for kindergarten through Grade 12 (K–12) teachers, university professors, and astronomers. The collaboration focused on the development of K–12 classroom curricula. These experiences yield curriculum content themes (e.g., sense of place, origins, and observation) and insights about the process of learning (e.g., transmitting, transacting, and transforming). The article portrays the lived experiences of the participants and summarizes the lessons learned during 4 years of work.

CORRESPONDENCE MAY BE SENT TO:
Alice Kawakami, Institute for Teacher Education, University of Hawai'i–Mānoa
1776 University Avenue, Wist Annex 2, Honolulu, Hawai'i 96822
Email: alicek@hawaii.edu

Hūlili: Multidisciplinary Research on Hawaiian Well-Being Vol.2 No.1 (2005)

This article has three purposes. First, we describe a project that linked Western notions of teacher professional development and curriculum research with the lived experiences of teachers in an authentic cultural setting. Second, we discuss the effect of the project on teachers' awareness of their own learning processes and the impact of teachers' learning on the development of curricula for their students. Third, we produce a written piece that retains the flavor and fluidity of the experience while keeping within the boundaries of academic publication.

Background

Astronomy in Hawai'i is both inspiring and controversial. Ancient Polynesian navigators used their knowledge of the environment to guide their voyages across wide oceans and to establish a sophisticated society in tune with their surroundings in the Hawaiian Islands. Modern-day astronomers have discovered that Mauna Kea provides a premier location for viewing space from Earth. This realization led to the development of observatories at the summit of the mountain, an initiative that continues to draw indigenous opposition.

Finding ways to teach school-age children to value the world of modern, technologically dominated astronomy as well as traditional ways of existing compatibility with the Hawaiian environment prompted the development of the New Opportunities through Minority Initiatives in Space Science (NOMISS) project (http://www.hubble.uhh.hawaii.edu). This work was funded by the National Aeronautic and Space Administration's (NASA) Office of Space Science through the Minority University Research and Education Partnership Initiative for the years 2001 to 2004. The purpose of this grant was to increase the awareness of space science among the general population of Hawai'i and, more importantly, to increase opportunities for kindergarten through Grade 12 (K–12) students to learn about the work in space science and Hawaiian culture on Mauna Kea. Specifically, NOMISS provided opportunities for astronomers and K–12 classroom teachers who work with minority students (Hawaiians, Asians, and Pacific Islanders) to find common ground in teaching students about the sophistication of traditional Hawaiian relationships with the environment, including the night sky, and the ongoing research at Mauna Kea.

The NOMISS grant was awarded to the University of Hawai'i–Hilo. The principal investigator was in the astronomy department and the coinvestigator in the education department. Dual leadership in the project was intended to engage teachers of K–12 students as well as university undergraduate astronomy majors.

This article describes the K–12 professional development and curriculum design activities. The collaboration involved classroom teachers from private schools, public schools, and public charter schools, as well as resource specialists, cultural practitioners, university undergraduates, professors, observatory personnel, an outreach scientist from NASA, and the local business community.

Method/Approach

The goal of the K–12 portion of the work was to increase opportunities for K–12 students to learn about space science and Hawaiian culture atop Mauna Kea. NOMISS focused on professional development for classroom teachers to equip them with the knowledge to design and implement relevant curricula for their students. NOMISS teachers made a commitment to learn about the connections between Hawaiian cultural practices and the study of modern space science. With that commitment, they participated in learning experiences that ranged from workshops on basic astronomy concepts to crew training on the voyaging canoe *Makali'i*.

As a group, NOMISS teachers reflected on the process of learning through experiences in authentic environments. As NOMISS teachers learned about culture and space science, they used their insights to design classroom curricula. The curriculum concepts were piloted in classrooms from Grade 2 to Grade 7 and included plans for a physics/astronomy course at the high school level.

This article describes the highlights of the NOMISS experience in the form of recollections written by the coinvestigator (Alice Kawakami) and a classroom teacher (Nani Pai), both of whom are Native Hawaiian educators. To retain the integrity of our experiences, we present the description of the project as personal narratives. Both of our voices are blended to recount the NOMISS activities in sequence over the 4 years of the project. Infused within our narratives are reflections from

the project coordination and classroom perspectives. Retrospective analysis and conclusions summarize lessons learned about the content of curriculum and the unique processes that emerged as a result of this project.

Our Nomiss Moʻolelo

> E lauhoe mai nā waʻa; i ke kā, i ka hoe, i ke kā; pae aku i ka ʻāina.
>
> *Everyone paddles the canoes together; bail and paddle, paddle and bail, and the shore is reached—Pitch in with a will, everyone, and the work is quickly done.*
>
> (Pukui, 1983, p. 40, no. 327)

Spring 2001: Project Start-Up

In the spring of 2001, as the NOMISS investigator, I began visiting schools to invite teachers to join the project. As a group, our excitement and näive optimism were fueled by good intentions and dreams of honoring both the traditions and culture of Hawaiʻi and the advances and study of modern space science. Mauna Kea is considered a sacred place to Hawaiians because it has been a spiritual and cultural resource from ancient times to the present day. In addition to being the home of Hawaiian deities, the location of both birth and burial sites, and a source of inspiration, it is a *wahi pana* (a sacred place) that holds precious cultural, environmental, and geological materials. Mauna Kea, or *Mauna a Wākea,* was named after Wākea, or Sky Father. According to a traditional chant, Wākea and Papahānaumoku's or Earth Mother union produced many of the Hawaiian Islands. Wākea is thought to be *ʻohana* (family) and a *kupuna* (ancestor).

Astronomy is a relative newcomer on the mountain. Because issues of access have been debated throughout the past 10 years or more, a contentious situation continues to surround the expansion of observatories at the summit of Mauna Kea. Thus, many Hawaiian teachers viewed NOMISS as a means of mitigating

the situation by clarifying the issues and empowering their students, the next generation of Hawai'i residents who would continue to face these concerns. A clash of epistemologies—Western science versus Hawaiian cultural traditions—was a focal point of tension for teachers who struggled personally with these issues and who realized the potential for significant educational impact.

Summer 2001: Retreat

Our first official NOMISS teacher activity was a weeklong retreat to begin the collaboration. The plan was to present a balanced set of information about current space science—particularly the work being conducted at the observatories on Mauna Kea—while learning about Native Hawaiian cultural perspectives. We learned about the observatories and adaptive optics from lectures and slideshow presentations. NASA outreach scientists from the Jet Propulsion Laboratory in California also trained us to use experiential methods to teach about the structure of the solar system using a technique called *kinesthetic astronomy*.

We began the retreat in a culturally appropriate manner, with a *pule* (prayer), *oli* (chant), and *hi'uwai* (water purification, spiritual cleansing). A memorable visit with Manulani Meyer foreshadowed the challenges of working in the area of the epistemological overlap (see Meyer, 1998).

We forged ahead and initiated exchanges with a panel of navigators and crew members from voyaging canoes. We tried our best to honor the culture with *huaka'i* (excursions) to culturally significant sites related to astronomy, including Kumukahi (for the sunrise), Hualālai (an attempt to visit Ahu a 'Umi), and Pu'u Poli'ahu atop Mauna Kea (for the sunset and nighttime observations of the sky).

During the summer, a few of the NOMISS teachers attended AstroVaganza 2001, a summer teacher workshop focused on voyaging and space science that was jointly sponsored by the University of Hawai'i–Hilo, NASA, and the Mauna Kea Astronomy Education Center. In many ways, it was similar to the NOMISS retreat, with the historic addition of Papa Mau Piailug (master navigator and teacher who single-handedly reclaimed and revitalized the ancient traditions of Polynesian navigation), Uncle Clay Bertelmann (the captain of the voyaging canoe *Makali'i*), and the voyaging canoe, *Makali'i*. NOMISS teachers joined teachers from across the state of Hawai'i and from the North American continent. AstroVaganza

provided space science concepts, excursions to Mauna Kea and Mauna Loa, classes on instructional strategies to teach about astronomy, precious early morning time with Papa Mau on *Makali'i* to see the night sky turn into day, and time to talk story about celestial navigation. Papa Mau's gentle directive to us was, first, that we all need to work together and, second, that what we learn must be shared with others just as he had shared what he knew with navigator Nainoa Thompson.

Fall 2001: First Classroom Pilot of NOMISS Curriculum

In the fall semester, NOMISS elementary teachers began to incorporate ideas and experiences from NOMISS activities into their classrooms. For the most part, standard grade-level curriculum was extended to include NOMISS activities for students. The study of space science and Polynesian migration and voyaging was linked to standards for student achievement. At the middle school level, a more ambitious effort was created by a team at Hilo Intermediate School. Their yearlong course of study was based on the *Ke Ala Pono* (path to righteousness) concept integrating the core subjects of language arts, social studies, science, and mathematics under a voyaging theme. This included learning about *wa'a* (canoe) and voyaging traditions, space science, and current issues surrounding access and use of Mauna Kea. Students' experiences included values-based team-building (students were assigned as "crew" for different wa'a), cultural protocol (including oli, genealogy, and wearing of *kīhei,* or shawl), and wa'a crew training. Space science was infused throughout the curriculum with the study of the universe through kinesthetic astronomy, the development of sail plans for a voyage, and a simulation of a day aboard a sailing canoe. Contemporary issues were addressed by a panel of adults representing different perspectives about Mauna Kea, including a spokesperson from NASA, a navigator from a voyaging canoe, a cultural practitioner, and astronomers. The year ended with a *hō'ike* (presentation or exhibition) and kīhei ceremony as a showcase of students' accomplishments.

As we began adapting our adult learning for K–12 students, we came to the realization that we were involved in an endeavor that was not a normal academic curriculum development project. During this time, teacher participants realized that the biggest gap in their knowledge and understanding was cultural protocol. Thus, NOMISS called on two cultural resources within the teacher group to lead us in our learning: Kumu Moses Crabbe and middle school science teacher Roxane Kapua Stewart agreed to provide cultural workshops for the group early in 2002.

Reflections on 2001

'IMI 'IKE: A SEARCH FOR KNOWLEDGE. For me, as a Hawaiian classroom teacher, 2001 was a year of *'imi 'ike,* searching for knowledge that could improve my foundation in space science. I felt comfortable with cultural protocol (thanks to my hula training) but felt a need to enhance the Western science portion of my curriculum. Because I was teaching summer school, I was not able to attend all of the sessions in the weeklong retreat. However, the time spent with NOMISS was invaluable. In addition, 2001 was a time to establish relationships within our NOMISS 'ohana. Many of us knew one another in some capacity, but there were some in our group whom we had not known before. Taking time to know one another was crucial in establishing trust and camaraderie, especially in a long-term learning relationship such as ours.

NEW WAYS OF LEARNING. As coinvestigator and project coordinator, I felt extreme gratitude for the people who gravitated to this work. Many of us had known each other since the early 1980s through our interest in culturally relevant teaching for our Hawaiian students. Others were new to the work but brought talents and passion to our group. NOMISS presented an opportunity to join forces in a project that would expand our professional and personal definitions as educators and as responsible members of our community. The experiences we had together touched the center of our souls, our identity. An incredible realization for me was that while there have been amazing advances in the study of space science through the uses of modern technology—which can be accessed by teachers who want to learn about astronomy and research—an even more challenging learning task was to figure out how to address the kinds of cultural learning opportunities that capitalized on the dynamic and fluid nature of cultural practice and the risks involved in such endeavors.

Spring 2002: Professional Development and Curriculum Design

In the spring of 2002, NOMISS teachers committed to learning about Hawaiian protocol. The purpose of the three Saturday training sessions was preparation to conduct proper protocol for our work together. This meant we needed to cultivate our own cultural understanding and demonstrate our awareness through practice of proper protocol. Because we were based in Hilo, our intent was to approach Mauna Kea in the correct way so that our work would give honor to this sacred site.

To begin, we explored the purpose of protocol, learned about our path from sea level at Hilo One (Hilo Bay) to the summit, as well as the accompanying spiritual, behavioral, and material preparation. Our learning about protocol first focused on *oli kāhea* (chant asking permission to enter), *oli komo* (admission/welcome chant), *moʻokūʻauhau* (genealogy), pule, *kinolau* (alternate plant or animal forms of a supernatural being), and *hoʻokupu* (offering). After these lessons, continuous protocol learning became part of the ongoing activities of NOMISS for the next 2 years.

Summer 2002: Retreat

By summer 2002, NOMISS had been together for a year and a half. Now that we knew the importance of proper protocol and purpose in our work, our second NOMISS retreat was an active learning week beginning with hiʻuwai, entry request chant, pule, reflections, and debriefing woven throughout our time together.

The space science focus included lessons on the properties of light and the construction of telescopes from kits. Uncle Clay Bertelmann generously allowed us to spend time with him and the *Makaliʻi* crew at Kawaihae and Māhukona on the Kona coast. We observed the night sky and the sunrise with him. A highlight of the summer was the trip to the Star Compass at the Hualālai Resort in Kaʻūpūlehu. We practiced our skills of observing nature as we tried to relate what we saw to what we had learned from both scientific and cultural perspectives. Our visit to Mauna Kea was successful as we began to understand the power of place by watching what happened when we approached culturally significant locations with the proper spirit of respect and gratitude.

At the retreat, the teachers demonstrated lessons they had developed and successfully implemented with their students. Lessons spanned a wide range of activities: building an edible universe with candies representing celestial objects (to scale), creating a map of the Pacific using blue tarps and masking tape to mark longitude and latitude, simulating a "man overboard drill," and reciting genealogy. During the last day of our retreat, a pivotal event occurred when one of our colleagues shared a videotape and described the work he had been doing with high school students by taking them to *Makaliʻi* and having them learn to sail as part of an extracurricular activity. The sharing of the *Makaliʻi Crew Training*

Manual led us to consider waʻa training for NOMISS teachers, an activity that was clearly not within the scope of the original project. The NOMISS work was taking us to our culture and traditions in ways that were completely outside of our comfort zone and entirely outside the academic paradigm of conventional teacher workshops.

Fall 2002: Making Big Plans

We began on an upbeat note by deciding that instead of meeting on Saturdays, we would meet on Monday evenings for potluck dinner and discussion. Some of our best memories are of the fellowship we shared, discussing and supporting each other's activities that were being implemented in K–12 classrooms. At this point, we decided that we needed to cultivate a closer relationship with *Makaliʻi* if we were to understand much of the knowledge and skills required to develop a curriculum on voyaging and astronomy. In October of that year, we spent a weekend in service to *Makaliʻi* while she was in dry-dock. This was truly a gift for us to be able to learn about the care and *aloha* (love, affection, compassion) that goes into the vitality of this waʻa. We also learned more about star lines (constellations used for celestial navigation) and made a videotape of oli that could be taught to our students.

To test our abilities to combine culture and science, we decided to design a summer program for students to be implemented the following summer (2003). Kamehameha Schools Kapālama Campus called for proposals for new initiatives to reach more Native Hawaiian students. We designed the Hawaiian Astronomy Institute as a collaborative program between NOMISS and Kamehameha Schools to provide a 4-week summer program for students who had just completed the fourth grade, from both public and private schools on Oʻahu and Hawaiʻi Island. The Hawaiian Astronomy Institute was to be implemented on Oʻahu and Hawaiʻi to teach the very things our NOMISS group had learned: cultural protocol, space science, observation, and voyaging. Simultaneously, a general science elective for high school students from Hilo High School was planned as a summer class, incorporating the same concepts at a more sophisticated level. While we made these plans, we were not sure if Kamehameha Schools and the Hawaiʻi Department of Education would welcome such a radical departure from the normal summer school curriculum.

Reflections on 2002

PLAN TO USE OUR KNOWLEDGE. From the classroom perspective, there were many highlights of 2002. One that stands out is the birth of the Hawaiian Astronomy Institute. This was an opportunity to teach all that we had learned about space science and voyaging through dual lenses, Western and Hawaiian. The institute was conceived as a possible answer to the question, "How do we know if this will work with our students?"

COURAGEOUS TEACHERS. As project coordinator, I was completely taken by the power of the teachers' commitment to coalesce what we had learned into an integrated summer experience for students. Putting together the plan for the Hawaiian Astronomy Institute for fourth graders and the summer class for high school students in Hilo was a marvel of collaboration and trust. These summer projects became the vehicle of accountability for what we had learned. Beyond knowledge and skills, we wanted to support each other in creating a holistic learning experience in our natural cultural landscape so our students could experience Hawai'i and space science as relevant and life enhancing.

Spring 2003: Focus on the Wa'a, Teacher Training, and K–12 Curriculum

Early in 2003, we were notified that our Hawaiian Astronomy Institute had been approved. Across the state of Hawai'i, during the school year, fourth graders study the history of Hawai'i, the solar system, and early astronomers of the Western tradition. We had an opportunity to build on the basic knowledge of the existing curriculum with our expanded understanding of the ties of cultural traditions, noninstrument navigation, and observation of the natural environment, particularly the night sky.

At the same time that Hawaiian Astronomy Institute was being planned, the NOMISS teachers on Hawai'i Island continued to learn about the basics of astronomy with weekly Monday night astronomy classes in Tom Chun's high school classroom at Kamehameha Schools Hawai'i Campus at Kea'au. A high school science teacher, Tom was generous in sharing his passion for astronomy, physics, and Hawaiian culture. In the fall of 2001, while he was at the Kapālama Campus, Tom had led the same type of classes for the NOMISS teachers there. It was so successful that they recommended the same opportunity be provided for their NOMISS colleagues on Hawai'i.

By invitation of the *Makali'i* 'ohana, NOMISS teachers joined other teachers from around the state for a wa'a training weekend in February 2003. It was an extraordinary experience that taught us about the interdependence of the voyaging community, our earth and sky, and the deep spiritual and emotional bonds that are built by a crew. We also learned about protocol, the history of Hawaiian voyaging canoes, how to tie knots and lashings, crew responsibilities, crew selection, how to work together to raise and lower the sail, how to handle the steering sweep, and how to identify star lines and patterns of nature. We had to pass a safety test for swimming, treading water, and rescuing. We learned more about observing the night sky, the stars, the sun, and clouds.

Beyond the knowledge and skills, we came to understand the importance of *laulima* (collective effort), in which trust and responsibility build the fabric of safety and well-being. Experiences with each other and time together on the wa'a truly transformed us as human beings. Our most precious moments were spent with individuals who generously shepherded us through the weekend. Our affection and deep aloha for the *Makali'i* crew and the Bertelmann 'ohana (Uncle Clay, Aunty Patty Ann, Uncle Bill, Luther, Chadd, Pomai, and Aunty DeeDee) cannot be adequately expressed.

Reflections on Spring 2003: Wa'a Training

AN EPIPHANY FROM ASTRONOMY TO WA'A. Early in 2003, plans for the Hawaiian Astronomy Institute progressed, and Monday night astronomy classes in Tom Chun's classroom provided continued professional development in space science while further cementing our NOMISS 'ohana bonds.

An experience that transformed me was the wa'a training in February with the crew of the *Makali'i*. Although I was terrified at the beginning that I would somehow fail, I quickly learned that *pa'ahana* (hard work) and determination would result in success. I also learned that anything is possible if we work together. The reward that weekend was the opportunity to board the *Makali'i* and sail her outside the harbor. Everything came together on that short sail. I understood, for the first time, what my ancestors had known instinctively: that we are born of the ocean. We are ocean people. What an epiphany!

TIME FOR RISK-TAKING. As project coordinator, I was able to set up and immerse myself in activities but always with the "protection" of the coordinator role, being able to jump back to get things ready or take care of logistics and details. It was comfortable for me to always have the ability to retreat into my safe zone when things got "scary." Although I had been surrounded by my trusted friends and colleagues, I still had not had to put complete trust in them and in the process. The *Makali'i* crew training and the Bertlemann 'ohana taught me more than the entire span of my academic training by getting me into a situation in which trust and connections to others were not only preferred but actually essential to the safety and well-being of each person. As someone who is not comfortable in and on the water, my reluctance to participate in ocean activities was overcome by crewmates encouraging me with genuine aloha and care. This was a rare experience for me, and it transformed my views about learning in general and professional development in particular. In the past I had written about collaboration and the perspective of social learning theory with the importance of interaction and support for learning. With wa'a training, the intellectual theory of the words came alive through the relationships developed by working together on everyday tasks of genuine purpose and learning. My biggest realization was that the "wa'a culture" of my ancestors has a great deal to teach 21st-century educators about being present and engaged in the world and in the lives of our families, students, and communities.

Summer 2003: The First Hawaiian Astronomy Institute

During the summer of 2003, *Makali'i* became the centerpiece of our work with students. The Hawaiian Astronomy Institute and a summer science class sponsored by the Queen Lili'uokalani Children's Center were made possible with Uncle Clay's support by bringing *Makali'i* to Hilo for a week. The wa'a became the classroom for both programs.

The purpose of the Hawaiian Astronomy Institute was to provide a 4-week experience that integrated celestial navigation, space science, and culture for Hawaiian *keiki* (children) from Kamehameha Schools and from the community. A big part of the institute was teaching the keiki proper protocol when visiting another wahi pana or when entering our class. Another important component was teaching observational skills, which are essential to understanding impending weather conditions. Star lines were also taught. Underlying everything was the knowledge and practice of Hawaiian values.

At the Kamehameha Schools Hawai‘i Campus, there were 9 boys and 10 girls in the Hawaiian Astronomy Institute. Of the 19 soon-to-be fifth graders, 11 were Kamehameha students, 7 were from Pāhoa Elementary, and 1 was from Nāwahīokalani‘ōpu‘u, a Hawaiian immersion school in Kea‘au. All of the students returned to their school of origin the following fall, except for one who became a new student at the Kamehameha Schools Hawai‘i Campus. To enroll in the institute, students were asked to submit an essay to be evaluated by a group of teachers. The essays were submitted for review; however, because of the low number of applicants, everyone who applied was invited to attend.

During the 1st week of the Hawaiian Astronomy Institute the students met at their home campuses, Kapālama and Kea‘au, on O‘ahu and Hawai‘i. This week was spent getting to know one another and learning the routines of protocol, homework with star journals, and other basics of culture and astronomy. During the 2nd week, O‘ahu students traveled to Hawai‘i to meet their counterparts and to visit significant sites there. During the 3rd week, Hawai‘i students reunited with their new friends on O‘ahu and learned about astronomy and culture on that island. In the final week of the institute, each class prepared to share all they had learned with their ‘ohana in a hō‘ike on their own islands.

The institute's activities focused on meeting several proposed goals and objectives. The main goal was to provide a 4-week summer enrichment experience integrating Hawaiian celestial navigation and space science. Evidence that the students met this goal includes their ability in the following:

- Identify more than five constellations used in celestial navigation.
- Behave appropriately when visiting a *heiau* (pre-Christian place of worship, shrine) dedicated to celestial navigation on O‘ahu.
- Keep a journal of observations made during the day and at night.
- Predict weather using the wind, cloud formations, and color of the sky as indicators.
- Present a hō‘ike at the end of the 4-week session about the things they learned.

The second goal was to provide a venue for developing experience-based curriculum to blend culture and science. Progress towards this goal is evidenced by lesson plans and activities provided for the Hawaiian Astronomy Institute.

The third goal was to provide a mechanism to link students and faculty at the Kapālama and Kea'au campuses with each other and with community resources. This was accomplished by constant communication and correspondences and a trip to O'ahu to spend a day planning together (which was funded by NOMISS).

Reflections on the Hawaiian Astronomy Institute, 2003

THE HAWAIIAN ASTRONOMY INSTITUTE WAS A SUCCESS. As a teacher in the first institute, I feel the experience was worthwhile and beneficial for all the keiki who attended. The pre- and post-tests indicate that the participants' understanding of celestial navigation, space science, and Hawaiian culture improved markedly. More important, I think they left feeling proud to be Hawaiian and deeply appreciative for the accomplishments of our kūpuna.

The partnership with NOMISS was invaluable. NOMISS university faculty were instrumental in providing support for the activities we planned, including our visit to Hale Pōhaku, the mid-summit observatory facility, the day we spent with *Makali'i* crew, and the astronomer panel. Because I did not have much outside help in my class, having occasional faculty assistance was very helpful.

We were able to implement our NOMISS curriculum in 4 short weeks. Despite organizational and logistical challenges, the students from Kamehameha Schools and the Department of Education learned cultural protocol, observational skills, space science, and a sense of place through their many experiences, both in and out of the classroom (Kawakami, 1999).

WALKING THE TALK. From the perspective of a university professor, I found that being able to work side by side with NOMISS teachers and their students was the most rewarding part of the Hawaiian Astronomy Institute. Fourth graders were thrilled to be on a canoe to learn each part of the wa'a and the responsibilities of crew members. They chimed in, calling out the stars in the star lines, and giggled over the "*hōkū* shopping cart" nickname for the constellation of Corvus, the Crow or Me'e, in the Ka Iwikuamo'o star line. They learned about *kuleana* (responsibility, privilege) and practiced protocol before they began their lessons. High school stu-

dents enrolled in the general science summer course also had to demonstrate their readiness and commitment to earn the right to learn and to sail. Rigorous training meant that each student had to pull his or her weight in supporting the rest of the group. The reward was to sail on *Makali'i*. Hō'ike for both Hawaiian Astronomy Institute fourth-grade and high school students demonstrated more than learning about voyaging and space science and included appreciation for their Hawaiian identity and a greater commitment to their cultural heritage. By integrating space science and culture, resources were made available through partnerships with the voyaging community of *Makali'i, Hōkūle'a,* and the Polynesian Voyaging Society, the astronomy community's observatories, university astronomy professors, the Institute for Astronomy, the Office of Mauna Kea Management, and the Queen Lili'uokalani Children's Center in Hilo. The Hawaiian Astronomy Institute especially benefited from the support of local Hilo businesses and the Keaukaha community, who contributed to the efforts with donations of goods and services.

Fall 2003: Preparation for Closure with Documentation

Fall 2003 began with a shift in focus. As we continued our learning about cultural practices, we agreed that an appropriate protocol would be to prepare kīhei to signify our accomplishments and to prepare for a final ascent to Mauna Kea. Just as we had seen students in the middle school Ke Ala Pono program prepare kīhei to reflect their genealogy and identity, we too needed to learn about creating a representation of our joint and individual identities as NOMISS teachers. During the summer, we each designed our kīhei and used *'ohe kāpala* (bamboo stamps) or plants for printing. Each design included a common bottom row of *kukui* leaves (candlenut tree, *Aleurites moluccana*) to signify our search for greater knowledge and enlightenment as kukui, in Hawaiian, means "light." Additional rows signified our years of NOMISS participation and expressed our individual identities. We ended the year with a kīhei ceremony, a final visit to Mauna Kea with proper protocol, and the agreement to develop a curriculum document in 2004 that would allow us to share the information we had learned in a culturally responsible manner.

Now that we had demonstrated that we could offer learning activities and programs that delivered culture and space science—both during the school year and for summer programs—our next task was to document what we knew so that information could be shared with others. As a group, we had learned the consequences of not being focused and prepared physically, intellectually, and

spiritually. To disseminate the information, we needed to be available, individually and collectively, after the project funding ended to support the learning of the next generation of teachers who would use our curriculum. As with the entire project, our documentation had to show that relationships are at the heart of the work—*pono* (moral, proper) relationships with each other, with our students, with Hawaiian cultural traditions and with Hawai'i itself.

Spring, Summer, and Fall 2004: Documentation and Dissemination

Spring 2004 found us engaged in many hours of intense dialogue and reflection. We decided to compile a document with information that (a) described the learning process that resulted in the transformation we had experienced as the NOMISS 'ohana and (b) provided classroom resources focused on the NOMISS themes for grade levels we had worked with. Copies of the "NOMISS Master Binder" (NOMISS, 2004) would reside with each of the original NOMISS teachers. As opportunities materialized for sharing the information with specific groups, the teachers could draw on the resource document and design appropriate training sessions and follow-up support.

As we compiled the information, we realized that to have appropriate closure to the project, we would need to use the document to widen our circle and begin to build relationships with new colleagues. We also realized that we would need to have a culturally appropriate protocol to signify the completion of the NOMISS-funded work and the continuation of meaningful relationships as the binding that holds us together.

We held our "New Colleagues Training" in June 2004 with a group of individuals with whom we had already established working relationships and who had expressed a commitment to integrating culture and space science for Hawaiian and other local students. The training session focused primarily on cultural protocol and the responsibilities of each person to provide the most engaging and appropriate education to their students with the approaches and themes in the NOMISS curriculum. It was successful in building a larger number of teachers who were committed to using NOMISS approaches and themes in their teaching.

As the "New Colleagues Training" was being planned, we received a request to train public school teachers in the NOMISS curriculum. Although this was a great opportunity for NOMISS, we were hesitant to agree to the request because we did not know the teachers through previous relationships, and we did not have any guarantee of a continuing relationship after the training. We finally decided that we could do this training if we could require teachers to be willing to participate in Hawaiian protocol and to maintain both the culture and science themes of NOMISS in their classrooms. The outcome was that the training was offered to Hawai'i Department of Education teachers of Hawaiian language immersion, Hawaiian studies, and Hawaiian language classes. The training involved classroom discussions, observations of the natural environment and a sunrise, and observations of the Hawaiian Astronomy Institute 2004 offered on O'ahu and Hawai'i that summer. The training was taught by six of the original NOMISS teachers. Teachers from the Hawai'i Department of Education also met twice in the fall semester to share portfolios documentating the follow-up implementation of the NOMISS curricula in their own classrooms.

NOMISS core group teachers and new colleagues implemented a formal closure of the project with an *'awa* (kava, *piper methysticum*) ceremony on O'ahu in late summer. It was a day with many positive signs that reflected the deep commitment of all to the NOMISS 'ohana and signaled the end of the first leg of our voyage together and the beginning of the next. At this gathering, we reflected on all of our experiences during the past 4 years and identified the highlights that have been described in this article. As a continuation of our commitment to share what we have learned, we plan to propose conference presentations and submit articles for publication. We also will maintain our network to support each other as individual efforts continue to expand.

Reflections on 2004

MAKE IT *PA'A* (SOLID). As one of the original NOMISS teachers, I am both hopeful and saddened when reflecting on 2004, the last year of NOMISS. Widening our circle to include colleagues who understood the importance of being grounded in Hawaiian culture and who possessed enthusiasm for teaching space science/voyaging was a critical component in assuring that we were not the only educators to benefit from our aggregated efforts. It is difficult to know how much impact

we really had on those educators in the short time we had with them. Perhaps only time will tell. Our ʻawa ceremony marked the formal end of the NOMISS project. The ceremony was beautiful. It was like a graduation, an end to a remarkable journey and a beginning of unexplored potential. Each of us had grown in so many ways, and our relationships with one another will forever be paʻa.

TO END AND TO BEGIN. When the NOMISS grant period came to an end, reports to the funding agency signaled the end of the project. As coinvestigator, I had to let go with the knowledge that even without the formal structure of NOMISS activities, what we built together would live on in each of us as we returned to our everyday routines and our classrooms. I left with hope that the relationships that were developed and the commitments that we built would endure. A sadness set in with the end of the project because we would not have regular contact with each other across the islands, and we would not regularly have formal opportunities to gather each summer to be together and to learn more about our culture. The Hawaiian Astronomy Institute could continue as a summer school program, and its future would lie in the hands of the host institution. NOMISS helped me to see education in Hawaiʻi with new eyes. In the past, classes on social studies methods for my preservice teachers focused on knowledge and skills documented in books and curriculum materials. As a result of NOMISS, I will try to give my students—preservice teachers—a taste of the strategies and content we had experienced as part of our authentic educational experiences. Including unconventional learning opportunities within the university system may be a challenge, but I will continue to learn more about being an effective teacher and to bring culture into teaching and learning for my students, who will then pass it on to their students.

Retrospective Analysis

In the following section, we step out of the narrative voice and summarize the findings of the project in terms of process and content. Throughout the NOMISS project, we followed a sequence of learning in our activities. First, we discussed the purpose for our activity and developed an agenda with shared responsibilities. Next, we participated in the activities and experiences with proper protocol and acknowledgment of our resources (cultural, scientific, environmental, and

spiritual). We came to realize very early in the project that the best way for us to learn from our experiences was to build common understanding by discussing our feelings and insights soon after the experiences in a debriefing session in which we shared our *mana'o* (belief, thought, intention). Finally, we were careful to write up notes and proceedings and to share lesson plans and reflections with one another thereby creating a record of our progress and accomplishments over time. This sequence was applied to all of the professional development activities and the curriculum development work. The systematic inclusion of NOMISS teachers' personal and professional perspectives allowed us to identify the central themes of a K–12 student-focused curriculum and to articulate the unique and powerful learning processes that we experienced as adults and now strive to recreate for our students.

Findings

NOMISS Perspectives on K–12 Curriculum Content

INFORMATION. As designers of curriculum, teachers must know how to organize both scientific and cultural information. To access information on modern space science for K–12 mathematics and science curricula, educators can use the Internet or the library to find information about the universe, the seasons, and the night sky. Cultural information, however, is more difficult to access because it is highly dependent on cultural context and personal knowledge. A certain amount of "factual" information is readily available, but often the behaviors that are most important to this type of learning are based on relationships with cultural practitioners. Access to this type of information takes time and trust among individuals who have clearly articulated motivations that will not undermine Hawaiian cultural values.

GOALS FOR LEARNING SKILLS AND BEHAVIORS. In a general sense, teachers organize learning experiences to support students in the acquisition of specific skills and behaviors. As we learned to observe and interact from a scientific and cultural perspective, we encountered information that could be easily transmitted in a single lesson as well as information that had to be cultivated over time. In an academic setting, accessible information is the norm. Protocols for scientific reports and examinations are available, and diligent students can demonstrate the skills

they acquire from their teachers and the curriculum. However, cultural skills and behaviors often require teachers and their students not only to obtain information but also to develop sensitivities and personal values that allow them to access cultural information in nonschool settings. Students were expected to achieve a level of cultural competence that had not been a part of their previous school experiences. Students' ability to master skills and behaviors in the cultural domain requires sensitivity and self-awareness related to knowledge of their identity, genealogy, and history. Combined with information transmitted through instruction in classrooms, learners were required to relate the information to their peer group and community. The behavior of NOMISS teachers reflected the impact of cultural learning on their identity and values. Learning about the powerful heritage of Hawaiian people helped to clarify our place in educating our students in modern-day society.

VALUES AND DISPOSITIONS. Values were inherent in the culture and space science curriculum because its underlying purpose was positive outcomes for the community. Aloha, laulima, and *lōkahi* (unity) were woven into learning about the linkages between culture and space science. The domains covered by the NOMISS curriculum extended beyond information and included the definition of one's place in a community. The curriculum involved real-life experiences such as activities in noninstrument navigation and voyaging, which can be hazardous unless all participants do their part. Fourth graders who participated in the NOMISS Hawaiian Astronomy Institute and high school students who took the general science course repeatedly wrote about the impact of their experiences in terms of newfound pride in the accomplishments of their voyaging ancestors and a keen interest in their natural and cultural environment.

NOMISS K–12 Curriculum Themes: Sense of Place, Origins, and Observation

NOMISS teachers at all grade levels identified three themes that effectively linked Hawaiian cultural practice and space science: sense of place, origins, and observation. Units and lessons across the grade levels repeatedly emphasized these themes to promote Hawaiian values and a sense of community.

Sense of Place

Location and context were critical. The place of learning strongly influenced every experience we had. Each location in Hawai'i has unique traditions and history. These traditions influenced experiences that occurred on a daily basis. Honoring our land and sea with values of *mālama 'āina* (care of the land) and *mālama kai* (care of the sea) not only maintained aloha and the positive regard that ancient Hawaiians held for the environment but also provided opportunities for students to practice modern science. Mauna Kea's traditional and cultural power and its distinction as the premier site for viewing space from earth supported relevant learning for students. The interest of these students was grounded in their own history as well as the potential for exploration of worlds beyond their shores and their planet. In addressing this challenge, learners began to explore and create their own resolution to the apparent dichotomous issues of culture and science.

Origins

The search for knowledge to explain our origins—whether it be cultural genealogies or the origin of the universe—was woven throughout learning activities designed by NOMISS teachers. "Who we are" and "where we come from," both individually and collectively, are universal questions. For Hawaiians, origins have been preserved in creation chants and family genealogies, providing a continuing source of strength and definition. For Western scientists, the question of the origin of the universe is an ongoing line of research.

For K–12 educators, relevant and engaging knowledge about culture and science can be incorporated into classroom learning with the support and relationships that extend into the cultural and scientific community. Polynesian voyagers sailed from the Far West and South Pacific using the skills of observation and noninstrument navigation. Modern astronomers and astronauts look to the sky to gain knowledge of other worlds and galaxies. This desire to know more about the world we live in and the courage it takes to look beyond the mundane have been central to the NOMISS curriculum themes as a common factor for both cultural traditions and modern space science.

Observation

The theme of observation was the simplest and most applicable method for linking cultural and scientific learning activities. Learning to use our sense of observation was essential to noticing patterns in nature over time. The analysis of those patterns led to both cultural and scientific knowledge. Observation, in the Western tradition, assumes consistency and reliability of quantifiable data to verify information that may be generalized to other settings. The validity of this type of observation lies in the belief that knowledge is static, and once verified, can be replicated under similar conditions. This assumes that information should be the same, regardless of the identity of the observer. While this method of observation may or may not utilize technology (telescopes and computers) to capture information, it still relies on human insight for analysis and interpretation.

In traditional Hawaiian epistemology, situational conditions (purpose, people, and place) and observation affected knowledge and learning. Both were vital in our work. In a cultural situation, knowing how to access the unseen (spiritual) dimension through protocol and interpretation of signs was the result of learning to observe and behave in culturally grounded ways. For many educators trained in a Western paradigm (including those of Hawaiian descent), comfort with and confidence in this type of observation did not readily occur without additional instruction. Critical to this type of observation were opportunities to experience and practice Hawaiian cultural protocol in culturally significant locations. The purpose of the activity, the identity of the participants, and the location of the activity were of primary importance. A cultural practitioner provided guidance by modeling the appropriate observational skills while supporting novices as they began to practice cultural protocols and observation of *hō'ailona* (signs, symbols, representations). An essential part of the learning process for this type of observation was the debriefing sessions at the conclusion of each experience. Through these discussions, participants learned from each other about the most significant factors to observe as well as the interpretation of these events and signs. The observations included natural phenomena and social responses among participants. Learning to observe with all of one's senses and intuition went beyond the realm of data for "scientific" observation and did not depend on technology.

NOMISS Perspectives on the Learning Process: Transmit, Transact, Transform

The learning experiences NOMISS teachers have gained and are trying to replicate for their students can be referred to as "holistic learning," as described by Miller, Cassie, and Drake (1990). These authors distinguished between learning that *transmits* information, learning that provides *transactions* about information, and learning that *transforms* the learner at a holistic level and changes the person's worldview. As NOMISS teachers discussed their unique professional development activities and the curriculum development process, they concluded that their experience was at the transformational level of learning.

The following list of critical factors for transformational learning provides the working environment for the NOMISS *Classroom Resource Document:*

1. Transformational learning occurs within a group and builds, develops, maintains, and nurtures a community of learners over time.
2. Transformational learning must support individual learning through personally meaningful experiences.
3. Transformational learning takes time. Multiple opportunities for experiences develop not only *'ike* (understanding and knowledge) but also *na'auao* (wisdom).
4. Transformational learning is directly linked to real communities and involves genuine service as part of the reciprocal relationship of giving and receiving.
5. Transformational learning must be grounded in specific places.
6. Transformational learning involves direct experience with places and people.
7. Transformational learning always includes appropriate protocol.
8. Transformational learning requires reflection and debriefing to create new learning at the level of knowledge, insight, and instinct.

Lessons Learned

Western notions of professional development and curriculum design can be linked to experiential undertakings focused on Hawaiian culture and sacred sites related to modern astronomy. Throughout the NOMISS experience, teachers learned more than facts and information about Hawaiian culture and space science. They repeatedly described profound changes in their perspectives and the impact of those changes in their personal and professional lives. Ultimately, the project affected the students of those teachers who were able to integrate the perspectives and values they gained from the project into their classroom curriculum and to influence their colleagues within their own grade levels and schools.

NOMISS was unique in two significant ways. First, the funding source (NASA) mandated that cultural and scientific perspectives coexist and be developed into a hybrid classroom curriculum for K–12 students. Second, the project lasted 4 years, which allowed for purposeful planning, shared experiences, individual and group reflection, and documentation of agreements over time. This opportunity for the development of relationships, of perspectives, and of people is rare. These aspects of the program are difficult to duplicate; however, the insights of the teachers and the results of the curriculum that they designed are valuable and enduring. Although the financial base for NOMISS is gone, the relationships will survive beyond the formal funding cycles and give hope to continuing the commitment to bridging the Hawaiian and Western perspectives for K–12 learners.

Writing about these experiences was challenging. Cultural perspectives on communication and academic style requirements for publication created a tension for us. In keeping with our cultural values and obligations, this information was first shared with our community by the teachers. The presentation was supported by dialogue, pictures, and personal testimony. We realize, however, that to truly build a bridge between cultural perspectives and the academia, articles need to be written and submitted for review, publication, and dissemination to a wider audience. The present article represents our effort to record the flavor and fluidity of our experiences while keeping within the boundaries of academic publication.

Conclusions

Although we may not be able to formally meet again, we are confident that we can depend on other NOMISS teachers to come to our aid if we need help. There are teachers on the Kamehameha Schools Hawai'i Campus who support the efforts described in this article. We are uncertain whether the Hawaiian Astronomy Institute can remain intact because it is cost-intensive in its current scope. However, most of the institute's objectives can be met with regular summer school funding. Perhaps another way to share our curriculum is to do a series of presentations within the community, although this approach can only provide the audience a small taste of the learning we have experienced.

The development of a core group of NOMISS teachers who are able to articulate the links between Hawaiian culture and space science was a significant accomplishment. These teachers have committed to continuing to use their knowledge through implementation of the NOMISS curriculum in their classes and through dissemination of the curriculum to their colleagues. We continue to look for ways to disseminate cultural information appropriately and with aloha.

> 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—A person whose knowledge is shallow does not have much, but he whose knowledge is great, does.*
>
> (Pukui, 1983, p. 80, no. 725)

> 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.*
>
> (Pukui, 1983, p. 40, no. 328)

References

Kawakami, A. (1999). Sense of place, culture and community: Bridging the gap between home and school for Hawaiian students. *Education and Urban Society, 32*(1), 18–40.

Meyer, M. (1998). Native Hawaiian epistemology: Sites of empowerment and resistance. *Equity and Excellence in Education, 31,* 22–28.

Miller, J. P., Cassie, J. R. B., & Drake, S. M. (1990). *Holistic learning: A teacher's guide to integrated studies*. Toronto, Ontario, Canada: Ontario Institute for Studies in Education.

New Opportunities through Minority Initiatives in Space Science (NOMISS). (2004, June). *Palapala hoʻonaʻauao: Classroom resources for Hawaiian culture and space science*. Hilo, HI: Author.

Pukui, M. K. (1983). *ʻŌlelo Noʻeau: Hawaiian proverbs and poetical sayings* [Collected, translated, and annotated by M. K. Pukui] (Special Publication No. 71). Honolulu, HI: Bernice P. Bishop Museum.

About the Authors

Alice Kawakami is associate professor at the College of Education, University of Hawaiʻi–Mānoa. She coordinates elementary teacher education cohorts, teaches classes in curriculum and instruction and social studies, and supports pre-service teachers in their field experience classrooms. Nani Pai is a fourth-grade teacher at the Kamehameha Schools Hawaiʻi Campus. She integrates Hawaiian culture and values in all aspects of her curriculum, and she played a key role as a teacher leader in the NOMISS program. Both authors focus on the education of Native Hawaiian learners and the role of cultural knowledge in education.