

MĀLAMA 'ĀINA: CODING TO RESTORE LAND AND IDENTITY IN HAWAI'I

Josiah Hester discusses a project that integrates computer science education with Native Hawaiian culture, language, and environmental stewardship principles

Over a millennium ago, master Polynesian navigators crossed thousands of miles of open ocean in double-hulled voyaging canoes, guided only by oral and ancestral knowledge of stars, winds, currents, and birds. Upon arriving in Hawai'i, they transformed these isolated islands into a thriving civilisation. They created intricate agroforestry and aquaculture systems, from the mountains (ma uka) to the sea (ma kai), guided by traditional knowledge and rigorous observation (kilo).

Native Hawaiians (Kanaka 'Ōiwi) placed land ('āina), water (wai), and plants like kalo (taro) at the centre of life, stemming from the belief that they are the younger siblings of the taro plant (Hāloa), and establishing a profound responsibility for environmental stewardship.

This intergenerational responsibility for environmental stewardship, or mālama 'āina, continues to guide Native Hawaiian communities today, inspiring a modern movement to blend traditional knowledge with cutting-edge technology for educational and restoration efforts.

Culture and computing: Mālama 'Āina through micro:bits

In Hawai'i, computing education is vital to prepare students for careers and joining the workforce (much needed in Hawai'i's tourism-focused economy), but it can also be used to strengthen language, culture,

identity, and feelings of responsibility (kuleana), for the land and waters that sustain them, much like students' ancestors.

The Mālama 'Āina through micro:bits project is a culturally relevant, place-based physical computing curriculum for Native Hawaiian students. Place-based learning is a student-centred, immersive approach to instruction that uses non-classroom environments as the foundation for lessons, connecting classroom content to real-world context.

The project started at Pū'ōhala School, a Hawaiian immersion bilingual public school in Kāne'ohe, O'ahu, Hawai'i, where instruction is delivered in the Hawaiian language ('Ōlelo Hawai'i). Hawaiian immersion schools, such as Pū'ōhala School, are important repositories of culture, language, and traditions for Native Hawaiian communities and bring together a broad community of cultural practitioners who work with the students and teachers.

During the Mālama 'Āina through micro:bits project, students worked at the Waikalua Loko I'a, a 400-year-old traditional 16-acre fish pond within walking distance of Pū'ōhala School, managed by the Pacific American Foundation. Located in Kāne'ohe Bay on O'ahu's windward coast, this pond was once an important food resource for the community. At Waikalua Loko I'a, students learnt how this natural feature was transformed into an aquaculture facility that cultivated natural processes to maximise



■ The Mālama 'Āina through micro:bits curriculum in action

food production while improving ecosystem functionality and human well-being.

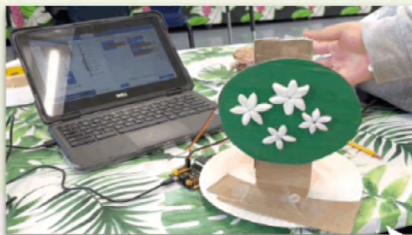
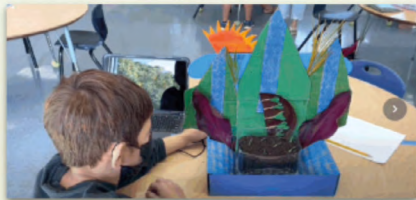
Students engaged in the ongoing restoration work of the site and community, using sensors, computing principles, and data science blended with traditional concepts of taking observations (kilo) and caring for and protecting the land (mālama 'āina). The project combined disciplines to support bidirectional learning where environmental engineering, cultural competency, computing, and AI technology synergistically supported one another. Research shows that integrating sustainability and mālama 'āina principles into CS learning — such as connecting loops and conditionals to both micro:bit programming and the logic of managing a fish pond (loko i'a) — improves engagement and outcomes.

In one example, students built sensor

Students worked on CS projects where they could express ‘Ōlelo Hawai‘i through micro:bit integrated projects.

Participating students:

- 20 students
- Grades 6-8
- Semester long course
- During the school day



He ‘a‘ali‘i kū makani mai au;
‘a‘ohe makani nāna e kūla‘i.

I am a wind-withstanding ‘a‘ali‘i; no wind can topple me over.

■ Improving engagement in CS learning through the principles of mālama ‘āina (caring for the land)



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STUDENTS LEARN HOW TECHNOLOGY CAN BE WIELDED IN SERVICE OF SOVEREIGNTY

systems with MakeCode to protect and monitor the fish pond. Students made connections between their micro:bit sensors (including light, ambient temperature, water temperature, and the level of dissolved solids), and sensors placed in the fish pond by local scientists. Students compared different data from different sites, along with their own observations, and then asked questions of the local experts at the pond.

In another example, students worked on CS projects where they could express Hawaiian language (‘Ōlelo Hawai‘i) through micro:bit-integrated projects. One student chose the proverb “He ‘a‘ali‘i kū makani mai au; ‘a‘ohe makani nāna e kūla‘i”, which means, “I am a wind-withstanding ‘a‘ali‘i [a native Hawaiian shrub]; no wind can topple me over” and wrote code that rotated a cardboard cutout painted like a traditional canoe. Other students interpreted proverbs about the moon and the first taro plant, all using micro:bits and coding as a medium to express their culture and identity.

Over the course of this programme, hundreds of curriculum modules were built, new words in ‘Ōlelo Hawai‘i were created to give meaning to CS concepts, and over

400 students and more than 20 teachers participated and continue to participate.

Supporting teachers (kumu) with culturally grounded AI

Unfortunately, one school revamping its curriculum is not enough to address 100 years of language suppression, alongside the significant lack of teachers who can speak ‘Ōlelo Hawai‘i and who have expertise in computing. A major barrier is that the cultural educational resources teachers need don’t exist, especially not in ‘Ōlelo Hawai‘i, or for technical subjects like computer science.

This is why our team created Kumu Connect, a web-based AI application that produces classroom-ready lessons in English and ‘Ōlelo Hawai‘i (kumuconnect.com). Kumu Connect guides teachers through creating lessons with the necessary CS standards, the desired language, and appropriate cultural anchors using a community-curated data set of Hawaiian stories, proverbs, practices, and ecological knowledge — each specific to a classroom’s land division (ahupua‘a). Teachers can further augment these lessons with AI, deliver them from their device, or print a

physical copy. Kumu Connect was iteratively co-designed and validated an MVP (Minimum Viable Product) prototype with over 50 teachers, and holds many of the lessons learnt from work at the fish pond and Pū‘ōhala School.

Reflections and the future

Place-based (‘Āina-based) education brings together educators, cultural practitioners, and technologists to design physical computing projects that serve the land and community — whether that means monitoring water quality in restored fish ponds, tracking soil health, or building solar-powered long-range networks for remote data collection. Students program micro:bits and sensors while speaking, reading, and writing in Hawaiian, learning not only how technology works, but also how it can be wielded in service of sovereignty, securing the future of food, water, and land for future generations. This place-based, culturally rooted approach ensures that computer science education is not just about preparing for jobs in tech — it’s about preparing the next generation to steward their lands, waters, and future. When our students code in their own language, for their own land, they are not just learning computer science — they are reclaiming and restoring land and identity. (HAW)