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Mālama ʻĀina through Micro:bits in Kāneʻohe: A Place-Based Approach to Teaching CS in a Kaiapuni (Hawaiian Immersion) Bilingual School Setting

Amanda Nelson*, Amy Guo†, Marcelo Worsley†, Derek Esibill‡ and Josiah Hester§
*Pūʻōhala School, †Northwestern University, ‡Pacific American Foundation, §Georgia Institute of Technology

***Abstract*—This experience report describes two years of work integrating coding with Micro:bits and Makecode into a Hawaiian immersion bilingual school setting to teach computer science (CS) skills in a place-based approach. This report highlights the collaborative partnerships and programs between a public Hawaiian immersion school, a non-profit organization that manages important cultural sites, and a university lab that develops sustainable technology. Students identified the importance of sustainability in computing by engaging with past, present, and future technologies in culturally relevant contexts. We describe ongoing work to improve the way we support students and teachers in a Hawaiian-immersion bilingual school setting.**

***Keywords*—Place-based computing, Traditional knowledge, Sustainability, Hawaii, Biocultural restoration, Micro:bits**

I. Introduction

The Mālama ʻĀina through Micro:bits in Kāneʻohe project (see Figure 1) seeks to build and deploy culturally relevant physical computing curricula for Native Hawaiian students that are place-based, integrated with existing programs and partners in Kāneʻohe, Hawaiʻi, and reinforces the Hawaiian concept of mālama ʻāina (to care for and protect the land) alongside concepts of computer science. This project combines disciplines to support bidirectional learning where environmental engineering, cultural competency, and computing synergistically support one another. This unique program focuses on engaging a historically underserved community for computing education, Native Hawaiians and Pacific Islander students.

The project builds on longstanding existing programs between the collaborating organizations:

Pacific American Foundation (PAF): a Native Hawaiian-led non-profit charged with the biocultural restoration of important natural sites in Hawaiʻi including the Waikalua Loko Iʻa, an important traditional fishpond built by Native Hawaiians.

Pūʻōhala School: Ke Kula Kaiapuni ʻo Pūʻōhala is a Hawaiian immersion bi-lingual public school in Kāneʻohe Hawaiʻi with 62% of students of Kānaka Maoli (Native Hawaiian) descent. Kaiapuni schools deliver instruction in ʻŌlelo Hawaiʻi (Hawaiian language). Pūʻōhala School has students in the Kaiapuni program receiving classroom instruction in ʻŌlelo Hawaiʻi (Hawaiian Language), while students in the English program receive classroom instruction in English. Kaiapuni schools 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. (termed "the school" throughout the paper).

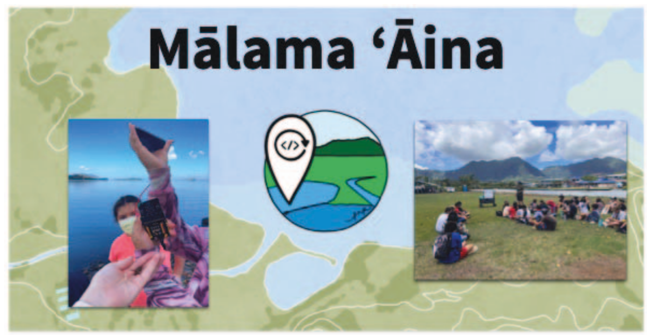

Fig. 1. Experience report of ongoing place-based, sustainability focused, CS curriculum in Kāneʻohe, Hawaii for Native Hawaiian students.

Ka Moamoa: a university computer engineering research lab at Georgia Tech in Atlanta and Northwestern University in Illinois. The lab is led by a Native Hawaiian (Kānaka Maoli), and researches sustainable physical computing devices. (termed "the lab" throughout the paper).

The project work described in this paper takes place at the Waikalua Loko Iʻa, a traditional Hawaiian 16-acre fishpond that is walking distance from the school. The Waikalua Loko Iʻa is a 400-year-old fishpond cared for by PAF. Located in Kāneʻohe bay on Oʻahu's windward coast (Fig. 1), this pond was once an important food resource for the community. PAF's mission is to improve the lives of Pacific Americans through education, leadership, and community service, via integrating relevant place/culturally-based learning. At Waikalua Loko Iʻa, students learn how this natural feature was transformed into an aquaculture facility which cultivated natural processes to maximize food production while improving ecosystem functionality and human well-being. Students are engaged in the ongoing restoration work of the site and community.

This paper describes a collaboration between these organizations with the goal of developing culturally relevant [1] and place-based physical computing curricula, resources, and learning opportunities for Native Hawaiian students. Computing skills are essential, even required, in early education. Native Hawaiians continue to be left behind in computer literacy and representation in computer programming jobs. Kaiapuni (Hawaiian Immersion) programs do not have the curricular and material resources to address these needs. Our work builds on literature that shows conservation and culturally relevant focused learning methods can help students better to understand taught concepts.

Specifically, we employ place-based [2], hands-on computing education [3]–[5] with embedded systems as an exciting way to engage Native Hawaiian students who are new to learning computing and engineering skills. Tools like Microsoft's Makecode [6] enable students to program the BBC micro:bit [7], a pocket-sized computer with LEDs, sensors, and Bluetooth used by over 20 million students in the UK and US. Unfortunately, hands-on computing educational offerings are **not relevant to Indigenous students,** including Native Hawaiian students, reducing learning outcomes for this underrepresented population of STEM learners [8], [9]. Cultural competence is known to support better learning outcomes [10], [11]. Native Hawaiian students care deeply about mālama ʻāina. This concept embodies the ideas of protecting and conserving the land, wildlife, and cultural practices. We embed mālama ʻāina in novice-focused hands-on computing geared towards conservation, in two programs.

A. *Program #1: Nā Maka o Ka Iʻa.*

Nā Maka o Ka Iʻa (Nā Maka) is a summer program at Waikalua Loko Iʻa that serves 27 students (grades 4-10). It is supported by 5 teachers and 4 community partners. Nā Maka is used to pilot the computer science curriculum at Waikalua Loko Iʻa in a small group setting, where students build sensor systems with Microsoft Makecode to protect and monitor the fish pond. Along with other activities like journalling and outdoor instruction.

B. *Program #2: School Essentials Rotations.*

Using experiences from Program #1, we modify the curriculum before integration into the *'Essentials Rotations'* (ER) classes for 275 students in Kaiapuni and English programs in Papa Mālaaʻo/Kindergarten - Papa 5/Grade 6 (M/K-6), which reaches students during the school day. Although the ER teachers are not all fluent in ʻŌlelo Hawaiʻi, they work to integrate as much ʻŌlelo Hawaiʻi as possible into classroom instruction. These ER programs with computing content build on prior research that shows that place-based, relevant, and inclusive techniques help students learn CS-related concepts (e.g., data analysis, algorithms, systems, iteration) [10]. Additionally, they address the essential need for students to see how computing can be a powerful tool for improving cultural preservation and conservation, which are closely linked to Indigenous communities [1].

II. Program Background and Context

A. *Sense of Place*

Native Hawaiians call themselves Kānaka Maoli (Kānaka means human being. Maoli means true, real, genuine). They are the original Indigenous inhabitants of the Hawaiian islands. Thousands of years ago, they traveled from Aotearoa (otherwise known as New Zealand) and settled on the shores of Maui. These voyages were made using only traditional navigation techniques and large open canoes across thousands of miles of the Pacific Ocean. Once on the islands (shown in Figure 2), Native Hawaiians developed a highly advanced communalistic and sustainability-focused society with carefully controlled agriculture and practices to preserve the land and ensure the people could live well and thrive.

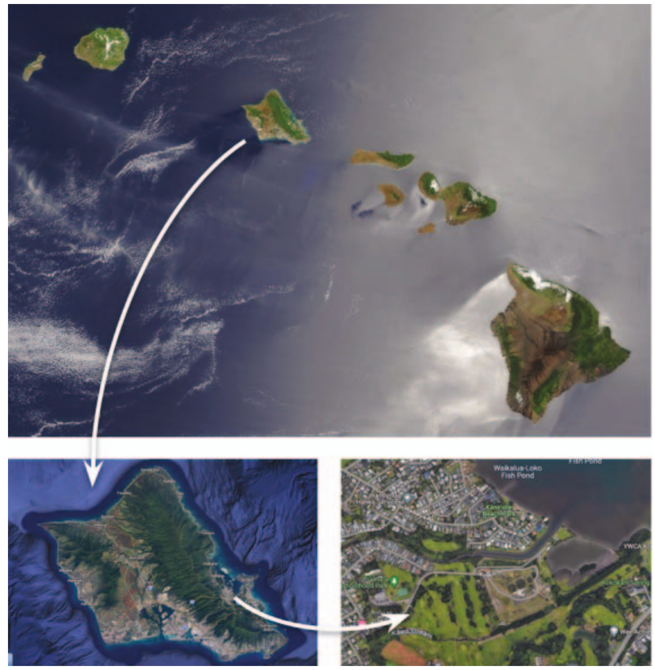

Fig. 2. Place of the work. Kāneʻohe, HI, and the Waikalua Loko Iʻa.

Traditions, such as surfing, farming, astronomy (with more than 270 Hawaiian names for various stars) [12], and voyaging, live on. Groups like the Polynesian Voyaging Society continue demonstrating these ancient navigational techniques. Hōkūleʻa, one such voyaging canoe, has traveled over 140,000 miles to discover stories of hope that are being shared with students and learners of all ages.

However, these traditions have been and continue to be under threat. Hawaii was a self-governing, sovereign, and advanced nation, with representation in pre-U.N. global political bodies and an active state in global politics, until July 1898 when the United States annexed the Kingdom of Hawai'i. This was after the U.S. supported a cadre of American sugar plantation owners who led an illegal, armed overthrow (with assistance of U.S. Marines) of the sovereign Queen Liliʻuokalani in 1893 [13], putting her in house arrest, and forcing abdication of sovereignty. Since then, Native Hawaiian culture was marginalized and oppressed, with land being stolen and given to plantation owners, the language being banned (and almost extinct), and Native Hawaiians being treated like second-class citizens in their own homes. Over a century later, the impacts are still being felt, with extreme disparities: poorer health outcomes [14], literacy rates, and 10 years lower life expectancy than other demographic groups (i.e, Asian American) on the island [15].

The past century has had a few positives, with the United States formally apologizing to the Hawaiian people and acknowledging their participation in the illegal overthrow in 1993, and more recently, a Hawaiian cultural revolution ensuing (and continuing now), with scores of our people returning to the islands, learning our language (ʻŌlelo Hawaiʻi), and engaging with our traditions and customs [16].

All of this context of place informs both how the community responds and reacts to western technologies, where colonial history's have caused a backdrop of socio-economic and health challenges for students, their families, and communities in Hawaii.

B. Educational Context

Before the annexation of Hawaiʻi, Hawaiians had one of the highest literacy rates in the world. Soon after, the language was outlawed and corporal punishment was the penalty for speaking. This and other systemic injustices have caused incredible harm to Native Hawaiian learners in only a century. Native Hawaiian students represent 10.0% of AP exam takers but make up 27.4 percent of public school enrollment. Native Hawaiian students are more likely to be low income, more likely to not graduate high school, and more likely to not finish college [8], [9]. This has had long-term effects, with only a single reported Native Hawaiian to earn a Ph.D. in computing fields in 2022, according to the most recent Taulbee Survey of Computing Departments. In 2018 no computing Ph.D.s were awarded to Native Hawaiians, only one was awarded in 2019 and 2020, and only two awarded in 2021 [17].

The report "Catching Up to Move Forward" commissioned by the Hawaiʻi Department of Education (HIDOE) analyzes the landscape of CS education in the HIDOE from 2017-2020 and makes recommendations for advancing CS education in Hawaiʻi [18]. The report highlights the importance of integrating culturally relevant CS content. These findings are based on the observation that "cultural and contextual efforts in computer science are not readily present," meaning that students are not afforded opportunities to connect their culture and their potential interest in CS. Therefore, the report recommends that the "HIDOE should consider how to more explicitly frame Nā Hopena Aʻo (HĀ) [Culturally Relevant Pedagogy] in the computer science efforts." A body of literature around HĀ has shown that integrating sustainability concepts and techniques like mālama ʻāina into Native Hawaiian educational programs leads to higher learner outcomes [19].

C. State Policy Context

Recent policy in Hawaii has embraced computer science as a required, and even potentially transformative workforce development and education initiative across the islands. Act 51 (HRS 302A-323) in 2018 noted, *"The legislature finds that promoting computer science education is a matter of statewide concern"* and requires HIDOE to develop and implement a statewide CS curriculum plan for K-12. On January 22, 2021, Bill SB 242 was signed in response to Act 51, saying *"A computer science pipeline can help to diversify Hawaiʻi's economy away from tourism and into cybersecurity, green energy, robotics..."*. Finally, the Foundational and Administrative Framework for Kaiapuni Education (FAFKE) outlines how the Kaiapuni Immersion schools across the island operate, placing the Hawaiian language, culture and knowledge at the center of Kaiapuni education, administration and operation, and assessment [20].

D. Educational Frameworks

In historical texts of interviews with kupuna (elders), Native Hawaiians regard the 'aina (land) as the provider of everything: "food, shelter over your head, and a place to plant your feet and stand firm." These conceptions of the land give an identity to Hawaiians [21]. Our own observations based on working and living in the Kāneʻohe community for decades, reinforce this—we know that our Native Hawaiian students care deeply about āina, the land which feeds us, and mālama ʻāina, stewarding that land. This relationship between people and place is foundational in Hawaiian Culture. Thus, the idea of a practice-linked learning environment [1], [22], [23] is the cornerstone of our program development.

This project is also situated within a larger body of literature considering culturally responsive computing (CRC) and ethnocomputing. CRC is a pedagogical approach that simultaneously uses culture to frame discussions of computing and uses computing to support existing cultural practices with the goal of developing student knowledge of computing. To date, most of this work has focused on engaging women and African-American, Indigenous and Latinx students in meaningful CS learning experiences [24]. Notably, however, CRC has scarcely been applied to Native Hawaiian culture, as noted by the HIDOE report. Several other bodies also inform the project, but we do not have space to explicate fully: Embodied Cognition [25], Constructionism, STEM Activation Framework [26], STEMS2 [27], and Making [28].

In the creation of these programs, we were able to leverage collaborations to develop computer science learning materials using physical computing resources built off of BBC Micro:bits that support students' learning at the Waikalua Loko Iʻa in Kāneʻohe. Micro:bits are pocket-sized computers with LEDs, sensors, and Bluetooth used by over 20 million students in the UK and US, and allow for hands-on education with embedded systems. They can be programmed via Microsoft Makecode, an online web interface (see Figure 3).

To support the development of physical computing resources, the university lab Ka Moamoa conducts research on extending the micro:bit to work with energy harvesters such as solar panels, allowing the devices to be battery-free [29]. University students that work in the lab develop the hardware and software for the micro:bit extensions, as well as co-design curriculum modules with teachers. Then, they share their work developed

Fig. 3. Coding via block-based Makecode software on a school computer.

with the school's students to use at the Waikalua Loko Iʻa. Using these materials, students collect data using the Micro:bits with sensors to better understand the environmental conditions at the Waikalua Loko Iʻa. This integrated partnership allows students to work with energy-harvesting devices that are currently being researched and developed at the collegiate level in a meaningful learning environment. Inspiring Hawaiian students to build computing that is sustainable, meaningful, and culturally relevant.

III. State of Practice

Ma ka hana ka ʻike – The learning is in the doing.

The above is an ʻŌlelo Noʻeau, a Native Hawaiian proverb, that reminds us to engage authentically in the learning process through the act of work or doing [30]. We have built the following project programs based on what we have learned through previous work of implementing culturally relevant, place-based, and computing curricula at Kaiapuni immersion schools, and from lessons learned in inclusive making efforts across Universities and K-12 schools. Each of the programs include aspects of curriculum and resource development, culturally relevant computing opportunities, and community collaboration (i.e., family and elder integration and meetings).

Through our curriculum development with the Micro:bits, we respond to the needs identified in the "Catching Up to Move Forward" report and embed ideas of mālama ʻāina with physical computing to support efforts in conservation. The key pillars of this project are:

1) Go beyond programming at a desk and computer—instead, use hands-on computing with sensors and wearables to encourage sustainable engineering practices, and engage in culturally relevant conservation practices.
2) Engage with our partners to support students in understanding that learning is a community affair and that computing devices can be a tool, when appropriate, to support restoration efforts at culturally important places.

Guided by the key pillars, Nā Maka and the ER Classes supported students in understanding and exploring how they can use sensors, embedded systems, and wearables (via Makecode and Micro:bits) to enable natural resource preservation. Students also participated in activities learning about health, art, and social skills in their community while respecting cultural norms related to sustainability. This effort works to bridge the gap between sustainable computing efforts, novice-focused programming environments, and culturally appropriate technology integration within the environment. Students learn to identify when it is appropriate to use modern computing devices to mālama ʻāina. They will also make connections about logical concepts that are present in different types of technologies. For example, identifying logical concepts like loops and conditionals in the loko iʻa (fishpond) and the Micro:bit technologies.

A. Early STEM Programs: Lessons and Operationalizing

Before 2019, various classes from the School would attend field trips to Waikalua Loko Iʻa on an annual basis, focusing on STEM topics such as water quality and ecology. In the school year 2016-17 and 2019-20, a kaiapuni class visited the loko iʻa each week for one quarter, and their kumu guided all lessons in ʻŌlelo Hawaiʻi. In the school year 2019-20, a multi school partnership with six bilingual family engagement field trips to the Waikalua Loko Iʻa were planned. The events were focused on sustainability and mālama ʻāina, while teaching about the history of the loko iʻa. All ʻohana (families including parents, grandparents, and siblings) were invited to participate with their keiki's (child's) class. A total of 451 participants joined for four of the six events, with the last two events canceled due to the pandemic. These earlier, STEM based programs informed the operationalizing of our current Computing focused programs, and provided us with knowledge on required parts of any program: Mālama ʻĀina (Taking Care of the Land), Kilo of ʻĀina (Observation), ʻOhana (family and community engagement).

B. Nā Maka o Ka Iʻa Program

The curriculum was first introduced during the height of the pandemic in the summer of 2020 to Nā Maka, run completely virtual over an online platform. Students were offered a plethora of opportunities to learn various topics which included: ahupuaʻa (traditional land division), Minecraft, kilo (observation), taxonomy and marine invertebrates, water cycle, Waikalua Loko Iʻa history, algae, limu (seaweed), stream, nā anakahi (using the body for measuring), pō mahina (moon phases), fish anatomy, nutrient cycles, water/beach environments, and sediment & sand. These lessons introduced logical thought and expressions. At that time, Micro:bits had not yet been integrated.

In the second and third year of the Nā Maka, students were learning in person at Waikalua. We built off of the initial student learning opportunities and integrated Micro:bits into instruction. As shown in Figure 4, students gathered outside at the fishpond and built sensor systems with Makecode to protect & monitor the fishpond. Students made connections between their micro:bit sensors to sensors placed by local scientists. One specific learning that we built off of was the idea of collecting data about the fishpond. Students learned about the importance of *kilo* (literally translated as: "to observe"), a traditional practice where knowledge keepers would observe environmental phenomena changing and carefully consider

Fig. 4. Nā Maka students suilding sensor systems with Makecode and Micro:bits to protect and monitor the fishpond.

those changes over time to direct resource management decisions. Students engaged in kilo daily by observing with their senses to collect observational data. Students learned that engaging in kilo is the most important practice to understand the fishpond, but there are more ways to collect data. They learned that they could use sensors with the micro:bit as another input to support their understanding of the place. For example, instead of using their sense of sight to always monitor the water level, they could set up a water level sensor to monitor the water level and collect ongoing data. This would eventually lead us to the installation of an artificial intelligence-driven environmental monitoring station that provides data for students and community members to engage with.

For the hands-on activities, students were able to build and deploy temporary sensors at the loko iʻa to measure data and learn critical ideas about sustainable practices including measuring water quality. The students were able to make connections between the sensors that they had set up and the sensors set up by local scientists that collect data at the fishpond. These learning experiences led to meaningful conversations about sea level rise with climate change, the importance of restoration efforts, and the integration of technology to support ongoing observations, when appropriate.

> *Thank you for taking your time to teach us all the cool things about the fishpond. I am also grateful that I got this opportunity to learn all these new things and have these new experiences.* - Student

C. The School's Essentials Rotations Classes

M/K-6 students participate in the ER classes. Every other week, students engage with Physical Education (PE), Science, Technology, Engineering, and Math class (STEM), Social and Emotional Learning (SEL), and Art in the community outdoor classroom at Waikalua. Prior to the integration of Micro:bits in the Nā Maka program in Summer 2021, all ER classes took place within the four walls of the traditional classroom After experiencing student success learning at Waikalua during the summer program, the need to bring students to Waikalua on a regular basis during the school day for ER classes became apparent. In our first year of ER classes at Waikalua, we were able to bring our upper elementary (3-6) students four times to the fishpond for integrated learning opportunities. In our second year, we were able to bring our lower elementary (M/K-2) to the fishpond once a quarter and upper elementary (3-6) students twice a quarter. Participation in the program is shown in Figure 5.

While we plan to eventually integrate computing opportunities in all rotation classes, we are currently focused on developing curriculum for the STEM class. In STEM class, students have been able to engage with Micro:bits during the STEM rotations using similar lessons and activities developed during Nā Maka. Since Micro:bit implementation, we have integrated solar panels in addition to having students work with sensors.

To support the instruction during the school day, we found that the lessons developed during Nā Maka needed to be modified to fit shorter blocks of time and to support all students in the program. Although we made modifications, students continued to experience being users and programmers of Micro:bits to understand the importance of using technology to support mālama ʻāina efforts during the school day. We have created mini activities where students interact with sensor data, discuss the importance of using sustainable energy sources like solar panels, and develop smaller projects Based on our observations, students have been able to make key connections in understanding how using technology like the Micro:bits can be used as a tool to support the loko iʻa and efforts to mālama ʻāina. We have also noticed that students have been asking more critical questions since we have been implementing this curriculum. For example, an elementary student was able to make connections to inquire about the relationship between the salinity (salt water content in the pond) and the temperature of the water on the survivorship of native fish.

D. Summary

Through both of our implementation programs, Nā Maka and ER classes, we have achieved our goal of broadening participation in computing within our community. Of course, much remains to be done, and significant limitations exist due to infrastructure and personnel needs. However, we have found that by implementing place-based computer science experiences in a small group pilot setting, we were able to learn how to expand the efforts to reach students in a school setting. This accomplishment has allowed us to provide meaningful place-based hands-on computer science experiences for students during the school day. It has also provided us with experiences that help us to better understand how we can move forward with supporting computer science efforts in our community in the future.

Fig. 5. Every other week students engage with Physical Education, STEM, Social and Emotional Learning, and Art classes at the fish pond. Micro:bits and sensors are integrated into the STEM rotation classes.

IV. Positionality Statement

We present our positionality as a group and individually, focused on our place of work, our home, and our relationship with the ʻāina. We are committed to studying and implementing programs that reinforce Native Hawaiian culture, and embrace bi-lingual curricula that is place based, relevant, and engaging for our students. We are a group of K-12 teachers, university professors, and researchers. We are also Kamaʻāina (locals in Hawaii) and Kānaka Maoli (Native Hawaiian, original inhabitants of the islands), as well as mainlanders (living in the continental USA). The first author is a Kamaʻāina K-12 STEM teacher working at the School, with advanced degrees and working fluency of ʻŌlelo Hawaiʻi. Born and raised on the island of Hawaiʻi, descended from white settlers. The second author is a former university student in Computer Science, degree holder, who has worked with the School and Foundation during her entire degree study, from the mainland. The third author is a Black Professor of Computing and Learning Sciences, invested in practice linked learning in urban schools in major metros in the USA (majority Black). The fourth author is Kamaʻāina, and invested in teaching and cultural revitalization efforts for many years, in partnership with organizations around the islands. The last author is a Kānaka Maoli professor of Computer Science, whose experiences of loss of culture due to colonialism influenced his path towards supporting cultural restoration via computing education programs like those discussed here. Together, our perspectives, lived experiences, and work, inform the programs and practice.

V. Limitations and Assumptions

We list some assumptions we make in our work, as well as things that may be regarded as limitations in our assessment of the programs for this experience report.

A. *Scaling is not a priority*

Larger sample sizes for assessing the validity and efficacy of a particular curriculum module or practice, would of course increase confidence. But, this is distinctly challenging within our context, since marginalized communities require significant trust and care when building relationships, which are a prerequisite before any programs can be run. Scaling, is in fact, not necessarily a goal of our project, as the problem with current CS practice, is it is built to scale and generalize, which leaves behind many (like our Native Hawaiian students) who have unique barriers, assets, and needs, and who engage differently with technology. These considerations required us to take a smaller scale approach focused on a single community and school in one island of Hawaii, so therefore, we do not make any claims on this scaling or being generalizable to other Indigenous populations, or even other Islands. Potentially, meta-frameworks as listed in the next section, and lessons learned, would be valuable in assembling and co-creating programs for other groups, but this is outside the scope of this experience report.

B. *Moving targets for assessment*

We co-located and deployed our modules and curricula within the classroom and in summer programs. These modules changed significantly year to year and even day to day, making rigorous validation of modules hard. Additionally, comparison points for validation are scarce, as all our students had little experience or interaction with computing outside of keyboard training and some lessons with Scratch. We conducted intuitive assessment, going off the teachers knowledge of individual students and classes, and their assessment of what worked or did not. Due to the fast pace of curriculum changing, we viewed these initial projects and programs as setting the stage via iterative refinement, for later rigorous evaluation mapped to outcomes deemed important by our teachers, as well as newly introduced state guidelines.

VI. Implications: Lessons Learned, Next Steps

While the two programs provided valuable experiences for the students to learn place-based physical computing at the loko iʻa, students need additional experiences that support the development of foundational computing skills. With these skills, students will be able to better understand how to be effective users of technology. We have learned that although students have grown in their understanding of computer science knowledge since participating in the program, we need to be more intentional about teaching tech literacy skills. We have also received feedback from teachers that supporting students with foundational tech literacy skills will support their work with computers during regular class instruction.

A. Culturally Relevant Technology Literacy

Since receiving the different types of feedback, we have learned that to broaden participation in computing for the students, we also need to provide resources for them to learn computing concepts and the foundations of computer science. These skills will help them understand the foundations of technologies, how to effectively use their devices, and how to better understand using computer science tools like the micro:bit. Teachers have noted that general technology literacy is valuable, and computer science (and programming) is one part of a broader conversation and set of training. This discussion around technology includes the use of common technology (i.e., keyboard and mouse, smart devices) and an understanding of function, form, and impacts of technology around them. Students often conflate technology and computing, and this causes confusion.

To begin to address this, we have developed drafts of resources to teach tech literacy skills. This includes resources about how to interact with different parts of their Chromebook devices, how to navigate computer systems, how to use common computer applications, how to program Micro:bits in the Makecode interface, and more. Future modules on technology (i.e. drones, robots, phones, general electronics and industry) will be introduced as well but via a culturally sustaining and inclusive lens. For example, some students consider wind energy particularly offensive, as wind farms on the island kill native birds and are a eye sore, and they feel they have no direct benefit. This potentially surprising aversion to a popular form of renewable energy provides and opportunity for discussion and reflection centered around mālama ʻāina. We hope to build curriculum to have these technology discussions, so they can further push forward our computing related modules.

The development of these resources has followed the same place-based focus as the two main programs to support a cohesive curriculum framework. It has also taken student interest, language, and culture into consideration for resource development. For example, because mele (music) is important to the students at Pūʻōhala, we made up songs to teach students about the parts of the Micro:bits. We also have worked to teach students how to use different Makecode modules and code blocks with challenges for students where they are able to integrate ʻŌlelo Hawaiʻi or add visual representations of native or endemic sea life. We also have been working on creating resources like virtual posters using pidgin (Hawai'i/English Creole) phrases like, "If can can, no can no can" to help students understand appropriate technology usage.

B. Community Focused, Collaborative Activities

Along with developing additional resources based on feedback, we have continued to pilot other curriculum work with students. In addition to the ER classes, we implemented a 3-week long activity where Kula Waena (middle school) students created a physical project using cardboard and the micro:bit. In this project, students had to choose an ʻŌlelo Noʻeau (Hawaiian proverb) that was meaningful to them and use the micro:bit with appropriate extensions to represent the ʻŌlelo Noʻeau they chose. They were asked to describe inputs and outputs, sensors used, and their process for developing the project.

We observed that during the work time for these projects, students were sometimes discouraged when their code did not work. However, when this occurred other students would step in and assist with debugging, or the student would instead focus on the design aspects of their project. An example of this project was a model where a student showed kanaka (people) working in a māla (garden) by themselves and another model where the kanaka were working together. She chose the ʻŌlelo Noʻeau:

ʻAʻohe hana nui ke alu ʻia

No task is too big when done together by all.

This was represented by programming an input of a button to create physical movement with a micro:bit servo on the side of the model with everyone working together.

C. Barriers to Immersion

Throughout all activities, we uncovered many portions of technology used that broke the immersive experience of a Hawaiian language classroom. The western keyboard layouts used on chromebooks, the instructions on Makecode and Scratch that were not in Hawaiian language, and importantly, the lack of fonts that supported the necessary diacritic markers– the glottal stop (ʻokina) and the macron (kahakō) which are essential to writing and reading

While this may seem trivial to outsiders, the students are provided a very safe, home like space where they can practice their native tongue and feel protected and included for who they are. Teachers commented that the breaking of immersion is a challenging thing to educate and teach around.

As part of our work, we identified fonts that would provide for all necessary diacritic marks by default, and adopted standard fonts for all curriculum modules to allow for better dissemination and immersion. Additionally, 3D printed custom keyboards were prototyped to provide a Hawaiian layout and symbols for the students.

Throughout all of these experiences developing and piloting computing resources, we learned we must continue thinking about computing curriculum from a holistic perspective that honors place, culture, language, and community.

VII. Conclusion & Future Work

In the future, we would like to continue offering computing opportunities that are place-based and increase the scope of the program. We have learned that we need a comprehensive curriculum for computing education–so our vision for future work consists of providing resources for students, teachers, and our community.

We are planning on collaborating with a cohort of teachers at the school to provide inclusive computing instruction. In this cohort, teachers will learn how to teach computer literacy and computer science concepts. With multiple teacher perspectives from our bilingual school community, we will be able to collaborate on projects that are in ʻŌlelo Hawaiʻi and English for students to learn logical concepts that are essential for understanding computer science. We also plan to develop a curriculum that supports teachers that may or may not be a part of the cohort to learn about how to implement computing curriculum in the classroom.

We plan on integrating additional CS opportunities into all ER classes. In STEM class, students can integrate Micro:bits with sensors to monitor the growth of plants. In PE, students can use Micro:bits to create step counters that help them calculate their steps as they engage in biocultural restoration. In art, students can work on fishpond-inspired artwork and document their projects in an augmented reality environment. In social-emotional learning (SEL), students can program micro:bit sensors to track their breathing patterns and heart rates while engaging in mindfulness practices.

We have designed our future project plans for the upcoming school year and beyond to build on past projects, events, field trips, and more to develop a cohesive, integrated experience for students that support further integration of place-based computing education. By developing more CS resources that are relevant to *place*, supporting teachers in creating and implementing culturally relevant computing activities, and expanding our current efforts with the integration of computing at Waikalua Loko Iʻa, we aim to solidify and sustain our efforts in broadening participation of computing in Kāneʻohe.

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