STEM Learning in Your Own Backyard

Designing a place-based middle school summer program

By **Brooke A. Whitworth**, **Stephanie Beyea** and **Melora Purell**

OUR STUDENTS ARE CONNECTED to a global feast of knowledge through daily consumption of social media, but know very little about local ecosystems or science processes happening in their own communities. The philosopher Comenius once said, "Knowledge of the nearest things should be acquired first, then that of those farther and farther off."[1] How can we engage students in their local culture, help them understand the environment they live in, and make science relevant to their everyday lives? One approach to making science relevant and relatable for students is to provide opportunities for place-based education.

STEM Instead is one such educational opportunity that replaced a former, traditional summer school program for middle school students in Waimea, Hawaii Island, Hawaii. The former program included significant amounts of direct instruction with little student engagement so we named our program *STEM Instead*. We hoped this title would communicate the idea that the new program would be "instead" of what students had known previously in summer school and would be radically different. This program asked students to learn about their own environment and local culture to gain knowledge and understanding of those things closest to them and to then apply that knowledge to other contexts. In this article we describe the value of place-based summer programs and the *STEM Instead* program, and provide ideas for how you could design your own program.

Place-based education involves students with their local ecology, culture, and landscapes.[2] Engaging students in experiences with the people, culture and natural resources in their communities promotes learning and understanding about their environment. Not surprisingly, research indicates place-based education can increase student achievement. Summer programs not only provide students with opportunities to connect with their community, but also to actively engage in science and engineering practices[3] and through these activities, develop a better understanding of the nature of science and improve their scientific literacy. Implementing this type of summer program can also provide opportunities for schools to create partnerships with both volunteers and agencies within their communities.

STEM Instead: Our Program

STEM Instead was designed during the spring of 2015 to replace a three-week traditional summer school program for middle school students in Waimea. This was the first year

of a program that we plan to continue annually for years to come. We had interested students apply to participate in the program and accepted 62 of the applicants. One of the criteria for acceptance was the ability of students to be present for all three weeks. Students who were going to miss more than 1-2 days of instruction were not accepted.

Throughout the program students participate in groups, containing a mix of all grade levels, and rotate between three different subject areas: biology, environmental science, and physics. The program provides hands-on experiences with local culture and ecology through field trips and on-site outdoor education, and engages students with field research and engineering projects to learn experimental skills and gain scientific knowledge about their environment.

Biology

In the Biology content area, students learn about plants, characteristics of life, classification systems used in science, the nature of science, and how to safely collect and preserve specimens from field sites. In our first year, students participated in three field trips to local natural areas, utilized the community garden as a research site, and volunteered at a nature preserve to remove invasive species. While on field trips, students learn about the historical and cultural aspects of the sites they visit. Throughout the week in Biology students maintain an observational journal and work toward creating a culminating assignment, an art piece demonstrating their appreciation and understanding of plant diversity and Hawaiian culture. Students also provided an identification key of any plant life they incorporated into the art piece and an essay describing the art itself.

Environmental Science

The Environmental Science week of our program focuses on students learning about plants and animals (micro- and macro-) that live in native Hawaiian rain forest and discovering relationships between geography, climate, native species, and invasive species. Students learn the Hawaiian names for common native plants and birds, and design field research that they then conduct in the forest. During this week, students keep observational journals and practice a variety of field sampling techniques. As a culminating project, students choose a research question to answer based on their observations in the field and learning in the classroom, design a sampling procedure to answer their question, collect data in the field, and write analysis based on their evidence.

Physics

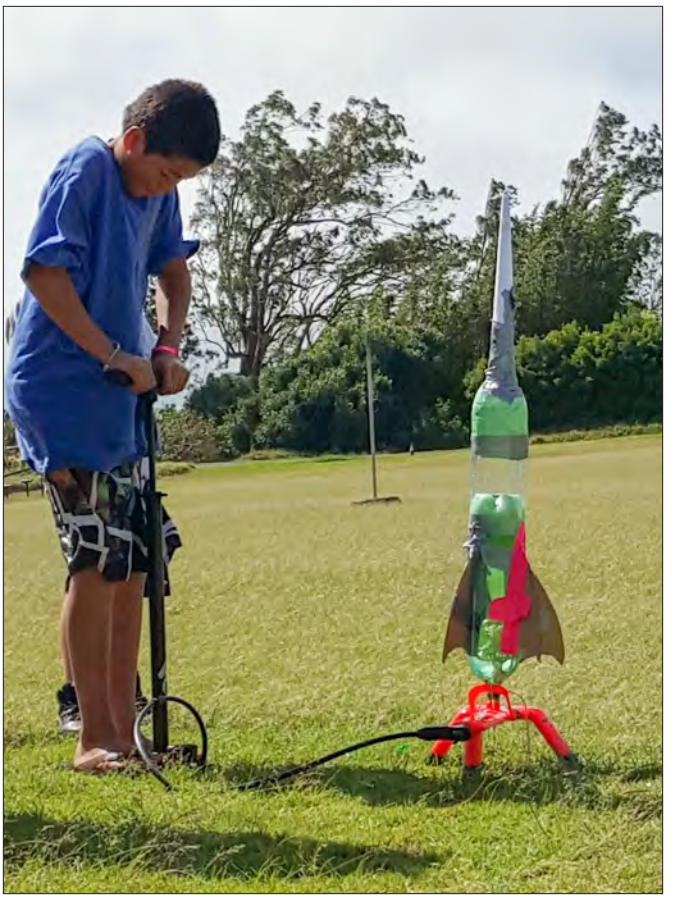
In Physics, students learn about forces, motion, and engineering. Students experiment with moving objects, including basketballs, toy cars, skateboards, and their own bodies using different types of technologies. They learn to gather data, make graphs, and how to analyze and interpret their data to write arguments. As part of our project students had to keep an engineering design log. Using the information they learned from engaging in these experiments, students designed and engineered water bottle rockets designed to fly as high as possible while protecting an egg during the flight as a culminating project. Given our constraints on transportation and chaperones, this unit was designed so students would remain on campus during the unit.

Designing Your Own Place-Based Program

Based on experiences in designing and implementing the *STEM Instead* program, we have several recommendations to help you design your own place-based summer program. In the following sections, we provide advice and ideas as you consider how to staff, develop curriculum, create partnerships, find local sites, embark on field trips, and deal with the logistics of creating your own program. Throughout this section we also share what we learned and how that might help you in the design and implementation of your own program.

Structure

Our program occurred over three weeks with six-hour days and covered three subject areas. Students were placed in mixed grade-level groups that rotated through the three subjects, changing at the beginning of every week. Two groups planned and took field trips, while one group remained on campus for the duration of the week. Depending on the length of your program, the number of students you want to include, and the resources at your disposal, you could structure your program in a multitude of ways. For the most part, we found that this structure worked well but did find that a whole week in just one content area could be overwhelming for students. In the future, we plan on having students rotate through each of the content areas for shorter class periods on Mondays and Fridays with at least an hour for lunch and community



building. For the remaining three days we plan on students spending one whole day with each subject area. This will allow students to have more variety throughout the week, but also allow students to participate in full-day field trips.

Staffing

In *STEM Instead* we chose to employ several different types of staff: Science Lead Teachers, Field Educators, and Teen Leaders. We would recommend that similar programs employ multiple levels of staff similar to what we describe here. Science Lead Teachers should be responsible for the development of the curriculum, the day-to-day instruction, and the management of the classroom. These individuals should be current or former teachers with a strong background in the content, comfortable leading students outside the classroom, and have experience in designing inquiry science lessons. Field Educators should be experienced with the content as either a teacher or scientist and very comfortable working with students. In our program, Field Educators supported the Science Lead Teachers in the classroom and in the field, served as chaperones for all field trips, and drove vehicles to transport students. Teen Leaders were responsible for supporting Science Lead Teachers in the classroom and on field trips, monitoring student behavior during meals and breaks, and developing relationships with students. Teen Leaders should have experience with field science and past experience supervising younger children. All staff that applied, had letters of recommendation, and went through appropriate screening processes.

We found three adults per 20 students was sufficient on field trip days. Furthermore, having the Teen Leaders assigned to a particular group of students and rotating with that group was helpful in creating a strong feeling of community and continuity for the students. Recruiting Field Educators locally may be one way to involve members of the community in the program. Reaching out to teachers from other schools, professors at nearby universities, scientists who work for local companies or organizations, and any environmental or sustainability organizations in your community may be a way to identify and recruit individuals for these positions.

Developing Your Curriculum

Once you have decided on the structure of your program and who your Science Lead Teachers will be, it is important to establish the common objectives that will cut across the content areas. For us, this was the science and engineering practices, the nature of science, and the cultural and historical aspects of the field sites we visited. Following these decisions, you will want to decide what content areas you want to cover in your program. Considerations of the content areas you select include the sites available to visit in your community, the expertise of your staff, and the resources (i.e. number of buses/vans for transportation) at your disposal. In our program, each Science Lead Teacher designed curriculum that would cover five days of instruction and could be easily repeated as students rotated through the content areas. We found this useful, as the Science Lead

Teachers had the opportunity to repeat the curriculum they developed and the amount of planning was minimized to five days rather than the full length of the program. However, we were limited by the number of buses and chaperones available for field trips so we chose to have one content area remain on campus and incorporate activities that could be done at the school.

Finding Local Sites

To have success with a program like *STEM Instead*, you must find local sites to take students on field trips. You may start by researching local tourist, conservation, or nature groups to see what locations are popular to visit. Utilizing popular sites provides field experiences for students but also safe trails to follow. Through this research you may find local groups that are willing to partner or support you in the field. Local colleges or universities may have sites or resources that they can make available for students to visit. We found that identifying sites with areas for students to eat lunch, play games, and enjoy nature also aided in our success.

Through this type of program, multiple partnerships can be developed between your school and the community. Oftentimes as relationships are built in the community, organizations will come forward suggesting opportunities or ideas for future collaborations. Therefore, not only will this initial community building effort be directly helpful to your program, but will provide many other benefits to your school over time.

Field Trip Safety

Planning ahead for the field trips is critical to your program being successful. Students and parents should complete consent and emergency forms. In our experience making this consent mandatory for their application proved to be useful in minimizing the amount of follow-up needed prior to trips. Obviously, there are many issues that may arise during a field trip so considering as many safety issues as possible prior to departure is important.[4] For example you will need to visit sites prior to the start of the program to identify safety concerns, ensure your vehicles can get to the location and find parking, locate student parameters and focal points, and ensure you have a sufficient number of chaperones. Prior to your first trip with students be sure to very clearly discuss behavioral expectations and consequences for not following behavioral expectations. One thing that will help to alleviate problems is to pre-assign groups for vans and work in the field. Depending on where you are taking students, you may also need to address the safety of touching and handling organisms in the wild, making sure you identify any poisonous organisms or those that could cause allergic reactions. It is also important to make sure groups have emergency contact information, adequate first aid equipment, and some form of communication (i.e. phone, two-way radio) that will work throughout the trip. Prior to departure, we made sure chaperones had all safety information for the students on their trip.

Logistics

In this type of program there are a myriad of logistics you must be aware of and prepare for. These include advertising, the application process, resources, transportation, determining program groups, the supervision of student arrival, attendance, and monitoring of meals, incorporating play time, and the culminating experience. You must consider how you will advertise the program and if or how you are going to ask students to sign-up. You also need to determine whether to accept all or only a limited number of students. If a limited number, the criteria for acceptance needs to be determined (i.e. first come first serve, grades in science courses, etc.). The application process needs to be clear and should require parents and students to commit to field trip permissions and behavior expectations, provide emergency information, and if applicable gain photo, video, and research releases.

A critical piece to the success of the program is considering the equipment, space, materials, and personnel that are needed. It is important to establish what resources are already available from the school and what resources will have to be funded through student costs, grants, or other sources. Knowing this information will allow you to establish a budget and determine what items (i.e. lab supplies, new technology, etc.) you will need to purchase to support the program. Furthermore, it is important to make sure that you account for all transportation costs associated with the program, and that all of the vehicles and drivers required for field trips are available when needed.

Prior to the program starting, we found it was helpful to assign students to groups, create name tags, attendance sheets, and any other required materials. We assigned each group a name (i.e. Green Honu, Black Pipipi, Yellow Ilima) which helped us when students rotated or participated in games outside of the classroom. The group names were also communicated to parents along with the locations of their student throughout the program in case of absence or emergency. Another area of consideration is how to supervise student arrival to campus, document and track attendance, and monitor meal time. It is important that there is a plan for communicating with parents about absences and attendance, in case students are not where they are supposed to be or are missing.

Additionally, you should consider how students will be supervised during meal times and any recreational time you incorporate into your program. We tasked our Teen Leaders with supervision during meals and free time. We often asked Field Educators to rotate during these times as well so that the Science Lead Teachers could have breaks. Field Educators and Teen Leaders would then take breaks

as needed during class time. We found it helpful to incorporate recreational "play" time for students throughout the program. At times, this play time was structured and at other times it was unstructured. In the future, we hope to make some of this recreational time much more structured for community-building activities. During these periods, we would play games and have competitions between the different groups. Regardless of how you choose to do it, we found the incorporation of recreational time was critical to helping students stay focused throughout the day.

Finally, it is important to consider what your culminating experience will be for students. As part of our program, we invited parents, family, and community members to come celebrate students' completion of the program at an "Ice Cream Social." At this event, Science Lead Teachers described the activities students engaged in during their classes, Teen Leaders passed out certificates of completion, and Field Educators put together a video for all to watch and enjoy. We also posted various products from the program around the auditorium. Parents voiced how much the experience had encouraged their students in science and helped students reignite a passion for learning science. Other parents identified the cultural and community connections as vital elements of the program and were grateful these had been included. The official ceremony was followed with games and treats for all to enjoy.

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Endnotes

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