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OUT IN THE FIELD

Learning About Plant Diversity

BY STEPHANIE BEYEA AND BROOKE A. WHITWORTH

How do we help students understand the world they live in? How do we make the science we teach relevant and relatable to their everyday environment? One approach to making science come alive for students is to engage in place-based education opportunities. *Place-based education* engages students with their local culture, ecology, and landscapes (PEEC 2010). It encourages students to use the land and resources in their community to learn and to better understand the environment in which they live. Research indicates that place-based education can increase student achievement and help students develop a connection to their environment (PEEC 2010). It can also be an opportunity for schools to develop partnerships in their communities with both agencies and volunteers. In implementing the unit described here, several partnerships were developed with agencies in the community and will continue in the years to come.

CONTENT AREA

Life science

GRADE LEVEL

6–8

BIG IDEA/UNIT

Plant life and diversity

ESSENTIAL PRE-EXISTING KNOWLEDGE

None

TIME REQUIRED

One day to one week, depending on what portion the teacher wants to implement

COST

Depends on location and resources available for field trips

SAFETY

Hiking safety review and first aid kit

FIGURE 1: Outline of the unit's day-to-day activities

	Day 1	Day 2	Day 3	Day 4	Day 5
Topics	<ul style="list-style-type: none"> •What is a plant? How is it different and classified in its own kingdom? •What are the structures of a plant? •How is a plant living based on the characteristics of life? 	<ul style="list-style-type: none"> •What are some alternative ways plants are appreciated? •Field trip to Ouli Park •What is the reproductive cycle of a plant? •Are there different methods of reproduction? •We know that bees and butterflies like flowers, but why? Do other organisms like flowers too? 	<ul style="list-style-type: none"> •Explore a protected rain forest and see what happens as nonnative plants begin to invade •Effects of canopy cover •Spatial distribution of plants due to available resources 	<ul style="list-style-type: none"> •What is the difference between fruits and vegetables? •Why are fruits and vegetables good for you? •Why are there so many different types of fruits? How are they made? •Can a plant in an arid ecosystem still reproduce and succeed? 	<ul style="list-style-type: none"> •Student presentation
Main activities	<ul style="list-style-type: none"> •What classifies something as living? [30–45 minutes] •What are the differences between the five kingdoms? <ol style="list-style-type: none"> Vores (omnivores and carnivores) and posers (decomposers) Cells Single celled versus multicelled [one hour] •Introduction to observation journals [20 minutes] •Visit to Mala'i'l Garden; students write an observation journal entry on the form of different plants [30–45 minutes] •Kingdom plantae: Plant dissection [one hour] 	<p>Field trip to Ouli Park (<i>grasses, trees, and small angiosperms</i>)</p> <ul style="list-style-type: none"> •Identify and photograph items with flowers and some with no flowers •Identify and photograph limbs from a bush and a tree •Explanation of the native versus nonnative plants •Explanation of traditional uses for native plants •Students explore collected samples and write journal entries [three hours] <p>Kingdom plantae</p> <ul style="list-style-type: none"> •Introduction to flower form and function [30 minutes] •Visit the garden, observing the flowers of different plants and writing an observation journal entry that includes a hypothesis. •Students prompted to notice pollinators interacting with the flowers [one hour] •Pollinator identification: Based on characteristics of the flower, what is the most likely pollinator? [30–45 minutes] 	<p>Field trip to Kalopa State Park (<i>bryophyte heavy</i>)</p> <ul style="list-style-type: none"> •Observation journal entry •Identify and photograph some ferns and moss •If permitted, collect different leaves, flowers and ferns for plant rubbing or pressing •Outdoor games [four hours] Time to work on projects [one hour] 	<p>Field trip to Koa'i'a Tree Sanctuary</p> <ul style="list-style-type: none"> •Observe an arid ecosystem •Evaluate ways in which the plants in this ecosystem manage to survive •Learn historic uses for various native plants [two hours] •Time to work on projects [one hour] <p>Kingdom plantae: Flower to fruit</p> <ul style="list-style-type: none"> •Introduction to fruit form and origin [30 minutes] <p>Visit the garden , observing flowers and fruit</p> <ul style="list-style-type: none"> •Write an observation journal, making connections between the structure of the flowers and the fruit [one hour] <p>Activity investigating fruits and flowers</p> <ul style="list-style-type: none"> •Connect which part of the fruit came from which part of the flowers [one hour] 	<ul style="list-style-type: none"> •Student presentation [two hours] •Wrap-up and review [30 minutes]

The focus of this unit was to get students out in their environment and learning about the diversity of plant form and function across various ecosystems.

The setting for the activities described in this article was the Mala'ai Garden, a community-driven project funded solely by donations and grants (the garden is located on the school campus). When students were not out in the field, they spent much of their time in the garden making focused observations on the structure of flowers, pollinators, fruits, and seeds. This unit was taught during a STEM

summer school program where students participated in mixed grade-level groups of incoming sixth- through eighth-grade students to deepen their content knowledge and nature of science understanding (Whitworth, Beyea, and Purell 2016). Even though we taught this unit during a summer program, it could be successfully used in a middle school classroom during the school year. When developing your own unit, look for community gardens in your area as a means to duplicate this portion of the unit.

Description of the unit

The goal of this unit was for students to discover the living characteristics of plants, with a focus on reproduction. Students spent time evaluating the survival methods of plants among different ecosystems by venturing out into their community and the environment they live in. A field journal was used throughout the unit to document their observations, experiences in the field, and to provide opportunities for students to write about their thinking (Figure 1).

We started the unit by brainstorming and creating a list of characteristics all living organisms share. As students shared their ideas for criteria, they were required to state any living organism(s) that met the criteria and why it should be criteria for all life. By doing this activity, we were able to formatively assess their prior knowledge and make connections to material already familiar to students. After completing the list of criteria, we reviewed the main differences of the five kingdoms (cell type, cell number, and diet). Students were then asked to explain in their journal how a plant is living and why it is not an animal. After the writing assignment, students also connected the newly learned material to a concrete example by dissecting the Amaranth plant (*Amaranthus paniculatus*). During the dissection, students investigated the structures necessary to classify a plant as a living organism. Afterward, students engaged in a discussion about the diversity of plant structures. As a result, students made connections to how plants adapt and evolve to their environment like other living organisms.

To give students experience in their community and in the field, we headed outside to look at the plants in their environment. The island of Hawai'i has various ecosystems all within a short distance from each other. However, the same effect can be achieved by visiting a location with good plant diversity. At a diverse plant site, you can design an activity for students to compare and contrast different types of plants within the same ecosystem instead of similar plants across various ecosystems.

Throughout the unit and on each field trip, students responded to writing prompts (Figure 2) that required them to construct explanations and design solutions in their field journals. For example, one prompt asked students to evaluate the reproduc-

tive methods of plants in a specific area of the park. Students were asked to provide evidence and details about whether or not plant reproduction involved any animals with declining population density and, if so, to describe ways to resolve the problem. A gen-

FIGURE 2: Overview of the alignment between lesson questions and guiding questions for observations and journal entries

Lesson questions	Guiding questions for observations and journal entries
<ul style="list-style-type: none"> How is a plant considered living based on the characteristics of life? 	<ul style="list-style-type: none"> What does it mean to be living? What makes something living? If we were to narrow all living characteristics into four characteristics that all living organisms share, what would they be?
<ul style="list-style-type: none"> What are the five kingdoms of life? What are the characteristics of a plant that classify it into their own kingdom? 	<ul style="list-style-type: none"> Can you name the five major groups that organisms are placed in? For example, animals are a group. What are the other four groups? Can you pull out the major characteristic of each of the five kingdoms based on diet and cells? What are the distinct characteristics of plants? Why is a Venus fly trap classified as a plant?
<ul style="list-style-type: none"> Why do bees and butterflies like flowers? What other organisms like flowers? 	<ul style="list-style-type: none"> How many of you have seen bees and butterflies around a flower? What part of the flower do the bees and butterflies like? Why? Given your answers, why do bees and butterflies like flowers? Walk around the garden and pay close attention to any other organisms that may be on the flowers of plants. Write about a flower and the organism in your notebook. Later, we will compare flowers and organisms to see if there is a pattern.
<ul style="list-style-type: none"> What is the reproductive cycle of a plant? What is the difference between a fruit and a vegetable? 	<ul style="list-style-type: none"> Think back to the plant dissection we did on the first day of class. What parts of the plant are for reproduction? While we are in the field today, note in your journal the different ways that various plants reproduce. This could be differences in flower, seed, etc. Look back at your notes from each field site and write about ways that plants living in harsh environments continue to succeed and reproduce without ample resources. During today's activity, we are going to evaluate the difference between fruit and vegetables. In front of you are a variety of fruit and vegetables picked from the garden. What would you say are the distinguishing differences? Note these differences in your journal.

eral example of this type of situation is the declining honey bee population in America. At the end of the day, the class shared their thinking to come to a consensus about the major takeaways from the field trip. If one of the native plants relies on pollination from an organism with a declining population, what effect will that have on the ecosystem, and is there any way that humans can resolve it?

Students also completed various activities centered on the cause-and-effect dynamics associated with survival techniques of plants. One specific activity students did in the garden focused on flower structure and reproduction. For the first part of the activity, students were asked to observe, draw, and compare all the components of three different flowers in their journal. During the second part of the activity, a conversation was initiated about pollinators by asking students why bees and butterflies are always around flowers. Again, we had students walk around the garden and note in their journal what organisms they noticed on different flowers. For the final part of this activity, students were given a key (see Resources) that identified pollinators based on flower structure. From this activity, students could evaluate the effects certain changes in the flower structure would have on the proportion of pollinators.

Another activity asked students to collect different types of leaves, flowers, or ferns for plant pressing or rubbings. In carrying this out in the field, it is important to make sure you have permission or a permit to collect these types of samples, as some parks and gardens do not allow the collection of specimens from live organisms. It is also critical to closely monitor students as they collect their samples and to ensure they do so in a safe manner and do not harm the plant. Depending on the number of students you have, it also may be wise to consider only collecting enough specimens for each group, rather than each student, so that a large number of plants are not damaged. Once samples were collected, students used local plant books, often available at the local library, to identify their samples. As the culminating assessment for the unit, students were assigned an art project requiring them to create a form of art using various plant samples. The

FIGURE 3: Student created a face as his culminating project

PHOTOS COURTESY OF THE AUTHORS

instructions asked for the art piece to demonstrate their appreciation and understanding of plant life and diversity, as well as an aspect of the Hawaiian culture (Figure 3). Along with the art piece, students provided a key identifying the species of plants used in the art and a short description of the art itself.

Our local sites

The island of Hawaii has a vast elevation range. In a 20-minute drive, students can travel from a desert to a tropical rain forest. Field trips to local sites were incorporated into this unit as a way for students to explore plant diversity and be exposed to the variety of ecosystems in their community. We visited three sites: Ouli Park, Kalopa State Park, and Koai'a Tree Sanctuary.

Ouli Park is in the process of being restored and prepared as a public park. The Keanuio-ma stream runs through it and is one of the major stream systems running from the Kohala Volcano. At Ouli Park, students observed a variety of native and nonnative organisms within a semi-arid ecosystem.

Kalopa State Park is a native ohia forest located at 610 m (2,000 ft.) (Figure 4). One of the unique features of Kalopa State Park is a point in the forest where students are immersed in the beauty and diversity of a rain forest, but take two steps and students are in a eucalyptus field. During our time at Kalopa State Park, students made connections to their cultural past. For example, students learned that their ancestors used the pulu hair from the hapu'u fern to make pillows and that the nut from the state tree, the kukui tree, were used as candles and laxatives. Students were also told the legend of the ohia tree and the lehua blossom, which tells why Hawaiians believe it will rain if you pick the lehua blossom from an ohia tree. We also discussed how long it takes an ohia tree to grow (> 50 years), the small areas that seeds sprout in, and the trees' vulnerability to the strangler

fig. The strangler fig grows up the ohia, choking the tree's future growth.

Our final field trip was to the Koai'a Tree Sanctuary, a fenced public park in which many nonnative plants are being removed by local volunteers to leave room for the planting and reestablishment of native species. During our time at this site, students gave back to their community by spending time pulling up invasive fountain grass at the sanctuary. This site was ideal for incorporating culture and history around the Hawaiian art of leis. Each island has a distinctive flower it uses in the creation of leis. As we hiked through the park, our guide showed students these different flowers and discussed the islands associated with it. We were also told stories about how their ancestors hiked this land to find flowers to create the leis.

Finding your own local sites

When designing your own unit, you may start by researching local nature or conservation groups to see what popular places there are to visit. Using popular places should provide experience in nature and safe

FIGURE 4: A group of students inspects the leaves, bark, and roots of a tree in order to identify the species at Kalopa State Park

trails to follow. As you research, you may also find local community groups, colleges, or universities willing to partner with or support you in the field. Calling the biology department of your local college or university is a good place to start when looking for these resources. Many local wildlife agencies also have personnel in charge of public relations that you can contact. While you may not have the same variety of locations as we did in Hawaii, selecting a variety of places to visit is important so students can notice differences among plants. We would also recommend picking sites with areas for students to have some free time to play games and enjoy nature. It can be helpful to have structured games in mind, but it can also be wonderful to allow students the freedom to play on their own.

Field trip safety and considerations

When taking students on field trips, there are many safety issues that can arise, and there are other considerations you may have to make prior to going into the field (Roy 2011; Scribner-MacLean and Kennedy 2007). During the implementation of this unit, we visited sites prior to selecting them as appropriate for our purposes. We collected appropriate field trip forms from parents, discussed behavioral expectations with students prior to departure, assigned groups for work in the field, and ensured we had an adequate number of chaperones. We also confirmed that each group had sufficient first aid equipment and a form of communication (i.e., phone, two-way radio) for the duration of the trip. Prior to departure, we talked with students about the safety of touching and handling plants in the wild, making sure we identified possible poisonous plants and ones that could cause allergic reactions. Given our locations, this was a critical aspect for ensuring the safety of our students. Additional safety considerations include the use of sunblock and appropriate headgear to protect against sunburn, as well as long pants and long-sleeved shirts to protect against insect bites, ticks, and scratches. All of these are important considerations when you design and plan field trips (Roy 2011), and should be handled and addressed prior to departing the school. Finally, we

recognize that these activities were conducted during summer school, but we believe you could easily adapt and modify the unit we created to be just as effective both during the academic year and over a longer period of time.

Incorporating agriculture and food

As stated earlier, visits to the Mala'ai Garden were incorporated into the unit to provide students a hands-on experience with growing crops. Within the garden, students explored the reproductive structures of different plants, evaluated the plants in different stages, and identified the structural changes as flowers became fruit. If you have a community garden you can take students to, this is an excellent way for students to understand more about the food they eat.

Students were also exposed to the effects of agriculture through our visit to Kalopa State Park. There, students were given time to sit and reflect on the differences they noticed between the native rain forest and the immediately neighboring eucalyptus fields. This allowed students to understand how sensitive an ecosystem can be to changes. If you do not have an area like Kalopa State Park near you, an alternative could be using a government data set from a study on ecosystem degradation due to urban sprawl or farming, preferably in your area, and have students evaluate the effects. This will create an awareness, even if students don't get to see it firsthand.

Incorporating art

Art is the academic study and development of painting, sculpture, and other visual arts. Students in Hawaii are familiar with the connection between art and nature on the Hawaiian Islands through leis, plant pressings, and native wear. Students were able to create plant pressings and see many of the plants used in Hawaiian art growing in their native state. Students were asked to also incorporate drawings, poems, and ideas for their projects in their observation journal entries. Students used these observation journals to help inspire their culminating projects. We also pro-

vided examples of various types of art incorporating plant life. A simple internet search can provide a variety of images to spur students' creativity. Students used their journals and knowledge to demonstrate their appreciation and understanding of plant diversity by creating an art piece. Students had access to a variety of art supplies including colored paper, paints, colored pencils, crayons, scissors, and other art supplies to create their projects.

Assessment

Formative assessment of student progress was done throughout the unit by collecting student observation journals. Fulton and Campbell (2014) recommend using notebooks as a means of formative assessment and warned against grading their content, as it may discourage students. This was the approach we took, merely collecting the notebooks as formative assessment to monitor student progress and understanding. Each day the journals were collected and a different color was used to write comments and feedback to students. As students were sometimes modifying or adding to previous pages, this let students easily find the new comments. We specifically tried to note if there had been any growth and encourage this growth in the student. Teachers will want to decide what the journals will focus on: predicting, recording and organizing data, drawing, questioning, and/or explanations. Focusing questions can then be developed to help students attend to these practices.

The summative assessment for this unit was the culminating art project. For our unit, students were assessed using the rubric (see Online Supplemental Materials). We asked students to assess themselves prior to us giving them feedback. This allowed students an opportunity to see if their work aligned with the stated expectations prior to handing in the assignment.

Student responses

Students were engaged throughout the unit, and they all learned new material. For example, the majority of students didn't realize fruits such as pineapple and berries were the product of multiple flowers

making one fruit; this unit allowed them to develop this knowledge. Students also become aware of pollinators other than bees and butterflies such as ants, moths, and flies. Some students went deeper with their thinking and were curious about the natural selection aspects of flower types. This exhibited a deeper level of interest and understanding.

As a result of this unit, we had several students who asked how they could get involved with the restoration and preservation work at Ouli Park and the Koai'a Tree Sanctuary. We also received comments from parents and students about how this experience had ignited student interest and passion for learning science. Furthermore, the art component helped students connect with their culture and community. In summary, the combination of exposing students to their environment, eliciting their curiosity about the ecosystems around them, using their creativity in the final projects, and engaging students in their culture and learning, was incredibly effective in helping students learn the content and develop a deeper understanding of the science content and their community. ●

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RESOURCES

Flower key—www.bio.fsu.edu/~winn/bsc3402L/chapter12.pdf

ONLINE SUPPLEMENTAL MATERIALS

Rubric—www.nsta.org/scope1711

Connecting to the *Next Generation Science Standards* [NGSS Lead States 2013]

- The chart below makes one set of connections between the instruction outlined in this article and the NGSS. Other valid connections are likely; however, space restrictions prevent us from listing all possibilities.
- The materials, lessons, and activities outlined in the article are just one step toward reaching the performance expectation listed below.

Standard

MS-LS1: From Molecules to Organisms: Structures and Processes

<http://nextgenscience.org/msls1-molecules-organisms-structures-processes>

Performance Expectation

MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

DIMENSIONS	CLASSROOM CONNECTIONS
Science and Engineering Practice	
Constructing Explanations	<p>Students respond to prompts in their journals. Prompts included:</p> <ul style="list-style-type: none"> • Describe and/or draw the structure of a flower in the garden. Hypothesize which pollinator would be drawn to the flower based on its form. • In your journal, write up a comparison of all three field sites we visited this week. Compare the conservation designs of the park and how effective it appears to be based on the number of native species present.
Disciplinary Core Idea	
<p>LS1.B. Growth and Development of Organisms</p> <ul style="list-style-type: none"> • Plants reproduce in a variety of ways, sometimes depending on animal behavior or specialized structures for reproduction. 	Students evaluate and compare the reproductive structures of two different flowers.
Crosscutting Concept	
Cause and Effect	<p>Students respond to the following journal prompt:</p> <ul style="list-style-type: none"> • Compare the three field sites. What were some efforts being made in each area to preserve biodiversity?

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