Education and Research: Testing Hypotheses

Place-based Wayfinding

Andrew Rogers, Sarah Howard, and Kirsten Matsumoto

Summary

The objective of this series of lessons is for students in any part of the world to ground their study of Climate Change and Stewardship of the Earth in their own sense of place. Through a personal and place-based lens, students develop empathy toward their home as they relate it to present day issues as well as to those of their ancestors. From one's own community to the stars in the sky, students identify their place in the universe, and more concretely, learn the cardinal directions. The lesson plans, while based in science, span cultural, geological, and political answers to the question "Where are you?"

Using astronomy, the path of the sun, hands as measuring tools, and Pacific Islander navigation traditions, students employ Next Generation Science Standards (NGSS) Science and Engineering Practices such as: developing and using models, constructing explanations, and using mathematics and computational thinking. Extensions include geocaching, map-reading, compass use, and navigation triangulation. These lessons can be adapted for students of all ages.

tags: wayfinding, geocaching, navigation, stars, models

Key Concepts

- Align place-based science with environmental teaching
- Unify personal stories and Environmental Pedagogy
- Bridge communities, culture, and location to identify place
- Find cardinal directions by day and by night

Next Generation Science Standards:

Science and Engineering Practices - Developing and using models, Constructing explanations, Using mathematics and computational thinking

Crosscutting Concepts - Scale, proportion, and quantity, Systems and system models,

Disciplinary Core Ideas - Earth and Space Science

ESS1. Earth's place in the universe

ESS1A. The Universe and its stars

ESS1.B: Earth and the Solar System

Ocean Literacy Principles:

1. *The Earth has one big ocean with many features.*

Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation (Coriolis effect), the Sun, and water density differences. The shape of ocean basins and adjacent land masses influence the path of circulation.

2. *The ocean and humans are inextricably interconnected.*

From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, serves as a highway for transportation of goods and people, and plays a role in national security.

The ocean is a source of inspiration, recreation, rejuvenation and discovery. It is also an important element in the heritage of many cultures.

Much of the world's population lives in coastal areas.

Objectives

Students will identify landmarks at school and create directions from Point A to Point B.

Students will observe shadows of the sun

Students will demonstrate knowledge of hands as measuring tools

Materials

paper
pencil
colored pencils
clipboard
science journal

Procedure

Day 1: Where is here? How do we find our way?

Engage: (10 minutes) Have all the kids sit in a circle on the ground, preferably outside, and ask questions such as these:

- How do we know where we are?
- Where is here?

(Possible answers: Because we can see we are in the school, we have maps, we just 'know,' use a compass.) However, that does not tell you where you are in relation to other landmarks. In a classroom, there are many ways to feel comfortable knowing where you are in relation to other places we know — this is called landmark navigation.

What if you were blindfolded, flown to a foreign country and dropped off in the middle of a city. How would you know where you are? (Possible answers: Ask someone? Purchase a map?) Now there are no familiar landmarks! If you do not speak the language, your best chance is to purchase a map, and see if you can match the new landmarks around you to the map.

Explore Activity: (30 minutes)
On a piece of paper on a clipboard, create a list of directions to go from any point A to any point B on our campus (student choice) that a partner would be able to follow if you were to read them aloud. The list of instructions should be the most direct route between the points. What landmarks will you include? Will you pace it out? Challenge up… could you give the instructions to that person and that person mentally tries to figure out where your destination is? They pace it out and see if they are correct?

Evaluate: (10 minutes)
Return to the circle and discuss their experiences both giving and receiving directions. Have they had similar experiences before? If you were to do this again, is there anything you would change?

Assess: By the end of the day, students have created a list from point A to B with at least 5 different directions.

Extend: If you have a 90-minute block period, try the explore activity again, switching up the partners and employing one new thing they learned from the discussion to change their strategy.

Day 2:

Engage: (5-10 minutes) Return to sitting in a circle today, and ask what students recall about yesterday's activity. How were they successful? What would they like to try differently next time?

-How do we find relationships between distances of landmarks too far away to get to?

Pre-activity: (5-10 minutes) Walk up on the hill behind the garden habitat and look out over Point Lobos.

-How far away is the tip of Pt. Lobos from our flag pole?

Ask students to figure out ways to hypothesize the distance. What measurements do they use? How is today's task different from yesterday's?

Explore: (30 minutes)

Introduce the science of wayfinding.

Have students read article about Moana and Wayfinding.

https://www.bustle.com/articles/195766-what-is-wayfinding-disneys-moana-introduces-viewers-to-the-art-of-navigation

Then recreate Shannon's lesson outside.

http://statemuseumpa.org/wp-content/uploads/2013/12/educ_guide_orion.pdf pp. 65

- using hand as a tool to figure out 360-degree circle around us

Extend:

Moana's hour of code:

http://partners.disney.com/hour-of-code/wayfinding-with-code

Day 3:

Engage: Return to yesterday's circle and ask: (10 minutes)

- How would we navigate during the day if we have no navigation equipment? (sun/shadows)
- How do we find the cardinal directions?

Explore: (10 minutes)
Students are outside in pairs to begin the Water Bottle Shadow activity. They have a piece of light-colored construction paper and orient it however they would like. Students place a water bottle on a large piece of paper and trace the shadow with a pencil. They label that with the time of day. Next, they hypothesize where the shadow will be in 30 minutes. Using a colored pencil, they draw the shape of the water bottle and label that with the word "hypothesis." In 30 minutes, students return with a different colored pencil and trace the shadow of the actual water bottle. Label this with the time of day as well.

While students are waiting for their second data point, they will have 20 minutes. Engage students in a discussion of why they hypothesized what they did. What do they notice about their place? Have they ever stayed late on the playground? What did they notice about the sun's location (it is setting in the west). Where does the sun rise? Does the sun really rise and set around the Earth? What else might explain the different location of the sun given this information. Model how this looks with a large and small ball.

Now they should understand that it is really the Earth's rotation that creates the illusion of the sun rising and setting. The concept they are learning is that shadows will be longer and pointing west in the morning, shortest at noon, and growing longer pointing east in the afternoon. From there, they will discuss and identify all four cardinal compass points.

Optional extra day
Repeat day three. The idea is that student hypotheses will be more accurate. Students can help each other with this. The time of day may be different than the day before.

During the 20 minutes students are waiting between their first and second drawings, teach the students the hand over hand technique of knowing how long until the sun sets. Why would this be useful? When can they imagine that they would use this skill?

http://modernsurvivalblog.com/survival-skills/how-to-determine-remaining-daylight/

Retrieve the papers from outside. If time, draw their Water Bottle Sketch activity in their lab notebooks.

Day 4

- How can we find the cardinal directions using the stars?
    - How would we navigate at night if we have no navigation equipment?

DISCUSS: (5-10 minutes)

Simulating a voyage on the ocean, navigating with the stars. (set the scene with ocean sounds and narration)

Engage:: How would we navigate if there were no landmarks?

- What if we were in the middle of the ocean? All you can see is water all the way to the horizon in every direction! How do we know where we are now? (Possible answers: Maps? Perhaps a savvy student will say stars!) Draw a box on the chalkboard and put a few waves in it. Ask the students if this map would be helpful to them. (Answer: No.) Is there anything around you that you can see and recognize? If no, student has mentioned it yet, suggest stars to help determine where they are. Next, draw another box on the chalkboard and put a few stars in it. Ask how helpful is this map? Tell the students that even if they recognize patterns in the stars, there is another problem: almost all of the stars move throughout the night! If students know that the North Star is fixed, tell them that that is a good start because you can always find the direction north. However, you can see the North Star from anywhere in the Northern Hemisphere, so you have only actually narrowed your location down to half of the earth!

Explore: (20 minutes)

- *The Stars* or *Finding Constellations* (H.A. Rey)

Let each group choose one constellation to draw on poster and present to class

Activity: (25 minutes)

- Make a Star Finder (https://omsi.edu/sites/default/files/field/educator-guide/navigating_by_the_stars_teacher_guide.pdf)

Day 5: ACTIVITY:

- Create your own constellation (with mythology)

Day 6: @ Science Camp - locating constellations in night sky

Day 7: AGE OF SAIL - locating constellations in night sky on night watch

Resources

Constellation identification (map)
Ocean sounds/audio (stream online)

The Stars or *Finding Constellations* (H.A. Rey)

Star compass: http://www.hokulea.com/education-at-sea/polynesian-navigation/the-star-compass/

Hawaii navigation: http://apps.ksbe.edu/kaiwakiloumoku/sites/apps.ksbe.edu.kaiwakiloumoku/files/documents/Q3%20U2%20les%201%20revised.pdf

Hands-Keys to the Universe: http://statemuseumpa.org/wp-content/uploads/2013/12/educ_guide_orion.pdf p. 65 - 70.

Measuring the sun: http://modernsurvivalblog.com/survival-skills/how-to-determine-remaining-daylight/

Star compass: http://www.hokulea.com/education-at-sea/polynesian-navigation/the-star-compass/

Navigation with triangulation: using maps and compasses to find location when two landmarks are known: http://www.paddlinglight.com/articles/navigation-fixes-and-triangulation/

Institute of Navigation resources: https://www.ion.org/outreach/lesson-plans.cfm

Article about Moana and wayfinding: https://www.bustle.com/articles/195766-what-is-wayfinding-disneys-moana-introduces-viewers-to-the-art-of-navigation

Star Finder Template: (https://omsi.edu/sites/default/files/field/educator-guide/navigating_by_the_stars_teacher_guide.pdf)

Assessment

- **Performance**—students will maintain their notes in lab notebooks as described in each lesson.
- **Product**—students will make their own star finder to take to science camp and Age of Sail.

Extensions/Differentiation

Exploration of Star Compass

Global Positioning System (GPS)

Compasses and Earth's Magnetic Field

Moana Coding and more advanced coding