



Broadening Research Interest in Geoscience, Habitat, and Technology (BRIGHT)

Investigation 1: GEOCACHING

Grades 9-12

Time requirement: 1 hour, 40 minutes

Next Generation Science Standards (NGSS)

Science and Engineering Practices

Scientific Investigations Use a Variety of Methods

- New technologies advance scientific knowledge.
- Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge.

Disciplinary Core Ideas

Influence of Engineering, Technology, and Science on Society and the Natural World

- Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications.

Crosscutting Concepts

Scale, Proportion, and Quantity

- Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.

Science is a Human Endeavor

- Technological advances have influenced the progress of science and science has influenced advances in technology.
- Science and engineering are influenced by society and society is influenced by science and engineering.

OVERVIEW

Students gain experience with GPS technology using scientific tools: GPS units or GPS-enabled mobile devices. In small groups, students use GPS to navigate to geocache locations.

LEARNING OBJECTIVES

Students will be able to:

- collect data with scientific instruments.
- navigate using a geolocation device.
- engage in collaborative group work.

INSTRUCTIONAL APPROACH

Geocaching builds students' locational awareness while using scientific instrumentation for a fun purpose. Encourage students to consider:

- *Where are we? What is here? How do we detect it?*
- *How does remote sensing help identify a location and its attributes?*

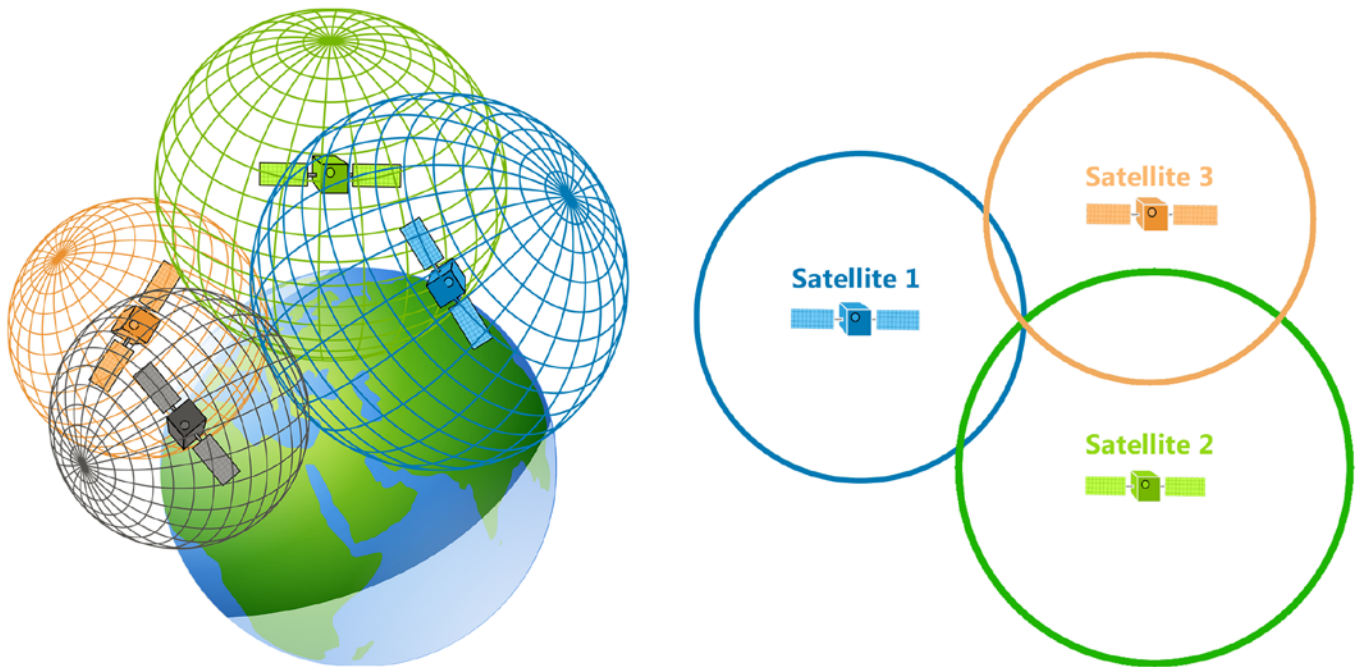
The instructor should ensure that students use the tools themselves, and should accept all student responses as value-neutral.

SCIENCE BACKGROUND

(<https://www.geocaching.com/guide/>)

Geocaching is an outdoor treasure hunt, using GPS-enabled devices to navigate to GPS coordinates corresponding to the locations of containers called geocaches. A Juneau geocaching enthusiast described it as “using millions of dollars of satellites to find Tupperware in the woods.”

GPS-enabled devices are computers that receive signals broadcast from GPS satellites. They give an approximate location on Earth, usually in latitude and longitude coordinates, and can be used to navigate from one location to another. GPS devices calculate their locations using trilateration (see figure below), which requires signals from at least three satellites at a time; four satellite signals provide a more accurate position.



GPS satellite trilateration: “GPS satellites broadcast signals as a sphere. Each satellite is at the center of a sphere. Where all spheres intersect determines the position of the GPS receiver.”
(<https://gisgeography.com/trilateration-triangulation-gps/>)

MATERIALS

- GPS units, manuals, and extra batteries or GPS-enabled mobile devices with Geocaching app, 1 per group of 3-4 students
- Geocaches (plastic containers of prizes) or preexisting geocaches, 1 per group
- Rite in the Rain 4x6” notebooks, 1 per group
- Pencils
- Optional: printed maps of geocache locations, 1 per group

ACTIVITY

Setup

1. Obtain GPS units, manuals, and extra batteries/chargers or register for a Geocaching.com membership and install the Geocaching app on a GPS-enabled mobile device.
2. Assemble and hide geocaches and note the coordinates, or determine locations of preexisting geocaches using the Geocaching app.
3. Optional: develop maps showing the approximate distribution and locations of geocaches, e.g., on a Google Earth satellite image. Print a copy for each group.
4. Charge GPS units or GPS-enabled mobile devices.

Introduction

10 minutes

Invite students to consider:

- *Where are we? How do we know?*
- *What is here? How do we detect it?*

Students may discuss questions with a partner before sharing with the entire group. Prompt them to give examples from their own experience:

- *Has anyone heard of GPS before? What does it stand for? (Global Positioning System)*
- *Has anyone used GPS before? If so, how?*

Address the military origins of GPS technology (<https://www.gps.gov/systems/gps/>) and its availability to civilians and scientists:

- *How does GPS work?*
- *How might scientists use GPS?*

Investigation

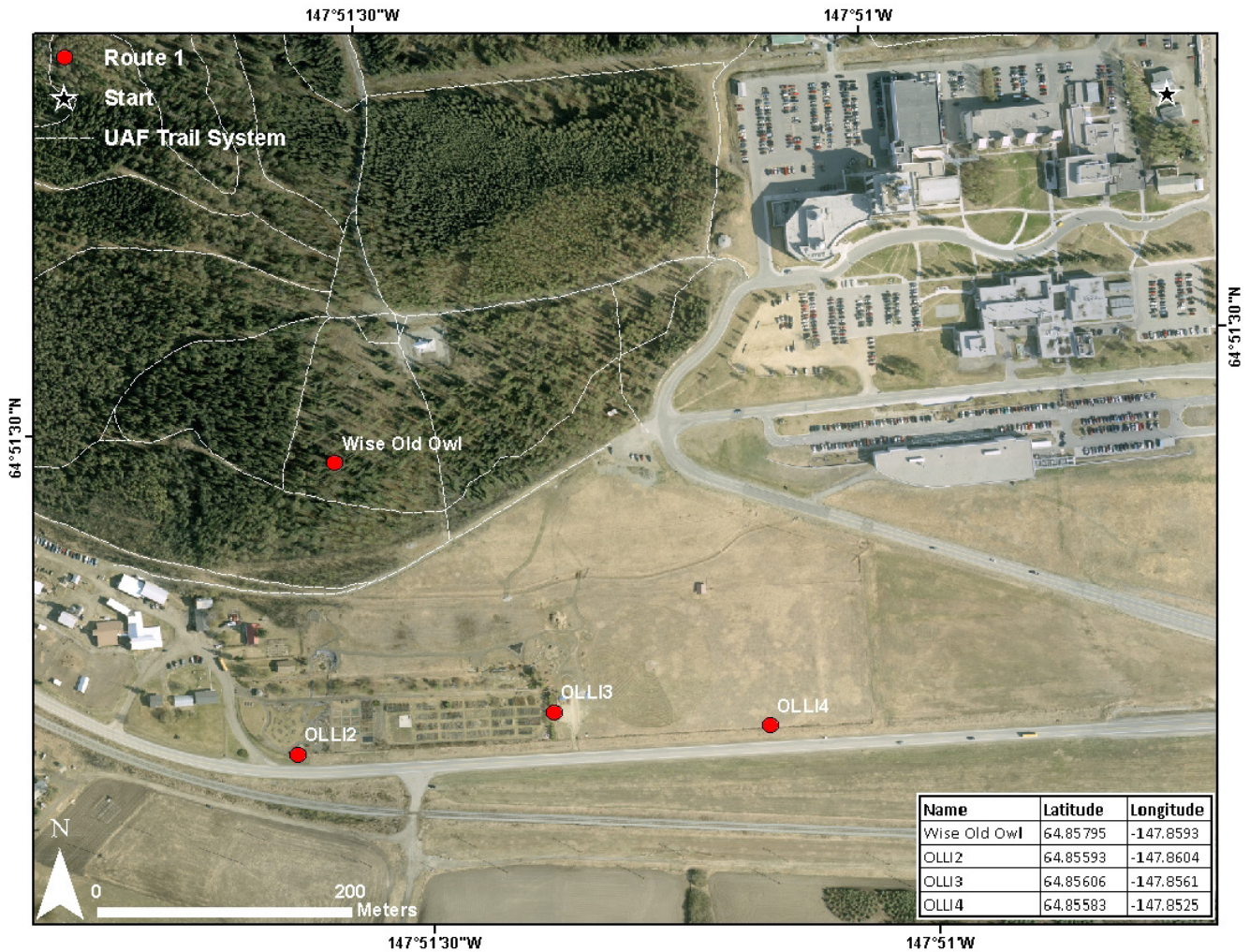
1.5 hours

1. Divide students into groups of three or four. Pass out GPS units or GPS-enabled mobile devices to each group and demonstrate the steps necessary to:

| GPS units | GPS-enabled mobile devices |
|--|--|
| <ul style="list-style-type: none">• enter geocache coordinates• use navigation mode• create a waypoint | <ul style="list-style-type: none">• use the Geocaching app to navigate to a geocache |

Have the student who learns first teach the next member of their group and that person teach the next person (and so on).

2. Give each group a Rite in the Rain notebook (and an optional paper map). Each group member should have a responsibility (recording coordinates of geocaches and waypoints, operating the GPS unit, navigating using the paper map). Tell the students to take a waypoint when they find a geocache. They can also take waypoints of interesting features along the way to revisit in Google Earth.
3. Encourage students to look around, take photos, and note what they see at each geocache location, to ensure they can recognize it in the future (as instruments' accuracy may vary, and it can be hard to recall details once back from the field).
4. Give students the chance to find multiple geocaches and switch roles within their groups.
Ask:
 - *What role did you prefer (recording, operating, navigating)? Why?*
 - *Did your process change from finding the first to the second geocache? How?*



Geocache locations on the University of Alaska Fairbanks campus. Map by Lisa Wirth

Extension

30 minutes

Materials

- Computers with Google Earth Pro (free), 1 per pair of students

1. Give a brief introduction to Google Earth with an activity that shows some of the Google Earth Oddities. Students enter the following coordinates and navigate to an odd thing on the landscape as seen from space. Instructors help pairs of students at each computer.

32.149593, -110.835905

38.484775, -109.679840

2. Students use Google Earth to plot the coordinates of the geocaches they found and the waypoints they took on a satellite image. Encourage them to measure the approximate distance they traveled using the ruler tool.

Other possible extensions include students making geocaches and hiding them for each other and using radio telemetry equipment, if available, to complement geocaching.

Using Google Earth for the first time as a group is a good opportunity to discuss the history of remote sensing briefly, e.g., aerial photography using kites and pigeons.

Kite aerial photography: <http://kap.ced.berkeley.edu/background/history1.html>

Pigeon aerial photography: <http://mentalfloss.com/article/55081/spy-pigeons-and-other-great-moments-history-aerial-photography>

OTHER RESOURCES

Geocaching: <https://www.geocaching.com/guide/>

GPS: <https://www.gps.gov/systems/gps/>

Trilateration: <https://gisgeography.com/trilateration-triangulation-gps/>

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