Geospatial Education

Grade Level: 4-8

Geocaching

Materials:
- GPS units
- Small ledgers
- Waypoints list
- Geocache containers
- GPS Unit: How it Works
- Small items for the geocache containers

Objectives:
1. Given instruction and materials, students will define a waypoint.
2. Given instruction and GPS units, students will locate at least 5 waypoints.

Teacher’s introduction to the material:
GPS is an acronym for Global Positioning System. GPS units use satellites to triangulate a position on the globe. A waypoint is a longitude and latitude coordinate. The teacher will need to use a GPS unit to cite several waypoints to which the students have access. Place a notebook and several items in a container at each waypoint. When students locate a geocache, they sign the ledger, remove an item, and place another item in the cache.

Instruction:
1. Read the GPS Unit: How it Works.
2. Place the GPS units in the sun and wait until each has located at least 3 satellites.
3. Give a group of students the list of waypoints, and ask them to locate each geocache using only the GPS.
4. When the first waypoint is located, instruct the students to sign their names to the ledger, remove an item, and place another item in the cache.
5. Continue to fine waypoints.

Skills: Discrimination, Geography, Math, Problem solving, Reading comprehension

Vocabulary: Latitude, Longitude, Waypoint

A waypoint is a longitude and latitude coordinate.

The waypoint example N 47°55′30″ W 097°1′58″ is read North 47 degrees 55 minutes and 30 seconds West 97 degrees 1 minute and 58 seconds. Some GPS units give degrees and minutes with the seconds as a decimal N 47°55.030′.

Compare the positional reading on the GPS unit with the waypoint you want to find:
N 47°55.030’ W 097°01.058 your location
N 47°55.046’ W 097°01.050 waypoint you are looking for
In this case you want to increase the north position and decrease the west position so you will walk northeast (NE).

N 47° 55.940 W 97° 02.411
N 47° 55.842 W 97° 02.391
To get to the waypoint you will walk in which direction?

N 47° 55.869 W 97° 02.455
N 47° 55.887 W 97° 02.490
To get to the waypoint you will walk in which direction?

N 47° 55.912 W 97° 02.531
N 47° 55.944 W 97° 02.618
To get to the waypoint you will walk in which direction?

N 47° 55.966 W 97° 02.758
N 47° 55.984 W 97° 02.006
To get to the waypoint you will walk in which direction?

N 47° 55.877 W 97° 02.006
N 47° 55.808 W 97° 02.638
To get to the waypoint you will walk in which direction?

N 47° 55.718 W 97° 02.474
N 47° 55.590 W 97° 02.352
To get to the waypoint you will walk in which direction?

N 47° 55.626 W 97° 02.312
N 47° 55.587 W 97° 02.313
To get to the waypoint you will walk in which direction?
Teacher's Note to Using a Handheld GPS Unit

When using a handheld GPS unit you can 1) enter known waypoints in advance so that the GPS unit guides you from one waypoint to the next; 2) walk a trail and have the GPS unit keep track of waypoints along the way so you can print a map later or 3) use a GPS unit more like a compass to find waypoints. Using the GPS unit like a compass is a great way to get comfortable with latitude and longitude.

Waypoint example N 47°55’30” W 097°1’58”. It is read North 47 degrees 55 minutes and 30 seconds West 97 degrees 1 minute and 58 seconds. Some GPS units give degrees and minutes with the seconds as a decimal N 47°55.030’.

Compare the positional reading on the GPS unit with the waypoint you want to find:
N 47°55.030’ W 097°01.058 your location
N 47°55.046’ W 097°01.050 waypoint you are looking for
In this case you want to increase the north position and decrease the west position so you will walk northeast (NE).

Waypoint Exercise Key
N 47° 55.940 W 97° 02.411
N 47° 55.842 W 97° 02.391
To get to the waypoint you will walk in which direction? less north less west = SE

N 47° 55.869 W 97° 02.455
N 47° 55.887 W 97° 02.490
To get to the waypoint you will walk in which direction? more north more west = NW

N 47° 55.912 W 97° 02.531
N 47° 55.944 W 97° 02.618
To get to the waypoint you will walk in which direction? more north more west = NW

N 47° 55.966 W 97° 02.758
N 47° 55.984 W 97° 02.006
To get to the waypoint you will walk in which direction? more north less west = NE

N 47° 55.877 W 97° 02.006
N 47° 55.808 W 97° 02.638
To get to the waypoint you will walk in which direction? less north more west = SE

N 47° 55.718 W 97° 02.474
N 47° 55.590 W 97° 02.352
To get to the waypoint you will walk in which direction? less north more west = SE

N 47° 55.626 W 97° 02.312
N 47° 55.587 W 97° 02.313
To get to the waypoint you will walk in which direction? less north more west = SW
GPS handheld unit - How it Works

GPS is an acronym for Global Positioning System
GIS is an acronym for Geographic Information System

Military navigation was based on radio stations thru the 1960’s. GPS is a satellite based navigation system that was initiated by the US Dept of Defense in the 1970’s. In 1973 the US Dept. of Defense unified the Navy and Air Force systems. The new system became operational in 1995. The system allows you to monitor your location based on a receiver

The Global Positioning System has 3 segments. The satellites are the space segment. The control segment is made up of the ground antenna control stations. The individual GPS units make up the user segment.

The earth is a sphere which means it has a circumference of 360 degrees. The 24 satellites are positioned in 6 equally spaced orbits (360/6=60 degrees). They are set at a 55 degree inclination from the equator. The satellites are placed in an orbit that has an altitude of 20,200km. What all of this means to you is that at any given time there will be 5-8 satellites that can find your handheld GPS receiver.

Moving objects have a variety of forces working on them. The monitor stations check the altitude, position, speed and overall status of each satellite and report the status to the control stations. The control stations transmit corrective data to each satellite as needed.
The third segment is the handheld GPS unit.
Trilateration – a method of determining the relative positions of 3 or more points by treating those points as vertices of a triangle.

With one satellite your location is somewhere on the surface of the earth at a specific distance from the satellite. In this diagram you see that your handheld unit gets a general fix on the satellites.

Add a second satellite and that narrows your location to the circumference of a circle where the 2 spheres intersect.

Add a third satellite and that narrows location to 2 points on the circle.
It takes the 4th satellite or the 4th sphere to identify your 3 dimensional position. The GPS unit scales the size of the satellite spheres all by exactly the same amount until the area is reduced to a point.

Time is part of the calculations done by the satellite to determine your position. The time the satellite received your signal compared to the time the signal left your GPS unit. Your handheld GPS unit has a quartz clock inside that is not precisely synchronized with the accurate atomic clocks of the satellites. A small error in time makes a large error in the calculation of the distance between you and the satellite. This internal correction is possible because all the signal measurements between your handheld unit and the satellites are made with the same clock and so are equally subject to the same proportional error. Knowing that your handheld unit needs to make this clock error correction, you now understand the importance of having a minimum of 4 satellites.

As with any technology you should always carry a backup technology. If you were going on a hiking trip in an unfamiliar area you should bring a topographic map and compass with you so that you are not completely dependent on the GPS unit.