Module I

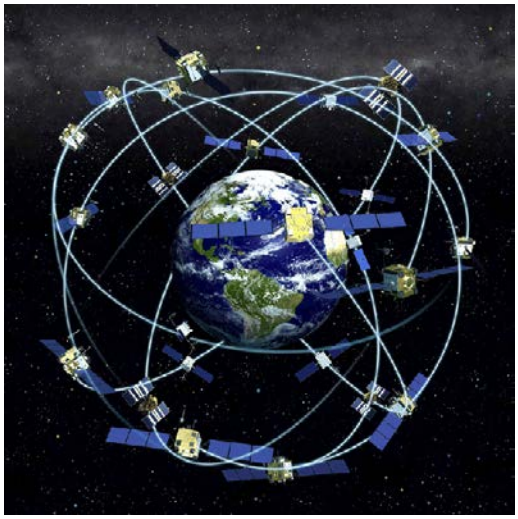
Grade Level: Middle School

Teaching Time: 2-3 class periods

Materials:
Student handouts 1-3
For each group doing the Trilateration activity:

- 4 pieces of different colored string
- pencil or pen
- large map

GPS receivers or smart phones



II. Where Am I?

Activity Summary

This activity explores geospatial systems so that students can create waypoints and record latitude and longitude of places in a watershed as a first step in monitoring a local waterway. These skills are basic to understanding how locations are found on earth with the use of maps, coordinates, and technology.

Learning Objectives:

Students will be able to:

- Explain the concept of locating a site on Earth with 3 satellites.
- Use latitude and longitude coordinates to identify features on a map.

- Use a GPS receiver or a smart phone to locate the waypoint of a local feature on the school grounds.

Background Information

Humans have looked to the skies to find their way since ancient times. Ancient sailors used the constellations in the night sky to figure out where they were and where they were going. Today, all we need is a simple hand-held GPS (short for Global Positioning System) receiver to figure out exactly where we are anywhere in the world. However, we still need instruments high in the sky to figure out where we are and how we get to other places.

Instead of stars, we use Global Positioning System (GPS) satellites, to help determine a location on the planet. The concepts behind GPS positioning are very simple, but the application and implementation require amazing precision. Over 30 navigation satellites are zipping around high above Earth. These satellites can tell us exactly where we are. GPS is a system. It's made up of three parts: satellites, ground stations, and receivers.
(http://spaceplace.nasa.gov/gps/en/)

Key Words

Latitude - Imaginary (unreal) lines drawn on maps to easily locate places on the Earth. Latitude is distance north or south of the equator (an imaginary circle around the Earth halfway between the North Pole and the South Pole). The latitude of the North Pole is 90° N, and that of the South Pole is 90° S. The latitude of every point in between must be some degree north or south, from 0° to 90°. One degree of latitude covers about 69 miles (111 kilometers).

Longitude - Imaginary (unreal) lines drawn on maps to easily locate places on the Earth. Longitude is distance east or west of the prime meridian (an imaginary line running from north to south through Greenwich, England) and is measured in terms of the 360 degrees (symbolized by °) of a circle. Longitude is measured in degrees east or west of the prime meridian.

Geospatial – Recent term that describes the data and technology used to determine a geographic location on, above, or in the Earth, referring to data that is geographic and spatial.

Global Positioning System - Using the Global Positioning System (GPS), every point on Earth has its own unique address -- its latitude, longitude, and height. The U.S. Department of Defense developed GPS satellites as a strategic system in 1978. Now anyone can gather data from them. GPS is a constellation of satellites that orbit approximately 11,000 miles above the Earth and transmit radio wave signals to receivers across the planet. By determining the time that it takes for a GPS satellite signal to reach your receiver, you can calculate your distance to the satellite and figure out your exact location on the Earth.

Watershed - The area that drains to a common waterway, such as a stream, lake, estuary, wetland, aquifer, or even the ocean.

Waypoint – Coordinate of a specific location as indicated by a GPS device.

Activity Procedure

Engagement

View "Geospatial Revolution, Chapter I" and discuss the first four questions in Student Handout #`1.Resources:

- http://geospatialrevolution.psu.edu

- Alternative video at NASA's Spaceplace: http://spaceplace.nasa.gov/gps-pizza/en/

1. Give 3 examples of common uses of GPS receivers. Aircraft monitories, transportation tracking, mapping cities, railroads, identifying important sites, finding your place on Earth, find restaurants or other places
2. What are 2 benefits of this technology of the uses of this technology in emergency situations? Provide information about the extent of damage and locations so that appropriate help can be sent to the area to specific areas. Provide maps of a damaged area to provide better flow of humanitarian relief.
3. Give another example of emergencies where GPS information might be crucial. Track the transport of aid or rescue workers. Identify places where text messages indicate people might be buried in rubble.
4. How would you use GPS technology in the study of water quality and organism like oysters? Track places where living oyster reef are located, where there might be sources of pollution, and where to start new beds of oysters (oyster reef).

Option 1 Exploration/Explanation

Students will investigate latitude and longitude coordinates on a USGS map of a small mining town, Triumph, Idaho, and in the Chesapeake Bay. Provide Student Handout #2 to the students. Point out to students that the latitude and longitude of the cursor is found at the bottom of the page and demonstrate the map tools. If students need a quick refresher about latitude and longitude, go to: https://www.youtube.com/watch?v=swKBi6hHHMA; then have them find the address of a favorite landmark using this tool, http://www.latlong.net/.

Ask students to copy and paste the site's URL. The latitude and longitude are displayed at the bottom of the map. Triumph, Idaho: http://ngmdb.usgs.gov/maps/TopoView/viewer/#13/43.6501/-114.2636 Alternatively, you can print topographic maps for groups of students to investigate.

Demonstrate the use of the tools on the map site.

Ask them to answer the following questions on Student Handout #1.
1. What feature do you find at 43°38'46"N and 114°14'40"W (Lucky Mine)
2. What feature do you find at 43°38'12"N and 114°14'46"W (Pumphrey Canyon)
3. What feature do you find at 43°39'13"N and 114°15'32"W (Courier Mine)

To look at something more local to the Chesapeake Bay. Go to this map
http://ngmdb.usgs.gov/maps/TopoView/viewer/#11/38.6346/-76.0697
Move/slide the dot at the top of the page all the way to the right so that the map reflects a 2010 date.

- You will see the latitude and longitude displayed on the bottom of the map.
- Click and drag Cambridge to the center of the screen and scroll in to magnify.
- Click and drag the map so that Cambridge moves to the right of your screen; your map is centered on Cornersville.
- Have students find the latitude and longitude of these airports.

4. Rossneck airport ($38^0$34'8" N, $76^0$14'8" W)
5. Big Oak Farm airport ($38^0$34'9" N, $76^0$17'11" W)
6. Pokety airport ($38^0$36'44" N, $76^0$10'19" W)

Option 2 Exploration/Explanation

Activity from National Geographic,
http://education.nationalgeographic.org/activity/introduction-gis/

1. This activity that will help students understand how GIS works. Pictures of the Practice Photo Gallery at the website give students a preview of the hands-on activity.
2. Invite a small group of 4-5 students to use the rope to create a map of the continental United States on the floor. Allow students to use reference material if they are not familiar enough with the shape of the country. Make sure students understand they do not have to use all of the rope, but it should take up a large part of the floor. Ask: *To create the United States, you created a shape, or a polygon. What are some other shapes you could have created?* (Possible responses: counties, cities)
3. Choose 3-4 different volunteers and ask them to create a major river with blue rope. Ask: *When you created the river, you created a line. What are some other lines you could have created?* (Possible responses: roads, trails, pathways).
4. Once the floor map is in place, ask each student to stand on a location they either have visited or would like to visit. Ask: *When standing on the place you'd like to visit, you created a point. What are some other points you could have created?* (Possible responses: home, school, grocery store)

5. Explain to students that you are going to touch their shoulder and ask them where they are standing, and why they chose to stand there. Take enough time that you can interact with as many students as possible. Then explain to students that when you touched their shoulders, or "clicked" on them, they told you information about why they chose to visit that place. You queried students, and they provided you with information. Common vocabulary terms used in GIS are *shapes, polygons, lines, points,* and *query*. Working together, the class simulated a simple, low-tech GIS.

Option 3 Explanation
Alternative Activity for more advanced students

Provide Student Handout #3. Trilateration is the process of using satellites to find a position in 2 dimensions (lat/long) or in 3 dimensions (lat/long and altitude). Students will simulate GPS positioning using 4 satellites. Full activity instructions and the map file can be found at http://www.gps.gov/multimedia/tutorials/trilateration/ and are included as student instructions with this activity. Students will pretend to be a GPS receiver somewhere on the map and will figure out where they are based on the 4 "signals" they receive.

A **GPS** receiver must be locked on to the signal of at least 3 satellites to calculate a 2-D position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the user's 3-D position (latitude, longitude and altitude). Four satellites are used to determine the three-dimensional position of a location on Earth. One reason for this is that three satellites actually establish two possible positions for an object. Since one of these is usually impossible (e.g., a position that is inside the Earth or out in space), the true position can often be worked out from three satellites alone. Ask students to complete Student Handout #2.

Extension

A good overview of watersheds in general can be found here: https://vimeo.com/14030972
Provide Student Handout #4. Have students investigate the location addresses of the part of the Chesapeake Bay watershed where they live. A widget on this page will identify their watershed by zip code. http://www.chesapeakebay.net/discover/baywatershed

Students can also investigate the use of GPS locally. Select 4 or 5 locations around your school yard and have students, individually or in small groups, find the addresses of what you have selected. Students should record their responses on Student Handout #4.

Option 1. If you have a few GPS receivers, students can find locations around their school in small groups.

Option 2. If students have access to smart phones, the compass app will provide GPS locations.

Option 3: You can use this online site to find lat/long addresses. http://www.latlong.net/

Finally, if time permits, introduce your students to geocaching, a popular activity for all ages. A cache or geocache is a hidden container housing a logbook, pen or pencil, and trinkets for people to exchange. Officially they are registered on the geocaching website (http://www.geocaching.com) but not if you are doing a more low-tech version around your school. Consider the ages of the students you are working with, and be sure to create 'caches' that they will enjoy finding!
http://www.natureplaywa.org.au/library/1/file/Geocaching/Lesson1.pdf

Evaluation

Checking for Understanding: Students should provide answers to the questions in each activity, which can be evaluated for completeness and understanding.

Three Dimensional Learning		How the Dimensions are Addressed.
Core Disciplinary Idea(s)	**MS-ESS3.B Natural Hazards**. Mapping the history of natural hazards in a region can help forecast the locations and likelihood of future events.	Being able to find a location on Earth is key to doing ecological mapping, water monitoring, and impacts from natural weather events. This activity sets the foundation for being able to use location-finding devices for their own investigations.
Science/Engineering Practice(s)	**Developing and Using Models.** Modeling builds on experiences and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems.	Students will model GPS systems on paper to see how 3 and 4 satellites can pinpoint a location on Earth.
Cross-cutting Concepts	**Scale, Proportion and Quantity.** Time and space phenomena can be observed at different scales. **Influence of science, engineering, and technology on society and the natural world.**	Students use simple algebraic equations to determine location of a GPS coordinate with time and speed. Students will investigate the various uses of GPS technology and its effect on society's needs.

Ties to Common Core	**Mathematics Grade 6.** Apply and extend previous understandings of arithmetic to algebraic expressions. Reason about and solve one-variable equations. **Mathematics, Grade 7.** Solve real-life and mathematical problems using numerical and algebraic expressions and equations.	Students use simple linear equations to determine GPS coordinates. This real-life application of mathematics simulates how GPS receivers work, the same technology found in many everyday devices.
Ties to MD Environmental Literacy Standards	**Standard 2 Interactions of Earth's Systems. Topic B: Systems Thinking.** Use Models and computer simulations to extend his/her understanding of scientific concepts.	Students will model GPS systems on paper to see how 3 and 4 satellites can be used to pinpoint a location on Earth, and is key to doing ecological mapping, water monitoring, and impacts from natural weather events.

Module References

Definitions of latitude and longitude. http://www-istp.gsfc.nasa.gov/stargaze/Slatlong.htm
How GPS Works poster. http://www.gps.gov/multimedia/poster/
Official website for U.S. Government information on GPS. http://www.gps.gov/NASA Space Place http://spaceplace.nasa.gov/gps/en/
Maryland Environmental Literacy Standards http://marylandpublicschools.org/programs/Documents/Environmental/MDEnvironmentalLitStandards.pdf

Additional Resources

Find It with GPS Lesson, http://tryengineering.org/sites/default/files/lessons/finditgps.pdf
Tutorial on Global positioning, http://oceanservice.noaa.gov/education/tutorial_geodesy/geo09_gps.html
Free GPS poster, http://www.gps.gov/multimedia/poster/
GPS Scavenger Hunt, https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_navigation/cub_navigation_lesson09_activity3.xml
Hide and Seek with Geocaching, https://www.sedl.org/afterschool/lessonplans/index.cgi?show_record=16
Map Stats for Kids, http://www.geovista.psu.edu/grants/MapStatsKids/MSK_portal/concepts_latlg.html