GPS Modeling

Learning Objectives

- Students will describe a satellite and how it helps locate a person on Earth.
- Students will explain how triangulation is used to find a location.
- Students will describe how engineers are involved in the design and use of satellites.

Activity Overview

- Students will learn the basic concept of global positioning systems (GPS) using triangulation and measurement on a small scale- within boxes in the classroom.
- Students will discover how GPS and navigation integrate mathematics and scientific concepts to create a standard for locating people and objects.

Standards Addressed

- ***SC.4.E.5.4***- Relate that the rotation of Earth (day and night) and apparent movements of the Sun, Moon, and stars are connected.
- ***SC.5.E.5.3*** – Distinguish among the following objects in the Solar System- Sun, planets, moons, asteroids, comets- and identify Earth's position in it.

Materials

Item	Quantity Needed	Notes
Cardboard Boxes	8	*Medium-sized; 1 per group*
String	1 skein	*8, 5-foot pieces*
Scissors	Class set	
Rulers	8	
Masking Tape	1 roll	
Box Map	8	*Print out, on bottom of box*

Preparation

- Cut off the four top flaps on each cardboard box.
- Use a marker to mark the center points on the three inner walls of each box. Do this by drawing lines to opposite corners of each box side, and finding the intersections, which are the center points.
- Label the walls.
- Cut string into 5-foot lengths.

Science Content

Satellites can help us know exactly where something is on Earth. Engineered or human-made, satellites can be instruments or machines that record different data measurements from outside the Earth's atmosphere for various purposes such as scientific research, weather research and prediction, navigation and observing the Earth. GPS satellites help us find a location by **triangulating** the position of an object or person as they move. Satellites do this by receiving and transmitting signals. Basically, a signal is sent from a computer or a person in one location on Earth up to a satellite orbiting the Earth and back down to the same or another person or computer somewhere else.

Engineers invented satellites and have always been involved with designing them, getting them into space, and analyzing their data. So, engineers need to have a good understanding of science, space and aerospace engineering. Engineers also need to understand mathematics and navigation systems on Earth.

Source: https://www.teachengineering.org/activities/view/cub_rockets_lesson06_activity1

Facilitation Guide

Engage (10 minutes)

1. Ask students if they have ever seen their caregivers use GPS to get to a place? How do you think that works? By satellites!
2. GPS satellites help us find a location by sending signals from a computer or a person in one location on Earth up to a satellite orbiting the Earth and back down to the same or another person or computer somewhere else.
3. The concept we are going to practice today is triangulation. This is done by finding the distance between three points, forming a triangle. This method is used to help find the location of a point.
4. Explain today's activity: using a map, your group is going to secretly choose a location point. Measure the distance from the point to the center point on three walls and record those values. You will then switch with another group and it is their goal to find the mystery location based on the distances recorded.

Activity (30 minutes)

1. Divide students into 8 groups and pass out a box to each group.
2. Have groups choose a mystery location on the map in the bottom of the box- but do NOT place a location marker on the map because it will be the challenge for another group to try and find that location.
3. After each group has chosen a specific location on the map, have students measure the distance from that point to each of the center marks on each wall of the box using string and a ruler. DO NOT cut the string! Record these values on the data sheet.
4. Have the groups trade boxes and data sheets. The challenge is to see if the other group can accurately locate the first group's mystery location given the data the group recorded.

5. Now with a new box and data sheet, have students measure and cut their string into three pieces according to the recorded length on the other group's data sheet. Then the group has three strings that go from the center of each of the three walls to the map.
6. Using the three cut strings, direct the students to find (triangulate) the mystery location on the map. To do this, have them tape each length of string to the matching center of the wall, pulling all of the strings tight and see where they meet on the map. Once they think they have the location, have them make a mark on the map.
7. Have groups retrieve their original boxes and verify in the other group found the correct location.

Reflect (10 minutes)

1. This was a small-scale model of what a GPS system does. In a real GPS system, what do the points on the walls of the box represent? *Navigation Satellites*
2. How many satellites did we need to find our location on Earth? *Three*
3. What do engineers need to understand to design satellites for GPS? *Engineers need to have a good understanding of science, space, and aerospace engineering*

Ideas for Extension or Adaptation

- Give students a challenge by having them find the center of the walls of the box themselves and do not label the box walls for them.
- Have students specify two locations on the map and then have the other group find both points and the distance between those two locations.