

## **Topic: Global Positioning System (GPS)**

**Primary Goal:** Students know how to use GPS, but will now learn how GPS actually works. Understanding the history and development of GPS is critical to allowing the students to look at the concept as an innovator or entrepreneur. Every day people are discovering ways to make our lives easier through GPS and this lesson aims to provide the students with a foundation behind the science.

### **Lesson Objectives:**

- Learn the history of GPS and how it was developed
- Understand the science of how GPS receivers work and how they determine your location

### **Lesson Outline:**

- I. Overview
  1. GPS is a satellite-based navigation system transmitting radio signals to users all over the world
    - i. Used in everything from ATMs, to dog collars, to farming equipment, to sailboats
  2. Made up of a network of 24 operational satellites maintained by the US Air Force
    - i. They have been flying 31 satellites to ensure that there is always sufficient availability of signals
  3. The satellites are arranged into six equally spaced orbital planes to ensure at least four satellites are available at any point on the earth
- II. History of GPS
  1. While there were many predecessors, GPS is a relatively new concept
  2. Created and owned by the US Department of Defense, GPS was initially created in 1973 to be used by the military
  3. The first GPS satellite system was launched from Vandenberg Air Force Base in 1978 and became fully operational in 1995
  4. Reliable use by civilians began in 2000 when President Clinton directed that the “Selective Availability” feature be turned off
    - i. Prior to that, GPS use for civilians was inaccurate and could be off by as much as 100 yards
- III. How GPS Works
  1. GPS satellites orbit the earth twice a day in a very precise orbit and transmit signal information to the earth
    - i. Travel at speeds of up to 7,000 mph
    - ii. Powered by solar energy. Interesting fact – they contain backup batteries in the event of a solar eclipse
  2. GPS receivers (e.g. your cell phone) take this information and use *trilateration* to determine your exact location

- i. Does this by taking the time a signal was transmitted by a satellite to the time it was received by your device
  - ii. The precise difference in time tells the GPS receiver how far away you are and sends an exact line of position
3. While 3 satellites can be used to determine your 2D location, 4 satellites are needed to determine your exact location (latitude, longitude, and altitude)
4. Once the GPS receiver knows your exact location, it can provide a great deal of information:
  - i. Speed, bearing/course, track, trip distance

### **Supplemental Resources:**

Educational materials provided by www.GPS.gov: <http://www.gps.gov/students/>

Garmin GPS description: <http://www8.garmin.com/aboutGPS/>

NASA SciFiles Video: <http://youtu.be/3zRlbboMvb0>

DNews - How GPS Works: <http://youtu.be/IoRQiNFzT0k>

GPS Poster: <http://www.gps.gov/multimedia/poster/poster-web.pdf>

### **Exercises/Activities:**

Allow the students to use hand-held GPS devices and give them some coordinates to determine their location. Garmin makes a hand-held device which tells you which of the 24 satellites the device is using to determine location.

<http://www.gps.gov/multimedia/tutorials/trilateration/>