

Geocaching Lesson Plan

I. Introduction and Motivator

- a. Today we are going to go on a scavenger hunt using high-tech technology that was developed for the military!
- b. Has any one ever heard of GPS? Ask students: what does GPS stands for? Where have you seen GPS used? What is the purpose of GPS?

Global Positioning System (GPS) Background

II. **Global Positioning System** is a space-based global navigation satellite system (GNSS) that provides reliable location and time information in all weather and at all times and anywhere on or near the Earth when and where there is an unobstructed line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible by anyone with a GPS receiver.

- a. Developed by the Defense Department in 1970s for military applications
- b. Government made GPS available to civilians, world-wide, in 1980s – free to use

III. Satellite/Space Component

- a. The space component consists of a “constellation of satellites” constantly transmitting radio signals to users (high frequency, low power)
- b. Solar-powered with battery back-up. Weigh between 3,000-4,000 pounds.
- c. Air force manages the constellation
- d. Currently 31 GPS satellites in orbit. At least 27 in operation at a time. Others can be reactivated if needed.
- e. Orbit at about 12,400 miles (20,200 km). Each satellite circles the Earth twice a day.
- f. Satellite orbits are arranged to ensure that there are at least 4 satellites in view from virtually any point on Earth.

IV. Receiver Component: Calculating Location – Trilateration

- a. Each GPS receiver is a computer that receives signals broadcast from GPS satellites. A receiver needs to read signals from at least three satellites at a time to calculate its general location by a process called trilateration.
- b. Satellite broadcasts information that is picked up by your GPS receiver. This info includes:
 - i. ID # of satellite
 - ii. Exact time the signal left the satellite
 - iii. Precise orbital information
- c. GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. Knowing the speed of the signal, your GPS is set to calculate your distance from the satellite, using basic geometry!
- d. Distance = rate x time
 - i. **Rate** of signal is known: The GPS radio signals travel through space at the speed of light, more than 186,000 miles per second
 - ii. **Time** is calculated by GPS receiver: difference between the time broadcast by the satellite and the time the signal was received.
- e. With signals from at least four satellites, a GPS receiver can calculate a more accurate location that includes altitude, as well as latitude and longitude. The more satellite signals the receiver reads, the more accurate the position it reports to you.