HOW GPS WORKS

Jesús Huerta

TEACHER GUIDE

Dear teacher,

In this video lesson, you will find information explaining how the GPS works and why it is important. Moreover, there are activities related to the concept of the GPS that you will be able to use and work on with the students in your classroom.

The goal is that students analyze the concept of geographic coordinates, spherical coordinates, and how the GPS works, as well as their applications to everyday life in an interactive and creative way, and especially making use of their previous knowledge for the activities proposed in this video lesson.

Previous knowledge that students should have before doing this video lesson is that related to the imaginary lines of the Earth, geographic coordinates, and the application of the GPS for cellular.

The materials needed are:

a) One world map for each student (a downloadable one is provided)

b) 2 white sheets of paper per student

c) Compass

d) Scissors

e) Ruler

f) Adhesive tape

g) Conveyor

h) Glue

i) Calculator

j) Measuring tape, meter, or Flexometer

k) Small rubber ball

l) Chronometer

The procedure to follow when showing the video in your classroom is the following:

Play the video until you reach **Activity 1**, and pause it for students to work on. In this activity, students will be asked about finding the distance between a person and a wall, given that the person is not being able to locate himself. Encourage your students to think of a formula that can

help them solve the situation, in such a way that they can determine the distance between the person and the object.

If your students cannot determine the formula that is being referenced, share the following with them: Distance = time/speed, where time is how long the sound takes in returning to the person, and speed refers to sound waves travelling at the speed of sound, or 343.3 m/s. Tell the students to suppose that the sound takes 5 seconds in returning to the person. Then, the distance of the person with respect of the object is 1716.5 meters.

Continue playing the video (in which the usefulness of GPS is mentioned), until you reach **Activity 2** and pause it. In this activity, you need to discuss with your students how they think GPS works, and how satellites and the program do the calculations. In small groups, they will talk about how GPS and satellites work.

Next, and also part of **Activity 2**, students will map the most important imaginary lines on the world map: the Equator, Tropic of Cancer, Tropic of Capricorn, and Greenwich Meridian.

On the same map, they then proceed to locate the following geographical coordinates. Do not tell students which places you are looking for.

-80 ° N-40 ° W (Greenland)
-60 ° N-140 ° W (Alaska)
-20 ° S-120 ° E (Oceania)
-40 ° S-80 ° (Chile)
-40 ° N 100 ° (North America)

Check that your students locate the points correctly and give them feedback with the correct names of the places to locate, if needed.

Continue playing the video where the basis for GPS is explained.

Do **Activity 3** with your students. You will need to make space at the center of the classroom in order to do it.

Trace a line that is 2 meters long. Make a small rubber ball travel that distance. Use a chronometer and have students respond: How long did the run take? What are the variables involved? Use the formula that is shown on the video: speed = distance/time. Use the formula above to find the distance. It becomes distance = time x speed.

Next, students will draw, on a sheet of paper, a triangle with three unequal sides. One side should measure 3 cm, another side should measure 5 cm and one of the angles should measure 30°. Have students respond: How could we calculate the length of the missing side and the two other angles? Ask them to review the law of sines and cosines and then do the corresponding calculations. Ask your students: Do you think these calculations are helpful to the functioning of the GPS?

Give feedback to the students on the results obtained. Correct their calculations if needed.

Continue to play the video, where the way GPS works is made explicit through trilateration.

In **Activity 4**, students will need to cut out three circles of different sizes, with known radii measurements. Ask them to paste the circles in a Cartesian plane, in such a way that the three circumferences come together at one point. Ask students to determine the coordinates of the point of intersection of the three circumferences. If the center of each circumference is a satellite located somewhere in space and the intersection point is your position- how are coordinates for this intersection point calculated?

The students should draw a line from the point of intersection to the center of each circle, which exemplifies the distance between the satellite and the mobile device. The student will answer this question: How do you think this calculation is done?

The students will use the formula: $d = \sqrt{(x - x_1)^2 + (y - y_1)^2}$ to determine, analytically, the distance between the center of a circumference and the point of intersection of the other circumferences.

These coordinates need to coincide with those that were obtained on the Cartesian Plane. Students should repeat the same procedure for the other two circumferences and determine the values that coincide. They need to obtain the value that shows their position.

Finally, end the video by providing feedback on the results of the activity, the different uses of GPS, and their value as a tool.

Encourage your students to research more than what was shown in this video lesson.

You can suggest to do a project in which, in a creative way, they find a solution for a problem in their everyday lives by using the GPS. They can make a model, explanation, or develop a project. Evaluate them according to your criteria for the project.