Raspberry Shake

Lesson #1:

What is Raspberry Shake?

Lesson Objective:

Explain basic concepts, such as:

- What seismology is and seismographs are
- How the geophone works
- How the data is processed and how it can be used
- Setting up a Raspberry Shake with the students. (You may decide to set one up before the students arrive, but the process of plugging in the Shake can be a simple yet powerful event for the students.)

Setting up and introducing students to a Raspberry Shake opens many diverse learning opportunities, pertaining to many disciplines for all ages and grade levels. The Shake can be applied to Earth Science, Physics, Computer Science, Engineering, Mathematics, and much more. Like all environmental sensors, the Raspberry Shake seismograph is a direct demonstration of how humans can interpret and interact with their environment.

Learning Context/Anticipatory Set:

Introduce Raspberry Shake to the students as a new scientific tool in your classroom to be applied to hands-on projects. To gain their excitement and interest, start the class by plugging it in, finding it online, and watching the data in real time!

1). Show the Shake to the class (unplugged).

2). Plug the Shake in, and watch the lights turn on.

3). Go to browser and type in rs.local, and open StationView and find your shake. As you and your students see the live data streaming, stand everyone up, countdown, and then jump as hard as you can all together. Watch the students' (of all ages) excitement!

Then, sit them down and use our presentation to explain to your students what the Raspberry Shake is!

Key Terms:

- Seismic: Related to ground movement
- Seismograph: A device that measures and records seismic movement
- Geologic Fault: A fracture, or break, in the earth's crust
- Seismic Wave: Acoustic energy that moves through the earth's layers
- Geophone: A sensor that detects vibrations in the ground

Direct Instruction:

To understand what the Raspberry Shake seismograph is and how it works, we must start by gaining an understanding of what seismology and seismic waves are. So, we will start with the question:

What is seismology?

Seismology is the study of seismic waves, waves of acoustic energy that travel through the earth. Like sound waves, seismic waves can be measured. Just like we can measure sound waves with microphones, we can measure seismic waves with seismographs.

Natural seismicity is caused by events such as earthquakes, volcanic activity, ocean currents, and extreme weather events, among other causes. Man-made seismicity can be caused by events like construction work, explosions, and fracking.

What are seismographs and how are they used?

A seismograph is any device that detects and records seismic wave energy, meaning basically any ground vibrations. The sensor, called the seismometer, is usually a suspended mass that stays in the same place while the frame around it moves in concert with the earth. As the mass moves, it sends analog voltage data to a "digitizer", which samples the voltage 100 times every second, by "counting" the amount of voltage on the geophone circuit. This data is then encoded digitally and saved to the Shake's internal memory, where it is converted into the squiggly-line graph format that is commonly seen, called a seismogram.

Seismographs can "feel" everything from earthquakes to cars driving by to human footsteps. Any movement that travels through the ground is picked up by these sensitive devices. For this reason, it is not common to see seismographs in areas with major traffic and other anthropogenic (noise pollution originating from human activity) disturbances.

Around the world, seismological concepts are used for different industries and areas of study, all pertaining to the movement of the earth. Seismologists use them to locate the epicenters (starting points) of earthquakes, volcanologists use them to detect underground magma movement, and petroleum geologists use them to discover oil underground.

What about our Shake? What is a geophone?

Our Raspberry Shake has two main components: the geophone sensor that actually measures the movement, and the analog-to-digital converter on the Shake board.

We can think of a geophone as a low-frequency "ground microphone". A geophone works by generating electric signals that represent ground motion (and earthquakes!). These signals are "+" and "-" like the terminals on a battery and, since they are measured through physical voltage, we commonly refer to them as "analog" signals. When you pass a magnet through a coil, an electrical current is generated in the coil. This is exactly what happens inside a geophone – a coil suspended on springs surrounds an electromagnet (Figure 1). As the earth moves and shakes, the magnet and the frame both move and shake with it, while the inertial mass remains stationary due to its inertia. This process creates a small electrical current, which is slightly larger the faster the ground moves. The Raspberry Shake board—the device that digitizes the data by turning it into ones and zeros that the computer can read—then converts that voltage to the digital signal that you can see on your computer screen.

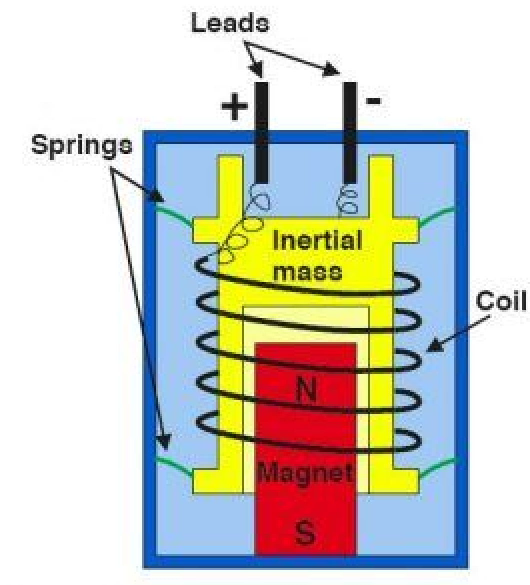

Figure 1: Diagram of a geophone and its parts.

How can we use our Shake?

The Shake can be used to measure anything that causes ground vibrations, and it can process that data in a variety of ways. The raw seismic data that the Shake records can be seen on the waveform-viewer application Swarm. Swarm can also be used to access all Raspberry Shake seismographs forwarding data to the network, so you can see the data from the nearly 1000 Shakes connected around the world.

The Shake can do much more than measure earthquakes. Any ground vibrations are detected by the Shake's sensitive geophone, meaning that the Shake can also "hear" traffic, trains, footsteps, fireworks, thunderstorms, strong bass speakers… anything that can cause the ground to vibrate even slightly!

The University of Michigan created a "cheer-meter", to measure which team had the biggest applause during sports games. They created Cheer Magnitude equations and everything! Just imagine the possibilities of use in our classroom, outside of an earthquake monitor.

Practice:

Time: 10-15 Minutes — Get to know Raspberry Shake

Allow students to use laptops to explore the Raspberry Shake website, especially the Station View (near real time map of Shakes around the world!) and EQ View (near real time map of earthquakes around the world) web apps. Explain how each of the stations play a part in the EQ View earthquake map (Figure 2), and how your Shake is a part (or will be a part) of that network.

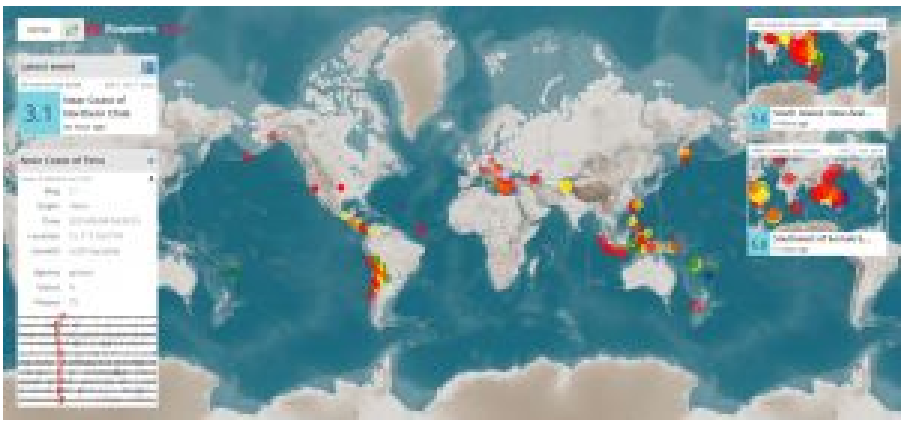

Figure 2: EQ View interactive map

Closing:

Time: 5-10 minutes — Planning for the Future

Option 1: Students get into groups of two or three and brainstorm five (5) uses for the Raspberry Shake seismograph *other* than detecting earthquakes. Then, ask for volunteers to share with the class. This will leave the students thinking all about future possibilities.

Option 2: Tell the students that it will soon become part of an important global seismic network, which detects, identifies, and measures earthquakes! They have to come up with ideas of the best place in the school to deploy the Shake as part of the seismic network. Noise, power, ethernet, etc. all need to be considered. A basement or lightly-used closet on a ground floor are often the best earthquake listening areas, but you can put it anywhere.