Australian Government
Geoscience Australia

EDUCATION PROGRAM

Make your own micro:bit seismometer: instructions and classroom activities

A guide for educators

Tapping a table to generate vibrations near a micro:bit seismometer.

Introduction and background information

What are seismometers?

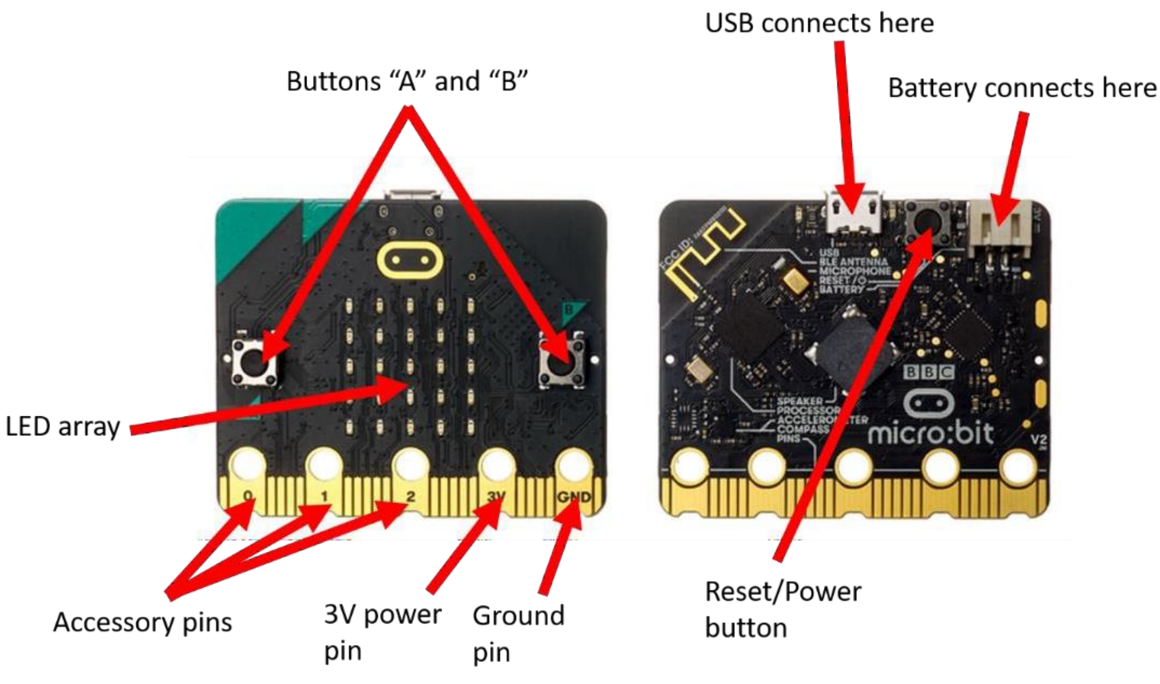
Seismometers are sensors that scientists use to monitor, measure, and study vibrations in the ground, typically caused by earthquakes. Seismometers can detect and record earthquakes from the other side of the Earth if the earthquakes are large enough. Seismometers can detect even the smallest vibrations caused by waves on the shoreline or wind blowing and moving trees. The data that scientists collect from these devices not only helps to keep communities and places safe, but it also helps scientists understand the composition of the Earth underneath our feet. Through the **National Earthquake Alert Centre** at Geoscience Australia, seismologists monitor earthquakes events all over the world and update the **earthquakes@GA** online data portal with current global and local earthquake information.

What are micro:bits?

Micro:bits are tiny inexpensive computers designed for classroom use. You can code a micro:bit to do a whole range of fun and educational things, from sensing temperature or sending messages to other micro:bits, to playing basic games like ‘Snake’, and rolling digital dice. This guide explores how to set up a micro:bit as a seismometer to collect vibration data and start measuring and recording ‘earthquakes’.

You can purchase micro:bits from the BBC micro:bit website **https://microbit.org/buy/**

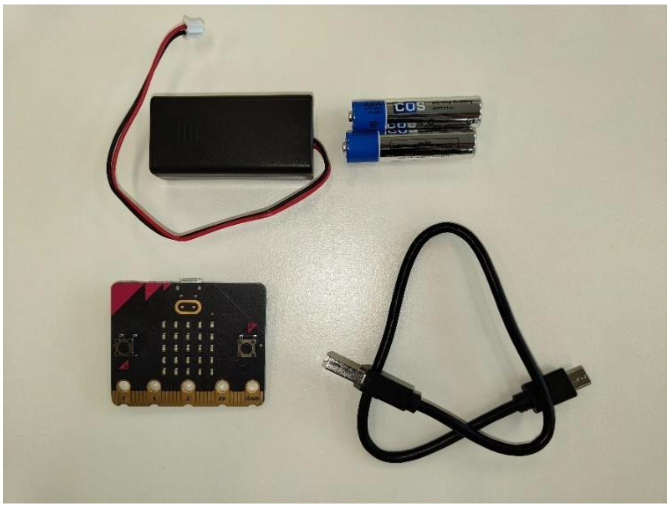
Below is a labelled diagram of the front and back of a micro:bit.



Using a micro:bit as a seismometer

You will only need standard micro:bit equipment:

- 1 micro:bit
- 1 micro-USB to USB cord
- 1 micro:bit battery pack
- 2 AAA batteries



Equipment for using a micro:bit as a seismometer: a micro:bit, a USB cable, the micro:bit battery pack, and 2 AAA batteries.

There are three main steps involved in setting up and using a micro:bit as a mini seismometer:

1. Provide power for the micro:bit,
2. Set up the coding application workspace (MakeCode) on a laptop or PC, and
3. Pair the micro:bit to the MakeCode workspace for data visualisation.

Step 1: Powering the micro:bit

1. Connect your micro:bit to a laptop or PC using the USB cable. Plug the USB into the micro-USB port on the micro:bit (see the diagram on page 2 for USB connection location) and plug the other end of that cable into your laptop USB port.

   If you plug the micro:bit directly into a laptop or PC, you will not need the batteries as the micro:bit will be powered through the USB cable.

   OR

2. Insert 2 x AAA batteries into the battery pack (orientation shown on inside of battery pack) and plug the battery pack into the battery connection socket on the micro:bit (see the diagram on page 2 for battery socket location on micro:bit), then connect the micro:bit to a laptop or PC using the USB cable as above.

Note: If you are using a completely new micro:bit, the first time you insert batteries or plug it into a laptop or PC, it will make lots of noise and lights – this is an inbuilt micro:bit tutorial that you can follow along with, which showcases some of the capabilities of the micro:bit.

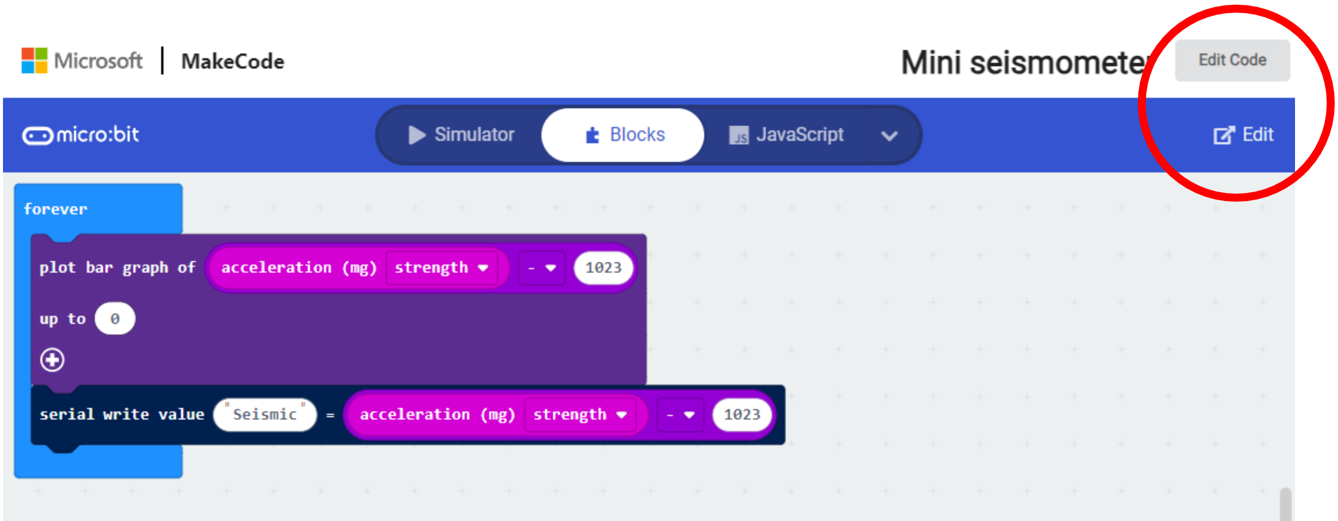
Step 2: Setting up the coding (MakeCode) workspace.

1. Click on the link below to bring up the micro:bit 'mini seismometer' code**.** This is the code that will turn your micro:bit into a seismometer, you do not need to modify or change the supplied code.

   https://makecode.microbit.org/S83758-60070-45752-03844

   You will be taken to a screen that looks like the image below.

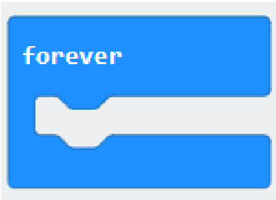
2. Click on the 'edit' button (circled in red). This will take you to the Microsoft coding website called 'MakeCode'.



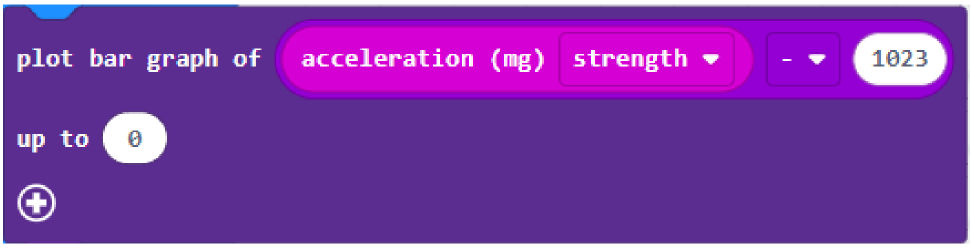
This code does not need to be edited or changed in any way to function.

The code explained:

In the MakeCode workspace, the chunks of code that make functions and programs are called ‘blocks’.



This block will run whatever code is inside it while the micro:bit has power.

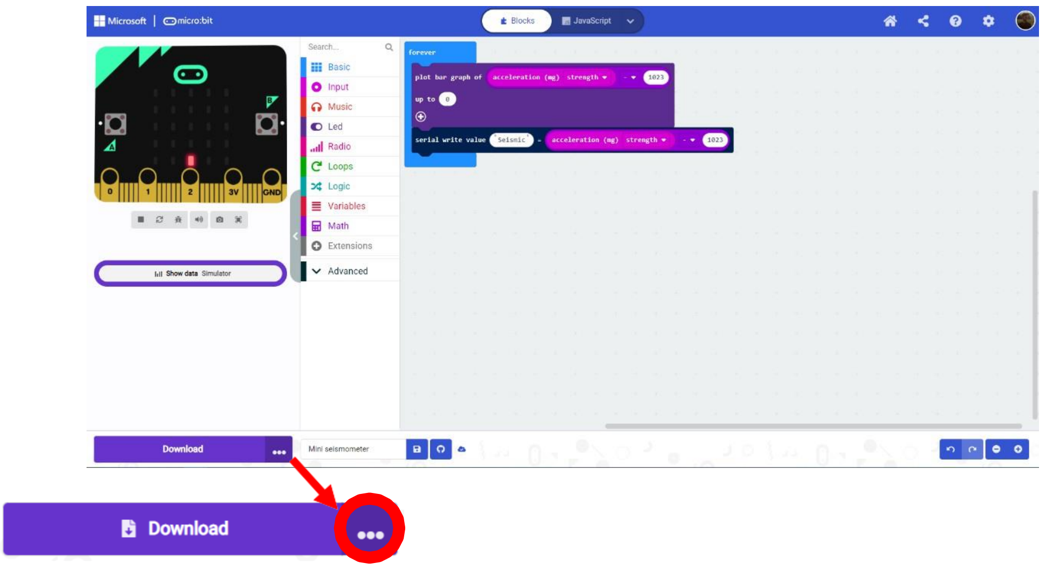


This block plots a real-time bar graph on the physical micro:bit representing the accelerometer data. ‘Strength’ is the sum of the x, y, and z axes or movement of the micro:bit seismometer. ‘-1023’ is a small adjustment to the measurement to account for the micro:bit lying flat on a surface.

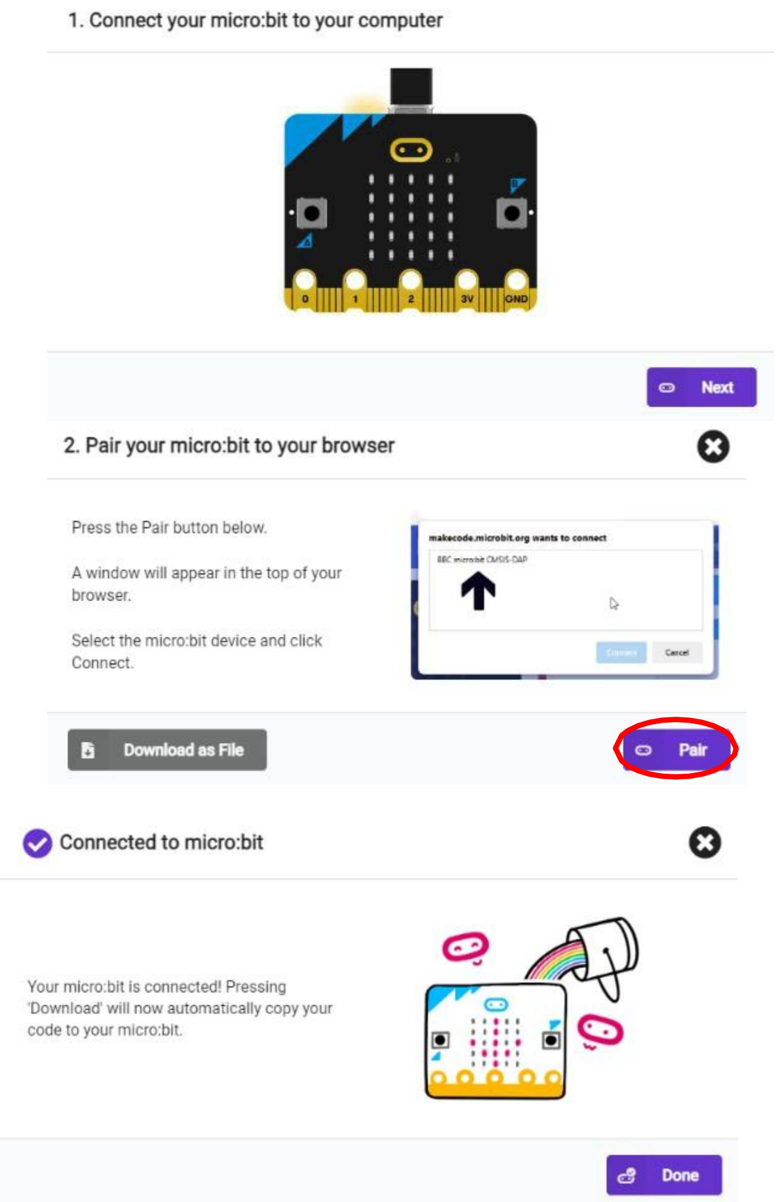
This block takes the same accelerometer data and feeds it back to the computer to be displayed in the MakeCode workspace.

Step 3: Pair the micro:bit and start viewing data

1. In the MakeCode workspace (pictured above), click on three dots next to the bottom left ‘Download’ button.
2. Select ‘Connect Device’.

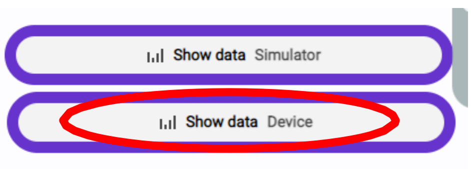


3. Follow the on-screen prompts to pair the micro:bit to the laptop or PC. Refer to the images below.

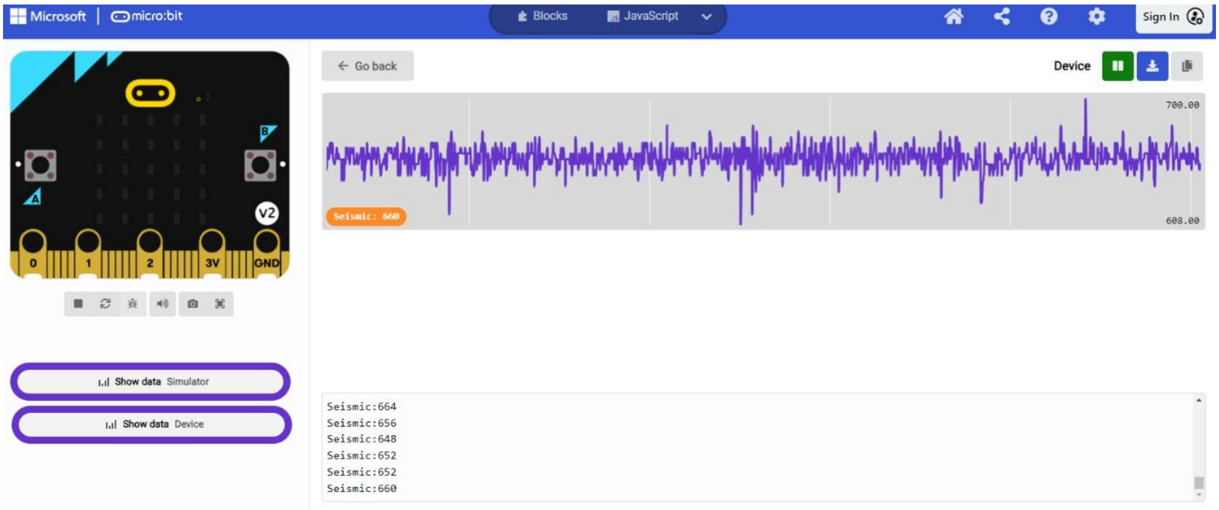


4. Click the ‘Download’ button on the bottom left of the MakeCode workspace to download the seismometer code onto the actual micro:bit (this will take about 10 seconds).

5. There will now be a new ‘Show data Device’ button below the little micro:bit simulator in the MakeCode workspace (see image below).



6. Click on the ‘Show data Device’ button and on your laptop or PC, you will see a display of the seismic data collected by the micro:bit similar to the image below.



7. Tap gently on the table near the micro:bit and watch the readout change, tap harder and watch the readout change again.

Extra information

To turn off the micro:bit you will need to unplug it from the laptop or PC **and** remove the batteries from the battery pack (if using one).

Each time you plug the micro:bit into a laptop or PC, you will need to re-pair the micro:bit to the MakeCode workspace by following all steps in **Step 3.**

Classroom activities.

Below is a collection of ideas for building knowledge on the way that vibrations travel through objects and the Earth and how to use the micro:bit as a seismometer in the classroom.

Introduction to vibrations

Vibrations are everywhere! Some that you can easily feel, and some that you cannot.
This first activity will introduce your students to some of the ways we can detect vibrations without using the micro:bit.

Arm vibrations

Do

Get your students to bend one of their arms and tap their elbow firmly around 5 times.

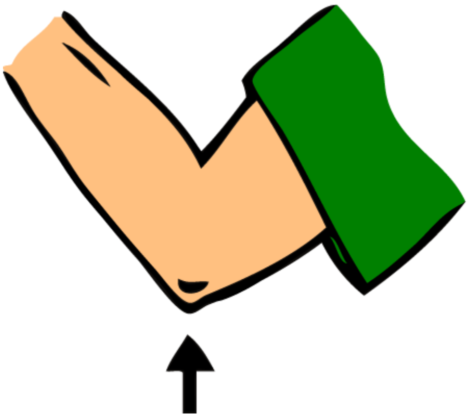


Image source: Shakespeare's English

Discuss

What can your students feel in their elbow?

Can they feel anything in the hand of their bent arm too?

You can feel the vibrations on your elbow, and some people may even be able to feel the vibrations in the hand of their bent arm.

Do

Now get your students to gently place one finger from their bent arm, into their ear on the same side, and tap their elbow firmly around 5 times.

Discuss

What can your students feel now? Do they hear anything?

The vibrations travel up their arm to their hand, keep travelling along their finger and into their ear! We know this is happening as we can now hear the taps on our elbow much more clearly.

Table vibrations

Do

Students place one hand palm-down on a desk or table and with the other hand tap the table about a metre away, increasing in strength, around 5 times. Students can also put their ear down on the table to hear the vibrations.

Discuss

Can your students feel anything in the table with their palm-down hand? What happens if you tap *really* gently on the table, or from farther away?

Similar to the vibrations travelling along our arm, vibrations travel along the length of the table, and we can feel them quite easily.

Ground vibrations

Do

Split your class into two groups standing about 5 metres apart in the classroom facing away from each other (or go outside if you need more space). Get one group to jump up and down on the spot, and the other group using their hands, trying to feel any vibrations in the floor/ground from their classmates. Swap group roles.

Discuss

Can your students feel any vibrations through the floor inside the classroom? What about through the ground outside?

These vibrations might be a bit harder for your students to detect with their hands as the floor/ground is much larger than their arms or tables, and so the vibrations need to travel farther making them harder to detect.

This is why scientists have designed special pieces of equipment to detect vibrations in the ground.

Measuring vibrations using the micro:bit seismometer

Now you get to use the micro:bit to measure and visualise vibrations your students can make. If you have a TV or smart board in your room, plug in your laptop or PC for the whole class to see.

Table vibrations 2.0.

Do

Place the micro:bit (attached via USB to computer/laptop and showing data collection as mentioned above) on one end of a long table and turn it on.

Have students at the other end of the table, gently tap the table, slowly increasing in strength.

Watch the computer/laptop graph the vibrations the micro:bit is receiving over time.

Discuss

Can you see a relationship between the vibrations students create and the recording of the micro:bit?

Does the data change as you increase the strength of vibrations?

Ground vibrations 2.0

Do

Place the micro:bit (attached via USB to computer/laptop and showing data collection as mentioned above) on a chair in the middle of the classroom and turn it on. (it is handy to source a very long USB cable, or a USB cable extender for this activity)

Have students stand around the chair, and softly stamp their feet, slowly increasing in strength.

Watch the computer/laptop graph the movement and vibration the micro:bit is receiving.

What happens if your students move farther away from the micro:bit and repeat?

Discuss

What can your students observe about the amplitude of the waves recorded?

Does the amplitude of the data change as your students move farther from or closer to the micro:bit?

Changing variables:

What variables could you change to alter the vibrations your students create? Does changing the surface of the table affect the wave amplitude? How far is too far? Does placing the micro:bit on sand affect the vibrations detected? What about the bottom or side of the table versus the top?

Further information and activities

Here are a few questions and some information to further explain and assist in student understanding of vibrations, and how devices like the micro:bit and seismometers record them.

Why were the amplitudes of the recordings smaller when making an 'earthquake' in the ground versus the table?

The ground is very large, it has much more surface area and volume than a table! Any vibrations that you make by stamping your feet move in all directions and spread out as they travel through the ground, and the vibrations detected at any one point are weaker.

The micro:bit that you have is a great tool for measuring vibrations on tables and chairs, but not so good at detecting vibrations that travel through the ground. For those vibrations scientists use more sensitive and accurate seismometers usually placed below ground on solid rock, ensuring that they function accurately.

Do you think one seismic station is enough for scientists to measure earthquakes properly?

To work out the size and location of earthquakes, scientists use the data from multiple seismic stations from all over the world. As the vibrations from the earthquake travel through the ground, seismic stations that are closer to where the earthquake happens detect the vibrations first, followed by those a further and further away. There are well over 100 seismic stations that scientists in Australia use to measure earthquakes.

When I create some vibrations for the micro:bit to measure, sometimes the spikes go up, and sometimes they go down, even if I make the same vibrations twice in a row – why does this happen?

Unfortunately, we do not know the answer to this one – It might be a bit of a quirk with the micro:bit itself.

How does the seismic readout from your class earthquake compare to this real seismic recording of a small earthquake in South Australia?

The seismic readout (or seismogram) above does look a bit different to the readouts we can make with the micro:bit. It shows an event then gradual reduction in the size of the recording. Events in the classroom fade very quickly and disappear from the recording as there is comparatively less energy in the vibrations.

As the vibrations created by an earthquake travel through the Earth's crust, each seismometer will detect those vibrations at different times – seismometers closer to the earthquake will record the vibrations before seismometers farther away from the earthquake. Seismologists use earthquake data from multiple stations around the country to accurately record and locate earthquakes.

Students from Kiwirrkurra school in Western Australia simulating an earthquake as part of a lesson involving micro:bits.

Extra information and resources

Earthquakes@GA website - **https://earthquakes.ga.gov.au/**

Earthquake information - **https://www.ga.gov.au/education/classroom-resources/hazards/natural-hazards/earthquake**

Earthquake monitoring GA video - **https://www.youtube.com/watch?v=GcNVpMZlIDo**

Earthquakes student activities - **https://pid.geoscience.gov.au/dataset/ga/76611**

Introduction to plate tectonics video - **https://www.youtube.com/watch?v=sKBY4aCsnnM&feature=youtu.be**

Joint Australian Tsunami Warning Centre (JATWC) - **https://www.community-safety.ga.gov.au/data-and-products/jatwc**

Understanding the National Earthquake Alerts Centre – **https://www.youtube.com/watch?v=2EZFr_uNyzw&t=33s**

Further information and educational resources
www.ga.gov.au/education/classroom-resources

Curriculum links

This document explores how earthquakes make vibrations in the ground, and how we can monitor and measure those vibrations. Specific curriculum ties with earthquakes don't appear in V9 of the Australian Curriculum until Year 8.

However, these activities support curriculum outcomes beyond the topic of earthquakes. This document explores how the use of digital technologies in the classroom can aid in explaining natural processes. Cross-curricular lines can be drawn between aspects of the primary digital technologies curriculum and general science understanding; the use of scientific tools and equipment and science as a human endeavour – to understand our world.

Thank you!

We hope you and your students had fun using micro:bit as a seismometer. These classroom activities are just a starting point, there is much more to explore using a micro:bit seismometer.

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