

SIEMENS STEM DAY ACTIVITY**GOING WITH THE FLOW****REAL-WORLD
SCIENCE TOPICS**

- An exploration of how erosion and stream formation are related
- An exploration of the speed of water flow changes the shape of a stream
- An exploration of how erosion and sedimentation can affect the landscape

ADDRESSES NGSS**LEVEL OF DIFFICULTY****3****GRADE RANGE****3–5****OVERVIEW**

In this activity, students use a stream table to model the processes of erosion and streambed formation. The students observe changes to the stream environment and make predictions about how these changes will affect the stream. They then study and sketch the resulting streams.

TOPIC

Stream Formation

OBJECTIVE

Students will gain an understanding of the value of using a scale model and the effect of water speed on erosion rate and stream formation.

MATERIALS NEEDED FOR STUDENT ACTIVITY

Materials Needed for Stream Table

- 90 cm x 90 cm sheet of plywood
- two 60-cm two-by-fours
- two 90-cm two-by-fours
- two 10-cm two-by-fours or four-by-fours
- books, bricks, or additional lumber to prop the end of the stream table up (at least 20 cm high)
- nails
- hammer
- drill with 3-cm bit

- large bucket (at least 20 L in capacity)
- hose
- faucet to connect the hose to
- bag of playground sand (at least 7 kg)
- plastic sheet, at least 100 cm x 100 cm in size
- large table
- rocks ranging from 1 cm to 5 cm in diameter
- small pieces of vegetation

Additional Materials Needed for Activity

- Several sheets of paper
- Pencil

TEACHER PREPARATION

Build the stream table by following the instructions provided below. This should be done prior to the day of the activity if possible.

Fill the upper two-thirds of the stream table with sand to a depth of 5 cm. This lab can create a mess with water and sand, so if possible perform the activity outdoors or in an area that is easy to clean up.

About 15 minutes before class starts, turn the hose on at a slow, steady drip and allow the water to run into the top of the sand. You may need to use tape or a clamp to hold the hose in place on the stream table.

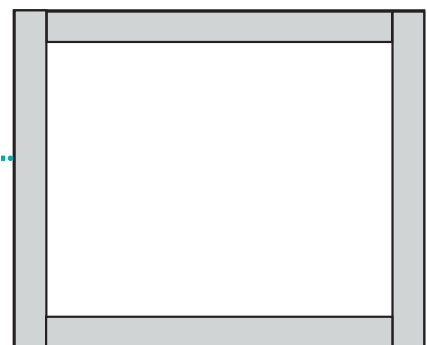
Instructions for making the stream table

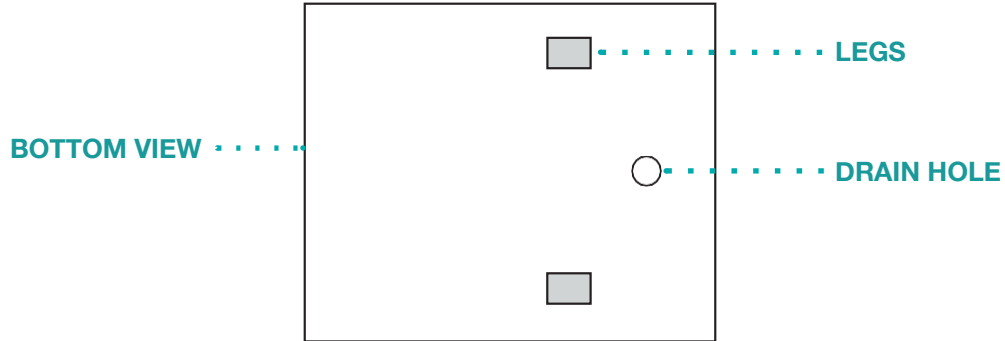
Drill a 3-cm hole about 20 cm from one end of the plywood. This will be the drain.

Nail the two-by-fours on the plywood so that they form a box on the plywood. Make sure the edges of the two-by-fours are touching tightly. See the diagram below. This will be the top of the stream table.

Turn the table over so that the two-by-fours are on the bottom. Nail the 10-cm two-by-fours to the underside of the table. They should be on the same side as the drain hole, but about 20-30 cm closer to the center of the table. See the diagram below. This will allow the drain hole to stick out over the end of the support table.

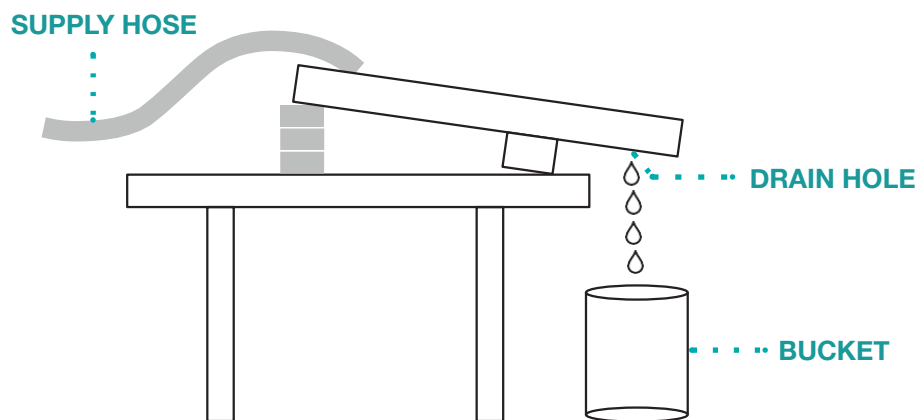
TOP VIEW





Place the plastic sheet inside the “box” formed by the two-by-fours on the top of the table. Press the sheet into the corners of the table, and make sure it is flat against the bottom of the table. Cut a hole in the plastic directly over the drain hole. The plastic will reduce the chances of water or sand leaking out of the stream table.

Place the stream table on top of the support table with the legs of the stream table near one end of the support table. Raise the other end of the stream table using books, bricks, or wood, as shown in the diagram below.



Place the bucket under the drain hole. You will need to empty the bucket periodically. Try to pour out just the water from the bucket, leaving behind any sand that has flowed out the drain.

NGSS THREE-DIMENSIONS

Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
<p>Analyzing and Interpreting Data</p> <p>Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.</p>	<p>ESS2.A: Earth Materials and Systems</p> <p>Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.</p>	<p>Patterns</p> <p>Patterns in the natural world can be observed.</p>

- 1. Warm-up Activity:** Show students a picture of the Grand Canyon and a picture of a small rivulet formed in sand, such as the pictures below. Ask students what these two landforms have in common. Guide students to realize that both were formed by water carrying particles of rock, sand, and soil downstream, a process called *erosion*.

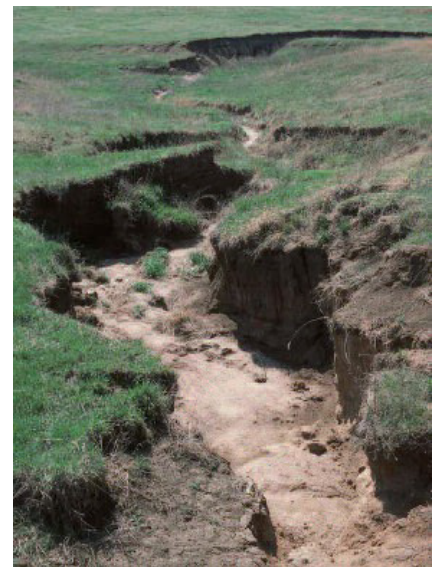
The Grand Canyon is a canyon more than 250 miles long that formed over 6 million years. The Colorado River cut through the rock of the canyon at the same time that the Colorado Plateau was shifting upward. From these movements, the canyon formed with some locations more than a mile deep.

A gully like this one can form during the course of one heavy rainstorm.

- 2.** Explain that erosion can happen on both large and small scales. Show them the picture of the gully again, and ask them how long they think it took to form. Since a small gully could form after a single rainstorm, students should realize that it can take anywhere from minutes to hours to form. Then show them the picture of the Grand Canyon again and ask them how long they think it took it to form. If they do not know, remind them that it took millions of years for the Grand Canyon to erode to a depth of several hundred meters.



Grand Canyon



Gully

- 3.** Discuss what factors might affect the how quickly erosion occurs.

Ask students what factors might affect how quickly erosion occurs and write their answers on the board. Students should come up with such factors as the amount and speed of the moving water, or the number and type of obstacles in the stream. Explain that in this activity they will be using a scale model to test how some of these factors affect erosion. Make copies and distribute the Going with the Flow Student Handout. Students can use this handout to record the answers to the questions posed in this lab. They will also need extra paper to sketch their observations.

- 4.** This will be a teacher-directed activity because the size of the stream table. When students arrive in class, the stream table should already be operational in a basic setup.

Lead the students to the table and ask them to make basic observations about the shape and structure of the stream. Is it curvy or straight? Is there only one channel or are there many? Has a delta formed? Have them record the answers to these questions on the handout and sketch the resulting stream.

- 5.** Begin making modifications to the stream table setup so that students can observe changes in the stream. Reset the stream table by filling the existing stream in with sand.

Ask students to suggest possible changes that could be made to the stream table setup. If they do not suggest them on their own, lead them to suggest changing the speed of the water flow, changing the slope of the table, and putting objects in the way of the stream. Tell the students that the next experiment

will involve increasing the flow of water from the hose. Ask them how they think that this will change the shape of the stream. Have them record their answers on the handout. Then, restart the hose with a greater flow than previously. After a stream has formed, have them again record their results on the handout and sketch the resulting stream.

6. Again, reset the stream table by filling the channel with sand. This time, raise the back of the table so that it has a steeper slope.

Ask students to predict what effect raising the table will have on the stream course. Encourage them to explain the reasoning behind their predictions. Have them record their answers on the handout. While the stream is forming, lead a discussion of the effect of water speed on the shape of the stream. From the previous exercise, they should see that faster moving water digs a deeper, straighter channel. Explain to them that increasing the slope of the stream table will also cause the water to move faster, so the channel formed in this part of the activity should be more like the stream formed by the fast moving water than the slow moving water. Once the stream is fully formed, have them draw a sketch and record its characteristics in the table on the handout.

7. Reset the table, and set up one final exercise. This activity will involve placing stones and pieces of vegetation in the course of a potential stream.

Have a bucket of pieces available for students to place in the sand. Once students have placed their pieces on the table, ask them what effect they think that these will have on stream formation. They should predict that the objects will slow down the flow of water and cause it to bend around the larger objects in the flow. Once the stream is formed, have them draw a sketch and record their observations of its characteristics.

8. **Wrap-up Activity:** Lead the class in a guided discussion of the results of this activity.

Ask students to describe the effects of the changes you made to the stream table on the shape of the stream. Then ask them to compare and contrast the scale model with a real stream. Guide them to look beyond the differences in size and to think about more subtle differences. This includes that most streams have to erode multiple types of rocks and soil instead of just sand. Discuss the fact that most streams also have plants surrounding them. The roots of these plants tend to hold soil in place, reducing erosion. Have students record their ideas on their worksheets. At the end of the discussion, point out the ways that people's actions can increase erosion, and lead a discussion about the potential effects of increased erosion. Examples of human actions that can increase erosion include removing vegetation and paving over soil (which increases runoff due to the low porosity of the pavement). Some effects of increased erosion include soil loss and degradation, habitat loss, and damage to aquatic ecosystems.

This activity setup allows for many types of investigations that are not included here. One activity that interested students could perform would be to use clay or rocks to construct a dam on the river and observe the effects that this has on the downstream water flow. Students could also supply other sources of water to form multiple streams that may or may not feed into one another. For any additional investigations, have students sketch the resulting stream and/or record its characteristics. They can then compare the results to previous results, and discuss similarities and differences.

BACKGROUND INFORMATION

How does erosion occur?

Wind, water, and ice can break rocks down into small pieces over time. Water or fast-moving wind can smash rocks into each other, making pieces chip off. This is called mechanical weathering. Chemicals in water also can dissolve some pieces of rock, leaving other pieces behind. This is called chemical weathering. The particles, called sediment, are then carried downstream. This is the process of erosion. Erosion is a natural process, important for many ecosystems. However, if erosion happens too quickly it can have negative effects on ecosystems.

Where does all that sediment go?

Much of the soil under your feet was once part of a mountain chain, like the Appalachians or the Rocky Mountains. Over millions of years, water and wind have worn down mountain ranges and carried the sediment to nearby areas. Some of this sediment became soil. Other sediment was buried and compressed to form new rock. Much of the sediment was carried into the ocean, and ended up on the ocean floor. Eventually the weight of this sediment becomes so great that the pressure causes new rocks to form. If the rocks are in the right place, they may eventually be thrust up above the ocean surface to form new mountains. Then, the process of erosion will begin again.

How does the speed of moving water affect the rate of erosion?

Water speed is an important factor in the rate of erosion. Faster moving water can carry larger particles. It can also carry particles further than slower moving water. The force of fast moving water may also be enough to break the physical bonds that hold soil particles to each other and to objects like roots.

How can people affect the rate of erosion?

Many human actions can cause erosion to speed up. A common way that people increase erosion rates is by removing obstacles in the stream or straightening the course of the stream. This process is called channelization. Water in a channelized stream moves more quickly than water in a natural stream, thus, faster moving water erodes its banks at a faster rate.

People also increase erosion rates by cutting down trees and other plants. Plant roots help to hold soil in place. Without them, the soil erodes more quickly. A third way that people increase erosion is by covering porous surfaces like soil with nonporous surfaces, such as concrete. Normally, most rain that falls on the ground soaks into the soil. The water moves through the soil slowly. Eventually, it reaches streams and rivers. Land that is covered in concrete cannot absorb rainwater. Instead, the water runs over the surface. It all enters the rivers and streams at once. This can cause flooding and increase the speed of the stream, which increases erosion.

KEY VOCABULARY

erosion: the process of sediment being carried over Earth's surface by wind, water, or ice

weathering: the process by which rock is broken down into sediment; can be either mechanical or chemical

scale model: a resized model of a physical system that allows observation of a process that is too slow, fast, large, or small to be easily observed at full scale

What do you think the stream will look like when the water comes out of the hose more quickly?

[Sample answer: I think the stream will be wider, because there will be more water to move the sand.]

What do you think the stream will look like when the table is slanted more steeply?

[Sample answer: I think the stream will be straighter and deeper. The fast-moving water in the previous exercise created a straighter, faster channel because the sand was moving too quickly to settle.]

What do you think the stream will look like when rocks and other objects are placed in the path of the stream?

[Sample answer: The stream will probably be curvier because it will have to go around the larger rocks instead of going in a straight line. It will also be shallower because the rocks and other objects will slow down the flow of the water, so some of the sand will settle out.]

List some ways that the stream that formed in the model is similar to real streams.

[Sample answers: They have similar shapes. They both form from running water. Their shapes change when the water moves faster or slower.]

List some ways that the stream that formed in the model is different from real streams.

[Sample answers: Real streams flow over many different materials, not just sand. They form much more slowly than the stream in the stream table formed. Water flows into them in more than one place.]

GO WITH THE FLOW

What do you think the stream will look like when the water comes out of the hose more quickly?

What do you think the stream will look like when the table is slanted more steeply?

What do you think the stream will look like when rocks and other objects are placed in the path of the stream?

List some ways that the stream that formed in the model is similar to real streams.

List some ways that the stream that formed in the model is different from real streams.
