

RIVERS

Rivers Instructional Case: A series of 4 student-centered science lessons

Lesson 4



Suggested Timeline

50 minutes

Materials

- 1 Stream table for each station (rectangular tray with drain hole at one end.)
- Approximately 3lb of sand for each station.
- 100g of clay for each station
- 1 16 oz plastic cup with small (1/16" to 1/8" diameter hole) per station
- 1 "flood" cup for each station (16 oz plastic cup with larger hole, ~1/4")
- 1 bucket per station for catching water and storing station materials
- 2 rulers or painter's sticks per station to secure water cups
- 2-3 1-2" tall wooden blocks or stacking pieces per station to adjust angle of stream tables
- 1 roll of masking tape
- 1 bag pieces or plastic cubes representing model buildings
- 1-2 extra containers for water per station

Stream Table Lab

Summary

Students will recreate a model of a river system in a table top experiment. The lesson advances students' qualitative understanding of how rivers shape the Earth's surface while explicitly providing opportunities to develop their science practices such as observation, modeling and experimentation. Students will gain the knowledge that the angle and amount of flow of water affects the shape of the river and observe the surface features that result.

Objective

- Students will investigate stream tables to learn about river systems and how river erosion shapes the landscape.
- Identify factors (e.g. slope, rate of water flow) that affect a river's ability to erode land and carry sediment.
- Students know rivers and streams are dynamic systems that erode, transport sediment, change course and flood their banks in natural recurring patterns.

Teacher Background Knowledge

Rivers are dynamic systems that are constantly changing. In this activity, students will model the evolution of rivers by changing a variety of variables such as the steepness of the terrain and the water flow rate. Rivers transport sediment in a process known as erosion. In this activity, students can observe the transport of sediment downstream by the flow of water. In addition, students will be able to observe the deposition of sediment where the stream empties into the open part of the stream table. The deposition of sediment at the mouth of the river in the stream table is analogous to a natural river emptying into the ocean or a valley forming a river delta or alluvial fan, respectively. Since the mouth of the stream in the table is not submerged, the sediment deposit would be more analogous to an alluvial fan (rather than a delta).

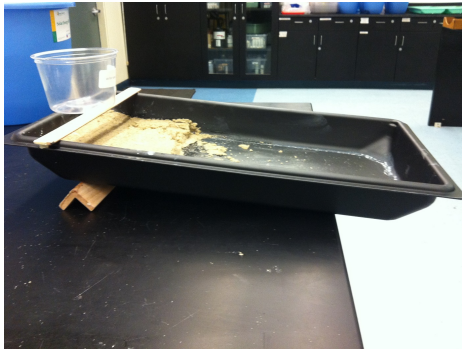
Although it is not possible to observe the spontaneous development of a meander in the stream table, it is sometimes possible to observe a meander if a channel with a sharp bend is cut into the sand before initiating the flow of water. Students can experiment with meanders as part of their investigations.

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Prep

1. Position your spill bucket under the hole in your stream table. Pour the clay into the sand
2. Mix the clay, sand, and some water together. The sediment should stick together but not be too watery. Use your hand or the angle to smooth the sand into a nice shelf.
3. Tape the ruler along the top part of the tray. Make sure the cup can sit on top of your stream table and ruler.
4. Carefully place your angle or book under the back of the stream table.



5. Lab setup will include: buckets containing all station materials, all labeled with a designated number for each station. Quantities of sand, clay, and water will be pre-measured.

Teacher Background Knowledge (continued)

Students will be given the opportunity to change the angle of the stream table and make observations about the differences that they observe. The stream gradient is the ratio of the change in elevation with the distance that the river flows. For example, saying a stream has a gradient of 1 m/km (“one meter per kilometer”) means that the elevation of the surface of the river decreases 1 m for every kilometer that the river flows. Rivers located in mountainous regions would have a high gradient (larger change in elevation over distance) and a higher water velocity. This higher water velocity allows the river to carry more sediment. Likewise, streams with a low stream gradient would have a lower water velocity and would be capable of carrying less sediment.

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Standards ¹²

NGSS Performance Expectations: <i>This lesson supports students in progressing toward the NGSS Performance Expectation.</i>		
MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. [Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.]		
Assessment Boundaries: <i>Assessment does not include the identification and naming of minerals.</i>		
In this lesson...		
Science and Engineering Practices	Disciplinary Core Ideas	Cross Cutting Concepts
Planning and Carrying Out Investigations Students will conduct an investigation to observe various factors that affect a river's ability to erode land and carry sediment. Students will have the opportunity to revise the experimental design to look at slope and rate of water flow. The observational data gathered will support the students' claims about erosion and sediment transportation.	ESS2.A: Earth's Materials and Systems Students learn about erosion and how this contributes to physical changes on the Earth's surface. Erosion may be caused by natural forces such as water, rain, waves, and other surface activities. Students are particularly looking at the landform itself and the amount of water within the system.	Systems and System Models Students will set up a river system containing water, sediment (clay and sand), other variables such as slope. Students will evaluate the model under different circumstances and observe sediment and erosion patterns.
In this lesson...		
CCSS Mathematics		CCSS English-Language Arts
<u>CCSS.MATH.CONTENT.7.RP.A.1</u> As mathematical extensions, students can compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. Students can take the amount of water over time and calculate the water flow rate. Students can also measure the size of the alluvial fan or estimate the amount of sediment that gets deposited into the alluvial fan.		<u>CCSS.ELA-LITERACY.RST.6-8.3</u> Students will follow precisely a multistep procedure of constructing a model of a river system and then when carrying out experiments, they will make observations and will also take measurements.

¹ NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, D.C.: The National Academies Press.

² National Governors Association Center for Best Practices, Council of Chief State School Officers Title: Common Core State Standards (insert specific content area if you are using only one) Publisher: National Governors Association Center for Best Practices, Council of Chief State School Officers, Washington D.C. Copyright Date: 2010

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Lesson

1. Activate Prior Knowledge
 - a. Personal experience - take a few examples of rivers (e.g., local rivers, famous rivers, historical examples), allow students to share personal examples
 - i. See San Francisco Bay Delta model, e.g.,
http://en.wikipedia.org/wiki/U.S._Army_Corps_of_Engineers_Bay_Model
 - b. Erosion/deposition are familiar terms from previous lessons
 - c. Warm-up prompt: what is an example of erosion caused by moving water?
 - d. Flood pics/video to encourage discussion – an example is the Science Friday video, “Recipe for a River”.
2. Lab Procedure
 - a. Roles: Assign roles to each student in group (pourer, sand sculptor, data recorder, etc.) – rotate roles between experiments
 - b. Teacher- demo with document camera.
 - c. Set up stream table with the dirt moved completely to one side.
 - d. Set a wooden block underneath the stream table to create a gradient where the water flows downhill on the slope.
 - e. Predict: What will happen when the water is turned on? Have students turn on the water so that it pours in a steady, moderate stream.
 - i. How will changing the angle of the stream table affect the water velocity?
 - ii. How will water velocity affect the amount of sediment that is carried by the “river”?
 - iii. How will changing the flow rate affect the erosion rate or channel shape/size?
 - f. Have students pour sand evenly into each tray until it is filled halfway. Spray the sand with water and dirt the sand around until it is moistened. (This will help hold the sand inside the aluminum tray when it is propped on an incline.
 - g. Have students place the water jug on the side of the aluminum tray opposite the runoff hole.
 - h. Freedom of angle inquiry: Day 1 (Day 2 load quantities) Tell students that they will perform an experiment to model and compare differences between river formation on a flat but inclined terrain, and river formation on a landscape with hills and valleys.
 - i. Freedom of meander/straight channel (sand sculptor role)
3. Whole Class / Small Group Critical Thinking Questions
 - a. What is the pattern of erosion that your group observed?
 - b. Where does the sediment come from? Where is the sediment being deposited?
 - c. What angle of flow carried the greatest sediment load?
 - d. Where is most of the sediment load deposited?
 - e. Does the channel always stay in the same place as the water is flowing? What happens to the channel over time?
 - f. How did the flood (changing flow rate) affect the experiment?
 - g. Describe the flow of the water and how the sediment load is carried.
 - h. If your group experimented with meanders, what happened to the meanders over time? Where did the erosion occur in the meanders?
4. Evaluate the Model
 - a. Limitations of the model versus an actual river
 - b. Revising the model to incorporate other factors

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Lesson on C-E-R

1. Discuss the C-E-R Framework with the class by asking students their definitions of claim, evidence and reasoning is.
2. Using the Audi Commercial: My Dad is an Alien to introduce students to the components of an explanation by asking them to identify the claim, the evidence, and the reasoning – or rule – that connects the evidence to the little girl's claim that her dad is a space alien.
3. Distribute the River Erosion C-E-R worksheet.
4. Next, we can ask and discuss with students:
 - a. What data do they need?
 - b. How does the angle flow affect river erosion?
 - c. And how did they collect that data?
 - d. How did they investigate?
5. Students will need to determine from their observations, data and print resources how angle of flow affects erosion. Review with students the investigation conducted and now, they can determine an explanation.

Ask students-what does a good explanation look like? Construct a poster with the students that looks like this:

6. In pairs, let students circle the claim, evidence and reasoning in the River Erosion C-E-R worksheet.

Potential Pitfalls

This activity is a model of how rivers may evolve over time. As an instructional model, it has its limitations and may vary from what actually occurs in nature. For example, it may be very difficult to observe the development of a meander and other features in the stream table. Students should also be mindful that real rivers evolve over geologic time whereas this activity accelerates the time scale to the class lab time. Lastly students may not be able to grasp the quantitative concept of the stream gradient, but can qualitatively understand that the angle of the stream table is analogous to the steepness of the landscape. This steepness of the stream table (landscape) affects the flow velocity of the water, the amount of sediment carried by the stream and the evolution of the river.

Note the following modifications for ELD students:

ELD Modifications

- a. Level 1: "Point to..."; "Show me..."; Pose Yes/No questions
- b. Level 2: Either/Or Questions; 1-Word Answer Prompts i.e. "What is this called?"
- c. Level 3: Sentence Frames; Prompts to describe, compare, share their observations
- d. Level 4: "What would happen if..."; Compare/Contrast i.e. lower vs. higher angle of flow