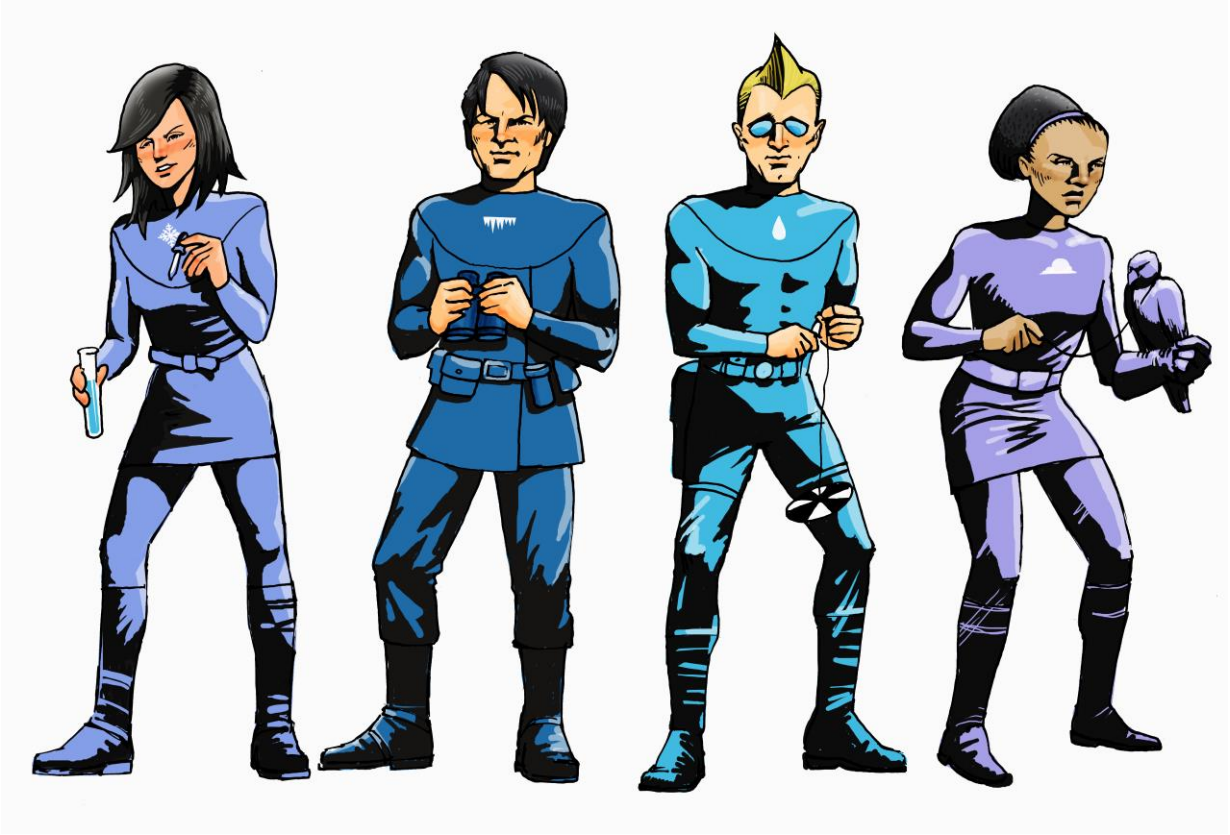
The Ways of Water

Teacher's Guide: Grade 8



AQUA TEAM

the Next Generation

Beaver Water District

Revised November 2015

Overview

Beaver Water District Building Blocks to Water Education Program

What are the project objectives?

Objectives: To develop age-appropriate educational materials to teach students about Beaver Lake watershed protection and water treatment at Beaver Water District.

Why was this project developed?

This project was developed to ensure that drinking water education and watershed education, based on Beaver Lake and the Beaver Lake Watershed, would be available in schools located in areas that receive drinking water from Beaver Water District.

Desired student outcomes:

1. Students will understand drinking water sources.
2. Students will understand that water is a valuable resource necessary for quality of life in Northwest Arkansas.
3. Students will relate watershed health to water quality in Beaver Lake.
4. Students will learn definitions related to drinking water and watershed.
5. Students will learn about activities and behaviors that will promote watershed health in Beaver Lake, and thus become stakeholders when it comes to their own water quality.
6. Students will relate this information and these behaviors to their family members and friends and others in the community.
7. Students in higher grade levels (such as high school) will understand lake zones, a natural lake vs. a manmade lake, and technical terms such as trophic, mesotrophic, oligotrophic, lacustrine zone, riverine etc.

What is the history of the Beaver Water District?

Mission: Our mission is to serve our customers' needs by providing high quality drinking water that meets or exceeds all regulatory requirements and is economically priced consistent with our quality standards.

History: Fifty years ago, visionary community leaders got together to discuss the need for a long-term supply of clean, safe water for Northwest Arkansas. With an eye to the future and knowledge that a large lake was the best source of water, these citizens worked to establish Beaver Lake Reservoir. Beaver Water District was created to pay for the drinking water supply allocation of the lake. The dam that created Beaver Reservoir and the first water treatment plant were completed in the mid-1960s. Since that time, the District has expanded facilities and improved to keep up with increased water demand and stricter drinking water standards. In addition, three other water utilities have been created to provide drinking water from Beaver Lake.

Where did the name originate?

The Beaver Water District got its name from Beaver Lake. Beaver Lake got its name from the town of Beaver, which is actually located in the Table Rock Lake region, according to the Corps of Engineers' office in Rogers, Arkansas.

What areas of Arkansas are covered and which towns and cities benefit from Beaver Water District?

Beaver Water District supplies safe, clean water to about 300,000 people and industries on Northwest Arkansas. The district sells water wholesale to **Fayetteville, Springdale, Rogers, and Bentonville**.

Fayetteville buys water from Beaver Water District and owns and operates the system in Fayetteville, Farmington, Greenland, Goshen, Wheeler, parts of Johnson and some rural areas in Washington County. Fayetteville also provides wholesale service to Elkins, West Fork, and Mount Olive Rural Water Association.

Springdale Water Utilities buys water from Beaver Water District and sells to consumers in Springdale, Bethel Heights, Elm Springs, the northern part of Johnson, the southern part of Lowell, and unincorporated areas of Washington and Benton counties that are within its designated water service boundary. Bulk sales are made to consecutive water systems operated by the cities of Cave Springs and Tontitown.

Rogers buys water from Beaver Water District and resells it to Rogers and a portion of Lowell and to Benton County Rural Development Authority (RDA) No. 4 Frisco Springs.

The city of *Bentonville* buys water from Beaver Water District and resells it in Bentonville and Bella Vista. You can access a diagram at the District's website at ***www.bwdh2o.org***.

How does Beaver Water District impact the Northwest Arkansas region?

Beaver Lake provides drinking water to more than 400,000 people and industries in Northwest Arkansas, including the largest concentration of food industries in the United States. Another way to put it is this: **One out of seven people in the state of Arkansas gets his or her drinking water from Beaver Lake**, which provides raw water to the District, as well as three other drinking water utilities.

According to a recent population study, there could be as many as 1.2 million people residing in Northwest Arkansas by 2055. Through its master planning process, Beaver Water District (BWD) stays ahead of a growing population's demand for industrial and residential water supplies and reduces the strains of rapid growth on infrastructure including wastewater treatment, roadway expansions, traffic management, waste disposal and other services.

The District's new administration building accommodates space needs for staff and increases **accessibility to the public for educational and other purposes**. The facility is built in accordance with the Leadership in Energy and Environmental Design (LEED) program, a green building rating system. Educational components of the building include a Water Education Center featuring a drinking water treatment plant model and a topographical wall sized map of the Beaver Lake Watershed, as well as educational kiosks and a self-guided walking tour of low impact development features (to be completed in Spring 2012).

Beaver Water District wants you to know that **your tap water is "food grade and table ready,"** and it has been since the plant began operations in the 1960s. The District operates around the clock to make sure that your water is safe to drink. So, the next time you turn on the tap or read an article comparing the merits of tap water versus bottled water, think about all the people beyond the pipe who make it possible for you to have potable water in Northwest Arkansas.

For more information & education resources send an email to:

education@bwdh2o.org
www.bwdh2o.org

Frameworks

Arkansas Framework Correlations have been aligned within each of the unit lessons. These frameworks can be found through the ***Arkansas Department of Education's web site for curriculum***

http://arkansased.org/teachers/frameworks.html

7 Es Teaching and Learning Model

Although the 7 Es Teaching and Learning Model (Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extensions) is not specifically detailed within each lesson, it is implied throughout the unit. We referenced this model from ***Primary Connections*** http://www.science.org.au/primaryconnections/5Es.html

CHAPTER 1

Lesson 1: Streams - Erosion & Deposition

Purpose

Streams are a major part of the erosion process. Along with weathering and mass wasting, stream erosion and deposition shapes the landscape.

Objective

Students will predict and then model changes when variables, such as load, slope, amount of water, or the composition of a stream bed are changed through erosion or deposition.

Each student team will generate a problem, hypothesis, and corresponding investigation dealing with water erosion and/or deposition.

Arkansas Framework Correlation

Language Arts

8th Grade

OV.1.8.2 Use standard English in classroom discussion and presentations
OV.1.8.6 Contribute appropriately to class discussion
OV.3.8.1 View a variety of visually presented materials for understanding of a specific topic

Science

8th Grade

NS. 1.8.1 Justify conclusions based on appropriate and unbiased observations.

NS.1.8.3 Formulate a testable problem using experimental design.

ESS.8.8.4 Synthesize and model the result of both constructive and destructive forces on land forms: deposition, erosion, weathering, crustal deformation.

ESS.8.8.8 Demonstrate an understanding of the agents of erosion: gravity, water, ice, wind, and animals including humans.

ESS.8.8.9 Using models of rivers, predict changes when variables, such as load, slope, amount of water, or the composition of a stream bed, are changed through erosion or deposition.

Social Studies

8th Grade

G.3.8.5 Analyze methods and consequences of environmental modification on world *regions* and populations (e.g., acid rain, erosion, clear cutting, desertification, global warming, ozone depletion, strip mining,)

Problem Question

This will vary by student group. (This activity is a high level, inquiry based science lesson requiring students to generate the problem and investigation and carry through.)

BACKGROUND INFORMATION

- A stream is a body of water that carries rock particles and dissolved ions and flows down a slope along a clearly defined path, called a channel.
- Running water is the major agent for shaping much of the Earth's surface.
- The amount of rock and soil that a stream can transport depends on the speed of the moving water and its discharge (volume of water flowing past a certain point at a given unit of time. m3/sec or ft3/sec).
- The speed of a stream is dependent on its slope and discharge.

- Streams may vary in width from a few centimeters to several kilometers.
- Billions of tons of sediment are carried by streams to lower elevations.
- Streams carry most of the water that goes from the land to the sea.
- Streams carry dissolved ions from chemical weathering, into the oceans and thus make the oceans salty.
- Streams are a major part of the erosional process. Along with weathering and mass wasting, stream erosion and deposition shapes the landscape.
- Streams are a major source of water and transportation for the world's human population.
- Most population centers are located next to streams.
- Stream load consists of suspended load made up of particles that are carried along with the water in the main part of the stream.
- Bed load consisting of coarser, denser particles that stay on the bed of the stream most of the time, but move (jump) when particles collide or there are turbulent eddies.
- Dissolved load made up of ions from chemical weathering that have dissolved in the water.

Keywords

Erosion: The chemical and mechanical or physical wearing down of Earth's surface by water/ice and wind.

Deposition: The mechanical settling or chemical precipitation and gradual accumulation of materials that have been transported by water/ice or wind.

Sediment: Matter that has been deposited after transport by water/ice or wind.

Weathering: Chemical and mechanical or physical changes in materials exposed to and acted upon by meteorological conditions: precipitation, temperature, wind.

Chemical Weathering: The alteration of chemical composition and dissolving of materials by water, atmospheric gases, or organism secretions.

Mechanical or Physical Weathering: The breaking down of materials into smaller particles resulting from changes in temperature and/or moving water/ice or wind, growing vegetation, and alteration by organisms.

Timeline

Two (2) class periods.

Materials

Sand
Potting soil
Other soils as available
Gravel
Dishpans or Al foil pans (or stream tables if available)
Paper or foam cups
Metal spoons or hand shovels
Water
Other containers or materials that students request (within reason).

Teacher Preparation

Make materials/supplies available.

Assign student groups of 3-4 the variable that they are to design an investigation and test (load, slope, amount of water, or the composition of a stream bed).

Additional Resources

Resources for materials not included:
UA Center for Math & Science Education
http://www.uark.edu/~k12info/
479.575.3875
Northwest Arkansas Education Co-Op
http://starfish.k12.ar.us/web/
479.267.7450
Beaver Water District
www.bwdh2o.org
479.717.3807
Know of other resources? Please let us know!
education@bwdh2o.org or 479.756.3651

7E's Streams - Erosion & Deposition

Elicit

Observation Charts:

- Post pictures of stream load, slope, amount of water, stream bed composition, and deposition (can be found and printed with search at Google images) around the room with chart paper at each.
- Give each set of student partners a marker.
- Have the student partners rotate around the room to each picture and write on the chart paper
    - What they observe.
    - What they think is happening, happened before, or is about to happen.
    - What questions they have.

Engage

At their tables, have student groups discuss each of the following animations/clips.

Modes of Sediment Transport animation: http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::640::480::/sites/dl/free/0072402466/30425/10_14.swf::Fig.%2010.14%20-%20Modes%20of%20Sediment%20Transport

Flood Plain and Stream Terrace: http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::640::480::/sites/dl/free/0072402466/30425/10_27_10_43_10_45.swf::Figs.%2010.27,%2010.43,%2010.45%20-%20Flood%20Plain%20and%20Stream%20Terrace

Meander Cut-offs and Oxbow Lakes:
http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::640::480::/sites/dl/free/0072402466/30425/10_22_10_23.swf::Figs.%2010.22,%2010.23%20-%20Meander%20Cut-Offs%20and%20Oxbow%20Lakes

River Flows into Lake:
http://www.classzone.com/books/earth_science/terc/content/visualizations/es0604/es0604page01.cfm?chapter_no=visualization

Streambed Load Transport: http://www.weru.ksu.edu/new_weru/multimedia/movies/dust003.mpg

The Graded (sloped) Stream:
http://www3.interscience.wiley.com:8100/legacy/college/strahler/0471238007/animations/ch17_animations/animation3.html

Explore

Procedure:

1. State your problem, hypothesis, then have approved by teacher.
2. Design an investigation using the materials and equipment provided to test your hypothesis. Have approved by the teacher.
3. Conduct the investigation, record results, analyze and draw conclusions.
4. Report to class.

Explain

Revisit the *Elicit* pictures and charts. Have student groups of 4 discuss each picture and the information on the charts from earlier.

Revisit the animations/clips from the *Engage* section. Have the students once again discuss each.

Elaborate

3 minute video clip from discoveryeducation.com: *How Does the Force of Streams and Rivers Shape the Earth?*
http://player.discoveryeducation.com/index.cfm?guidAssetId=E38503D9-6681-4F11-A83E-954692198165&blnFromSearch=1&productcode=US

Make it Relevant: Students research and share information about well-known landforms and waterways in Arkansas and the rest of the United States that serve as examples of the changes brought about by water erosion and deposition.

Evaluate

Students will be evaluated

- As each stage of the inquiry activity is approved and observed.
- As student teams discuss and fill out charts (Elicit) and discuss animations/clips (Engage).
- On journal write-ups of analysis and conclusions based on investigations.

Extensions

Field trip to a local stream to

- Observe streambed, stream banks, surrounding landforms, etc.
- Test water quality, water velocity at the surface and below the surface, etc.

Lesson 2: Topographic Mapping – The Ups & Downs of Mapmaking

Purpose

The Beaver Lake Watershed includes all the rivers, streams, and runoff from sloping land which flows into Beaver Lake. It is impacted by activities that occur within the surrounding waterways and sloping areas. Activities such as recreation, farming, construction, and industry all affect the quality of the water in Beaver Lake. Geologic Beaver Lake Watershed maps may be found at the Beaver Water District website, www.bwdh2o.org , and the United States Geological Survey website, http://www.usgs.gov/pubprod/.

Objective

Students will construct a 3-dimensional watershed model and generate 2-dimensional (planar) map of their watershed.

Arkansas Framework Correlation

Language Arts

8th Grade

IR.12.8.9 Use research to create one or more oral, written, or visual presentations/products.

Science

8th Grade

ESS.8.8.3 Conduct investigations to compare and contrast different landforms found on Earth: mountains, plateaus, plains

ESS.8.8.7 Use topographic maps to identify surface features of Earth

Mathematics

8th Grade

G.8.8.2 Make, with and without appropriate *technology*, and test *conjectures* about characteristics and properties between *two-dimensional* figures and *three-dimensional* objects.

Social Studies

8th Grade

G.1.8.3 Construct specialized maps using data (e.g., *climate*, population, *political* units, resources).

G.1.8.5 Analyze the influence of Earth's physical features on the development of *regions* of the world.

Problem Question

What man-made constructions and/or natural features have the greatest effect on stream dynamics and water quality in the Beaver Lake Watershed?

BACKGROUND INFORMATION

- A topographic map is a map that depicts changing elevation in landforms. (the ups and downs of the terrain)
- Beaver Lake is surrounded by sloping landforms and numerous streams flow into it.
- In 1879 the U.S. Geological Survey (USGS) was established and produced the first topographic map.
- In the 1940's, scientists began to measure and interpret aerial photographs to produce topographic maps.

- On a topographic map, different colors are used to model natural structures and elevations.

- On a topographic map, brown contour lines show landform elevations.

Timeline

One to two (1-2) class periods.

Materials

- Modeling medium (choose from clay, sand, soil, dough, etc.)
- If a volleyball sand court is available, use it!
- Water in pouring container (optional) *How much mess are you willing to deal with?*
- String or yarn
- Tray, board, or AL foil covered cardboard for model base
- Scissors
- Paper and pencil (mapping)
- Paperclip

Teacher Preparation

Make materials and art supplies available.

Additional Resources

Resources for materials not included:
UA Center for Math & Science Education
http://www.uark.edu/~k12info/
479.575.3875
Northwest Arkansas Education Co-Op
http://starfish.k12.ar.us/web/
479.267.7450
Beaver Water District
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479.717.3807
Know of other resources? Please let us know!
education@bwdh2o.org or 479.756.3651

7E's Topographic Mapping

Elicit

In pairs or small teams, students answer questions (at the end of this lesson) about topographic maps. Use whatever resources you have available to collect data on what the students already understand.

- Have students write letters of correct answers on a sheet of paper or individual sized marker boards and hold up their team's answer after each question.
- Use an electronic clicker system.
- Use a program in the computer lab to enter the questions and gather data

Engage

Interactive building of a topographic map to be done in pairs or in a whole group, on computer in the classroom with a projector. http://www.forgefx.com/casestudies/prenticehall/ph/topo/topo.htm.

Explore

Procedure:

1. Using the modeling materials supplied by the teacher, construct a watershed with hills of varying elevations.
2. Optional: Be sure that it is water-tight. Then, partially fill the "lake" of your model.
3. Using a pencil point or paperclip end, make rows of holes (at same height) all around the "lake" and at other levels on the model. **The holes in each row should be the same height.** Use a ruler to keep the holes level.
4. Carefully, lay lengths of string (yarn) around each hill to join the holes in each row.
5. Looking down on your model, the lines of string will be the contour lines on the map.
6. Draw the topographic map of your model. Be sure to draw a line at the height of the lake edges.
7. Place your model and maps where the teacher instructs to prepare for walk-around.

Explain

Walk Around; Student teams will now rotate around the room comparing student topographic maps to the watershed model that was constructed. Leave notes at each model about what is good and how to improve. (Teacher may want to time the rotation and have students rotate to the next model approximately every 2 minutes.

Elaborate

Student teams use the notes from other teams and the teacher to improve their model and topographic maps.

Evaluate

Student will be evaluated by

- the walk around by students during *"Explain"* part of lesson.
- informal monitoring of the teams as they build the model and draw the maps.
- formal assessment of the model and corresponding maps.

Extensions

Using aerial photographs of the Beaver Lake Watershed, have student partners draw topographic maps of the area.

Questions for Elicit

1. On a topographic map, a contour line shows points of __ elevation(s)?
    a. equal
    b. higher
    c. lower

2. Topographic maps show
    a. political boundaries for congressional districts
    b. manmade features such as historical markers
    c. contour lines showing shape and elevation of land

3. What color is a contour line on a topographic map?
    a. black
    b. white
    c. yellow
    d. brown

4. What color is water on a topographic map?
    a. white
    b. green
    c. blue

5. Woodlands are what color on a topographic map?
    a. white
    b. green
    c. blue
    d. black

6. V shaped contour lines point
    a. downstream
    b. upstream

7. The first U.S. Geological Survey (USGS) topographic map was produced in
    a. 1752
    b. 1879
    c. 1925

8. In 1940 a great stride was made in mapmaking. What brought this about?
    a. satellite imagery
    b. aerial photography
    c. infrared imagery

Answers to Questions for Elicit

1. A
2. C
3. D
4. C
5. B
6. B
7. B
8. B

Lesson 3: H_2O: An Agent of Erosion

Purpose

The West Fork of the White River Watershed includes all the rivers, streams, and runoff from sloping land which flows into Beaver Lake. It is impacted by activities that occur within the surrounding waterways and sloping areas. Activities such as recreation, farming, construction, and industry all affect the quality of the water in Beaver Lake. West Fork of the White River Watershed geologic maps may be found at the Beaver Water District website, www.bwdh2o.org , and the United States Geological Survey website, http://www.usgs.gov/pubprod/.

Objective

Student teams will investigate erosion caused by water flowing over surface areas and the effect on water sources.

Arkansas Framework Correlation

Language Arts

8th Grade

OV.1.8.2 Use standard English in classroom discussion and presentations.

OV.1.8.6 Contribute appropriately to class discussion.

OV.3.8.1 View a variety of visually presented materials for understanding of a specific concept.

OV.4.8.2 Organize ideas by using such graphic organizers as charts/graphs, and formal outlining with main topics, sub-topics, and details.

Science

8th Grade

ESS.8.8.4 Synthesize and model the result of both constructive and destructive forces on land forms: deposition, erosion, weathering, crustal deformation.

ESS.8.8.8 Demonstrate an understanding of the agents of erosion: gravity, water, ice, wind, and animals including humans.

ESS.8.8.9 Using models of rivers, predicts changes when variables, such as load, slope, amount of water, or the composition of a stream bed, are changed through erosion or deposition.

Social Studies

8th Grade

G.3.8.5 Analyze methods and consequences of environmental modification on world *regions* and populations (e.g., acid rain, erosion, clear cutting, desertification, global warming, ozone depletion, strip mining).

Problem Question

What is the role of water as an agent of erosion? How do changes in land use affect stormwater runoff, water quality, stream dynamics, and watershed topography?

BACKGROUND INFORMATION

- Erosion is the natural process by which soil and rocks are moved by wind or water along the earth's surface.

- The eroding of fertile topsoil causes loss of land productivity.
- Eroded particles will eventually settle out of the air or water and change the environment on which they settle.
- As particles in water settle, bottom organisms are covered and channels are filled with sediment. These particles may also absorb chemicals such as fertilizers, pesticides, heavy metals and other toxins and carry them to water sources.
- Most sediments come from non-point sources (bare fields, housing projects, construction sites and cities).
- Crop productivity and landscaping is enhanced by the use of commercial fertilizers and animal manure to supply nutrients. However, some of this fertilizer will dissolve in water and leach into the ground water supply or be carried during erosion as runoff.

Timeline

One to two (1-2) class periods.

Materials

- Bags of potting soil (or do investigation outside using soil in schoolyard)
- 1 metal spoon or hand shovel
- 3 Plastic dishpans or Al foil roasting pans
- paper or foam cups with 10-15 toothpick holes punched in the bottom of one of the cups
- facial tissue

Teacher Preparation

Make materials and supplies available.

Additional Resources

Resources for materials not included:
UA Center for Math & Science Education
http://www.uark.edu/~k12info/
479.575.3875
Northwest Arkansas Education Co-Op
http://starfish.k12.ar.us/web/
479.267.7450
Beaver Water District
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479.717.3807
Know of other resources? Please let us know!
education@bwdh2o.org or 479.756.3651

7E's H2O: An Agent of Erosion

Elicit

Using the interactive activity at http://www.kineticcity.com/mindgames/warper/ find out what students know about types of erosion.

AND/OR

Agree/Disagree: Give student partners the list of agree/disagree statements at the end of this lesson. They read the statements one at a time and together decide if they agree or disagree and write a rationale for their decision.

Engage

Concentration game to be done whole group in the classroom or as individuals or partners in the computer lab. http://www.quia.com/cc/512.html?AP_rand=1511523442 .

Explore

Procedure:

1. Fill the first pan with soil and smooth it flat to form level land.
2. Fill the cup that does not have holes with water.
3. One student holds the cup with holes 12 inches above the "plain."
4. Another student gently pours the water from the other cup into the cup with holes.
5. Sketch the setup into your journal, watch what happens and record the observations in your journal.
6. Fill another pan with soil and form a hill or mountain near the center.
7. Repeat steps 2-5 in the mountain pan.
8. Fill a third pan with soil and cover the hill or mountain with facial tissue to model a grass covered hillside.
9. Repeat steps 2-5 with the "grass" covered hillside.

Explain

Exit slip the day of the lab: What did you learn from this investigation?

Elaborate

Collaborative posters: Students list places they have seen or know of vegetation being planted to prevent erosion. (In groups of 4-6, each student takes a turn writing one place. Each student uses a different color of marker.)

Evaluate

Student will be evaluated by

- Teacher observations during lab

- Journal entries
- Student partners will revisit their agree/disagree statements and rationales and write a statement explaining any changes in their thinking, citing evidence from their unit experiences

Extensions

Build 2 soil "mountains" beside one another in the schoolyard. Cover one "mountain" with sod and leave the other uncovered. Photograph the mountains twice weekly for several weeks to record changes in the mountains caused by erosion. Post the photos in the classroom for all students to observe. Students write a conclusion in their journal about what they have learned from the observations of the 2 "mountains."