Art and Nature as Inspiration for River Restoration

(300 min - 5 days, for 45-60 min)

Authors

Leigh Metcalfe

Dwan Blue-Stewart

SUBJECT/GRADE LEVEL

Subject Area: Science
Grade Level: 4th grade

Materials

For a class of 30 students:

- Images: Andy Goldworthy art, nature as art
  - Slides to present images to students
  - If possible, print in color, laminate and allow students to manipulate and look closely
- Access to Discovery Education or Gizmo
  - Discovery Education Simulation
  - Gizmo Simulation
- Materials for all stations:
  - Science notebooks, pencils, computers
- Station 1
  - Sugar cubes
  - Plastic tray
  - Ziploc baggie
- Station 2
  - Viewing handout with questions
- Station 3
  - Coarse sandpaper
  - Rocks (limestone, calcite, or other soft stones)
- Erosion/River Modeling Supplies:
  - Bag of sand
  - 1 Pen or pencil
  - 1 Cup of small rocks
  - 1 Large bottle of water
  - 1 Baking tray (or similar sized container)
- Natural and reused materials
  - Collected by students on a campus/nature walk

STANDARDS

Next Generation Science Standards

- 4-ESS2-1 Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
- 4-ESS3-2 Earth and Human Activity: Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*

Engineering -

- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Mathematics Standards | Common Core State Standards

- MP.2 Reason abstractly and quantitatively.
- MP.4 Model with mathematics.
- MP.5 Use appropriate tools strategically.
- 4.MD.A.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. (4-ESS2-1)
- 4.MD.A.2 Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale. (4-ESS2-1)

English Language Arts Standards | Common Core State

- W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-ESS2-1)

LESSON OBJECTIVE(S)

As students explore nature as inspiration for art and engineering, they will engage in a variety of activities that model and explain weathering and erosion.

Students will be able to:

1. Run experiments and models how rivers and streams change Earth's surfaces.
2. Record data about the changes to a stream during weathering and observe how materials are moved during the process of erosion.
3. Use nature as an inspiration to redesign engineering solutions that will reduce the materials carried away by the weathering process.
4. Apply the data collected from the models and provide evidence and explanations for the phenomenon during a science seminar.

CAREER CONNECTION(S)

Mentor Background:

Kyle McKay: U.S. Army Engineer Research and Development (ERDC); Vicksburg, Mississippi

S. Kyle McKay is a research civil engineer with the U.S. Army Engineer Research and Development Center (ERDC) Environmental Laboratory (EL). He is stationed in New York City to facilitate cooperative research between the ERDC, local U.S. Army Corps of Engineers offices, the City University of New York, and other local partners. His research focuses broadly on examining ecological effects of water resources infrastructure with applications related to urban ecosystem restoration, ecological models, dam operations and decommissioning, and flood risk management. Integrated water resource management is "a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (Global Water Partnership). Dr. McKay's team generally works on the science, techniques, and tools to realize the vision of integrated water resource management.

STEM Careers:

- **Environmental Engineer** - As the nation's environmental engineers, the U.S. Army Corps of Engineers manages one of the largest federal environmental missions: restoring degraded ecosystems, constructing sustainable facilities, regulating waterways, managing natural resources, and cleaning up contaminated sites from past military activities. Environmental engineers conduct assessments of existing facilities and infrastructure, environment habitats, resources and natural water systems to develop ways of mitigating degradation to the environment.
- **Environmental Scientist**- Environmental scientists and specialists use their knowledge of the natural sciences to protect the environment and human health.
- **Material Moving Machine Operators** - Material moving machine operators use equipment to move earth and materials for construction and engineering projects.
- **Environmental Science and Protection Technicians**- Environmental science and protection technicians monitor the environment and investigate sources of pollution and contamination.
- **Arts and Design Occupations** - create products and concepts that have practical or aesthetic purposes. For example, industrial designers combine art, business, and engineering to develop the concepts for manufactured products.
- **Urban Planner**/**Real Estate Agent**: Develop land use plans and programs that help create communities, accommodate population growth, and revitalize physical facilities. Real estate brokers and sales agents help clients buy, sell, and rent properties.

References:

Bureau of Labor Statistics, U.S. Department of Labor, [Occupational Outlook Handbook], on the Internet at [https://www.bls.gov/ooh/] (visited [6/29/2023]

US Army Corps of Engineers [U.S. Army Corps of Engineers Headquarters Website], on the Internet at [https://www.usace.army.mil/careers/] (visited [6/29/2023]

ENGAGEMENT

Duration: 10-45 min
Brief Description: Students will observe, consider and discuss photographs of natural landforms and Land Art. Students will analyze the use of nature to inspire art, nature as art and how elements of nature can inspire engineered designs.

Procedures:

Teacher prep prior to lesson:

Decide on the format for the engage lesson

- display images in a presentation format- Slideshow
- or print and laminate the images in slideshow for students to select, discuss, and compare

Teacher will:

- Use presentation to introduce the phenomenon and engineering challenge
- Organize students into pairs or small groups for discussion
- present the images to the students (through presentation or print)

Students will:

- Individually - select a pair of images that stand out to them and answer a few questions in their science notebook or on the student hand out.
- Discuss their answers with small group
- Select a second set of images and follow the procedure again
- Participate in a whole class discussion of the prompts and generate observation, questions and connections that they have made to previous content/experiences.
- Use student responses to assign roles to students and to inform the organization of students into selective grouping. Students will gravitate toward images and provide responses that will allow them to be grouped into groups of 4, one of each of the following roles 1. Artist/landscape architect 2. Environmental scientist/conservation biologist/researcher 3. Engineer/material moving machine operators 4. Urban planner/communication specialist
- After the class discussion
    - Take students on a nature walk around the school
        - Have students look for art in nature, art inspired by nature and any engineering solutions they can find around the school
        - If possible, ask students to collect small natural items to use in the engineering design challenge later in the lesson.
            - Tell students they are looking for natural items that would inspire them to create artist engineering projects. These items would be things like - rocks, twigs, sticks, plant fibers, grasses that could be braided, ect.

Opportunities for formative assessment:

- As students explore the images, the teacher can circulate the room and listen to student discussion to gather information about student background knowledge and misconceptions.
- Prompt students to share answers during whole group discussion to gather student questions, background information and misconceptions.

EXPLORATION

Duration: Two-Three 45-minute class periods

Brief Description: Students can model the effects of weathering and erosion to create small scale landforms to understand how particular structures and formations may arise from weathering and erosion processes.

Students will need to explain the difference between climate and weather and how humans can help improve/decrease the effects of erosion. Create a foldable (tri-fold) about the impact that nature can repair itself and how humans can help make it better, types of erosion and how it affects different regions around the world.

Procedures

Use this video to begin you research -DEMYSTIFIED: What's the difference between weather and climate? | Encyclopaedia Britannica

Divide students into three groups. Allow the groups to rotate through each station, using science notebooks to record observations from the mini-lab activity.

Station 1 - Physical Weathering

- Students will model the process of physical erosion.
- Students will be using sugar cubes (3 -6).
    - Place a tray on the table and put six sugar cubes in a plastic bag.
    - Have students press down and crush the cubes apart.
    - Discuss what happened and make observations.
    - Focus Question for students - if enough pressure is applied to a rock or an area that is eroding, what do you think is happening/has happened?

- Teacher will provide students with quick vocabulary review using Quizlet
    - (https://quizlet.com/815023567/weathering-erosion-deposition-flash-cards/?i=sh7de&x=1qqt)
- This will be a whole class activity to engage students and review understanding of key terms and the concept surrounding erosion.

Station 2 - Kissimmee River Restoration Project (FL)

- Students will view the video and follow along with the video to answer questions regarding what was learned. Use the information to make observations. Teacher will explain to the students that this summarizes the research and engineering involved in the restoration process for the river. Students will view the video using leading questions/handouts to take notes. (the handout has the link for the video attached).
- The Kissimmee River: Then and Now Video GUIDED NOTE-TAKING STUDENT WORKSHEET | CES/FAU

Station 3 - Wind Erosion

- Focus question for students is to determine which part of the demonstration modeled erosion and which part of the demonstration modeled deposition?
- Place a rock on the table with coarse sandpaper. Have students sand the rock for a few minutes to demonstrate wind. Have students discuss and record observations regarding sediment movement and how wind reshape the rock formation.

Station 4 - Erosion Podcast (5 minutes)
Have students create a brief podcast.

- Have students make observations about erosion from the playground, neighborhoods, and local construction sites. Using the information gained as they move through the stations and these observations, have students create a brief podcast.
- Guide students with these questions:
    - How can humans help improve nature?
    - How does nature rebuild itself as a result of erosion?
    - If you are working for a company and need to create a way to reduce erosion for a riverside nature trail in your hometown, what materials (not plastics or any other harmful materials) would you need to use?

Formative Assessment: To help support and provide more information, students can use BrainPop video to provide evidence of the effects of the rate of erosion through weathering. The quiz will provide a way to check for understanding (interaction between the teacher and students).

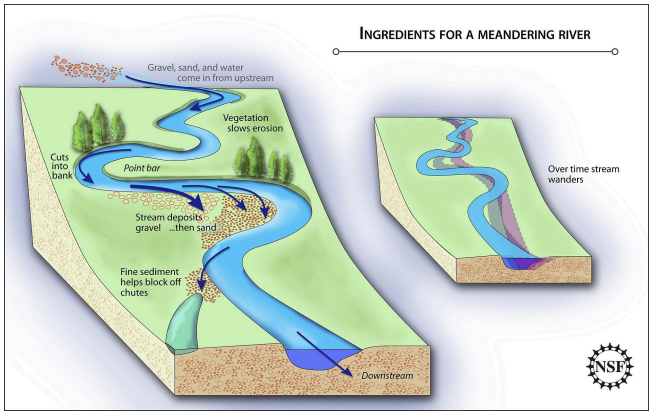
Students will build knowledge using the movie, assess what was learned using the Erosion Challenge and Quiz. Differentiate individual students, when necessary, using other activities and resources attached to the movie-for more engagement-individualized student needs.

Additional resources to enrich or supplement in the lesson:
1_Erosion.pdf
2_Erosion Questions.pdf
ErosionLevel2_SG_CE_Final_rev.pdf
https://www.ces.fau.edu/education/resources/
https://www.ces.fau.edu/education/resources/climate-change.php
https://www.youtube.com/watch?v=I5OJJPcyngk

EXPLANATION

Duration: 45-minutes to an hour
Brief Description:
Students will:

- apply what they learned in the exploration to design and test a model of stream/river bank weathering, erosion and deposition.
- They will be able to change the shape, depth and materials that make up the river using a few supplies and a reusable bottle of water.



Procedures:
The teacher will set up stations or allow students to design their own models to test.

If teacher makes models:

- Create models of the local river systems
- or find images online to create stations.

If the students are designing their own; the students will: (Slideshow with roles and responsibilities)

Students take on the role they have been assigned and complete the tasks that match their role

Teacher models each step so students can see what the step looks like, but then have the freedom to create their own model with in the parameters set by the teacher. You can show this video as a model.

- Engineer:
  - Make a landmass with the sand in one half of the tray, the landmass will slightly lower than the edge of the tray on one side, then slant downhill leaving space at the bottom where the eroded soil can collect.
- Scientist:
  - Students will lightly drag a pen or pencil through the sand in an "S" shape to create a riverbed.
- Artist/Architect
  - Place rocks/river rock/stone along the riverbed.
  - Slowly pour water where the riverbed starts and then allow it to run downhill along the riverbed.
- Communications & Artist
  - Observe the results of the water running through the riverbed at the bottom of the hill
  - Draw a diagram of the model they tested, then discuss a plan to reduce the amount of sand that is at the bottom of the river using the recycled/reclaimed/natural materials they have collected.

After the students have explored the river models and erosion:

The teacher will:

- Introduce the concept of "Engineering with Nature" and challenge students to create nature-based erosion reduction devices from the recycled materials they collected.
- Revisit the engineered approaches discussed in the engage
- Explain that teams decide on objectives/problems to solve using nature
  - Ask students to select two of the following goals to address with their plan
    - beauty, habitat, pollination, erosion reduced, artistic, use only materials provided by nature, wildlife, plant life
- Introduce the concept of "constraints" - Time, Materials, Cost, Location
  - In this challenge, you will have the constraints of time and materials
  - Possible math extension- add the constraint of cost
    - Students will develop a budget to purchase materials used in design

As a team, students will continue to consider the perspectives from their role, but collaborate to complete the following steps in their science notebook:

- ***Plan*** an artistic and nature-based solution to the problem of erosion
  - Have students clearly identify two objectives/problems they will solve using nature: beauty, habitat, pollination, erosion reduced, etc
- ***Explain***:
  - why they think it would work
    - Include explanation of how they will address the constraints
    - Describe how their design achieves the selected objectives

ELABORATION

Duration: 45-minutes to an hour
Brief Description: During this phase, students will learn a bit more about some of the innovative "Engineering with Nature" solutions used to improve stream health across the United States. With the new ideas in mind, students will revisit the plans that they made, modify and improve their designs then implement the engineering solution. They will collect data from testing the model and evaluate the effectiveness of the design.

Procedures:
Teacher:

- Use the slide show to revisit the explanation of Engineering with Nature and provide an overview of modifications to rivers that have been implemented in the US. (Slide 18)
    - Suggestion: look for local examples that may be found in your city, state or region and supplement the slides with local images.
- Share the background information with the students about each engineered with nature example.

Students will:

- Share out why they think it follows the description of Engineered with Nature.
- Generate questions that they have about the images
- Discuss in their groups, would this example be helpful for *their* model.

Teacher will revisit the expectations for the Engineering Design Challenge

- Their solution should follow the Engineering with Nature definition
- Their solution should meet the two goals they agreed upon as a team
- Their solution should be able to be completed within the constraints of time and materials available.

Teacher will remind the students than they have specific roles and will complete specific tasks

- Step 1: Whole Team collaboration- explain that all engineering projects require a wide variety of team members and they all have different role. They must work together and find consensus and compromise to complete the project.

Students will

- Discuss the sediment found in the bottom of the initial model
- Why it happened and plan to reduce the amount of sand that is at the bottom of the river
- Determine how the recycled, reclaimed, natural materials collected could be used

Engineer:

- Use the natural materials team collected to engineer the solution team agreed upon
- Once it is created, set it on the table/desks, do not add it to the model yet.

Scientist:

- Recreate the initial riverbed model, and create an "S" shape to which will act as the riverbed

Artist:

- Design the ecosystem, Replace rocks/river rock/stone along the riverbed.

- Work with team to determine the best location for engineered by nature solution, now add it to the model

Communications:

- Once the model is reset, and the new addition inspired by nature is in place, rRun the water over the new design
- Record the results of the test- What changed? What moved? What was improved? Did anything get worse?

Artist again:

- Draw a diagram of the new model, the engineered solutions that you added and any changes your team saw from the new design.
- Label items that - improved, changed in other ways, became worse

Teacher will:

Guide students in Team

- Take a moment to reflect on your design
- Did you team meet your goal
- Did you team stay within the constraints
- What new idea do you have about using nature to inspire engineering solutions

Guide students Individual reflection

- What was the hardest part of this challenge for you
- What was the hardest part of this challenge for members of your team
- What did you learn about "Engineering with Nature" from this project

Reflection and discussion are opportunities for teachers to use a checklist or observation for formative assessment.

EVALUATION

Duration: 30-45 min

Brief Description:

Students talk with a partner about their ideas on certain claims and the evidence provided to them. They have a chance to practice their arguments in a relaxed way before a whole class discussion. They then participate in the Science Seminar, a group discussion in which students make sense of evidence and debate which claims are best supported.

Procedures:

Teacher:

- Introduce science seminar and show slides with claims (Slide 34) (5 Min)

Students:

- In preparation for the Science Seminar, students consider the claim they think is the most convincing and decide which pieces of evidence supports this claim.

Preparing for the Science Seminar

Teacher:

- Provide the instructions for the partner discussion. Allow students an opportunity to rehearse their argument in a low-stakes environment prior to engaging in the all-class discussion.
- Remind students of the expectations for productive participation in a Science Seminar, introducing them to the procedure.

Students:

- Discuss and debate their ideas about the claims and evidence with a partner. (10 min)
- Participate in the Science Seminar (20 min.)
- Students apply ideas about erosion, weathering, deposition, engineering with nature and practice scientific argumentation through a collaborative group discussion.

Teacher:

- Ask students to reflect on their experiences
- Assess the students' understanding of the major concepts and ability to prepare for and engage in scientific discussion.

Alternative ideas for Evaluation:

Tri-fold brochure - Climate change examples, types of erosions, how humans affect the process of erosion and climate change and global changes made as a result of changes.

Climate Podcast (5 minutes) -have students produce a podcast and present it to the class. Instructions given during the exploration part.

Use quizlet, kahoot (as a vocabulary review)

1. Describe the difference between climate and weather citing an example of each.
2. Describe how water (ocean, lake, river) has a local effect on weather and climate and provide evidence.
3. Describe how global patterns of wind such as the jet stream or ocean currents influence weather and climate of local regions. Describe how human impact can affect these patterns in a negative way.

REFERENCES

- Bureau of Labor Statistics, U.S. Department of Labor, [Occupational Outlook Handbook], on the Internet at [https://www.bls.gov/ooh/] (visited [6/29/2023]
- US Army Corps of Engineers [U.S. Army Corps of Engineers Headquarters Website], on the Internet at [https://www.usace.army.mil/careers/] (visited [6/29/2023]