

IMPLEMENTING OUTDOOR EDUCATION CURRICULUM: THE BENEFITS OF,
BARRIERS TO, AND MATERIALS REQUIRED FOR SUCCESSFUL OUTDOOR
EDUCATION

by

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Project Summary

I have had the opportunity to spend my entire life living in locations with access to tremendous amounts of outdoor green spaces and heavily forested areas. This has provided me with the opportunity to learn about the world around me by being a part of it and studying it closely in a natural setting. When I became a teacher, it was an easy decision to go into the sciences as my chosen specialty because I wanted to share my own interests in nature with the students I interacted with. Somewhere along the way I fell into the same trap as many other teachers, however: I stopped focusing on natural learning and spent far too much time indoors talking about abstract ideas that kids were not relating to. Luckily, years spent interacting with other science teachers and witnessing how they used our on-site school forest led me back to the use of outdoor learning as a strategy to engage my students and encourage deeper learning. I have personally witnessed many of the benefits touted by researchers such as a longer retention of learned information (Fagerstam and Blom, 2012) and a greater connection to nature with an emphasis on being good stewards of natural resources (Stern et al., 2008). Seeing these benefits first hand made me want to share my experience with others, but I knew that I would need to be able to convince reluctant educators to venture outside, and to do that I needed a compelling argument for taking learning outdoors. This led me to trying to answer the following question to share with others: *How can outdoor education be used successfully to improve the success and well-being of children?*

To answer this question, I developed a curriculum for fourth grade students that incorporates outdoor learning elements to foster a greater understanding of how classroom concepts impact the real world and encourage students to internalize the information that they are interacting with. The curriculum also offers students an opportunity to be active outdoors, which

has been shown to improve mental health symptoms associated with conditions such as attention-deficit/hyperactivity disorder (Guardino et al., 2019) as well as general physical health due to the heightened levels of physical activity found in students who are learning outdoors (Mygind, 2007). These lessons were created to balance both indoor and outdoor education to provide a level of comfort for teachers who are not yet comfortable venturing outside every day with classes of students, but could all be adapted to be taught in an outdoor setting if the teacher desired. The lessons included in this curriculum are intended to provide students an opportunity to view concepts from the classroom happening in real-time within their own community, as well as provide them with opportunities to simulate their own theoretical situations and explore the results of their trials.

The lessons found within this curriculum are ordered in a way that allows them to address two fourth-grade Minnesota science standards tied to the processes of weathering and erosion. Each lesson builds upon the ones that came before it, presenting students with increasingly challenging situations that require them to draw upon their new knowledge about weathering and erosion to solve problems and reflect on their discoveries. Each lesson was designed to take between 30 and 60 minutes out of respect for the tightly controlled learning schedule that many elementary school teachers report operating within (Reese, 2018).

Each lesson was formatted using a template modified from the work of Wiggins and McTighe (2011), creators of the Understanding by Design (UbD) curriculum framework. The template begins by sharing the broad unit overview, as well as the lesson overview, to emphasize the goals of the curriculum and where in that curriculum the particular lesson fits. Next, a section featuring desired results highlights which standards the unit is working towards meeting, as well as what the learning goals are for that particular lesson. The desired results section also

highlights the essential questions that students should be trying to answer when completing the lesson. The third section of the template outlines what will be available to students during the lesson to use as learning tools, as well as what will be available to the teacher to assess student learning. Finally, the fourth section, identified as the learning plan, provides a materials list, a brief list of learning activities for the lesson, and a more detailed breakdown of the full lesson plan for the benefit of the teacher. Following each template is a copy of every document or worksheet that will be used during the completion of that lesson. These documents can be used as individual worksheets, digital worksheets, or as documents that are glued into science journals for better organization and reflection.

Student learning and progress will be assessed using four point teacher rubrics attached at the end of each lesson template. Each rubric identifies a skill or set of knowledge that students should be attempting to master during the lesson, as well as descriptions of what each level of mastery would look like to the assessing teacher. Lessons steadily build up the skills of students until they are prepared to show their mastery of the entire standard in a summative assessment. Summative assessment rubrics contain the code for the standard being addressed, as well as the skills each student must demonstrate to achieve different mastery levels associated with the standard. These rubrics can be used or modified as needed by teachers to identify standard mastery achieved by individual students based on work produced by the student. In addition to demonstrating increasing content knowledge, students are expected to demonstrate increasingly proficient levels of reflective behavior, problem solving, and solution planning abilities.

Unit: Weathering and erosion

Grade: 4

Lesson 1: What are weathering and erosion?

Length: 30 minutes

Overview

Unit overview: In this unit, students will be exploring the causes and results of weathering and erosion and creating ways to prevent weathered materials from being taken away from their source. First, students will become familiar with the terms weathering and erosion and find places in their own home environment that have been impacted by these natural processes. Next, students will explore simple ways that weathering and erosion can be sped up or slowed down. Third, students will attempt to create their own artificial weathering and erosion systems to break down a material as quickly as possible with natural means. Finally, students will create a way to keep weathered material from eroding away from its source location.

Lesson overview: In this lesson, students will be brainstorming ways that a large source material, such as a mountain, could be torn down over time and reduced to nothing more than piles of sand. This will result in the introduction of two natural phenomena: weathering and erosion. This lesson is intended to be the first in a series of 11 lessons that will lead students to an understanding of how weathering and erosion can be altered by natural and artificial means. Students will be introduced to the idea of source material being broken down, as well as the idea of movement of materials such as sand as you do not see mountain-sized sand piles very often. They will work in groups with peers to brainstorm ways that mountains could be reduced to sand particles, then discuss together the means for spreading out the sand. As a whole group, they will share out ideas before learning that these two processes have names: weathering and erosion.

Weathering and Erosion: Weathering is the process by which a larger material is broken down into smaller pieces through natural means such as wind, water, ice, or biological interactions. Erosion is the process where weathered particles are transported to new locations, often by natural means such as blowing wind, running water, or moving glaciers. Together, these forces reshape the surface of Earth over a tremendous length of time. However, these forces can also be observed on a much shorter time-scale, often around the homes of students in the form of cracked roads, washed-out driveways, and sidewalks broken by tree roots.

Desired Results

Established Goals: 4E.1.2.1.1: Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation. 4E.1.2.1.2: Plan and carry out fair tests in which variables are controlled and failure points are considered to improve a model or prototype to prevent erosion.

Student Learning Goals:

- I can describe a way to break down a large object and move the pieces away
- I can work with peers to solve a

Essential Questions:

- What natural force has the power to reduce large objects, such as mountains, to smaller objects, such as

<p>problem</p> <ul style="list-style-type: none"> ● I can describe what it means to weather an object ● I can describe what it means when an object is eroded 	<p>sand, over time?</p> <ul style="list-style-type: none"> ● Where do the smaller objects go after they have been broken free and how did they move at all?
<h3>Assessment Evidence</h3>	
<p>Student Learning Tools:</p> <ul style="list-style-type: none"> ● Essential questions ● Large and small group discussion ● Brainstorming Guide 1 	<p>Assessments of Learning:</p> <ul style="list-style-type: none"> ● Informal observations ● Brainstorming Guide completion ● Teacher Rubric
<h3>Learning Plan</h3>	
<p>Learning Activities:</p> <ul style="list-style-type: none"> ● Students work with partners to explain mountain deterioration. ● Students participate in whole-group share-out. ● Students estimate the time it would take to destroy a mountain. ● Teacher will explain weathering. ● Students work with partners to explain how small materials are moved to new places ● Students participate in whole-group share-out of new ideas. ● Teacher will explain erosion. ● Students glue Brainstorming Guide into notebooks for safe keeping. 	
<p>Materials: Science notebook, pencil, Brainstorming Guide 1, glue, pictures of a mountain and a beach</p>	
<p>Lesson Plan:</p> <ul style="list-style-type: none"> ● Begin by handing out a copy of the “Brainstorming Guide 1” to each student. ● Organize students into groups of 3 to work together. ● Show students pictures of two things: a mountain and a sandy beach. <ul style="list-style-type: none"> ○ These pictures may be taken from books that students are familiar with, social studies texts, nearby landmarks, or simply google searches if nothing relatable can be found. ● Instruct students to answer the first question on the Brainstorming Guide together: What is powerful enough to turn a mountain into sand? ● When they have finished, allow a representative from each group to share their best idea. <ul style="list-style-type: none"> ○ Record ideas on the board. ● Have students answer question 2 from the Brainstorming Guide: How long do you think this process would take? ● Allow students to share answers as a whole group, recording them on the board as well. ● Briefly introduce the word weathering and what it means, noting that it happens over millions of years. ● Have students include an explanation of what weathering is for question 3 in the 	

Brainstorming Guide.

- Next, students should answer questions 4 and 5 on the Brainstorming Guide together: “Where does all of the material go?” and “How does it get moved there?”
- Once more, allow a student from each group to share an answer for each question, recording them on the board.
- Introduce the concept and definition of erosion to students.
- Students should record a definition of erosion under question 6 on the Brainstorming Guide.
- Have students take out their science notebooks.
- Students should glue their Brainstorming Guide 1 into their science notebook.
- Inform students that they will be creating weathering and erosion right in front of their eyes tomorrow!

Template adapted from Understanding by Design, written by Wiggins and McTighe (2011)

Brainstorming Guide 1

Name: _____

1. What is powerful enough to turn a mountain into sand?

2. How long do you think this process would take?

3. What is weathering?

4. Where does all of the material go?

5. How does it get moved there?

6. What is erosion?

Guided Questions

The following page contains questions that may be helpful for interacting with struggling students while they are completing the first brainstorming guide, specifically questions 1, 4, and 5. Some students may have a difficult time relating the destruction of a mountain to something they are familiar with, or vice versa. These questions, or questions like them, may allow students to access prior knowledge and help them apply it to the abstract example of a mountain being weathered or eroded.

Question 1:

- What small thing could be turned into sand? (a rock)
 - How would you turn a rock into sand?
 - How could that be applied to something larger?
- What things could you use from your garage to make a large rock smaller? (hammer, sandpaper)
 - What could then act like nature's hammer or sandpaper?

Question 4:

- What is the material? (sand, rocks, boulders, pebbles)
 - Where do you see those things nearby? (deserts, driveway, beaches, lake bottoms, rivers)

Question 5:

- Why isn't there a giant pile of sand left over where a mountain used to be? What could possibly carry that away?
- Why are there piles of rock at the bottom of hills or mountains? (gravity)

- Why do dogs need a bath? (They get dirty, and dirt is tiny rock being moved with the dog)
- Have you ever felt the sting of sand hitting your face? What carried the sand? (the wind)

Rubric

	1	2	3
Brainstorming Completion	Student's answers did not relate to the content matter at all, or worksheet was not present in journal.	Student completed only part of the worksheet, or provided some answers that did not relate to the subject matter.	Student completed entire worksheet, ideas are on-topic and sensible.
Weathering and Erosion	Student was unable to describe either new vocabulary word accurately, or did not attempt to describe either word.	Student was able to accurately describe one of the two new terms in their brainstorming log.	Student accurately described both weathering and erosion on their brainstorming log.

Unit: Weathering and erosion

Grade: 4

Lesson 2: Weathering and erosion lab

Length: 60 minutes

Overview

Unit overview: In this unit, students will be exploring the causes and results of weathering and erosion and creating ways to prevent weathered materials from being taken away from their source. First, students will become familiar with the terms weathering and erosion and find places in their own home environment that have been impacted by these natural processes. Next, students will explore simple ways that weathering and erosion can be sped up or slowed down. Third, students will attempt to create their own artificial weathering and erosion systems to break down a material as quickly as possible with natural means. Finally, students will create a way to keep weathered material from eroding away from its source location.

Lesson overview:

In this lesson, students will be using candy and water to simulate the effects that water can have on a solid object. Students will be putting several drops of water on a piece of candy at a time, then recording the results of their actions. After a time, changes will be made to how the water is applied, as well as how the water moves, by altering the position of the container being used. This will allow students to simulate different water flow speeds, erosion patterns, and the effect that gravity can have on the movement of weathered materials.

Desired Results

Established Goals:

4E.1.2.1.1: Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation.

4E.1.2.1.2: Plan and carry out fair tests in which variables are controlled and failure points are considered to improve a model or prototype to prevent erosion.

Student Learning Goals:

- I can make a prediction about an event that will happen in the future.
- I can collect evidence about a naturally occurring event.
- I can use evidence to support or reject my prediction
- I can explain how water is able to weather objects slowly over time
- I can explain how water is able to erode small materials
- I can use a model to support my

Essential Questions:

- What happens to solid objects that are repeatedly struck by water?
- How do the effects of weathering change when I apply water to an object in different ways?
- How do the effects of erosion change when I change the layout of an environment?

claims	
Assessment Evidence	
Student Learning Tools: <ul style="list-style-type: none"> ● Weathering and erosion lab ● Data collection table ● Weathering and erosion lab sheet ● Turn and talk review with partners 	Assessments of Learning: <ul style="list-style-type: none"> ● Informal observation of lab participation ● Data collection table ● Weathering and erosion lab sheet ● Teacher rubric
Learning Plan	
Learning Activities: <ul style="list-style-type: none"> ● Students will turn and talk to a partner about the meaning of weathering and erosion. ● Students will complete the weathering and erosion lab. ● Students will complete the follow-up questions on the lab sheet. ● Students will glue the lab sheet and data table into their science journals. 	
Materials: Bag of jolly ranchers, plastic bins, water, droppers (pipettes), weathering and erosion lab sheets and data tables, pencil, science journal, glue	
Lesson Plan: <ul style="list-style-type: none"> ● Have students take out their science journals and turn to the copy of “brainstorm guide 1” that should be glued inside.. ● Have students turn and talk to a neighbor about what they wrote down as a description for both weathering and erosion to remind them what the two terms mean. ● Explain that everyone will be doing a group activity today to help them understand how weathering and erosion happen. ● Put students into groups of 4 if possible, while a group of 5 is also workable if needed. ● Send students to their group location and provide each group with a plastic bin. ● Hand out a copy of the weathering and erosion data table and a weathering and erosion lab sheet to each student. ● Read through the instructions from the lab sheet with the students as a group. ● Provide each student with one dropper and one jolly rancher. ● Students follow directions from their lab sheets and conduct the experiment. <ul style="list-style-type: none"> ○ They should be filling out the data table as they progress through the activity. ● When finished with the lab, students should answer the follow-up questions found on the weathering and erosion lab sheet. ● Students should glue the weathering and erosion lab sheet and data table into their journals when they are finished. 	

Template adapted from Understanding by Design, written by Wiggins and McTighe (2011)

Weathering and Erosion Lab

Introduction: In this lab, you will be working with partners to study the effects of weathering and erosion on a solid object using water and a piece of candy. Follow all directions carefully.

Step 1: Make sure you have all of the materials you need. Your group should have the following items: A plastic bin, 1 water dropper per person, a cup of water, and one piece of hard candy per person.

Step 2: Each group member should unwrap their candy and place it in one corner of the plastic bin. Groups of 5 will need to have someone put their candy in the center of the bin.

Step 3: Fill up your water dropper, then carefully and slowly place 2 drops of water onto your candy.

Step 4: Observe what happens, then fill in what you did and saw on your weathering and erosion data table for trial 1. Include that you used 2 drops of water, and share what you saw happen in the observation section.

Step 5: Place two more drops of water slowly on your candy, then record your observations again under trial 2.

Step 6: For trial 3, place 4 drops of water slowly onto your candy and record your results in the data table. Do the same thing for trial 4.

Step 7: For trial 5, place 4 drops of water quickly onto your candy, then record the results on your data table.

Step 8: For trial 6, place another 4 drops of water quickly onto your candy, then record the results on your data table.

Step 9: Find something thin but sturdy, such as a notebook or a thin book, and place it under 1 end of your candy bin so that the bottom of the bin now has a slope.

Step 10: For trial 7, use your dropper to put 4 drops of water quickly onto your piece of candy, then record the results on your data table.

Step 11: For trial 8, place as many drops as you would like on your candy, but keep track of how many you use. Be sure to record the number of drops, as well as your observations, on the data table when you have finished.

Step 12: Throw your remaining candy in the garbage, rinse out your bin, and put all of your lab materials inside of the clean bin for your teacher to collect.

Step 13: Complete the follow-up questions about the lab to show what you learned.

Weathering and Erosion Lab Follow-up Questions

1. In this lab, where did you see weathering?

2. In this lab, where did you see erosion?

3. What sort of real-world, large objects could be weathered like the candy from this lab?

4. What sort of real-world things could break down an object like the water did in this lab?

5. How could you tell that the piece of candy was slowly being weathered by the water?

6. What happened when you started to add more water each time?

7. What happened to the erosion when you added a slope to the plastic bin?

8. What would be some possible reasons why one mountain would get weathered and eroded faster than another mountain?

Weathering and Erosion Lab Data Table

Trial	Number of Drops	Observations
1		
2		
3		
4		
5		
6		
7		
8		

Lab Sheet Answer Key

1. Weathering happened when pieces of the hard candy were slowly broken away by the water.
2. Erosion happened when the broken pieces of candy were carried away from the large remaining piece of candy
3. Rocks, mountains, hills, roads, driveways, river beds, or any other solid objects could be weathered like the candy.
4. Weather such as rain and wind, flowing water, ice, or vegetation growth could all damage an object like the water in our lab.
5. I could see the water turning colors, which meant it was breaking loose pieces of candy. The piece of candy also got smaller.
6. The piece of candy disappeared faster and the pieces were carried farther and farther away.
7. The tiny pieces of candy and the water all moved much farther away from the big piece of candy, and they did it much faster. It may also have caused extra weathering on the pieces of candy lower in the bin.
8. One mountain might get more rain or water flow, one mountain could have a steeper slope so that the water did more damage to the rock and also carried pieces farther away, or one mountain might be made of softer materials that are easier to break off and carry away.

Teacher Rubric

	1	2	3	4
<p>Standard 4E.1.2.1.1 Using observations and measurements to provide evidence of the effects of weathering or rate of erosion by forces of water</p>	<p>Student did not complete the activity OR student was not able to identify which parts of the lab simulated weathering and which parts simulated erosion.</p>	<p>Student was able to complete the lab activity, but was only able to use observed evidence to identify and describe changes to weathering OR erosion.</p>	<p>Student successfully performed lab and recorded data to support their claims.</p> <p>Student successfully used data and observations to describe changes to weathering and erosion from the lab</p>	<p>Student successfully performed lab and recorded data to support their claims.</p> <p>Student successfully used data to describe changes to weathering and erosion from the lab.</p> <p>Student was able to apply the lab to a real-world scenario to describe probable causes of different rates of weathering and erosion.</p>

Unit: Weathering and erosion

Grade: 4

Lesson 3: Weathering and Erosion Field Trip

Length: 60 minutes

Overview

Unit overview: In this unit, students will be exploring the causes and results of weathering and erosion and creating ways to prevent weathered materials from being taken away from their source. First, students will become familiar with the terms weathering and erosion and find places in their own home environment that have been impacted by these natural processes. Next, students will explore simple ways that weathering and erosion can be sped up or slowed down. Third, students will attempt to create their own artificial weathering and erosion systems to break down a material as quickly as possible with natural means. Finally, students will create a way to keep weathered material from eroding away from its source location.

Lesson overview: In this lesson, students will apply their new knowledge of weathering and erosion to real-world environments to determine whether these new phenomena occur in their own home region. Students will be reviewing what they learned in the previous lab activity with their peers and teacher, then they will be taking a trip outside to make observations about potential areas where weathering or erosion have occurred around their school. They will be recording their observations and answering questions about what they have seen at a later time.

About the field trip: I strongly recommend doing this lesson in the spring after snow has melted. This provides an excellent opportunity to witness damage done by water runoff and ice in the form of cracked or uneven roadways, ditch erosion, weathering and erosion of river or lake banks, cracked sidewalks, or places where dirt or soil have been washed away on dirt paths around the school grounds. It is also beneficial to pre-plan your route outside to maximize the amount of examples that students can see in the most efficient time possible.

Desired Results

Established Goals:

4E.1.2.1.1: Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation.

4E.1.2.1.2: Plan and carry out fair tests in which variables are controlled and failure points are considered to improve a model or prototype to prevent erosion.

Student Learning Goals:

- I can use the words weathering and erosion correctly in conversations with peers.
- I can identify weathering events in my own community.
- I can identify erosion events in my own community.

Essential Questions:

- What are examples of weathering events that have taken place in your own community?
- What are examples of erosion events that have taken place in your own community?

<ul style="list-style-type: none"> ● I can document my observations for later reflection. 	
<h3>Assessment Evidence</h3>	
<p>Student Learning Tools:</p> <ul style="list-style-type: none"> ● Group review of previous lab activity ● Whole-group review of previous lab activity ● Field trip outside to view weathering and erosion events ● Weathering and erosion observation sheet 	<p>Assessments of Learning:</p> <ul style="list-style-type: none"> ● Completed weathering and erosion observation sheet ● Informal assessment of answers provided in review activities ● Teacher rubric
<h3>Learning Plan</h3>	
<p>Learning Activities:</p> <ul style="list-style-type: none"> ● Students will review work done in the previous lesson with their lab groups. ● Students will share answers to post-lab questions as a whole-group. ● Students will participate in a walk outdoors, writing down observations they make related to weathering and erosion in their own community. ● Students will glue their observation sheet into their science journal. 	
<p>Materials: Science notebook, weathering and erosion lab sheet and data table, pencil, clipboard, weathering and erosion observation sheet, glue</p>	
<p>Lesson Plan:</p> <ul style="list-style-type: none"> ● Have students take out notebooks and turn to the page where they glued the weathering and erosion lab sheets and data table ● Give students 5 minutes with their lab groups from the previous lesson to review what they wrote as answers to the follow-up questions. <ul style="list-style-type: none"> ○ Student groups should select 1 answer per question to share with the class. They should try to make sure that each person from their group gets to answer at least 1 of the questions. ● In a whole group, allow each of the groups to share out an answer to the questions from the lesson 2 follow-up worksheet. <ul style="list-style-type: none"> ○ Carefully highlight correct portions of responses, while gently correcting any mistakes that may have been in student responses. ● Once finished, pass out a copy of the “weathering and erosion field trip” sheet attached to this document. ● Inform students that they will be taking a short walk outside to discover whether weathering and erosion happen around their own school. ● Briefly go through the instructions with them as a whole group so that they understand what sort of observations they should be writing down and describing. ● Give each student a clipboard to write on and make sure everyone has a pencil. ● Go for a walk outside, giving students time to write down observations whenever they 	

are near evidence of weathering and erosion.

- Upon returning inside, have students glue their field trip observations sheet into their science journal.

Template adapted from Understanding by Design, written by Wiggins and McTighe (2011)

Weathering and Erosion Observations

Directions: You are about to take a short walk through the areas surrounding your school. As you walk, keep an eye open for any signs you see of weathered objects or places where materials have been eroded away. Whenever you see something, fill out one of the “What do you see?” sections on this sheet, then be sure to write in whether you think it is weathering, erosion, or both.

Observation Number	What do you see?	Is it weathering, erosion, or both?
1		
2		
3		
4		
5		
6		
7		
8		

Teacher Rubric

	1	2	3	4
Weathering and Erosion Observations	Student's observations are not recorded or do not correctly identify any signs of weathering or erosion from within their community.	Student provides some correct examples of weathering and erosion, but also provides examples that do not exhibit weathering or erosion, or improperly labels their examples.	Student provides clear observations of weathering and erosion that are properly identified.	Student provides clear observations of weathering and erosion that are properly identified. Observations are highly detailed and offer theories as to why the weathering or erosion may have occurred.

Unit: Weathering and erosion
Lesson 4: Field Trip Reflection

Grade: 4
Length: 30 minutes

Overview

Unit overview: In this unit, students will be exploring the causes and results of weathering and erosion and creating ways to prevent weathered materials from being taken away from their source. First, students will become familiar with the terms weathering and erosion and find places in their own home environment that have been impacted by these natural processes. Next, students will explore simple ways that weathering and erosion can be sped up or slowed down. Third, students will attempt to create their own artificial weathering and erosion systems to break down a material as quickly as possible with natural means. Finally, students will create a way to keep weathered material from eroding away from its source location.

Lesson overview: In this lesson, students will be relating their knowledge of weathering and erosion to real-world examples that they observed in their own community during the previous lesson. Students will be sharing a selection of their observations with the entire class before reflecting on one of their own observations and answering questions about it.

Desired Results

Established Goals:

4E.1.2.1.1: Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation.

4E.1.2.1.2: Plan and carry out fair tests in which variables are controlled and failure points are considered to improve a model or prototype to prevent erosion.

Student Learning Goals:

- I can describe a specific example of weathering from my own community.
- I can describe a specific example of erosion from within my own community.
- I can predict what led to the weathering or erosion of a location in my community.

Essential Questions:

- What is an example of weathering that you have seen in your own community?
- What is an example of erosion that you have seen in your own community?
- What do you think caused these weathering and erosion changes?

Assessment Evidence

Student Learning Tools:

- Whole-group share-out of observations made about instances of weathering and erosion
- Field trip reflection assignment to

Assessments of Learning:

- Informal assessments of student-provided observations from the previous lesson's field trip
- Field trip reflection assignment

relate observed weathering and erosion to potential causes	<ul style="list-style-type: none"> • Teacher Rubric
Learning Plan	
<p>Learning Activities:</p> <ul style="list-style-type: none"> • Students will share some of their observations from the previous lesson's field trip in a whole-group format. • Students will complete a reflection of their field trip observations and make predictions about what may have caused the weathering and erosion. • Students will glue their reflection into their notebooks for safe keeping. 	
<p>Materials: Science journal, pencil, weathering and erosion field trip observations sheet, field trip reflection sheet, glue</p>	
<p>Lesson Plan:</p> <ul style="list-style-type: none"> • Instruct students to take out a pencil and their science journal, turning to the page where they glued the weathering and erosion field trip observations. • Have volunteers provide examples of their observations for both weathering and erosion from the field trip. <ul style="list-style-type: none"> ○ Write 3 examples of weathering on the board, as well as 3 examples of erosion. • Give each student a copy of the "field trip reflection" assignment. • Go through the instructions for the reflection assignment with the students as a whole group. • Give students time to complete the reflection assignment using their observations from the previous lesson. • Students should glue their field trip reflection assignment into their journal when they are finished filling it out. 	

Template adapted from Understanding by Design, written by Wiggins and McTighe (2011)

Field Trip Reflection

Directions: Using your field trip observations about weathering and erosion, answer the following questions to the best of your ability.

1. During your walk around the school, what was one example you saw of an object or area that had been weathered?

2. How could you tell that this object had been weathered, or broken down?

3. What do you think could have actually weathered, or broke down, the object or area?

4. During your walk around the school, what was one example you saw of an object or area that had been affected by erosion?

5. How could you tell that material had been eroded, or carried away, from this area?

6. What do you think could have eroded, or carried away, material from this area?

Teacher Rubric

	1	2	3	4
Weathering and erosion reflection	Student is unable to identify a weathering or erosion event correctly and support it with evidence, or student did not complete the assignment.	Student correctly identifies an example of either weathering or erosion and provides evidence to support their claim.	Student correctly identifies both weathering and erosion events, and is also able to provide evidence supporting their claims. Student may incorrectly predict the natural causes of the weathering and erosion.	Student correctly identifies both weathering and erosion events, and is also able to provide evidence supporting their claims. Student is able to provide realistic and probable predictions for the causes of weathering and erosion.

Unit: Weathering and erosion

Grade: 4

Lesson 5: Realistic Weathering Lab Preparation

Length: 30 minutes

Overview

Unit overview: In this unit, students will be exploring the causes and results of weathering and erosion and creating ways to prevent weathered materials from being taken away from their source. First, students will become familiar with the terms weathering and erosion and find places in their own home environment that have been impacted by these natural processes. Next, students will explore simple ways that weathering and erosion can be sped up or slowed down. Third, students will attempt to create their own artificial weathering and erosion systems to break down a material as quickly as possible with natural means. Finally, students will create a way to keep weathered material from eroding away from its source location.

Lesson overview: In this lesson, students will review possible causes of weathering and erosion in their own community before beginning the planning phase for their next lab activity: creating a situation where weathering and erosion can take place via natural means on an artificially created rock structure. Students will review key questions and answers from their previous field trip reflection assignment. Afterwards, students will be given an introduction to the lab activity that they will be participating in during the next lesson. Students will then have time to plan out how they want to create their own artificial weathering and erosion situations.

Weathering Blocks: Weathering blocks are a combination of plaster of paris, sand, and water. They will be created by putting the mixture into disposable cups, letting it harden, and then removing the cups from the outside of the blocks. Instructions for recommended ingredients will be included in a page at the end of this lesson. You may wish to test the experiment prior to making blocks for each student, as you may want to alter the hardness of the blocks to suit your available environment.

Desired Results

Established Goals:

4E.1.2.1.1: Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation.

4E.1.2.1.2: Plan and carry out fair tests in which variables are controlled and failure points are considered to improve a model or prototype to prevent erosion.

Student Learning Goals:

- I can identify real-world causes of weathering and erosion.
- I can create a plan for an experiment to be carried out at a later time.
- I can predict ways that I may be able to weather and erode a rock-like

Essential Questions:

- How can rock be weathered in your community?
- How can pieces of weathered material be eroded in your community?
- How could you recreate weathering and erosion using materials found in

material using natural resources found in my school forest.	your school forest?
Assessment Evidence	
Student Learning Tools: <ul style="list-style-type: none"> ● Whole-group review of the field trip reflection ● Planning guide for the realistic weathering lab 	Assessments of Learning: <ul style="list-style-type: none"> ● Informal assessment based on observations during work time ● Realistic weathering lab planning guide ● Teacher rubric
Learning Plan	
Learning Activities: <ul style="list-style-type: none"> ● Teacher will lead a whole-group review of key questions from the field trip reflection assignment in the previous lesson. ● Teacher will briefly introduce an upcoming realistic weathering lab to students. ● Students will complete a planning guide for the upcoming weathering lab. ● Students will glue the planning guide into their science journal for safe keeping. 	
Materials: Science journal, realistic weathering lab planning guide, pencil, field trip reflection sheet, glue, weathering block, plaster of paris, sand, water, disposable cups	
Lesson Plan: <ul style="list-style-type: none"> ● Students should take out their science journals and turn to the page containing their field trip reflection questions. ● Allow students to share out answers to questions 3 and 6 regarding potential real-world causes of the weathering around the school. ● Hand out a copy of the realistic weathering lab planning guide to each student. ● Inform students that they will be doing a lab activity requiring them to weather a rock-like block using only things they can find in the school forest. ● Pass around a sample “weathering block” so that students know what they will be attempting to break down. ● Review the directions for the planning guide with the whole class and explain that they will be using this guide to make a plan for their lab activity tomorrow. ● Allow students to complete the planning guide, providing advice as needed to struggling learners. ● Students should glue their planning guide into their notebooks when they have completed it. 	

Template adapted from Understanding by Design, written by Wiggins and McTighe (2011)

Realistic Weathering Lab Planning Guide

Background: You will be doing a lab where you must weather, or break down, an object that is a lot like a rock. You must use things you find in the school forest to accomplish this goal. This guide will help you plan out how you will accomplish your goal.

Directions: Complete each question and part of this guide in order. This guide will ask you questions and give suggestions to help you plan out how you will weather an object that is a lot like a rock.

1. You recently reviewed your field trip reflection questions. What are some ways that objects near your school could have been weathered, or broken down?

2. Your school forest has many resources in it, including fallen branches and trees, standing water, pieces of bark, rocks and pebbles, sticks, leaves, and many other things. Wind and rain are two of the most common ways to weather, or break down, rock. What are 2 ways you could use these resources to make your own rain or wind?

3. For the lab activity, you will not be able to touch the block with your hands once you have set it down, but you may use other objects to touch the block. How could you get a material like water to your block without using a bucket from the school or your hands to carry it?

4. Write down a detailed plan for how you will weather, or break down, your weathering block using things that you can find in the school forest. Remember that your goal is not to completely destroy the weathering block; only to remove small pieces at a time. Be sure to include step-by-step instructions of the different methods you want to try out so that someone else could follow your directions, and make a list of materials that you will need to gather from the forest so that you don't forget anything! This process should also be something that could realistically happen over time!

Materials: _____

Instructions: _____

How to Make Weathering Blocks

Weathering blocks: These blocks are firm enough to hold their shape, but are not rock solid. This allows students to weather them at a reasonable rate by adding water and, in some cases, even air flow. They are very easily broken down by repeated contact with solid objects as well. They should be strong enough to resist crumbling under light pressure, but should dissolve slowly under a steady stream of water, such as the water pressure from a faucet.

Materials: Powdered plaster of paris, water, sand, and cups to hold the final mixture, a container to mix in (I would suggest something that can be thrown away afterward), something to mix with (something disposable is best)

Cups note: The cup you choose will determine the size of the weathering blocks you end up with. I recommend choosing a cup made of styrofoam or paper as they are far easier to remove after the block has hardened than plastic cups.

Step 1: Set out the cups that you intend to fill with your mixed material.

Step 2: Measure out the amount of sand that you want to use and add it to the mixing container. The ratio for sand to water to plaster of paris is 8-2-1. For example, if you put 8 cups of sand into your mixing container, you would then need to add 2 cups of water and 1 cup of plaster of paris.

Step 3: Add the appropriate amount of plaster of paris to the sand in the container, remembering that the plaster is the 1 in the 8-2-1 ratio. I suggest mixing the two gently before step 4 as it ensures that the plaster of paris is more evenly spread out.

Step 4: Add the appropriate amount of water, following the 8-2-1 ratio, with water being the middle number.

Step 5: Quickly mix the ingredients in the container with your mixing tool, ensuring that the water is evenly distributed throughout the entire mixture.

Step 6: Pour the completed mixture into the cups. Fill the cups until you have the amount desired to create the size block you wish to use with your students.

Step 7: Repeat as many times as necessary until you have filled enough cups for each student. I would recommend making plenty of extras in case some crumble when they are removed from their containers.

Step 8: Allow the mixture to harden for 24 hours.

Step 9: Remove the paper or styrofoam container from around the weathering block to reveal the completed product.

Teacher Rubric

	1	2	3	4
Lab planning guide	Students' plans are unclear, or impossible to carry out, or the plan was not completed.	Student created a plan that is possible to follow, but may be unclear in places. Materials list may be missing some items.	Student created a plan that is clear enough for another person to follow and realistic enough to be completed. Materials needed are also included.	Student created a plan that is highly detailed and very easy to follow and complete. Materials needed are all included in the plan.

Unit: Weathering and erosion

Grade: 4

Lesson 6: Realistic Weathering Lab

Length: 60 minutes

Overview

Unit overview: In this unit, students will be exploring the causes and results of weathering and erosion and creating ways to prevent weathered materials from being taken away from their source. First, students will become familiar with the terms weathering and erosion and find places in their own home environment that have been impacted by these natural processes. Next, students will explore simple ways that weathering and erosion can be sped up or slowed down. Third, students will attempt to create their own artificial weathering and erosion systems to break down a material as quickly as possible with natural means. Finally, students will create a way to keep weathered material from eroding away from its source location.

Lesson overview: In this lesson, students will be using a plan that they have created to simulate weathering of a rock-like block using resources available to them in their school forest. Students will begin by reviewing the plan they created in the previous lesson. They will then proceed out to their school forest, where they will each be given a “weathering block” to use in their experiment. They will use materials from the school forest to artificially weather the block as best as they can, without directly touching the block themselves. They will record their observations and results as they proceed through the experiment.

Desired Results

Established Goals:

4E.1.2.1.1: Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation.

4E.1.2.1.2: Plan and carry out fair tests in which variables are controlled and failure points are considered to improve a model or prototype to prevent erosion.

Student Learning Goals:

- I can use a plan that I have created to carry out an experiment.
- I can record my observations and actions during an experiment.
- I can successfully weather a hard object using things from my local environment.

Essential Questions:

- How can I artificially weather a solid object using only the resources available naturally in my surrounding environment?

Assessment Evidence

Student Learning Tools:

- Review of student-created experiment

Assessments of Learning:

- Informal observations of students

plan <ul style="list-style-type: none"> ● Weathering lab data sheet ● Experiment to artificially weather a solid object 	working <ul style="list-style-type: none"> ● Weathering lab data sheet ● Teacher Rubric
Learning Plan	
Learning Activities: <ul style="list-style-type: none"> ● Students review their plan for the experiment. ● Students conduct their experiment in the school forest. ● Students glue their data sheet into their journal for safe keeping. 	
Materials: Science journal, realistic weathering planning guide, weathering lab data sheet, clipboard, pencil, weathering blocks (plaster of paris, sand, water, disposable cup), glue Optional Materials: Devices to take photographs of progress for later reference	
Lesson Plan: <ul style="list-style-type: none"> ● Students should take out their science journal and review their “realistic weathering planning guide” from the previous lesson. ● Provide each student with a clipboard and a copy of the “weathering lab data sheet”. ● Explain how to use the data sheet to record actions taken and the effects that they had on the weathering block during the experiment. ● Once students have their clipboard, data sheet, planning guide, and a pencil, take them out to a central location in the school forest. ● Review your behavior expectations with students once in the forest so that they all know what they should be doing, what is off limits, and what they need to do to be safe. ● Give each student a weathering block to use in their experiment. ● Allow students to complete the experiment. ● When experiment time has finished, collect remaining weathering block pieces and return to the classroom. ● Students should glue their weathering lab data sheet into their science journal upon returning to the classroom. 	

Template adapted from Understanding by Design, written by Wiggins and McTighe (2011)

Weathering Lab Data Sheet

Directions: For this lab activity, you will be using a plan that you created to cause weathering to happen. Follow the instructions carefully so that you do not miss any steps or forget to write down what you have done.

Step 1: Get a weathering block from your teacher.

Step 2: Choose a location for your weathering block and carefully set it down. You may not move it once it has been set down!

Step 3: Gather up the resources you think you will need from the school forest around you.

Step 4: Use one of the items you have collected to try to weather, or break down, the weathering block. Remember that you are not trying to destroy the whole block; only break small pieces off each time.

Step 5: Use the data sheet on the next page to write a description of what you did to the block, as well as an observation about what your weathering attempt actually did to the block. There is also a page you can use to sketch what the block looks like after you try to weather it.

Step 6: Continue to weather the block, making sure that you record your observations and what you have done each time you do something to the block.

Step 7: When your teacher announces that it is time to finish up, carefully bring what is left of your block to your teacher.

Step 8: Return any unused materials from your experiment to the places in the forest where you found them.

Step 9: Make sure that you have all of the materials you brought outside with you before returning to your classroom.

Step 10: Glue your data sheets into your science journal.

Directions: Keeping track of your actions and the results of your actions is very important when doing a science experiment. While you try to weather your block, record what you tried to do to your block in the “What I Did” column, and what happened to the block in the “Observations” column. Each time you attempt to weather your block, you should fill out a “What I Did” box and an “Observations” box so that you have a detailed record of everything you tried. You may also take pictures of your progress if you have a device capable of taking pictures and have your teacher’s permission. If you do not have a device but want to record the progress you make, there will be a place to draw and label pictures at the end of this sheet.

Weathering Attempt	What I Did	Observations
1		
2		
3		
4		

5		
6		
7		
8		
9		
10		
11		

Pictures Page

You may use this page to draw a quick sketch of your weathering block. Be sure to label each picture so that you know which observation it goes with.

Observation _____:	Observation _____:
Observation _____:	Observation _____:
Observation _____:	Observation _____:
Observation _____:	Observation _____:
Observation _____:	Observation _____:

Teacher Rubric

	1	2	3	4
Weathering Lab Data Sheet	Student records are either incomplete or do not contain enough detail to understand what the student did during the experiment or what resulted from their actions.	Student records of what they did to their weathering block and what resulted from their actions are present, but may be unclear at times or lack necessary detail to clearly identify what was done or what happened.	<p>Student recorded basic descriptions of what they did to their weathering block.</p> <p>Student recorded basic descriptions of what their actions did to their weathering block.</p>	<p>Student recorded very detailed descriptions of what they did to their weathering block.</p> <p>Student recorded very detailed descriptions of what their actions did to their weathering block, including identifying signs of erosion as well as weathering.</p>

Unit: Weathering and erosion
Lesson 7: Weathering Lab Reflection

Grade: 4
Length: 30 minutes

Overview

Unit overview: In this unit, students will be exploring the causes and results of weathering and erosion and creating ways to prevent weathered materials from being taken away from their source. First, students will become familiar with the terms weathering and erosion and find places in their own home environment that have been impacted by these natural processes. Next, students will explore simple ways that weathering and erosion can be sped up or slowed down. Third, students will attempt to create their own artificial weathering and erosion systems to break down a material as quickly as possible with natural means. Finally, students will create a way to keep weathered material from eroding away from its source location.

Lesson overview: In this lesson, students will have an opportunity to reflect individually and with peers on the successes and failures they encountered during their attempts to weather a solid material using natural resources from a local school forest. Students will begin by answering reflection questions individually to guide them to highlighting potential successes and failures of their project design. Afterward, students will have an opportunity to share their discoveries with peers in a small-group setting.

About this reflection: This reflection is designed as a separate lesson from the lab experiment to allow for proper time management. It can be done immediately following the lab activity from lesson 6, or in the days following the assignment as available work time dictates.

Optional Language Arts Curriculum: This lesson can be adapted to fit and meet several language arts standards listed in the desired results section. This reflection can be formatted into a writing assignment allowing students to create their own informative text about their learning, backed by evidence and facts.

Desired Results

Established Goals:

4E.1.2.1.1: Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation.

4E.1.2.1.2: Plan and carry out fair tests in which variables are controlled and failure points are considered to improve a model or prototype to prevent erosion.

Optional Language Arts Goals:

Standard 4.6.1.1: Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

Standard 6.6.2.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

<p>Student Learning Goals:</p> <ul style="list-style-type: none"> ● I can identify successful and unsuccessful parts of an experiment that I have designed and conducted. ● I can reflect on a project design and find ways that it could be improved for future trials. ● I can explain how I was able to weather an object and what the erosion patterns looked like. 	<p>Essential Questions:</p> <ul style="list-style-type: none"> ● How were you able to successfully weather your weathering block? ● What kind of erosion patterns did you witness? ● What could you do differently in the future to increase or decrease weathering rates as needed?
<p>Assessment Evidence</p>	
<p>Student Learning Tools:</p> <ul style="list-style-type: none"> ● Weathering Lab Reflection assignment ● Group sharing of reflections 	<p>Assessments of Learning:</p> <ul style="list-style-type: none"> ● Informal assessment of group conversations ● Weathering Lab Reflection assignment ● Teacher rubric
<p>Learning Plan</p>	
<p>Learning Activities:</p> <ul style="list-style-type: none"> ● Students will complete a guided reflection assignment about a lab activity they conducted in the previous lesson. ● Students will share their reflections with peers in a small-group setting. 	
<p>Materials: Science journal, weathering lab reflection sheet, realistic weathering lab data sheets, glue</p>	
<p>Lesson Plan:</p> <ul style="list-style-type: none"> ● Students should take out their science journals and turn to the pages containing their observations from the realistic weathering lab in the school forest. ● While they do so, hand out a copy of the “Weathering Lab Reflection” assignment to each student. ● Read through the directions and questions for the weathering lab reflection assignment with the entire class. <ul style="list-style-type: none"> ○ Clarify questions as necessary. ● Give students time to complete the reflection of their lab work. ● Assign students to groups as they complete their lab reflection. <ul style="list-style-type: none"> ○ Groups should discuss their answers to the reflection questions, focusing on things that were or were not successful, as well as things that they would do differently to increase or decrease weathering effects if they could do the weathering activity over again. ● When students have finished conversing about their reflections, they should glue the weathering lab reflection sheet into their science journal for safe keeping. 	

Template adapted from Understanding by Design, written by Wiggins and McTighe (2011)

Weathering Lab Reflection

Directions: Use your data sheets from the weathering lab to answer the following questions to the best of your ability.

1. What did you do in the lab that was most successful at weathering the block in a slow, controlled way?

2. What was one weathering attempt that did not work very well? What about it didn't work?

3. Did any of your weathering attempts cause a lot of damage to your block all at once? If so, what did you do that caused so much damage?

4. Did all of your weathered pieces of material stay close to your bigger weathering block? If not, how far away did some of them get?

5. What caused the small pieces of the weathering block to be eroded away from the large weathering block?

6. If you could perform this experiment again, what specific things would you do differently to have more control over how fast the weathering happens?

7. If you could give another student advice before they tried this experiment, what would you tell them?

Teacher Rubric

	1	2	3	4
<p>Standard 4E.1.2.1.1 Providing evidence of weathering effects by water, wind, ice, or vegetation.</p>	<p>Student did not complete the activity OR student was not able to evaluate the effectiveness of a weathering technique.</p>	<p>Either student is able to describe and evaluate the effectiveness of one weathering method and uses data to support their claim</p> <p>OR</p> <p>Student is able to describe two ways to weather something, but does not provide data from their own experiments to support their claims.</p>	<p>Student is able to describe and evaluate the effectiveness of at least two weathering methods and use data to support their claims.</p>	<p>Student is able to describe and evaluate the effectiveness of at least two weathering methods and use data to support their claims.</p> <p>Student effectively reflects on their attempts and uses what they learned to describe realistic ways that their experiment could be improved to better control rate of weathering in a second trial.</p>
<p>Standard 4E.1.2.1.1 Providing evidence of the effects on the rate of erosion by water, wind, ice, or vegetation.</p>	<p>Student is unable to describe erosion that took place, or did not complete the assignment.</p>	<p>Student identifies that erosion took place, but is unable to provide evidence to explain why it happened.</p>	<p>Student is able to describe erosion patterns and reflect on potential causes of the erosion, using data to support their claims.</p>	<p>Student is able to describe erosion patterns and identify specific causes that led to different erosion patterns or rates, using data to support their claims.</p>

Unit: Weathering and erosion
Lesson 8: Plan Improvements

Grade: 4
Length: 30-40 minutes

Overview

Unit overview: In this unit, students will be exploring the causes and results of weathering and erosion and creating ways to prevent weathered materials from being taken away from their source. First, students will become familiar with the terms weathering and erosion and find places in their own home environment that have been impacted by these natural processes. Next, students will explore simple ways that weathering and erosion can be sped up or slowed down. Third, students will attempt to create their own artificial weathering and erosion systems to break down a material as quickly as possible with natural means. Finally, students will create a way to keep weathered material from eroding away from its source location.

Lesson overview: In this lesson, students will be using their reflections from the previous lesson to improve their weathering and erosion plans for their weathering blocks, as well as brainstorming ways that they could prevent erosion from moving their materials so far away from their block. Students will begin by sharing their most successful weathering techniques with classmates in a group setting. Afterward, they will brainstorm together to find ways that they could possibly keep weathered materials from traveling away from the block, thus keeping the materials available for use near the source. Afterward, they will individually create plans for another weathering experiment, this time with the goal of successfully weathering their blocks, but limiting or eliminating erosion beyond a certain distance from the source block.

About erosion control: Farmers often plant trees around their farm to reduce wind-induced erosion. They also plant rows horizontally along hillsides to slow water movement down the hill and therefore reduce the rate of erosion. Cities use vegetation planted in strategic places to hold soil tightly in place. The roots act almost like fingers, working to hold clumps of soil tightly in their location, while also slowing the rate of water movement. Rolled erosion blankets can also be laid on areas to trap moving materials caught up by water, and are often seen at locations where steep hillsides are being landscaped.

Desired Results

Established Goals:

4E.1.2.1.1: Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation.

4E.1.2.1.2: Plan and carry out fair tests in which variables are controlled and failure points are considered to improve a model or prototype to prevent erosion.

Student Learning Goals:

- I can clearly express my experimental results to others.
- I can identify ways to improve a plan that I have created and tested.

Essential Questions:

- How can you improve your weathering plan and techniques?
- What could you do to reduce erosion of materials away from your

<ul style="list-style-type: none"> I can plan ways to reduce or eliminate erosion in weathering settings. 	weathering block?
Assessment Evidence	
Student Learning Tools: <ul style="list-style-type: none"> Small group discussion Whole group discussion Erosion control lab plan 	Assessments of Learning: <ul style="list-style-type: none"> Informal assessment of discussions Erosion control lab plan Teacher rubric
Learning Plan	
Learning Activities: <ul style="list-style-type: none"> Students will share their best weathering techniques with others in a small group. Students will discuss the importance of controlling erosion for a farm in a small group. Students will discuss the importance of controlling erosion for a city, such as erosion of city streets in a small group. Students will share their best ideas for controlling erosion in both settings as a whole group. Students will brainstorm ways to prevent erosion in the farm and city settings in a whole group. Students will complete an erosion lab control plan to prepare for their next lab activity. 	
Materials: Science journal, weathering lab reflection, erosion control lab plan, glue	
Lesson Plan: <ul style="list-style-type: none"> Have students turn to their “weathering lab reflection” page in their journals. Assign students to groups of 3 to 4 students to share briefly about their most successful weathering technique. Next, students should briefly discuss how far from their block some of their weathered material traveled. Ask students to discuss why erosion would be a problem in a farmland setting. Allow 1-2 people per group to share a concern about erosion’s effects on a farm. Next, ask students to discuss problems with erosion in a city setting, such as with a street. Allow 1-2 people per group to share a concern about erosion’s effects on a city. As a whole group, brainstorm ways that erosion could be stopped on the farm, listing the ideas on the board. Then, brainstorm ideas together on how erosion of a city street could be controlled or stopped, writing ideas on the board. Inform students that they will be working with a second weathering block, this time using their most effective weathering method the entire time. Let them know that their new goal is to create a way to stop or limit the erosion of their block material, keeping as much of it as possible within an inch of their block’s starting position. Students should complete the “erosion control lab plan” assignment. 	

- Students should glue their erosion control lab plan into their science journal.

Template adapted from *Understanding by Design*, written by Wiggins and McTighe (2011)

Erosion Control Lab Plan

Answer each question to the best of your ability. These questions will help you create a plan to control the erosion caused by your weathering activities in the next lab.

1. You will need to weather a weathering block slowly over time to try to control the erosion of materials away from the block. Briefly describe which weathering method you used in the outdoor weathering lab to most successfully weather the block.

2. Your job is going to be to prevent materials from eroding, or moving away, from the weathering block. All materials should be kept within 2 inches of the weathering block. What is one way that you could possibly stop the materials from being carried away if you use the weathering plan that you shared in question 1?

3. What kind of materials would you need to gather from the school forest to be able to carry out your erosion control plan from question 2?

4. In the space below, draw a picture of a weathering block in the center of the page. Next, draw a picture of the erosion plan that you would create around the weathering block to try and prevent the weathered materials from moving away from the block.

Teacher Rubric

	1	2	3	4
Lab planning guide	Students' plans are unclear, or impossible to carry out, or the plan was not completed.	Student created a plan that is possible to follow, but may be unclear in places. Materials list may be missing some items.	Student created a plan that is clear enough for another person to follow and realistic enough to be completed. Materials needed are also included.	Student created a plan that is highly detailed and very easy to follow and complete. Materials needed are all included in the plan.

Unit: Weathering and erosion
Lesson 9: Erosion Control Lab

Grade: 4
Length: 60 minutes

Overview

Unit overview: In this unit, students will be exploring the causes and results of weathering and erosion and creating ways to prevent weathered materials from being taken away from their source. First, students will become familiar with the terms weathering and erosion and find places in their own home environment that have been impacted by these natural processes. Next, students will explore simple ways that weathering and erosion can be sped up or slowed down. Third, students will attempt to create their own artificial weathering and erosion systems to break down a material as quickly as possible with natural means. Finally, students will create a way to keep weathered material from eroding away from its source location.

Lesson overview: In this lesson, students will once again be traveling outdoors to the school forest to conduct an experiment on a weathering block. They will use the knowledge they acquired from the previous outdoor weathering lab to choose a method of weathering that will produce slow, steady weathering of their weathering block. Then, they must build some sort of system to control the erosion of the weathered materials. Materials must be kept within 2 inches of the weathering block to be considered a successful plan. Students will then weather their weathering block and observe how well their plan controlled the erosion.

Desired Results

Established Goals:

4E.1.2.1.1: Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation.

4E.1.2.1.2: Plan and carry out fair tests in which variables are controlled and failure points are considered to improve a model or prototype to prevent erosion.

Student Learning Goals:

- I can use a plan that I have created to conduct an experiment.
- I can successfully weather an artificial object.
- I can create and employ an erosion control method.
- I can successfully control the erosion caused by my weathering attempt.

Essential Questions:

- How can I weather a rock-like object using only materials found in the school forest?
- How can I prevent the weathered materials from eroding more than 2 inches away from my block?

Assessment Evidence

Student Learning Tools:

- Review of student-created experiment

Assessments of Learning:

- Informal observations of students

<p>plan</p> <ul style="list-style-type: none"> ● Erosion control lab data sheet ● Experiment to artificially weather a solid object and control the erosion that results 	<p>working</p> <ul style="list-style-type: none"> ● Erosion control lab data sheet ● Teacher Rubric
<h2>Learning Plan</h2>	
<p>Learning Activities:</p> <ul style="list-style-type: none"> ● Students review their plan for the experiment. ● Students conduct their experiment in the school forest. ● Students glue their data sheet into their journal for safe keeping. 	
<p>Materials: Science journal, erosion prevention lab plan, erosion prevention lab data sheet, clipboard, pencil, weathering blocks (plaster of paris, sand, water, disposable cup), glue</p> <p>Optional Materials: Devices to take photographs of progress for later reference</p>	
<p>Lesson Plan:</p> <ul style="list-style-type: none"> ● Students should take out their science journal and review their “erosion control lab plan” from the previous lesson. ● Provide each student with a clipboard and a copy of the “erosion control lab data sheet”. ● Explain how to use the data sheet to record actions taken and the effects that they had on the weathering block and the surrounding area during the experiment. ● Once students have their clipboard, data sheet, lab plan, and a pencil, take them out to a central location in the school forest. ● Review your behavior expectations with students once in the forest so that they all know what they should be doing, what is off limits, and what they need to do to be safe. ● Give each student a weathering block to use in their experiment. ● Allow students to complete the experiment, gathering necessary materials as needed during the process. ● When experiment time has finished, collect remaining weathering block pieces and return to the classroom. ● Students should glue their weathering lab data sheet into their science journal upon returning to the classroom. 	

Template adapted from Understanding by Design, written by Wiggins and McTighe (2011)

Erosion Control Lab Data Sheet

Directions: For this lab activity, you will be using a plan that you created to try to prevent erosion of materials from a weathering block while you use a strategy to weather the block. Follow the instructions carefully so that you do not miss any steps or forget to write down what you have done.

Step 1: Get a weathering block from your teacher.

Step 2: Choose a location for your weathering block and carefully set it down. You may not move it once it has been set down!

Step 3: Gather up the resources you think you will need from the school forest around you.

Step 4: Carefully build your erosion control structure. Use whatever you can find in the school forest to help in your building process.

Step 5: Use the items you collected to begin weathering your block. Remember that you are not trying to destroy the whole block; only break small pieces off each time.

Step 6: Use the data sheet on the next page to write a description of what you did to the block, as well all of your observations about how well your erosion control method has worked for each trial. There is also a page you can use to sketch what the block looks like after you try to weather it, and where your materials were eroded to.

Step 7: Continue to weather the block, making sure that you record your erosion observations and what you have done each time you do something to the block.

Step 8: When your teacher announces that it is time to finish up, carefully bring what is left of your block to your teacher.

Step 9: Return any unused materials from your experiment to the places in the forest where you found them.

Step 10: Make sure that you have all of the materials you brought outside with you before returning to your classroom.

Step 11: Glue your data sheets into your science journal.

Directions: Keeping track of your actions and the results of your actions is very important when doing a science experiment. While you try to weather your block, record what you tried to do to your block in the “What I Did” column, and what happened to the block and all of the eroded materials in the “Observations” column. Each time you attempt to weather your block, you should fill out a “What I Did” box and an “Observations” box so that you have a detailed record of everything you tried, as well as how far away eroded materials traveled. You may also take pictures of your progress if you have a device capable of taking pictures and have your teacher’s permission. If you do not have a device but want to record the progress you make, there will be a place to draw and label pictures at the end of this sheet.

Weathering Attempt	What I Did	Observations
1		
2		
3		
4		

5		
6		
7		
8		
9		
10		
11		

Pictures Page

You may use this page to draw a quick sketch of your weathering block and the erosion details. Be sure to label each picture so that you know which observation it goes with.

Observation _____:	Observation _____:
Observation _____:	Observation _____:
Observation _____:	Observation _____:
Observation _____:	Observation _____:
Observation _____:	Observation _____:

Teacher Rubric

	1	2	3	4
Erosion Control Lab Data Sheet	Student records are either incomplete or do not contain enough detail to understand what the student did during the experiment or what resulted from their actions.	Student records of what they did to their weathering block and how well their erosion control method worked, but may be unclear at times or lack necessary detail to clearly identify what was done or what happened.	Student recorded basic descriptions of what they did to their weathering block. Student recorded basic descriptions of the impact their erosion control solution had on the movement of materials away from the weathering block.	Student recorded very detailed descriptions of what they did to their weathering block. Student recorded very detailed descriptions of the impact their erosion control solution had on the movement of materials away from the weathering block.

Unit: Weathering and erosion

Grade: 4

Lesson 10: Erosion control lab reflection

Length: 30 minutes

Overview

Unit overview: In this unit, students will be exploring the causes and results of weathering and erosion and creating ways to prevent weathered materials from being taken away from their source. First, students will become familiar with the terms weathering and erosion and find places in their own home environment that have been impacted by these natural processes. Next, students will explore simple ways that weathering and erosion can be sped up or slowed down. Third, students will attempt to create their own artificial weathering and erosion systems to break down a material as quickly as possible with natural means. Finally, students will create a way to keep weathered material from eroding away from its source location.

Lesson overview: In this lesson, students will have an opportunity to reflect individually and with peers on the successes and failures they encountered during their attempts to control erosion in an experimental setting within their local school forest. Students will begin by answering reflection questions individually to guide them to highlighting potential successes and failures of their project design. Afterward, students will have an opportunity to share their discoveries with peers in a small-group setting.

About this reflection: This reflection is designed as a separate lesson from the lab experiment to allow for proper time management. It can be done immediately following the lab activity from lesson 9, or in the days following the assignment as available work time dictates.

Optional Language Arts Curriculum: This lesson can be adapted to fit and meet several language arts standards listed in the desired results section. This reflection can be formatted into a writing assignment allowing students to create their own informative text about their learning, backed by evidence and facts.

Desired Results

Established Goals:

4E.1.2.1.1: Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation.

4E.1.2.1.2: Plan and carry out fair tests in which variables are controlled and failure points are considered to improve a model or prototype to prevent erosion.

Optional Language Arts Goals:

Standard 4.6.1.1: Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

Standard 6.6.2.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

<p>Student Learning Goals:</p> <ul style="list-style-type: none"> ● I can identify successful and unsuccessful elements of my erosion control plan. ● I can reflect on my project design and find ways to improve my design for future use. 	<p>Essential Questions:</p> <ul style="list-style-type: none"> ● How successfully did your erosion control plan work? ● What kind of erosion patterns did you witness as a result of your plan? ● What could you change in the future to improve your erosion control plan?
<p>Assessment Evidence</p>	
<p>Student Learning Tools:</p> <ul style="list-style-type: none"> ● Erosion control lab reflection assignment ● Group sharing of reflections 	<p>Assessments of Learning:</p> <ul style="list-style-type: none"> ● Informal assessment of group conversations ● Erosion control lab reflection assignment ● Teacher rubric
<p>Learning Plan</p>	
<p>Learning Activities:</p> <ul style="list-style-type: none"> ● Students will complete a guided reflection assignment about a lab activity they conducted in the previous lesson. ● Students will share their reflections with peers in a small-group setting. 	
<p>Materials: Science journal, erosion control lab reflection sheet, erosion control lab data sheets, glue</p>	
<p>Lesson Plan:</p> <ul style="list-style-type: none"> ● Students should take out their science journals and turn to the pages containing their observations from the erosion control lab in the school forest. ● While they do so, hand out a copy of the “Erosion Control Lab Reflection” assignment to each student. ● Read through the directions and questions for the erosion control lab reflection assignment with the entire class. <ul style="list-style-type: none"> ○ Clarify questions as necessary. ● Give students time to complete the reflection of their lab work. ● Assign students to groups as they complete their lab reflection. <ul style="list-style-type: none"> ○ Groups should discuss their answers to the reflection questions, focusing on things that were or were not successful, as well as things that they would do differently to increase their control of erosion if they could do the erosion control activity over again. ● When students have finished conversing about their reflections, they should glue the erosion control lab reflection sheet into their science journal for safe keeping. 	

Template adapted from Understanding by Design, written by Wiggins and McTighe (2011)

Erosion Control Lab Reflection

Directions: Use your data sheets from the erosion control lab to answer the following questions to the best of your ability.

1. Briefly describe what you did to weather your weathering block.

2. Briefly describe what you built or did to prevent the weathered materials from eroding away from the weathering block.

3. What was one part of your plan that worked well to control the erosion of weathered materials?

4. What was one part of your plan that didn't work as well?

5. If you were going to attempt this activity again, what could you do to improve your erosion control plan? What things would you change or do differently to keep materials from moving away from the weathering block?

Teacher Rubric

	1	2	3	4
4E.1.2.1.2: Student conducts an experiment in which variables are controlled carefully.	Student does not control either variable to ensure accurate results, or does not complete the experiment.	Student conducts an experiment and controls one variable, either weathering or erosion, but fails to control or maintain a single strategy for the other variable.	Student conducts a controlled experiment using 1 weathering strategy and 1 erosion strategy.	Student conducts a controlled experiment using 1 weathering strategy and 1 erosion strategy. Student makes additional efforts to ensure that other natural weathering or erosion methods are controlled as well, ensuring that nothing weathers the block or erodes material except the things that they intend to use.
4E.1.2.1.2: Failure points of a model are considered to improve a plan for erosion control.	Student does not identify any failures in their model or identify ways to improve the model, OR student does not complete the reflection.	Student identifies a failure point in their erosion control model, but does not provide a plan for improving the model.	Student correctly identifies a clear failure in their erosion control method and provides a basic improvement plan to make the model better.	Student correctly identifies all failure points in their erosion control method and creates detailed plans to improve their model.

Unit: Weathering and erosion

Grade: 4

Lesson 11: Real-World Application

Length: 40 minutes

Overview

Unit overview: In this unit, students will be exploring the causes and results of weathering and erosion and creating ways to prevent weathered materials from being taken away from their source. First, students will become familiar with the terms weathering and erosion and find places in their own home environment that have been impacted by these natural processes. Next, students will explore simple ways that weathering and erosion can be sped up or slowed down. Third, students will attempt to create their own artificial weathering and erosion systems to break down a material as quickly as possible with natural means. Finally, students will create a way to keep weathered material from eroding away from its source location.

Lesson overview: In this lesson, students will use what they have learned about weathering and erosion to come up with solutions for one of two real-world examples of issues with erosion control. Students will begin by choosing between two problems facing real people. The first is a problem that a farmer has with wind removing the fertile topsoil from his fields. They will need to create a plan that the farmer could use to resolve his soil erosion issues. The second option is about a driveway that suffers from deeply eroded channels every time it rains. They will brainstorm a way to help reduce the erosion of the driveway. Once they have chosen their scenario, students will create a plan to resolve the issue that they think would work best. At the end of class, they will have the opportunity to share their plan in a whole-group setting with classmates to show off what they have learned during the unit.

Desired Results

Established Goals:

4E.1.2.1.1: Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation.

4E.1.2.1.2: Plan and carry out fair tests in which variables are controlled and failure points are considered to improve a model or prototype to prevent erosion.

Student Learning Goals:

- I can apply what I have learned about weathering and erosion to complete a plan to minimize or prevent erosion in a real-world scenario.

Essential Questions:

- How can you stop wind erosion on a field?
- How can you stop water erosion on an unpaved driveway?

Assessment Evidence

Student Learning Tools:

- Whole group review
- Real-world erosion control scenarios
- Whole group share-out

Assessments of Learning:

- Informal assessment of student responses during whole group work
- Completion of plans for one of the two

	real world erosion scenarios <ul style="list-style-type: none"> ● Teacher rubric
<h2>Learning Plan</h2>	
<p>Learning Activities:</p> <ul style="list-style-type: none"> ● Students will review weathering and erosion as a whole group. ● Students will create a list of weathering and erosion events that they remember witnessing in their field trip outside as a whole group. ● Students will create a plan to minimize the effects of erosion in one of two different scenarios. ● Students will share their plan with their classmates to demonstrate their knowledge of erosion and erosion control. 	
<p>Materials: Science journal, Farmers Field Erosion worksheet, Drizzly Driveway Erosion worksheet, glue</p>	
<p>Lesson Plan:</p> <ul style="list-style-type: none"> ● Briefly review the definitions of weathering and erosion with the whole class. ● Ask students to share examples of weathering that they remembered seeing in their community from the field trip in lesson 3. <ul style="list-style-type: none"> ○ Make a list of the examples the students share on the board to keep track of what has been stated already. ● Explain to the students that they will be showing off all of their knowledge about weathering and erosion by coming up with a solution to a real erosion problem. ● Introduce the two real-world scenarios so that students have a good understanding of the problems that each situation presents. ● Ask students to choose one of the two scenarios, then give them the appropriate handout for each one: Farmers Field Erosion or Drizzly Driveway Erosion. ● Students should read their scenario and answer the questions to create an erosion control plan for their scenario. ● After completing the scenarios, allow students to briefly share their ideas for erosion control with the class. ● Students can glue their chosen and completed scenarios into their science journals for safekeeping when finished. 	

Template adapted from Understanding by Design, written by Wiggins and McTighe (2011)

Farmer's Field Erosion

Directions: Read the story below, then answer the questions to create a possible solution to a problem that a farmer is facing with erosion in his fields.

Background: Farmer Fred had a large bean field in North Dakota. Every year he spread out a thick layer of soil that was perfect for growing beans. He noticed that halfway through the year, he needed to add more soil because the top layer always disappeared. He kept a closer watch on his field after that and noticed that the wind seemed to be blowing so hard across the field that it was carrying away his perfect soil! Farmer Fred needs your help coming up with a plan to stop his valuable soil from blowing away!

1. Erosion can happen for a number of reasons. What natural force is eroding, or moving, Fred's soil from his field?

2. Stopping the wind from blowing isn't possible, but there are ways to help. What would you suggest Fred should do to his field or his property to keep his soil from blowing away?

3. How will your idea stop the wind from eroding Fred's soil?

Drizzly Driveway Erosion

Directions: Read the story below, then answer the questions to create a possible solution to a problem that a woman is facing with erosion in her driveway.

Background: Diane has a pretty house in Seattle, but she has a problem. Her house is on top of a steep hill and the driveway goes straight up the hill. Her driveway is made of loose dirt and sand, and is nearly as long as a football field. Every time it rains, the rain rushes down her driveway and erodes the dirt and sand, leaving deep trenches up and down her driveway that she needs to fill in. Diane really needs your help to come up with a way to stop her driveway from eroding!

1. Erosion can happen for a number of reasons. What natural force is eroding, or moving, Diane's dirt in her driveway?

2. Stopping the rain from falling isn't possible, but there are ways to help. What would you suggest Diane should do to her driveway or her property to keep her dirt from washing away during every rainstorm?

3. How will your idea stop the water from eroding Diane's driveway?

Teacher Rubric

	1	2	3	4
Application of standards to real-world scenarios	Student is not able to create or explain a plan to prevent erosion, or does not complete the assignment.	Student identifies the cause of erosion, but has trouble creating a realistic plan to stop the erosion from happening, or is not able to explain how their plan will actually stop the soil or dirt from moving away from the area.	<p>Student is able to identify the cause of erosion and create a plan that could solve the problem.</p> <p>Student is able to offer a simple explanation for how their plan will stop the soil or dirt from blowing or washing away.</p>	<p>Student identifies the cause of erosion and creates a plan that could solve the problem, relating their plan to their own experiences with erosion prevention to rationalize their choices.</p> <p>Student is able to explain in detail how their plan will prevent the erosion, drawing from their own experiences and lab activities to provide evidence supporting their plans likelihood of success.</p>

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