

## SECTION 3.1 INTRODUCTION

**3.1 Understand the Challenge****Thinking about Erosion**◀  $1\frac{1}{2}$  to 2 class periods\***Overview**

Students are introduced to the challenge of the *Learning Set*: how to prevent erosion deposition at the bottom of a hill near the school so that a basketball court can be built there. To solve this problem, they first identify erosion on the grounds of their school and determine what they know about erosion and what they need to learn. They then are introduced to the *Project Board*, which is used to organize their ideas and track their progress with the challenge. Finally, they update the class's *Project Board*, which prepares them to investigate erosion further.

\*A class period is considered to be one 40 to 50 minute class.

Targeted Concepts, Skills, and Nature of Science	Performance Expectations
Scientists often work together and then share their findings. Sharing findings makes new information available and helps scientists refine their ideas and build on others' ideas. When another person's or group's idea is used, credit needs to be given.	Students work with their groups to decide which examples of erosion they can agree on and which they want to learn more about.
Criteria and constraints are important in design.	Students identify criteria and constraints with the class.
Scientists must keep clear, accurate, and descriptive records of what they do so they can share their work with others, consider what they did, why they did it, and what they want to do next.	Students keep track of what they are learning and what they need to learn using the <i>Project Board</i> . They also record their observations using sketches and notes.
Erosion is the process of soil and other particles being displaced by water, waves, wind, and gravity.	Students observe erosion around the school and make conjectures about what caused the erosion.

### Materials

- 1 per student *Erosion-Walk Observation* pages
- 1 per student *Project Board* page
- 1 per class *Project Board*  
(optional) digital cameras if available or if students want to bring them in for the walk.
- 1 per student  
(optional) photocopy of the erosion images on page 46 to refer to during their Erosion Walk.

## Activity Setup and Preparation

- Determine where you will take students for their erosion walk prior to class. Walk around the school grounds looking for signs of erosion.
- This section is two class periods. A good place to have a break between class periods is just after either the erosion walk or the *Conference* segment, and before the *Create the Project Board* segment.

## Homework Options

### Reflection

- **Science Content:** Based on the examples of erosion you observed, in what kind of environment would you expect to see the worst erosion? Describe it. (*Students should describe an environment that combines the factors that lead to heavy erosion: an environment with sloping land and heavy rainfall. There are many other factors that could be listed: sparse vegetation, fine soil, and winds among them.*)
- **Science Process:** How did looking at erosion around school help you better understand what causes erosion and determine what you need to learn? (*This question is intended to get students thinking about effective ways of solving problems and learning.*)

### Preparation for 3.2

- **Science Content:** What are some of the things your group decided they need to learn about erosion? How do you think you could find the answer? (*Students' answers should reflect some of the topics that were discussed in class.*)

## SECTION 3.1 IMPLEMENTATION

**3.1 Understand the Challenge****Thinking About Erosion**

You are going to begin by identifying the criteria and constraints of this challenge. Then you will walk around your school, looking for examples of erosion. This will help you understand what erosion is and what causes it. That will be important for addressing the challenge.

**Identify Criteria and Constraints**

It is always a good idea, before beginning to address a challenge, to make sure you understand the challenge. One way to do that is to identify the criteria and constraints. Remember that criteria are what you need to accomplish, and constraints are limitations on your solution. For the *Basketball-Court Challenge*, your criteria are what you need your erosion-control method to be able to do. The constraints on your solution are what you have to keep in mind and be careful about as you work on a solution. Review the letter that you received from the school superintendent, and record the criteria and constraints you identify. Then, as a class, list and discuss the criteria and constraints for this challenge.

It is always a good idea to identify criteria and constraints when working on a design challenge. That way, you have a way of checking which of your ideas are worth spending more time on. You can also identify which ideas are not worth spending time on.

**Erosion**

Erosion is the process in which soil and other particles are moved from one place to another. These particles can be moved by running water, gravity, wind, waves, or even glaciers. When the particles are laid down in a new place, it is called **deposition**. Erosion can happen quickly or slowly. During a landslide, tons of soil and rock move downhill very quickly. Some erosion takes millions of years. The Grand Canyon was formed by erosion over millions of years. Much of the erosion you see around you happens over days, months, or years.

**deposition:**  
the laying down  
of soil or other  
materials in a  
new location.

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**3.1 Understand the Challenge****Thinking about Erosion**

5 min.

*Before students begin identifying the criteria and constraints it is important for them to understand what erosion is. Elicit students ideas by asking them what they think erosion is. Ask students for examples of erosion they have seen or heard about. Then ask students also what they know about erosion management Make sure students have provided examples before going through the text box on what erosion is.*

**△ Guide**

After reading the letter, tell students that in order to understand the challenge they will need to know what erosion is. Go through the text box on page 45 that describes erosion. Emphasize that erosion is the process in which soil and other particles are moved from one place to another by wind, water, or ice and gravity.

## Identify Criteria and Constraints

10 min.

Have students identify the criteria and constraints for the Basketball-Court Challenge.

### META NOTES

To begin, students will provide a definition of erosion from an example, "Erosion happens when water carries dirt downhill." Students may not be able to clearly state more than this. The definition of erosion will be revised informally throughout the *Learning Set*.

Read the text if students have continued difficulty defining erosion. Also, students will be finding examples of erosion on the erosion walk so they will be able to further define erosion based on those results. Emphasize that erosion is the process in which soil and other particles are moved from one place to another by wind, water, or ice and gravity.

erosion. ... understand what ... what causes  
That will be ... ant for addressing the challenge.

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It is always a good idea to identify criteria and constraints when working on a design challenge. That way, you have a way of checking which of your ideas are worth spending more time on. You can also identify which ideas are not worth spending time on.

#### Erosion

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**deposition:**  
the laying down  
of soil or other  
materials in a  
new location.

### △ Guide

Initiate a discussion of the importance of understanding the criteria and constraints of the challenge. Review the meaning of criteria and constraints. Criteria are the conditions that must be met and constraints are limitations in how the criteria can be met.

### TEACHER TALK

“We have discussed the problem—if you put a basketball court at the bottom of the hill, water will run down the hill and eroded dirt, carried by the water, will cover the basketball court. We want to find a way to build the basketball court without that happening. We need to identify the goals and limits of the challenge. That is, we need to know what our criteria and constraints are. Remember criteria are the conditions that must be met and constraints are the limitations.”

Review the letter sent to the students, if necessary. Use the information in the letter to identify the criteria and constraints of the challenge. As students identify criteria and constraints, create a class record of them so that students can reference the list as they work on their solutions.

**PBIS**

Learning Set 3 • The Basketball-Court Challenge



Rills are small grooves cut into the soil by moving water that carries particles of soil and rock. If the erosion continues, small gullies can eventually form.



When water moves across Earth's surface, it picks up and carries particles of soil, sand, or gravel.



Gravity pulls soil, rocks, and other particles down slopes or hillsides.



Wind can pick up and carry particles for some distance. Sand dunes, seen at many beaches, are created by wind erosion and deposition.

**META NOTES**

*Understand the Challenge* sections generally include identifying criteria and constraints. These sections help the students better understand the challenge so that they might address the challenge effectively.

## The Erosion Walk

25 min.

*Lead students on a walk around school grounds to identify examples of erosion and to consider their cause.*

**META NOTES**

Bring digital cameras if they are available.

## ◆ Evaluate

Before proceeding, make sure that these criteria and constraints are in the class list:

Criteria: must prevent erosion at the top of the hill from covering a 28 m × 15 m basketball court at the bottom of the hill

Constraints: the basketball court must be 5 m from the base of the hill; the project must not damage houses (30 m × 10 m) that are 12 m from the court on either side; the height of the hill is 10 m.

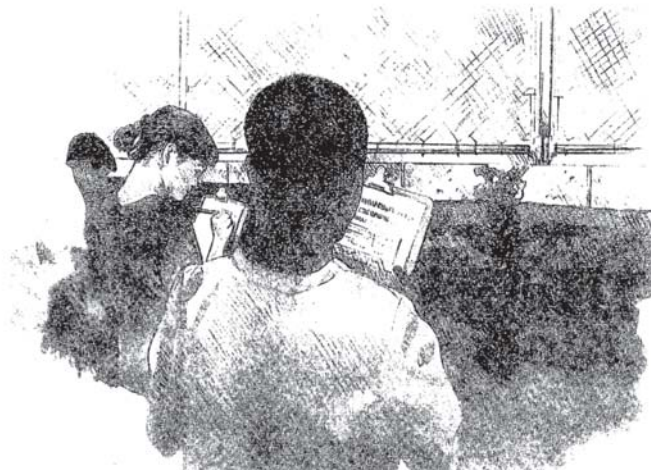
### The Erosion Walk

You will be taking a walk around your school and looking for examples of erosion. Look for things you might not usually notice. These might include a pile of pebbles on the side of the road or small gullies formed by a recent rainfall. You do not have to go very far to find examples of erosion.

Working with a partner, identify at least five examples of erosion. Also identify at least two examples of places where erosion should have happened but did not. Try to find examples that other students have not noticed.

It helps to notice small details. Look for clues, such as dirt that looks different than other dirt around it, or rocks piled together. It is important to remember that the effects of erosion can be small or large. Erosion may cover only a few inches of ground, or you might see large areas where soil is washed away. Look carefully as you walk around.

You should also look for places where erosion should have happened but did not. For those places, try to identify what prevented the erosion. If you have any questions about how erosion happens or does not happen, be sure to record them so you will remember.



## ○ Engage

Ask students if they have seen examples of erosion like the ones in the photographs on page 46. Probe students to describe where they have seen this type of erosion. Ask them to consider why the erosion may have happened.

### △ Guide

Introduce the “Erosion Walk.” Suggest that erosion is not just a problem near rivers or oceans but can be found everywhere. They will now walk around the and look for examples of erosion. Ask students to think about what they might see, near the school, that would indicate erosion. Students should suggest piles of pebbles, small gulleys, and any places where the soil has a different color from the surrounding soil.

Students will be working in pairs and each pair will find five examples of erosion (if the erosion walk path is paved, you can have students find three examples). Students should make a sketch of each example of erosion they see, record where they saw it, and indicate on their sketches where the eroded material came from and where it was deposited. For each of the expected examples of erosion that they didn't see, they should explain why the erosion did not occur. Each partner will have an *Erosion-Walk Observation* page, so together they can record eight observations.

### ◇ Get Going

Distribute the *Erosion-Walk Observation* pages, and lead the students through a walk. Bring digital cameras if you have them and use them to record but the erosion evidence and idea about why the erosion occurred.

### △ Guide and Assess

As students identify examples of erosion and make their sketches, encourage them to pay attention to small details. Look at students' sketches and make sure they are capturing these details.

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#### META NOTES

The Erosion Walk provides students with a common experience from their environment. When students experience science first-hand, they are able to connect the science knowledge more readily to their lives. It would be possible to send students home with this assignment for homework but it would then lose the collegial and sharing aspects. By doing the Erosion Walk as a class, students will have similar experiences and will be able to discuss, throughout the Unit, this common event.

#### META NOTES

During a conference, members of a group discuss their ideas. After the Erosion Walk, students will share different occurrences of erosion they found. Articulating their ideas helps students refine their thinking. Later, during class discussions, groups' ideas are further refined. In this case they begin thinking about what causes erosion.

## Conference

10 min.

Have groups discuss their observations and identify what they think they know and what they still need to learn about how erosion works.

### META NOTES

Some very interesting examples of erosion might be too difficult for students to explain inhibiting students from sharing these examples. Encourage students to share the examples that interest them whether they have an explanation or not.

### Recording Your Observations

**Erosion-Walk Observation Page**

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Location: _____ Description: _____ Cause: _____	Location: _____ Description: _____ Cause: _____
Location: _____ Description: _____ Cause: _____	Location: _____ Description: _____ Cause: _____

Based on your walk, make a list of the places you think erosion is most likely to occur.

Based on your walk, make a list of causes of erosion.

Record your examples on *Erosion-Walk Observation* pages. You will be able to fit four observations on each page, so each pair of students will have room to record eight examples. For each example, make a sketch of the eroded area. If you can see where the eroded material came from, your sketch should also include the path the material traveled and what was formed when it was deposited. Record the location of your example, and describe it in words. Try to figure out what caused the erosion, and record that as well. For your examples where erosion did not happen, figure out and record what prevented the erosion. You may need to look closely at the area around where you found the example of erosion to figure out how it happened. Record enough so that you will be able to share your observations with others. You and your partner may agree or disagree. If you disagree, write enough so that you remember what you disagreed about.

You will need a hard surface to write on as you complete your *Erosion-Walk Observation* page, so take a book or workbook with you. You should also have a pencil and your *Erosion-Walk Observation* page.

### Conference

After you return from the erosion walk, share your observations and ideas with your group members about what caused your examples of erosion. Make sure everybody has a chance to share. As a group, select two examples of erosion, and make your best guess about how each happened. For example, you may have found a small ditch carved out in a flat area. You might think that the wind slowly carried particles of dirt away from the area. Your guess may not be correct, but do your best based on what you know so far.

### △ Guide

When the class returns from their erosion walk, have each pair meet with another pair to form a group of four. Groups should share all the examples they found and select two examples of erosion to share with the whole class. They should explain why the erosion occurred. Then they should select an example of a place where they expected erosion but did not see it. They should try to explain why it did not occur. Finally, groups should discuss which of their answers they are unsure of and what they need to learn to be sure of their understanding.



## Introducing the Project Board

Introduce the Project Board and why it is used.

### META NOTES

The *Project Board* is a critical aspect of the PBIS curriculum and is introduced in this *Learning Set*. Through the *Project Board* discussions, students consider what they already know, questions they would like to investigate, what they are learning and their evidence for their learning and how it all works together to help them address the Unit challenge.

The *Project Board* is used several times throughout this *Learning Set*. In subsequent Units, the *Project Board* will be used throughout the Unit, being updated as ideas are developed.

The most important feature of the *Project Board* is the discussion that occurs as the students' learning is being documented. How students' ideas are accepted, questioned, supported, and clarified will determine how successfully the *Project Board* is integrated into the classroom culture.

The *Project Board* segments generally require the inclusion of certain questions or content to move the Unit discussion forward.

### 3.1 Understand the Challenge

Then select an example of a place where erosion did not happen. Try to come to an agreement about why it did not occur.

When you are finished, try to answer the two questions at the bottom of your *Erosion-Walk Observation* page.

- Where is erosion most likely to happen?
- What causes erosion?

In the time you have left, discuss which of your answers you are sure about and which you are less sure about. Discuss what you think you still need to learn to fully understand your observations.

#### Introducing the Project Board

When you work on a project, it is useful to keep track of your progress and what you still need to do. You will use a **Project Board** to do that. It gives you a place to keep track of your scientific understanding as you make your way through a Unit. It is designed to help your class organize its questions, investigations, results, and conclusions. The *Project Board* will also help you to decide what you are going to do next. During classroom discussions, you will record the class's ideas on a class *Project Board*. At the same time, you will keep track of what has been discussed on your own *Project Board* page.

The *Project Board* has space for answering five guiding questions:

- What do we think we know?
- What do we need to investigate?
- What are we learning?
- What is our evidence?
- What does it mean for the challenge or question?

Each time you use the *Project Board*, you will record as much as you can in each column. As you work through a Unit, you will return over and over again to the *Project Board*. You will add more information and revise what you have recorded. Everything you write in the columns will be based on what you know or what you have learned. In addition to text, you will sometimes want to put pictures or data on the board.

**Project Board:** a space for the class to keep track of progress while working on a project.

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### △ Guide

Explain that the *Project Board* is a tool that will be used throughout the course. It is used by the class to organize ideas, questions, and answers when working on a challenge. The *Project Board* helps keep track of all the things they learn in the Unit.

Emphasize that the class will be filling out the first two columns (*What do we think we know?* and *What do we need to investigate?*) today and that they will add to all the columns as they work on the challenge.

Next, describe the five columns. Explain that the third and fourth columns go hand in hand (the third basically lists the claims and the fourth lists the evidence that backs up those claims based on observations and information from experts), and the fifth explains how it is connected with the challenge or a bigger question.

### TEACHER TALK

“Over here I have set up our class *Project Board* for the *Basketball-Court Challenge*. All of you have ideas about how erosion works. You probably discovered on the erosion walk that you already know some things. Other things you might not be sure about. Our *Project Board* will help us organize our ideas as we work on this challenge. We will need to answer many questions as we work on the bigger question of the challenge. A *Project Board* is a way to keep track of what we think we know, what we want to investigate, what we are learning and how we know it, and how it all hooks up with the addressing the challenge. (Show the headers on the *Project Board*). We will be returning to our class *Project Board* and updating it many times while we work on our challenge.”

### NOTES

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### META NOTES

Students will develop a deeper understanding of what belongs in each column of the *Project Board* as they continue to update it. It is not necessary that students understand how the *Project Board* will be used at this point, there will be many opportunities for them to gain more knowledge of how they can use the *Project Board*.

### META NOTES

The first column includes the word *think*. The intention is to imply the tentative nature of science knowledge, even the science knowledge they come to class with.

### META NOTES

You may want to distribute the student *Project Board* pages at this time. Students should be keeping a personal copy of the class *Project Board* that they can refer to as needed and that you will be keeping the class *Project Board* and recording the class's ideas and questions on it until the end of the Unit.

## Create the Project Board

35 min.

*Students are now ready to share ideas about erosion (so they will be able to address the Basketball-Court Challenge). At the same time, students need to learn to use a Project Board for monitoring progress on their challenge. Lead a class discussion using the Project Board to record students' ideas about erosion.*

PBIS

### Create the Project Board

To get started on this *Project Board*, identify the important science question you need to answer. To design erosion-control measures for a basketball court, you need to understand the answer to this question: *What causes erosion, and how can it be controlled?* Write this question on your *Project Board*.

The erosion walk was meant to help you recognize what you understand about erosion. It also helped you think about what you do not understand well enough yet. These are exactly the things you will record in the first two columns of the *Project Board*.

What causes erosion, and how can it be controlled?				
What do we think we know?	What do we need to investigate?	What are we learning?	What is our evidence?	What does it mean for the challenge or question?

### Engage

Connect the Erosion Walk to the challenge again and help students understand that as engineers and scientists work challenges, they need to keep a record of their ideas so they can monitor their progress. Tell them they will be doing this using a *Project Board*.

#### TEACHER TALK

“You found a lot of examples of erosion on the Erosion Walk. Examples of erosion are everywhere. Remember, there are criteria and constraints to this challenge. The goal is to find a way to control erosion so that it does not damage or disturb the proposed basketball court. We also have to keep in mind that we do not want to damage the other properties nearby. We are just getting started and you have a lot of ideas and questions to test before we get close to a solution. We will need a way to keep track of our ideas and progress just as scientists and engineers do as they are addressing challenges. We’ll keep track of our ideas using a *Project Board*.”

## ◻ Get Going

Begin students on the *Project Board* by starting with the question: *What causes erosion, and how can it be controlled?* Emphasize that they need to be able to answer this question for the school board to build the basketball court. Write this question across the top of the *Project Board* or have a student write it for the class across the top of the *Project Board*.

## △ Guide

Then move to the first column and ask the students what they think they know will help them to address the Challenge. There is no need to figure out right now if these ideas are right or wrong.

Then include some ideas about what they need to investigate. Use the second column for their questions. This includes questions about ideas students don't agree on or have a hard time accepting. Students will disagree about some of the items in the first column. These are indications of questions that need to go in the second column. Things students are surprised by should go in the second column as well.

- What did you list as things you think you know?
- What did you talk about in your group that everyone agreed on?
- What do you know about erosion from your erosion walk?
- What did you list as things you were unsure about?
- What did you talk about that not everyone agreed on?

See the sample *Project Board* below. Your class won't come up with exactly these ideas and questions.

## ◇ Evaluate

With students, look over the ideas and questions on the *Project Board*. Make sure all students have had the opportunity to contribute and that their ideas are represented. There should be questions about what causes erosion or how wind, water, or ice cause erosion. Don't expect students to be experts at this point.

### META NOTES

Students do not think about science or engineering as dynamic processes that changes as new information becomes available. They may be surprised to hear that they will be returning to the *Project Board* and updating it over time.

It is helpful to keep track of the date items were posted. That way, students can monitor changes in their ideas and their progress on the challenge.

Linking items in different columns that are related to each other with arrows helps students to see how ideas and questions are connected.

During the discussion, listen for students' ideas about what causes erosion and their reasoning.

What do we think we know?	What do we need to investigate?	What are we learning?	What is our evidence?	What does it mean for the challenge or question?
<p>Erosion is when soil is moved from one place to another by wind, water, or ice as a result of gravity. <i>March 30</i></p> <p>Erosion is more likely to occur where bare soil is then when it is covered with vegetation. <i>March 30</i></p> <p>Erosion is more likely to happen where there is a slope. <i>March 30</i></p> <p>Erosion is more likely to happen where water flows. <i>March 30</i></p>	<p>Does erosion affect gravel more or less than soil? <i>March 30</i></p> <p>What determines where rainwater will flow? <i>March 30</i></p> <p>How does water cause erosion? <i>March 30</i></p>			

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## 3.1 Understand the Challenge

**What Do We Need to Investigate?**

In this column, you will record what you need to learn more about. During your group conference, you probably came up with questions about how to explain some of your observations. You might also have figured out some things you are confused about. And you might have found that you and others in your group disagreed about some things. This second column is designed to help you keep track of things that are confusing. Record what you do not understand well yet and what you disagree about. These are the things you will need to investigate. They will be important for achieving your challenge (designing a method to control erosion).

Sometimes you are unsure about something but do not know how to word it as a question. One of the things your class will do together around the *Project Board* is to turn what you are curious about into questions you can investigate.

Later in this Unit, you will return to the *Project Board*. For now, work as a class and begin filling in the first two columns.

**What's the Point?**

You made some observations in your schoolyard or nearby neighborhood of examples of erosion. Some may have been small and hard to notice and others may have been large and quite visible. They were also caused by different forces in nature, such as running water, wind, and gravity.

You started a *Project Board* to help you keep track of what you understand. You also added some questions and ideas you would like to investigate further. The *Project Board* is a space to help the class work together to understand and solve problems. Using it will help you have good science discussions as you work on a project.

Now that you have identified the questions you need to answer, you know what you need to do next. You need to investigate to find the answers to some of those questions.

**What's the Point?**

*Less than 5 min.*

*Students should have a working understanding of erosion and how it might happen in their local area. They should be able to identify examples of erosion in their environment and in pictures. Ask students why it is important to be able to identify what they need to know and how this connects to the challenge.*

**META NOTES**

It is important for students to be able to figure out what they need to know when they are working on a challenge so that they can figure out what to investigate to solve the challenge.

### Assessment Options

Targeted Concepts, Skills, and Nature of Science	How do I know if students got it?
<p>Scientists often work together and then share their findings. Sharing findings makes new information available and helps scientists refine their ideas and build on others' ideas. When another person's or group's idea is used, credit needs to be given.</p>	<p><b>ASK:</b> Why was it important to discuss your ideas about erosion with the other members of your group?</p> <p><b>LISTEN:</b> Students should recognize that they needed to discuss their ideas about erosion with their groups to see where they might need to understand erosion better.</p>
<p>Criteria and constraints are important in design.</p>	<p><b>ASK:</b> Why was it important to identify the criteria and constraints of the challenge?</p> <p><b>LISTEN:</b> Identifying the criteria and constraints helps students fully understand the challenge, and may help them begin to see solutions.</p>
<p>Scientists must keep clear, accurate, and descriptive records of what they do so they can share their work with others, consider what they did, why they did it, and what they want to do next.</p>	<p><b>ASK:</b> How did you use the observations?</p> <p><b>LISTEN:</b> Students should have used their observations during their group discussions to determine what they need to understand better.</p>
<p>Erosion is the process of soil and other particles being displaced by water, waves, wind, and gravity.</p>	<p><b>ASK:</b> How would you describe what erosion is?</p> <p><b>LISTEN:</b> Descriptions should specify that erosion is when soil and other materials are moved from one place to another by wind, water, or ice.</p>

### Teacher Reflection Questions

- What difficulties do you expect students to have understanding the concepts involved in erosion? What can you do to help them with these difficulties?
- What evidence do you have that students effectively identified what they don't yet understand about erosion? What can you do to help them identify what they need to learn?
- How were you able to manage the class's time during the erosion walk? What could you try in future erosion walks to make time management easier?