

## Ever-Changing Earth

*Ever-Changing Earth* is based on a unit *Earth Structures and Processes* developed by the Geographic Data in Education (GEODE) Initiative and the Center for Learning Technologies in Urban Schools (LeTUS) at Northwestern University. *Ever-Changing Earth* was developed by the *Project-Based Inquiry Science* project in conjunction with the Center for Curriculum Materials in Science at Northwestern University (Brian Reiser, Daniel Edelson, Bruce Sherin, PIs).

### **Ever-Changing Earth**

#### **Developers**

Edward Denecke  
Jennifer Mundt Leimberer  
Janet L. Kolodner  
Mary L. Starr

#### **Project Consultant**

Daniel Edelson

#### **Contributing Field-Test Teachers**

Bryce Cahn  
Tara O'Neill  
Christopher Poli  
Carmelo Ruiz  
Purvi Vora  
Ester Wiltz

### **Earth Structures and Processes**

#### **Project Director**

Daniel Edelson

#### **Lead Developers**

Jennifer Mundt Leimberer  
Josh Radinsky

#### **Other Developer**

Mary Pat Pardo

### **Contributors**

Lindsey Own  
Ben Loh  
Matthew Rossi  
David Smith  
Darlene Slusher

### **Consultants**

LeeAnn Sutherland  
Rebecca Schneider  
Colleen Riley

### **Pilot Teachers**

Joan Billingham  
Jean Bramelette  
Lou Ellen Finn  
Sonia Flores  
Jennifer Mundt Leimberer  
Kathleen North-Tomczyk  
Jennifer Olson  
Mary Pat Pardo  
Thea Raedeke  
Carlos Rodriguez  
Sandi Terry  
Judith Lachance-Whitcomb

### **Production Assistants**

Samuel Hong  
Elizabeth Van Buren  
Andrew Watson  
Jean Sutow



The development of *Ever-Changing Earth* was supported by the National Science Foundation under grant nos. 0137807, 0527341, and 0639978. The development of *Earth Structures and Processes* was supported by the National Science Foundation under grants no. ESI-0352478, REC-9720377, REC-9720383, REC-0337598. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

# Table of Contents

## What's the Big Question?

**What Processes Within Earth Cause Geologic Activity?** ..... EE 3

### Learning Set 1

*Science Concepts: Topography, elevation, depth, sea level, maps, shaded-relief maps, satellite imaging, topographic maps, contour lines, using visualization tools, organizing data, sharing data.*

**How Can My Region Be Described?** ..... EE 33

1.1 Understand the Question

Thinking About How My Region Can Be Described..... EE 34

1.2 Investigate

How Can My Earth Structure Be Described?..... EE 47

More to Learn

How Do Topographic Maps Represent Earth's Surface? ..... EE 52

**Back to the Big Question** ..... EE 55

### Learning Set 2

*Science Concepts: Plates, plate tectonics, structure of Earth, crust, mantle, core, seismic waves, seismology, density, magma, lithosphere, asthenosphere, mesosphere, inner core, outer core, Earth systems, atmosphere, biosphere, hydrosphere, geosphere, plate boundaries, faulting, folding, oceanic and continental crust, understanding models, making observations and inferences, organizing data, sharing data, using evidence to explain.*

**What Is the Structure of Earth?**..... EE 59

2.1 Understand the Question

Think About the Structure of Earth ..... EE 60

2.2 Explore

A Model of Earth's Structure..... EE 64

2.3 Explore

Making Observations and Inferences ..... EE 67

2.4 Read

What Do Scientists Know About Earth's Surface and Interior? ..... EE 71

More to Learn

Density ..... EE 80

2.5 Explore

Modeling Earth's Structure ..... EE 83

More to Learn

Earth Systems ..... EE 86

**Back to the Big Question** ..... EE 88

### Learning Set 3

*Science Concepts: Plate boundaries, earthquakes, tsunamis, focus, epicenter, body waves, surface waves, P-waves, S-waves, longitudinal waves, transverse waves, seismograph, magnitude, Richter Scale, intensity, Modified Mercalli Intensity Scale, earthquake safety, finding the epicenter, locating plate boundaries, using visualization tools, working with maps, reading and analyzing data, using evidence to explain, sharing data.*

**What Happens at Plate Boundaries?** ..... EE 91

3.1 Understand the Question

Think about What Happens at Plate Boundaries ..... EE 92

3.2 Read

What Causes Earthquakes and What Happens When They Occur? ..... EE 96

3.3 Read

How Do Scientists Collect and Evaluate Data From Earthquakes?..... EE 105

3.4 Explore

How Do Scientists Find the Epicenter of an Earthquake? ..... EE 116

3.5 Explore

What Can Earthquake Data Tell You About the Location of Plate Boundaries? ..... EE 123

3.6 Investigate

How Can One Year of Earthquake Data Help You Better Identify Plate Boundaries? ..... EE 131

3.7 Explore

Where Are Plate Boundaries Located Across the Entire Earth? ..... EE 141

**Back to the Big Question** ..... EE 145

**Learning Set 4**

**Science Concepts:** *Movement of Earth’s plates, convection, convection currents, mid-ocean ridge, lava, ocean-floor spreading, using visualization tools, organizing data, using evidence to explain, sharing data.*

**What Causes Earth’s Plates to Move?** ..... EE 149

4.1 Understand the Question

**Think About Why Earth’s Plates Move**..... EE 150

4.2 Investigate

**What Causes Earth’s Mantle to Move?**..... EE 153

4.3 Read

**Why Does the Mantle Move the Way it Does?**..... EE 159

**Back to the Big Question** ..... EE 168

**Learning Set 5**

**Science Concepts:** *Types of volcanoes, volcanoes at plate boundaries, volcanic eruptions, Volcanic Explosivity Index, comparing and classifying volcanoes, formation of volcanoes, hot spots, underground volcanic activity, igneous intrusion, igneous rock, using visualization tools, organizing data, using evidence to explain, sharing data.*

**What Can Volcanoes Tell You About Plate Interactions?** ..... EE 171

5.1 Understand the Question

**Think About What Volcanoes Can Tell You About Plate Interactions** ..... EE 172

5.2 Explore

**How Do the Volcanoes in Your Region Compare to Those Around the World?**..... EE 180

5.3 Read

**What Is a Volcano?** ..... EE 189

5.4 Explore

**What Can the Volcanoes in My Region Tell Me About How the Plates are Moving?**..... EE 203

**Back to the Big Question** ..... EE 207

**Learning Set 6**

**Science Concepts:** *Plate interactions, convergent boundaries, subduction zones, buckling zones, divergent boundaries, rift zones, transform boundaries, trenches, basaltic magma, andesitic magma, using visualization tools, organizing data, using evidence to explain, sharing data.*

**What Geologic Activity Happens at Plate Boundaries?** ..... EE 215

6.1 Understand the Question

**Think About What Geologic Activity Happens at Plate Boundaries**..... EE 216

6.2 Read

**How Do Scientists Describe the Interactions Between Moving Plates?**..... EE 221

More to Learn

**Magma** ..... EE 239

6.3 Investigate

**What Type of Plate Boundaries and Interactions Are Found in Your Region?** ..... EE 241

**Back to the Big Question** ..... EE 245

**Answer the Big Question**

**What Processes Within Earth Cause Geologic Activity?**..... EE 249

More to Learn

**How Do Scientists Answer the Big Question?** ..... EE 251

**Using My World Software** ..... EE 259

**English & Spanish Glossary**..... EE 265

**Index** ..... EE 279

**Credits** ..... EE 287



## Introducing PBIS

# What Do Scientists Do?

## 1) Scientists...address big challenges and big questions.

You will find many different kinds of *Big Challenges* and *Questions* in *PBIS* Units. Some ask you to think about why something is a certain way. Some ask you to think about what causes something to change. Some challenge you to design a solution to a problem. Most of them are about things that can and do happen in the real world.

### Understand the Big Challenge or Question

As you get started with each Unit, you will do activities that help you understand the *Big Question* or *Challenge* for that Unit. You will think about what you already know that might help you, and you will identify some of the new things you will need to learn.

### Project Board

The *Project Board* helps you keep track of your learning. For each challenge or question, you will use a *Project Board* to keep track of what you know, what you need to learn, and what you are learning. As you learn and gather evidence, you will record that on the *Project Board*. After you have answered each small question or challenge, you will return to the *Project Board* to record how what you've learned helps you answer the *Big Question* or *Challenge*.

### Learning Sets

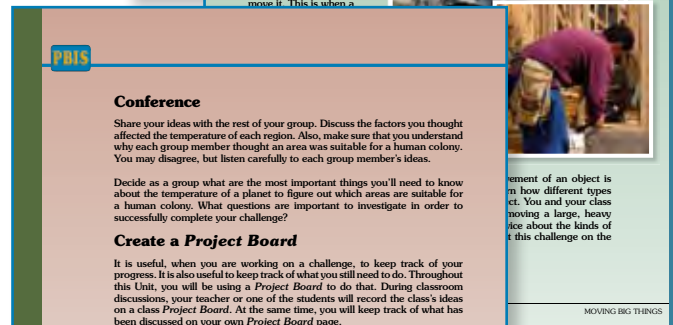
Each Unit is composed of a group of *Learning Sets*, one for each of the smaller questions that need to be answered to address the *Big Question* or *Challenge*. In each *Learning Set*, you will investigate and read to find answers to the *Learning Set's* question. You will also have a chance to share the results of your investigations with your classmates and work together to make sense of what you are learning. As you come to understand answers to the questions on the *Project Board*, you will record those answers and the evidence you've collected. At the end of each *Learning Set*, you will apply your knowledge to the *Big Question* or *Challenge*.



### What's the Big Question?

How do machines help move large, heavy objects?

When you think of heavy objects, you might think of a box of books, a large appliance, a car, or mounds of dirt and rock. There are plenty of heavy things in the world that need to be moved. Sometimes people can use their own strength to move something heavy. At other times, the object is so heavy that even the strongest person cannot move it. This is when a



#### Conference

Share your ideas with the rest of your group. Discuss the factors you thought affected the temperature of each region. Also, make sure that you understand why each group member thought an area was suitable for a human colony. You may disagree, but listen carefully to each group member's ideas.

Decide as a group what are the most important things you'll need to know about the temperature of a planet to figure out which areas are suitable for a human colony. What questions are important to investigate in order to successfully complete your challenge?

#### Create a Project Board

It is useful, when you are working on a challenge, to keep track of your progress. It is also useful to keep track of what you still need to do. Throughout this Unit, you will be using a *Project Board* to do that. During classroom discussions, your teacher or one of the students 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.

Which regions of a newly discovered planet have appropriate surface temperatures for a human colony?

What do you think we know

PBIS Learning Set 1 • How Do Flowing Water and Land Interact in a Community?



### Learning Set 1

#### How Do Flowing Water and Land Interact in a Community?

The big question for this unit is *How does water quality affect the ecology of a community?* So far you have considered what you already know about what water quality is. Now you may be wondering where the water you use comes from. If you live in a city or town, the water you use may come from a river. You would want to know the quality of the water you are using. To do so, it is important to know how the water gets into the river. You also need to know what happens to the water as the river flows across the land.

You may have seen rivers or other water bodies near your home, your school, or in your city. Think about the river closest to where you live. Consider from where the water in the river comes. If you have traveled along the river, think about what the land around the river looks like. Try to figure out what human activities occur in the area. Speculate as to whether these activities affect the quality of water in the river.



To answer the big question, you need to break it down into smaller questions. In this Learning Set, you will investigate two smaller questions. As you will discover, these questions are very closely related and very hard to separate. The smaller questions are *How does water affect the land as it moves through the community?* and *How does land use affect water as it moves through a community?*

Project Based Inquiry Science



**Address the Big Challenge**

**How Do Scientists Work Together to Solve Problems?**

You began this unit with the question, *how do scientists work together to solve problems?* You did several small challenges. As you worked on these challenges you learned about how scientists solve problems. You will now watch a video about real-life designers. You will see what the people in the video are doing that is like what you have been doing. Then you will think about all the different things you have been doing. After this unit, each of you will write about your experience as a scientist.

**1.1 Understand the Question**

**1.1 Understand the Question**

**Think about the Questions**

The questions for this Learning Set are *How does water affect the land as it moves through the community?* and *How does land use affect water as it moves through a community?* It is a good idea to think about what you already know about how moving water affects the land and how the land affects the water. It is also important to think about what you are unsure about and what you would like to investigate.

**Get Started**

Think about these questions, and share ideas about the source of your water, and the lands it flows through with your class. Listen carefully to all the ideas presented. You may want to write down some of the ideas you hear.

During the discussion with your classmates, you may have discovered that there are a few things you already know. You probably also discovered that there are many things you don't know yet. These are things you need to know in order to answer the questions. You are going to think of several questions that might help you to answer this Learning Set's questions and add them to the Project Board.

You are going to develop two questions that might help you understand how water changes as it moves through the land and communities live. When you develop your questions, keep in mind questions should:

- be interesting to you,
- have no yes/no or one-word answers
- require several resources
- relate to the big question
- require collecting and using data



IDEO is an online tool for designing and prototyping. You will use this tool to design a solution to a problem. You might use this tool to design a solution to a problem.



**Learning Set 1 • What Is Temperature and How Does It Differ across Earth's Surface?**

**1.4 Investigate**

**Compare Your Temperature Map to a Real-World Temperature Map**

Scientists often compare their ideas to real data. In this activity, you will have the opportunity to do the same. You will open both the visualization you created on the computer and another one that contains actual data. As you study them, look for similarities and differences. By comparing the two maps, you will see if there are still things you need to learn.

**Procedure: Comparing Maps**

Begin by opening "My World" Open Planetary Forecaster.

1. Open the temperature map you created earlier, showing your predictions of surface temperatures.
  - a) Locate the "Visualize" tab and click on it.
  - b) Click on the "SurfTempPredictions" layer in the Layer List. There is a dropdown menu within this layer showing different data sources.

**Learning Set 3 • How Can Changes in Water Quality Affect the Living Things in an Ecosystem?**

**3.3 Explore**

**The Marry Martans River Mystery: Macroinvertebrates in an Ecosystem**

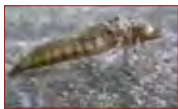
**ecologist:** a scientist who studies the relationships between organisms and their environment.

You watched a video of scientists collecting macroinvertebrates. You should now have a good sense of how scientists organize and classify macroinvertebrates. Once scientists identify macroinvertebrates in an ecosystem, they can use this information to better understand the conditions in an ecosystem.

You also learned about diversity and abundance. Recall that diversity refers to the types of organisms found in an environment. Abundance refers to the number of each type. In this activity, you will examine the diversity of macroinvertebrates in an area. You will see how diversity can indicate water quality and ecosystem health. You will be working with some macroinvertebrate data collected by an ecologist. The ecologist has been asked to help the residents of a small community solve a mystery. What you learn from this case study will help you address this Learning Set's question.

**Examine a Case Study**

A group of residents live on a small lake called Marry Martans Lake. The Marry Martans River flows into the lake at one end. The lake drains back into the river at the other end. (See the picture on the next page.) Over the past few months, the residents have noticed a lot of algae growing in the lake. The young people in the community know about water-quality indicators from their science classes. They remember that sudden algae and plant growth could be a sign of high amounts of fertilizer running off into the river.



The young people and their parents decide to investigate the case. Where might the fertilizer be coming from? They discover that there are three farms upriver. These farms are upstream from the lake and border the river. They wonder if fertilizer runoff from the farms is causing the problem. The residents discuss this with the farmers. Each of the three farmers denies that they have a fertilizer-runoff problem.

**Answer the Big Question / Address the Big Challenge**

At the end of each Unit, you will put everything you have learned together to tackle the *Big Question or Challenge*.

**2) Scientists...address smaller questions and challenges.**

**What You Do in a Learning Set**

**Understanding the Question or Challenge**

At the start of each *Learning Set*, you will usually do activities that will help you understand the *Learning Set's* question or challenge and recognize what you already know that can help you answer the question or achieve the challenge. Usually, you will visit the *Project Board* after these activities and record on it the even smaller questions that you need to investigate to answer a *Learning Set's* question.

**Investigate/Explore**

There are many different kinds of investigations you might do to find answers to questions. In the *Learning Sets*, you might

- design and run experiments;
- design and run simulations;
- design and build models;
- examine large sets of data.

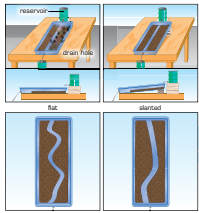
Don't worry if you haven't done these things before.

The text will provide you with lots of help in designing your investigations and in analyzing your data.





PBIS Learning Set 1 • How Do Flowing Water and Land Interact in a Community?



Your teacher will set up the stream table in four different ways, as shown in the diagrams. Sketch the different models. As you watch the water flow through the model, pay very close attention to the way the land on both sides of the river changes. Pay attention to

- how the soil moves,
- where along the bank the soil moves, and
- where the soil ends up.

Make notes about what you observe for each of these situations. You might want to mark your sketches based on what you observed.

**Stop and Think**  
Look at your sketches and the notes you took about the river models you observed. What did you notice about how the soil was moved by

### 3) Scientists...reflect in many different ways.

PBIS provides guidance to help you think about what you are doing and to recognize what you are learning. Doing this often as you are working will help you be a successful student scientist.

## Tools for Making Sense

### Stop and Think

*Stop and Think* sections help you make sense of what you've been doing in the section you are working on. *Stop and Think* sections include a set of questions to help you understand what you've just read or done. Sometimes the questions will remind you of something you need to pay more attention to. Sometimes they will help you connect what you've just read to things you already know. When there is a *Stop and Think* in the text, you will work individually or with a partner to answer the questions, and then the whole class will discuss the answers.

### Reflect

*Reflect* sections help you connect what you've just done with other things you've read or done earlier in the Unit (or in another Unit). When there is a *Reflect* in the text, you will work individually, with a partner or your small group to answer the questions. Then, the whole class will discuss the answers. You may be asked to answer *Reflect* questions for homework.

### Analyze Your Data

Whenever you have to analyze data, the text will provide hints about how to do that and what to look for.

### Mess About

"Messing about" is a term that comes from design. It means exploring the materials you will be using for designing or building something or examining something that works like what you will be designing. Messing about helps you discover new ideas—and it can be a lot of fun. The text will usually give you ideas about things to notice as you are messing about.

### What's the Point?

At the end of each *Learning Set*, you will find a summary, called *What's the Point?*, of the important information from the *Learning Set*. These summaries can help you remember how what you did and learned is connected to the *Big Question or Challenge* you are working on.

**Reflect**

Think about the book support you designed and built so far. Try to think about the science concepts you have read about and discussed as a class. Answer the following questions. Be prepared to discuss your answers with the class.

1. Was your structure strong? If not, did it collapse because of folding, compression, or both?
2. How could you make the structure stronger to resist folding or compression?

PBIS Learning Set 3 • How Does a Planet's Tilt Affect Surface Temperatures?

**Analyze Your Data**

Calculate the temperature range for each location using a table like the one shown.

Location	Temperature Ranges		Yearly Temperature Change (high-low)
	High Temperature	Low Temperature	
Greenland (61°N 36°W) polar			
Helinki, Finland (60°N 24°E) mid latitude north			

PBIS Learning Set 3 • The Whirligig Challenge

**Mess About with the Whirligig**

**Messing About:** an exploratory activity that gives you a chance to become familiar with the materials you will be using or the function of the product you will be designing.

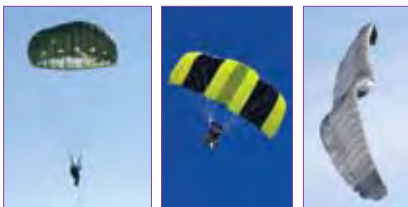
To help you think about how to achieve your challenge, you will begin by **messing about** with the whirligig. You will use the basic whirligig that now appears on the back of the cereal boxes.

You will get a template (pattern) of a whirligig. It will look like the one shown below. The whirligig has several parts: blades, paper clips, and a stem. If you call them by those names when you talk about the whirligig, everyone will know what you are talking about.

Cut out the template. To form the whirligig, fold the cutout template. Attach two paper clips to the stem.



PBIS Learning Set 4 • The Parachute Challenge



**What's the Point?**

Through *messing about*, you became familiar with the way parachutes work. You developed a feel for the materials you will use later. You were also able to identify some of the variables that might affect how slow a parachute will fall. This allowed you to do two things:

- Identify the criteria and constraints of the challenge (what you need to accomplish and the limitations).
- Identify questions you need to investigate to be able to design the best parachute.

In your class discussions around the *Project Board* you made a list of factors that would be appropriate to investigate. Different groups came up with different ideas of what affects a parachute's fall. It was only by collaborating (working together) as a class that you were able to record a full set of questions about how the parachute might work.

## 4) Scientists...collaborate.

Scientists never do all their work alone. They work with other scientists (collaborate) and share their knowledge. *PBIS* helps you be a student scientist by giving you lots of opportunities for sharing your findings, ideas, and discoveries with others (the way scientists do). You will work together in small groups to investigate, design, explain, and do other things. Sometimes you will work in pairs to figure out things together. You will also have lots of opportunities to share your findings with the rest of your classmates and make sense together of what you are learning.

### Investigation Expo

In an *Investigation Expo*, small groups report to the class about an investigation they've done. For each *Investigation Expo*, you will make a poster detailing what you were trying to learn from your investigation, what you did, your data, and your interpretation of your data. The text gives you hints about what to present and what to look for in other groups' presentations. *Investigation Expos* are always followed by discussions about the investigations and about how to do science well. You may also be asked to write a lab report following an investigation.

### Plan Briefing/Solution Briefing/Idea Briefing

Briefings are presentations of work in progress. They give you a chance to get advice from your classmates that can help you move forward. During a *Plan Briefing*, you present your plan to the class. It might be a plan for an experiment or a plan for solving a problem or achieving a challenge. During a *Solution Briefing*, you present your solution in progress and ask the class to help you make your solution better. During an *Idea Briefing*, you present your ideas. You get the best advice from your classmates when you present evidence in support of your plan, solution, or idea. Often, you will prepare a poster to help you make your presentation. Briefings are almost always followed by discussions of your investigations and how you will move forward.

### Solution Showcase

*Solution Showcases* usually appear near the end of a Unit. During a *Solution Showcase*, you show your classmates your finished product—either your answer to a question or your solution to a challenge. You also tell the class why you think it is a good answer or solution, what evidence and science you used to get to your solution, and what you tried along the way before getting to your answer or solution. Sometimes a *Solution Showcase* is followed by a competition. It is almost always followed by a discussion comparing and contrasting the different answers and solutions groups have come up with. You may be asked to write a report or paper following a *Solution Showcase*.

**Learning Set 1 • How Do Flowing Water and Land Interact in a Community?**

**Communicate Your Results**

**Investigation Expo**

Use the *Analyze Your Results* questions as a way to discuss the results of your investigation in your group.

For the *Investigation Expo*, create a poster with a diagram of your land-use model. Make your diagram as detailed as you possibly can. Include all your land covers as well as your results. Indicate on your diagram places of erosion and deposition, and places where there was a lot of runoff in your model.

During the *Investigation Expo*, you are going to describe to your class how your model worked. You need to include enough details in your presentation so that your classmates will understand how the land cover in your model changed how the water moved. Answer the following questions in your presentation:

- How did the water move in different parts of the stream table?
- How do you think the land cover you modeled might affect how the water is absorbed by the ground compared to vegetation (plant life) or bare soil?

As you listen to the presentations of the other groups, observe how water flows for each land use. Compare the places where erosion and deposition occur in the different models. Compare the amount of runoff produced by different models.

---

**4.5 Plan**

**Communicate Your Plan**

**Plan Briefing**

As you are finishing your design plan, begin to draw a poster for presentation of your design plan to the class. Your teacher will provide you with a large sheet of paper to create your *Plan-Briefing* poster and possibly a template to follow. You will have 20 minutes to create a *Plan-Briefing* poster and organize your presentation.

Your teacher will then lead your class through a *Plan-Briefing* session.

**Introducing a Plan Briefing**

**Preparing a Plan-Briefing Poster**

A *Plan Briefing* is very much like the other presentations you have learned to do. In a *Plan Briefing*, you present your design plan. You must present it well enough so that your classmates can appreciate your ideas. They should be able to identify if you have made any mistakes in your reasoning. Then they can provide you with advice before you begin constructing your parachute. As a presenter, you'll learn the most from a *Plan Briefing* if you can be very specific about your design plans and about why you made your design decisions. You'll probably want to draw pictures, maybe providing several views. You certainly want everyone to know why you expect your design to achieve the challenge.

The following guidelines will help you as you decide what to present on your poster:

- Your poster should have a detailed drawing of your design with at least one view. You might consider drawing multiple views so that the audience can see your design from different angles. It is important that the audience can picture what you are planning to build.
- Parts of the design and any special features should all be labeled. The labels should describe how and why you made each of your design decisions. Show the explanations and recommendations that support your decisions. Convincing others that your design

---

**4.6 Build and Test**

Remember, you can learn a lot from attempts that did not work as well as you expected. Do not be shy about presenting what has not worked as well as you expected. You and others can learn from mistakes. Your peers can give you advice about design, construction, and testing.

**Solution Showcase**

After every group has a chance to iterate several times on their designs, it will be time to finish this activity. You will present your final design in a *Solution Showcase*. Recall that a *Solution Briefing* is a presentation that allows presenters and audiences to communicate effectively about a design or product. This time, however, you will not get a chance to make your parachute design better. However, after the *Solution Showcase* you might find that these presentations help you understand the science you are learning better.

Explain why you think you might have a very slowly falling design.

**Introducing a Solution Showcase**

The goal of a *Solution Showcase* is to have everyone better understand how each group approached the challenge. You get the opportunity to see the variety of solutions that might work. You can also learn what both successful and unsuccessful designs reveal about the way the world works. Be sure to discuss how you included the *Explanations and Recommendations* that the class generated in your final design.

A *Solution Showcase* should include the history of your design. Review your original design plan. Then tell the class what happened when you tested it. Talk about how you explained those results. Then report what you did to revise your design. Make sure to present the reasons you made the changes you did. Do this for the whole set of iterations you did. Make sure that the class understands what your final design is. Your teacher will tell you how long you have to present. You will not have a lot of time. Figure out how to present your design's history quickly.

As you listen, it will be important to take each design carefully. You should ask questions about how the design meets the criteria of the challenge. Be prepared to ask (and answer) questions such as these:

- What techniques were tried and how were they done?
- How well does the design meet the goals of the challenge?
- How did the challenge constraints affect the use or success of this design?
- What problems remain?
- What other ideas does the group want to test?

PBIS Learning Set 1 • How Do Flowing Water and Land Interact in a Community?

First, develop your own questions. When you have completed your two questions, take the questions back to your small group. Share all the questions with one another. Carefully consider each question and decide if it meets the criteria for a good question. With your group, refine the questions that do not meet the criteria. Choose the two most interesting questions to share now with the class. Give your teacher the rest of the questions so they might be used later.

**Update the Project Board**

How does water quality affect the ecology of the community?				
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?

PBIS Learning Set 1 • What Is Temperature and How Does It Differ across Earth's Surface?

**Conference**

Teams of scientists often work together to solve problems. They hold group discussions. That is what you are going to do. During your discussion, you can present questions that you have. Sometimes if you do not have an answer, someone else might. You might also present a question that no one else had thought of. This can start your group thinking in a new direction.

Discuss your map with a partner and then with your group. Listen and observe as others present their maps to the group. As you present your prediction map, include answers to these questions:

- How did you decide what temperatures to use to color each area?
- How did you decide where to start and where to go to next?
- In which parts of the world do you feel very confident about your predictions, and which parts do you feel unsure about?

After everyone has presented their maps, take note of where there was agreement and where there were differences. Later on you will compare your predictions to a real surface-temperature map.

You have compared your temperature predictions for Earth with those of others in your group. Now, work again with your partner to create a prediction map based on discussions you've just had. Begin with areas where most people in the group were in agreement. Then focus on areas where there is disagreement. Each person should be given a few minutes to support their opinion with facts or evidence. If you change your mind about something, think about what made you change your mind. After you come to agreement on your prediction, you will begin working with a computer program called My World. You will use computer software to create a prediction map similar to the one you made here.



Project-Based Inquiry Science

**Update the Project Board**

Remember that the *Project Board* is designed to help the class keep track of what they are learning and their progress towards a Unit's *Big Question* or *Challenge*. At the beginning of each Unit, the class creates a *Project Board*, and together you record what you think you know about answering the *Big Question* or addressing the *Big Challenge* and what you think you need to investigate further. Near the beginning of each *Learning Set*, the class revisits the *Project Board* and adds new questions and things they think they know. At the end of each *Learning Set*, the class again revisits the *Project Board*. This time you record what you have learned, the evidence you've collected, and recommendations you can make about answering the *Big Question* or achieving the *Big Challenge*.

**Conference**

A *Conference* is a short discussion between a small group of students before a more formal whole-class discussion. Students might discuss predictions and observations, they might try to explain together, they might consult on what they think they know, and so on. Usually, a *Conference* is followed by a discussion around the *Project Board*. In these small group discussions, everybody gets a chance to participate.



**What's the Point?**

Review what you have learned in each *Learning Set*.



**Communicate**

Share your ideas and results with your classmates.



**Stop and Think**

Answer questions that help you understand what you've done in a section.



**Record**

Record your data as you gather it.

