

Astronomy

Astronomy (PBIS) is based on *Astronomy*, a unit developed by the University of Michigan's Center for Highly Interactive Computing in Education (hi ce).

***Astronomy* (PBIS version)**

Lead Developer

Mary L. Starr

Contributor

Julia Plummer

Deano Smith

***Astronomy* (Michigan version)**

Lead Developer

Julia Plummer

Other Developer

Mary Pat Pardo

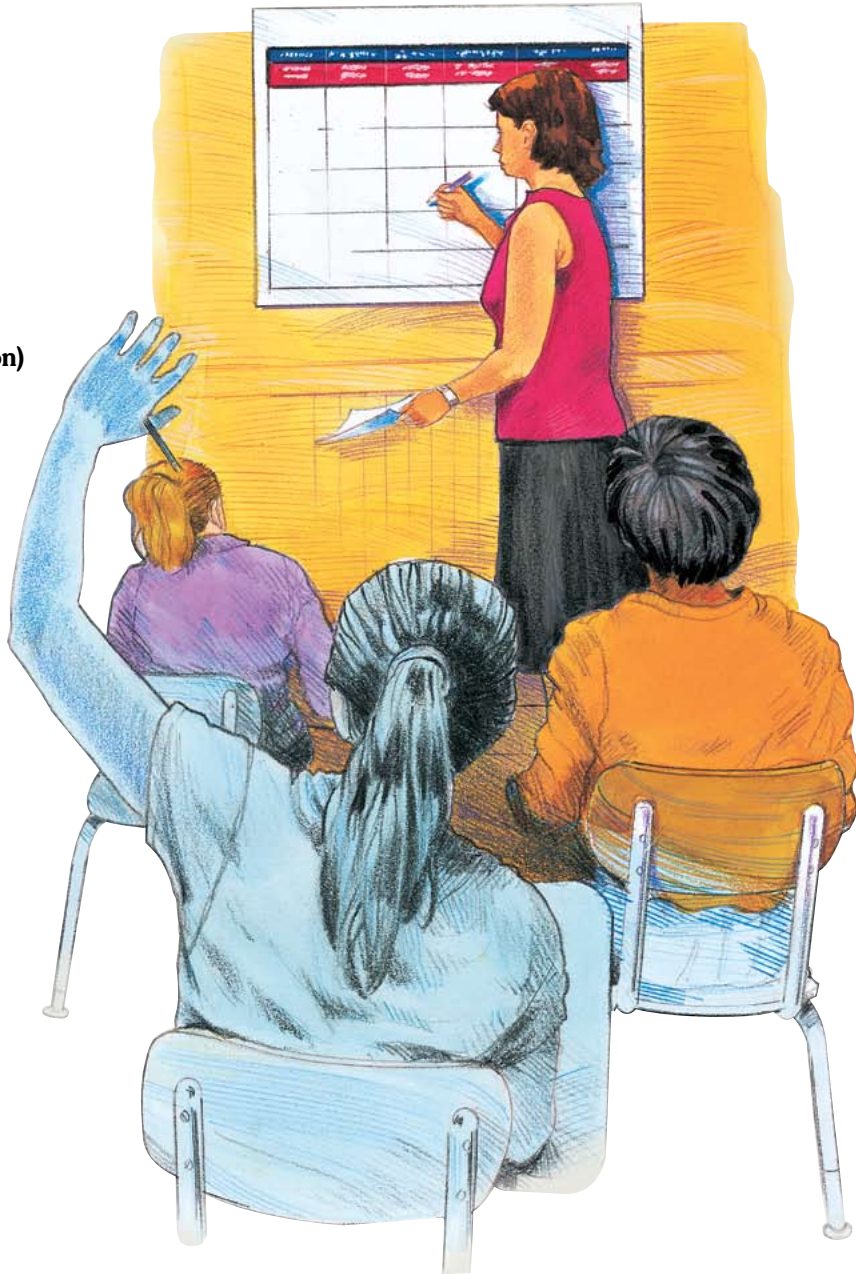
Other Contributors

Lisa Scott Holt

Steve Best

Joe Krajcik

Matthew P. Linke



The development of all versions of *Astronomy* was supported by the National Science Foundation under grant nos. 0137807, 0527341, and 0639978. 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?

How Can You Know if Objects in Space Will Collide? AST 3

Learning Set 1

Science Concepts: Historical contributions in astronomy, impact craters, telescopes, characteristics of impact craters, satellite images, astrogeology, erosion and weathering, age of geological features (Earth and the Moon), meteors and meteorites, components of the solar system, asteroids, comets, asteroid belt, designing an experiment, understanding models, independent and dependent variables, experimental controls, making predictions, communicating plans, analyzing data, working with maps, using visualization tools, using evidence to support claims, developing explanations.

Have Objects in the Solar System Collided? AST 13

1.1 Understand the Question

Think About What Happens When Objects Collide AST 15

1.2 Investigate

Model a Collision With the Moon AST 18

1.3 Explore

What Are the Characteristics of Craters on the Moon? AST 29

1.4 Explore

Does Earth Have Craters Formed by Collisions with Space Objects? AST 33

1.5 Explore

Why Are Craters More Difficult to Find on Earth Than on the Moon? AST 39

1.6 Explore

What Happens When a Meteorite Hits Earth? AST 47

1.7 Read

What Other Evidence Exists of Past Collisions in our Solar System? AST 50

Back to the Big Question AST 57



Learning Set 2

Science Concepts: Apparent motion, rotation and revolution, definition of a day, the Sun as the source of reflected light, phases of the Moon, orbital motion, Earth-Moon-Sun system, relative sizes of objects in the solar system, measurement on the celestial sphere, lunar eclipses and solar eclipses, total eclipses and partial eclipses, shadows (umbra and penumbra), characteristics of the Sun, solar atmosphere, fusion in stars, sunspots, gravity and motion, tides, formation of the Moon, understanding models, collecting and organizing data, building models, developing explanations, using evidence to support claims, using scientific knowledge, using visualization tools, simulations, scale models, scientific theories, making measurements.

How Do Earth, the Moon, and the Sun Move Through Space? AST 65

2.1 Understand the Question

Think About How You Can Find Out About the Motions of Earth, the Moon, and the Sun AST 66

2.2 Model

Make a Model of the Apparent Motion of the Sun AST 73

2.3 Explore

Where is the Moon Located, and How Does It Move?... AST 80

2.4 Explore

How Do the Sizes of Earth and the Moon Compare, and How Far Apart Are They? AST 95

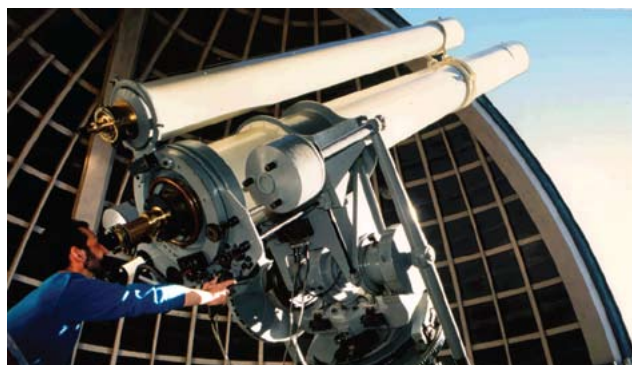
2.5 Explore

What Do Eclipses Tell You About Distances to the Sun and the Moon? AST 103

More to Learn

How Are Tides Caused by Gravity of the Sun and the Moon AST 109

Back to the Big Question AST 111



Learning Set 3

Science Concepts: Position of objects in the solar system, distances between solar system objects, scale models, calculating scale factors, designing models of the solar system, comparing characteristics of planets (inner and outer planets), revolution and definition of a year, astronomical unit, gravity and planetary motion, orbital characteristics, apparent motion of planets, heliocentric and geocentric models of the solar system, historical contributions in astronomy, formation of the solar system, using visualization tools, understanding models, building models, collaboration, building on the work of others, organizing and analyzing data, finding trends in data, using evidence to support claims.

How Do Other Solar-System Objects Move Through Space? AST 115

- 3.1 Understand the Question
Think About Making a Model of the Solar System? AST 117
- 3.2 Develop a Model
Choose Objects for a Model of the Solar System AST 122
- 3.3 Explore
How Can You Predict the Locations of the Planets? ... AST 133
- 3.4 Explore
What Do Moving Planets Look Like From Earth? AST 142
- 3.5 Explore
Where in the Solar System Are Smaller Objects Found? AST 152
- Back to the Big Question** AST 159



Learning Set 4

Science Concepts: Space exploration, telescopes, photography and astronomy, stellar magnitude, distance measurement in astronomy (parallax and indirect methods), astronomical units of distance, characteristics of the Milky Way galaxy, the Sun’s position in the Milky Way galaxy, stellar spectra, Doppler shifts, historical contributions in astronomy, classification of stars, types of stars (main sequence, giant, supergiant, white dwarf, neutron star), radio astronomy, black holes, stellar evolution, nebulae and the formation of stars, types of galaxies, structure and composition of the universe, scale of the universe, age and origin of the universe, current technology in astronomy, making careful observations, using evidence to support claims, using scientific knowledge, analyzing data, collecting observational data, sampling, organizing data, comparing and contrasting data, communicating plans, making recommendations.

How Do Objects Outside Our Solar System Move Through Space?..... AST 163

- 4.1 Understand the Question
Think About How Objects Outside Our Solar System Move Through Space AST 165
- 4.2 Explore
How Can You Know How Bright a Star Is and How Far Away it Is? AST 169
- 4.3 Read
The Milky Way AST 179
- 4.4 Explore
How Do Stars Move in the Milky Way Galaxy? AST 184
- 4.5 Read
What Does a Star’s Light Reveal About a Star? AST 191
- 4.6 Explore
Can Galaxies Collide? AST 199
- 4.7 Read
How Is Technology Aiding New Discoveries in Astronomy AST 206
- Back to the Big Question** AST 213
- Answer the Big Question**
How Can You Know if Objects in Space Will Collide? AST 215
- English & Spanish Glossary**..... AST 221
- Index** AST 231
- Credits** AST 238

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

Weather is an important part of your daily life. What you wear and do outside depends on the weather. Weather describes what the atmosphere is like at a given time and place. It includes things like temperature, precipitation, wind, air pressure, and humidity. Over a long period of time, these factors determine the **climate** of an area. Though humans have figured how to survive in a variety of climates, some climates require more energy to survive.

Challenge: Use average conditions of the weather of a place.

TO: All Potential Research Scientists
FROM: The Cooperative Space Agency
SUBJECT: Request for research

The Cooperative Space Agency (CSA) is looking for scientists to help us find a planet very similar to Earth. The planet is from the same star system as Earth. We need to support a human colony on the planet. We are looking for scientists who can help us understand the climate of the planet. We need to know what regions of the planet have appropriate surface temperatures for a human colony.

Advances in technology have helped scientists find

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

MOVING BIG THINGS

PBIS

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.

ment of an object is in how different types ect. You and your class moving a large, heavy ice about the kinds of t this challenge on the

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

What do you think you know about this challenge?

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 on 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 a community?* and *How does land use affect water as it moves through a community?*

Project Board 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 those 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 work, you will write about your own ideas as a scientist.

IDEO is an organization that is focused on designing products that are useful and fun to use. You might be interested in these questions about scientists.



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 it moves through the land in communities here. When you write your questions, keep in mind these 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 analyzing data.



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 Primary Forecast.

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 sets. Select the "Actual" data set.

the right menu. Select "Actual" if you want to reveal a statement of reality. The average of all surface temperatures rather than the visualization. July sources. A calculator is where no

Learning Set 2 • 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 questions.

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.



Read

Like scientists, you will also read about the science you are learning. You'll read a little bit before you investigate, but most of the reading you do will be to help you understand what you've experienced or seen in an investigation. Each time you read, the text will include *Stop and Think* questions after the reading. These questions will help you gauge how well you understand what you have read. Usually, the class will discuss the answers to *Stop and Think* questions before going on so that everybody has a chance to make sense of the reading.

Design and Build

When the *Big Challenge* for a Unit asks you to design something, the challenge in a *Learning Set* might also ask you to design something and make it work. Often, you will design a part of the thing you will design and build for the *Big Challenge*. When a *Learning Set* challenges you to design and build something, you will do several things:

- identify what questions you need to answer to be successful
- investigate to find answers to those questions
- use those answers to plan a good design solution
- build and test your design.

Because designs don't always work the way you want them to, you will usually do a design challenge more than once. Each time through, you will test your design. If your design doesn't work as well as you'd like, you will determine why it is not working and identify other things you need to investigate to make it work better. Then, you will learn those things and try again.

Explain and Recommend

A big part of what scientists do is explain, or try to make sense of why things happen the way they do. An explanation describes why something is the way it is or behaves the way it does. An explanation is a statement you make built from claims (what you think you know), evidence (from an investigation) that supports the claim, and science knowledge. As they learn, scientists get better at explaining. You'll see that you get better, too, as you work through the *Learning Sets*.

A recommendation is a special kind of claim—one where you advise somebody about what to do. You will make recommendations and support them with evidence, science knowledge, and explanations.

PBIS Learning Set 5 • How Does Elevation Affect Surface Temperature?

5.3 Read

What is Different between Lower Elevations and Higher Elevations?

In the previous investigation, you noticed that the temperature decreased as elevation increased. Mountain climbers also notice this difference in temperature. It gets very cold as they reach the top of a high mountain. What is different about lower elevations and higher elevations that causes the temperature to be lower at high elevations?

The Atmosphere is an Ocean of Air

To help answer that question, scientists often use an **analogy**. They describe the atmosphere as an ocean of air. This is helpful because you are able to see what happens in liquids like oceans. You are not able to see what is happening in gases like the atmosphere.

Scientists can make an analogy between the atmosphere and an ocean because gases and liquids have an important thing in common. The

Analogy: the similarity between things that are different.


Build: a substance that is able to flow (takes the shape of its container).

ground. This is because in a solid, molecules are stuck together, the molecules are surrounded by a solid. In a liquid, the molecules bump into each other. In a gas, the molecules bump into each other and gases. A gas can move in all directions of space. The properties of a gas are different from the properties of a solid.

1.2 Design

1.2 Design

A Better Book-Support Design



You have already built a book support. You have built a better version of the book support. You have also learned about the properties of solids, liquids, and gases. A gas can move in all directions of space. The properties of a gas are different from the properties of a solid.

PBIS Learning Set 1 • The Book-Support Challenge

Plan Your Book-Support Design

The first time you built a book support, it was for the purpose of understanding the design challenge. You built it quickly and without a lot of planning. During this second attempt, you are aiming to design and build a book support that really works. Consider what you learned from your first attempt. You might also get ideas by thinking about other products that are similar to a book support. Consider the positives and negatives of each idea. Discuss them with your group members. This will make your design better.

Build and Test Your Design

Now you will iteratively build and test a working book support. Keep records of each iteration.

Iteration

When people design things, they usually call the thing a product. Often, designers do not create the best or most successful product the first time. Just like you did with your group, they try something. Then they figure out what was good and not good about what they did. They might decide that they need different materials. They might decide that they need to put things together differently. They might decide to make small changes or to make big changes. After the first time, they understand that their design is not working. They might decide to start over. They might decide to try again. Each

Iteration: a repetition that attempts to improve on a previous product.

4.3 Explain and Recommend

4.3 Explain and Recommend

Explanations and Recommendations about Parachutes

As you did after your whirligig experiments, you will spend some time now explaining your results. You will also try to come up with recommendations. Remember that explanations include your claims, the evidence for your claims, and the science you know that can help you understand the claims. A recommendation is a statement about what someone should do. The best recommendations also have evidence, science, and an explanation associated with them. In the Whirligig Challenge, you created explanations and recommendations separately from each other. This time you will work on both at the same time.

Create and Share Your Recommendation and Explanation

Work with your group. Use the hints on the Create Your Explanation pages to make your first attempt at explaining your results. You'll read about parachute science later. After that, you will probably want to revise your explanations. Right now, use the science you learned during the Whirligig Challenge for your first attempt.

Write your recommendation. It should be about designing a slow-falling parachute. Remember that it should be written so that it will help someone else. They should be able to apply what you have learned about the effects of your variable. If you are having trouble, review the example in Learning Set 3.

Create Your Explanation

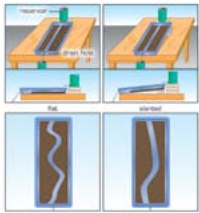
Use the hints on the Create Your Explanation pages to make your first attempt at explaining your results. You'll read about parachute science later. After that, you will probably want to revise your explanations. Right now, use the science you learned during the Whirligig Challenge for your first attempt.

Write your recommendation. It should be about designing a slow-falling parachute. Remember that it should be written so that it will help someone else. They should be able to apply what you have learned about the effects of your variable. If you are having trouble, review the example in Learning Set 3.

Work: is being others helps. It is work helps.

RE DRIVING IN TO SCIENCE

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

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

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.

| Temperature Ranges | | | | | |
|---|------------------|-------|-----------------|-------|--------------------------------------|
| Location | High Temperature | Month | Low Temperature | Month | Yearly Temperature Change (High-Low) |
| Greenland (61°N, 36°W) polar | | | | | |
| Helsinki, 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.

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.

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

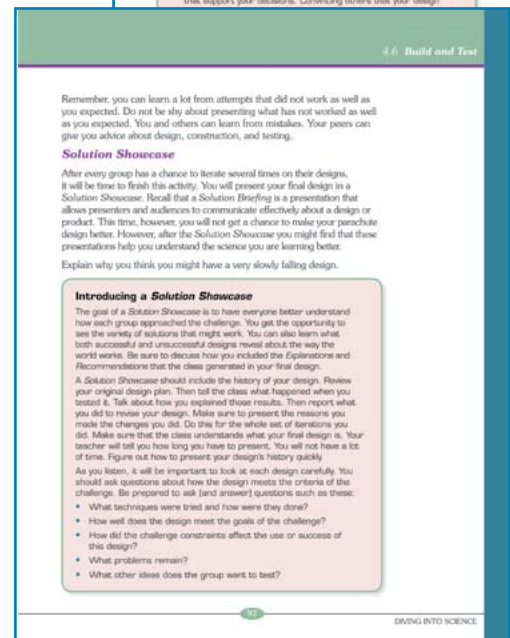
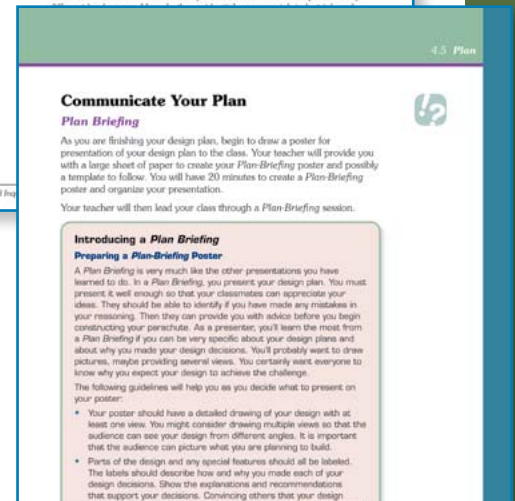
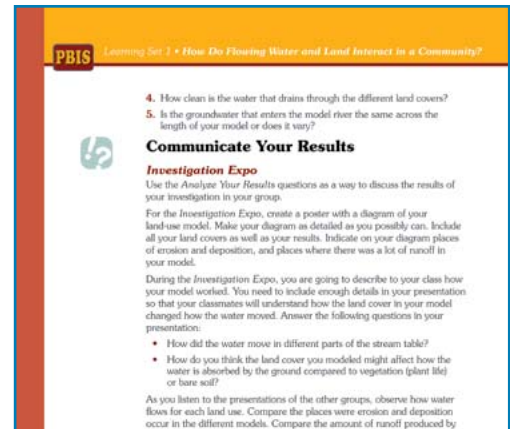
In an *Investigation Expo*, small groups report to the class about an investigation they've done. For each *Investigation Expo*, you will make a poster detailing what you were trying to learn from your investigation, what you did, your data, and your interpretation of your data. The text gives you hints 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*.



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

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.

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

Conference

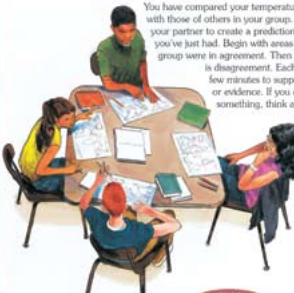
Teams of scientists often work together to solve problems. They hold group discussions. That is what you are going to do. During your discussion, you can present questions that you have. Sometimes if you do not have an answer, someone else might. You might also present a question that no one else had 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 where to start and where to go to next?
- How do you decide what temperatures to use to color each area?
- 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 predictions, 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



What's the Point?

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



Stop and Think

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



Communicate

Share your ideas and results with your classmates.



Record

Record your data as you gather it.

