

Planetary Forecaster

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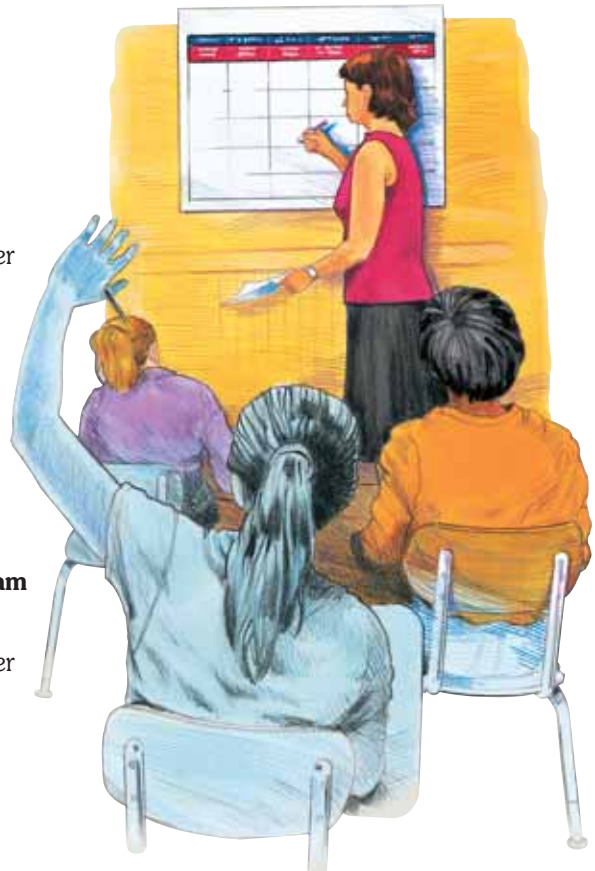
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Introducing PBIS

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 needs 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 that convinces you of what you've learned. At the end of each *Learning Set*, you will apply what you've learned to the big question or challenge.



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 during this unit. Lastly, you will write about what you have learned about doing science and being a scientist.

IDEO. IDEO is an challenge of designing is are doing many of is that you did not you see. next page. You might bring these questions ur do 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 question and Project Board.

You are going questions that understand how it moves through communities. If your questions should be interesting, have no require se relate to require co



1.4 Investigate

1.4 Investigate

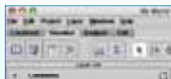
Compare Your Temperature Map to a Real-World Temperature Map

Scientists often compare their ideas to real data. In the 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 can see how accurate your predictions were and if there are still things you need to learn.

Procedure

1. Begin by opening the temperature map you created earlier with your predictions of surface temperatures.
2. Locate the "Visualize" tab and click on it.
3. Click on the "SurfTempPredictions" layer in the Layer list. There is a drop-down menu within this layer showing different fields. The field containing your temperature predictions is currently selected.
4. Click on the arrow on the right side of the drop-down menu. Select the other field in this layer, "1.4 JulyAvgTempF." This will reveal a map with the actual measurement of surface temperatures in July.

The real temperature map shows the average temperatures in July over a period of twelve years, from 1982 to 1994. Temperatures are measured at thousands of weather stations



3.5 Explore

3.5 Explore

Connections to Other Living Things

You looked at how small organisms and plants in an aquatic ecosystem can be affected by changes in water quality. It might seem obvious that organisms that interact with the water would be affected. The question for this *Learning Set*, however, is how water quality affects living things in an ecosystem. So, the important question to consider now is *How might the effects of water quality on a few living things affect all of the living things in the ecosystem?*

To get a sense of how connected other living things are to one another, you can look at your own interaction with living things. Earlier, you learned about the needs of living things. You know that most living things require food or nutrients in order to survive. Consider exactly where you get your nutrients.

Procedure

1. Think about a simple breakfast of cereal and milk. You can buy cereal and milk at a grocery store. However, from where does it actually come? Use a diagram like the one shown. Trace the parts of this breakfast back to their source. Add to the diagram as you trace the sources of this food. You will do this step with your teacher and class.
2. Your breakfast, what you eat, relies on other living things. As a group, work together on another example. Examine a meal that students your age often enjoy, a cheeseburger and fries!



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

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

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 learn 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.

3.3 Read

3.3 Read

What is the Relationship between a Planet's Tilt and Its Seasons?

This is a satellite image of the night sky falling over the Earth. As you know from your investigation, the length of daylight is not the same across the planet. This is due to the Earth's tilt. The tilt of Earth's axis is also the cause for the change of seasons throughout the year.



1.2 Design

1.2 Design

A Better Book-Support Design



CASTER

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: a repetition that attempts to improve on a process or product.

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 the challenge better. After the second time, they may also find that their solution isn't as good as they'd like. Designers often have to try again and again before they get the product just the way they want it. Each time they try, it's called an **iteration**.

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 claim. 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

Name: _____ Date: _____

Use the hints to explain the science of your investigation. You will use this science to help you make a recommendation.

Make a claim about the health of your investigation. You will use this science to help you make a recommendation.

Make a claim about what you recommend or a solution that you have learned from your investigation.

Evidence: Use what you learned from your investigation to support your claim.

Science Knowledge: Describe about the things you learned. You may have learned the things you learned about the effects of your variable.

Write your recommendation using the Claim, Evidence and Science Knowledge.

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PBIS Learning Set 2 • How Do You Determine the Quality of Water in a Community?

Stop and Think

Answer the following questions while observing the demonstration. Be prepared to discuss your answers with your group and the class.

- When looking at the three jars of water that your teacher used in the demonstration, could you tell them apart? Why or why not?
- After the indicator was added to each jar, was there a difference in the water in each jar. Describe what you saw.
- Here is a picture of water from a clean swimming pool.
 - How does the water look? Compare it to the water in the jars in the demonstration.
 - Would you swim in this water? Explain your answer.
 - Would you drink this water? Think about the way water in a pool smells when you explain your answer.



pH scale: a scale used by scientists to measure the acidity of a solution.
neutral: solution with pH of 7.

Acids and pH

The pH Scale

Scientists use the **pH scale** to measure how acidic a solution is. The

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 in a class. Answer the following questions. Be prepared to discuss your answers with the class.

- Was your structure strong? If not, did it collapse because of folding, compression, or both?
- How could you make the structure stronger to resist folding or compression?
- Was your book support stable? That is, did it provide support so that the book did not tip over? Did it provide this support well? Draw a picture of your book support showing the center of mass of the book and the places in your book support that resist the load of your book.

Project-Based

1.3 Read

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 what you've learned.

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 or with a partner or your small group to answer the questions, and then the whole class will discuss what you've learned. 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.

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 (81°N 36°W) <i>polar</i>					
Helsinki, Finland (60°N 24°E) <i>mid latitude north</i>					
Atlanta, USA (33°N 84°W) <i>mid latitude north</i>					
Quito, Ecuador (0° 78°W) <i>tropic</i>					
Darwin, Australia (14°S 131°E) <i>tropic</i>					
Buenos Aires, Argentina (34°S 58°W)					



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PBIS Learning Set 3 • The Whirligig Challenge

Mess About with the Whirligig

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.

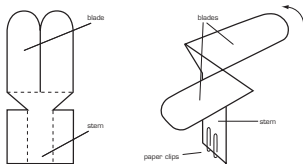
You will get a template (pattern) of a whirligig. It will look like the one shown below. The whirligig has several parts: blades, paper clips, and a stem. If you call them by those names when you talk about the whirligig, everyone will know what you are talking about.

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

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.

structure: the way the parts of an item are put together. (This is a different definition of structure than the one you saw while making your book support.)

mechanism: the way the parts of an item connect and move.



As you Mess About with the whirligig, explore how it works. Think about what it is capable of doing. While Messing About, see if you can answer the questions below. This will help you identify more about what you still need to learn and help you figure out what investigations to do.

- What is the **structure** of the item I'm working with? (Structure means the way the parts are put together.)
- What are its **mechanisms**? (Mechanism refers to how the different parts connect to each other or move with each other to make the object behave the way it does.)
- How is this item supposed to behave? What might I change in the item to affect that behavior?

Project-Based Inquiry Science

What's the Point?

At the end of each *Learning Set*, you will find a summary, called *What's the Point*, of the important things we hope you learned from the *Learning Set*. These summaries can help you remember how what you did and learned is connected to the big challenge or question you are working on.

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 things out 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 what you've learned 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 what you've learned and how you will move forward.

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.

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

Communicate Your Results

Investigation Expo

Scientists always share their understandings with each other. Presenting their results to others is one of the most important things that scientists do. You will share what you have found in an *Investigation Expo*. To prepare for this, you will use an overhead transparency.

Trace the diagram that you drew of your model onto an overhead transparency. Be ready to describe your investigation and clearly detail all your results. The answers to the following questions will be very helpful in preparing your presentation.

- Describe how the water moved in the model. (What patterns did you see?)
- Describe why you think your prediction was accurate or inaccurate.
- How did the outcome compare to your prediction?
- Where did the water flow more quickly? How was the flow different from what you predicted?
- Where did the water pool?

As you look at the overheads presented by other students, make sure you can answer these questions. Ask questions that you need answered to understand the results and the explanations others have made.

What's the Point?

In this section, you built a model to simulate how water flows across a landscape when it rains. Placing different-sized objects under the paper created the high and low elevations. You also drew a sketch of the

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 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 created by you and your classmates that support your decisions. Convincing others that your design choices are quality ones means convincing them that you are making informed decisions backed by scientific evidence.
- Make sure to give credit to groups or students who ran the experiments that inform your design and who gave you ideas.

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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 *Explorations 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.

Solution Showcase

Solution Showcases usually appear near the end of a Unit. During a *Solution Showcases*, 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 Showcases* 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 Showcases*.

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 *Big 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 to the *Project Board*. 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.

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's been discussed on your own *Project Board* page. (The *Project Board* is similar to a RWL chart that you may have used in previous units.)

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?

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?

DIVING INTO SCIENCE

1.3 Investigate

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 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 each area should be?
- 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 others in your group. Now, you and your group will work together to create a single group prediction map. Begin with areas that most people in the group are in agreement on. 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 group's prediction, you will begin working with a computer program called *My World*. You will create a prediction map similar to the one you made here using computer software.



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.