Section 1

Handout #: _____

Thinking Like a Scientist

Reading Preview

Key Concepts

- What skills do scientists use to learn about the world?
- What attitudes are important in science?

Key Terms

- observing
- quantitative observation
- qualitative observation
- inferring • predicting
- classifying • making models
- science • skepticism

Target Reading Skill

Asking Questions Before you read, preview the red headings. In a graphic organizer like the one below, ask a *what*, *how*, or *why* question for each heading. As you read, write answers to your questions.

Thinking Like a Scientist

Question	Answer
What does observing involve?	Observing involves . . .

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Lab zone Discover Activity

How Keen Are Your Senses?

1. Your teacher has arranged for an unexpected event to occur. At the count of three, the event will begin.
2. List as many details as you can remember about the event.
3. Compare your list with those of your classmates.

Think It Over

Observing How many details could you list? Which of your senses did you use to gather information?

Once, as I walked through thick forest in a downpour, I suddenly saw a chimp hunched in front of me. Quickly I stopped. Then I heard a sound from above. I looked up and there was a big chimp there, too. When he saw me he gave a loud, clear wailing wraaaaah—a spine-chilling call that is used to threaten a dangerous animal. To my right I saw a large black hand shaking a branch and bright eyes glaring threateningly through the foliage. Then came another savage wraaaah from behind. Up above, the big male began to sway the vegetation. I was surrounded.

These words are from the writings of Jane Goodall, a scientist who studies wild chimpanzees in Gombe National Park in Tanzania, Africa. What would you have done if you were in Jane's shoes? Would you have screamed or tried to run away? Jane did neither of these things. Instead, she crouched down and stayed still so she wouldn't startle the chimps. Not feeling threatened by her, the chimps eventually moved on.

It is not always easy to study animals in their natural homes. But Jane was determined to learn all she could about these great apes. One of the most remarkable things about Jane Goodall is that she essentially trained herself to be a scientist. **Scientists use skills such as observing, inferring, predicting, classifying, and making models to learn more about the world.** However, these skills are not unique to scientists. You, too, think like a scientist every day.

Observing

Jane Goodall has spent countless hours among the chimpanzees—quietly following them, taking notes, and carefully observing. **Observing** means using one or more of your senses to gather information. Your senses include sight, hearing, touch, taste, and smell. By using her senses, Jane learned what chimpanzees eat, what sounds they make, and even what games they play! During her time in Gombe, Jane made many surprising observations. For example, she observed how chimpanzees use stems or long blades of grass as tools to "fish" out a tasty meal from termite mounds.

Like Jane, you use your senses to gather information. Look around you. What do you see? What do you hear and smell? You depend on your observations to help you make decisions throughout the day. For example, if it feels chilly when you wake up, you'll probably dress warmly.

Observations can be either quantitative or qualitative. **Quantitative observations** deal with a number, or amount. Seeing that you have eight new e-mails in your inbox is a quantitative observation. **Qualitative observations,** on the other hand, deal with descriptions that cannot be expressed in numbers. Noticing that a bike is blue or that a grape tastes sour are qualitative observations.

Reading Checkpoint *What senses can the skill of observation involve?*

FIGURE 1
Observing
By patiently observing chimpanzees, Jane Goodall learned many things about chimpanzee behavior. The inset shows one of Jane's earliest discoveries—that chimps use sticks as tools to fish for termites.

Inferring

One day, Jane Goodall saw something peculiar. She watched as a chimpanzee peered into a hollow in a tree. The chimp picked off a handful of leaves from the tree and chewed on them. Then it took the leaves out of its mouth and pushed them into the tree hollow. When the chimp pulled the leaves back out, Jane saw the gleam of water. The chimp then put the wet leaves back in its mouth.

What was the chimpanzee doing? Jane reasoned that the chimpanzee might be using the chewed leaves like a sponge to soak up water. Seeing the chimp chew on leaves, put them in the hollow, and then squeeze the liquid out are all examples of observations. But Jane went beyond simply observing when she reasoned why the chimpanzee was doing these things. When you explain or interpret the things you observe, you are **inferring,** or making an inference.

Making an inference doesn't mean guessing wildly. Inferences are based on reasoning from what you already know. Jane knew that chimpanzees, like all other animals, need water, and that rainwater collects in tree hollows. She reasoned that the chimp was using chewed leaves to get the water out of the tree.

You, too, make inferences all the time. Because your brain processes observations and other information so quickly, you may not even realize when you have made an inference. For example, if you see your friend smile after getting back an exam, you might automatically infer that she got a good grade. Inferences are not always correct, however. Your friend's smile might not have anything to do with the test.

Reading Checkpoint **What is inferring?**

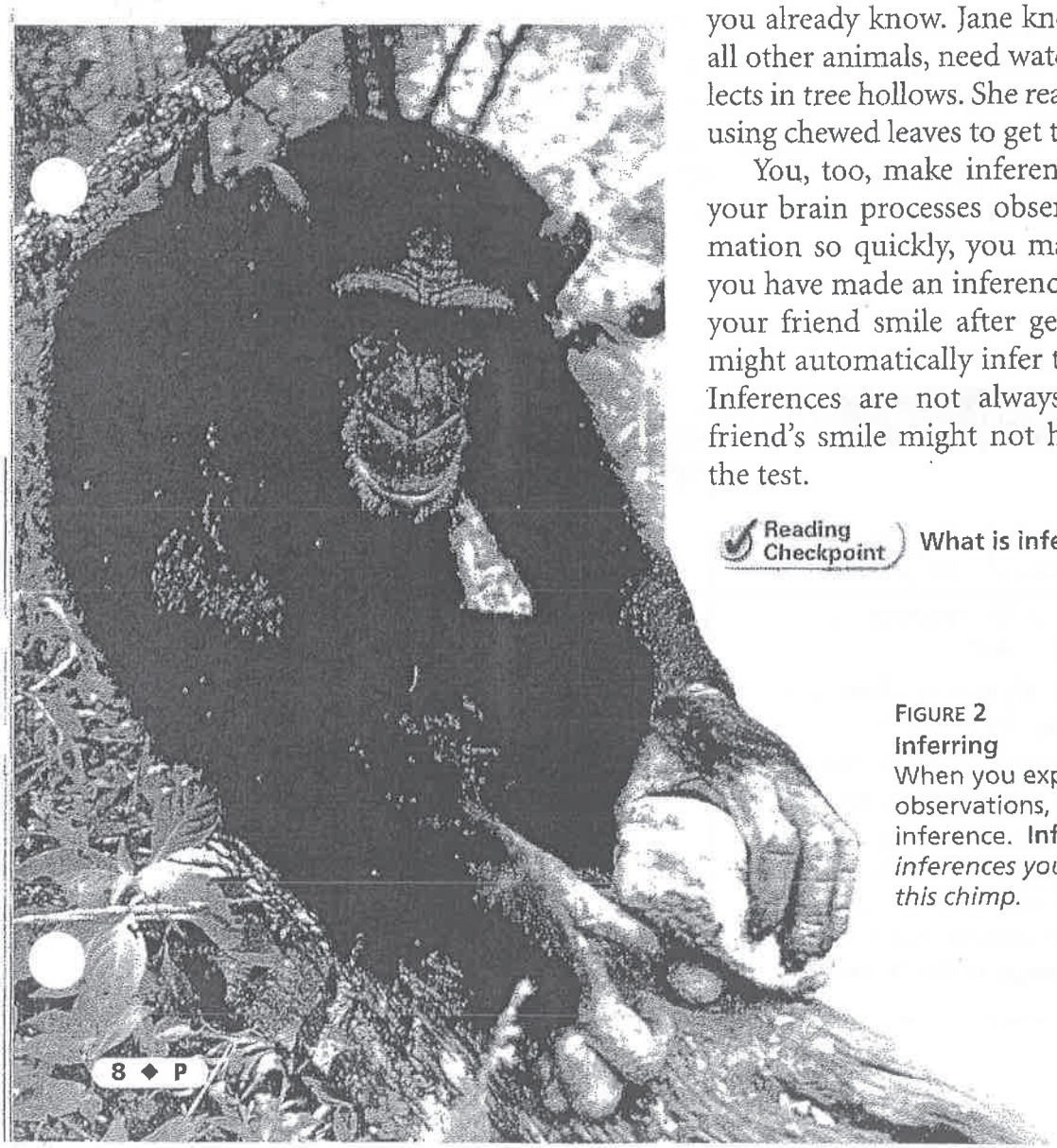


FIGURE 2
Inferring
When you explain or interpret your observations, you are making an inference. **Inferring** *List three inferences you can make about this chimp.*

Predicting

Jane's understanding of chimpanzee behavior grew as time went by. Sometimes, she could even predict what a chimp was going to do next. **Predicting** means making a forecast of what will happen in the future based on past experience or evidence.

Through her observations, Jane learned that when a chimpanzee is frightened or angry, its hairs stand on end. This response is sometimes followed by threatening gestures such as charging, throwing rocks, and shaking trees, or even an attack. Therefore, if Jane sees a chimp with its hairs on end, she can predict that there might be danger and move away.

Likewise, you would probably move away if you saw a dog growling or baring its teeth. Why? Because predicting is part of your everyday thinking. You might predict, for example, that your basketball team will win tonight's game if you have always beaten the other team in the past. Predictions, of course, are not always correct. New players this year may increase the other team's chances of winning.

Predictions and inferences are closely related. While inferences are attempts to explain what is happening or *has* happened, predictions are forecasts of what *will* happen. If you see a broken egg on the floor by a table, you might infer that the egg had rolled off the table. If, however, you see an egg rolling toward the edge of a table, you can predict that it's about to create a mess.

FIGURE 3
Predicting
Predictions are forecasts of what will happen next.
Predicting *What do you think this chimp will do next?*

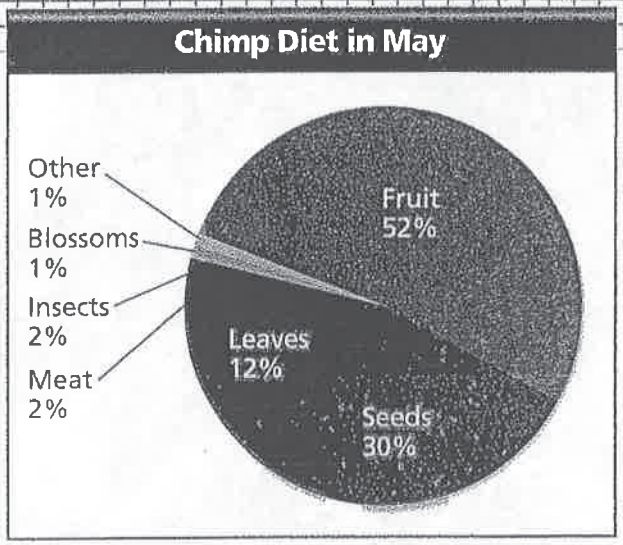
Reading Checkpoint **What are predictions based on?**

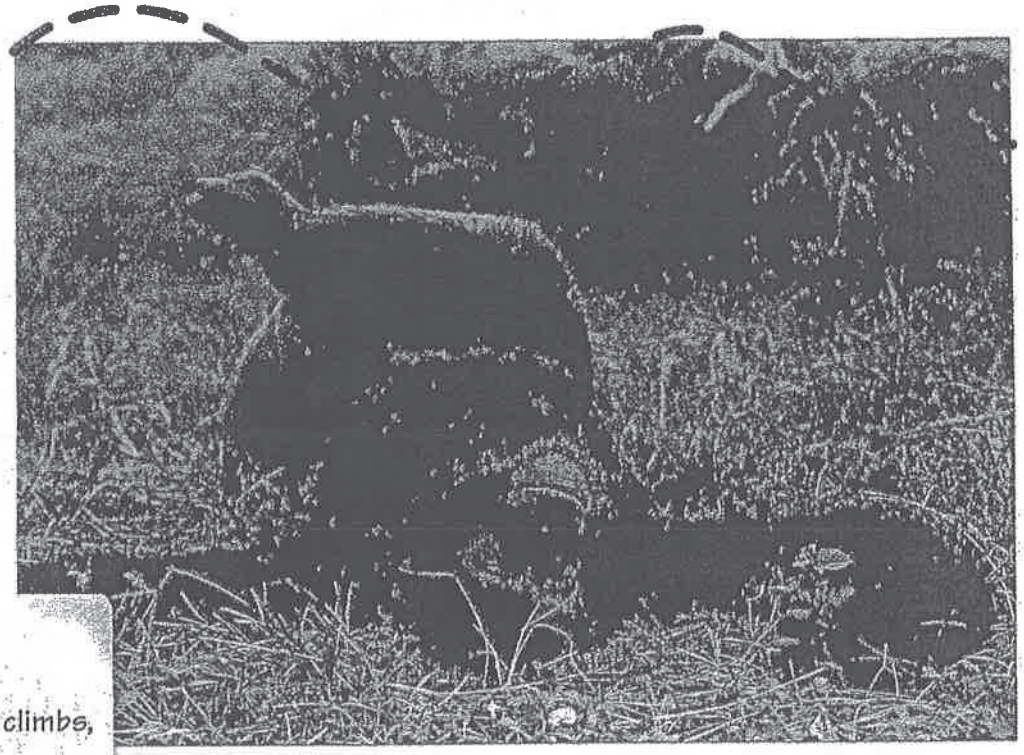
Math Analyzing Data

Chimp Food

This graph shows the diet of chimps at Gombe National Park during May of one year.

1. **Reading Graphs** According to the graph, what foods do chimps eat?
2. **Interpreting Data** Did chimps feed more on seeds or leaves during this month?
3. **Calculating** What percentage of the diet did blossoms, seeds, leaves, and fruit make up?
4. **Predicting** Suppose you learn that November is the main termite-fishing season, when chimps spend a large part of their time eating termites. Predict how the chimp diet might change in November.





Resting

6:45 Jomeo in nest

6:50 Jomeo leaves nest, climbs, feeds on *viazi pori* fruit

7:16 Wanders along, feeding on *budyankende* fruits

8:08 Stops feeding, climbs, and feeds on *viazi pori* fruit again

8:35 Travels

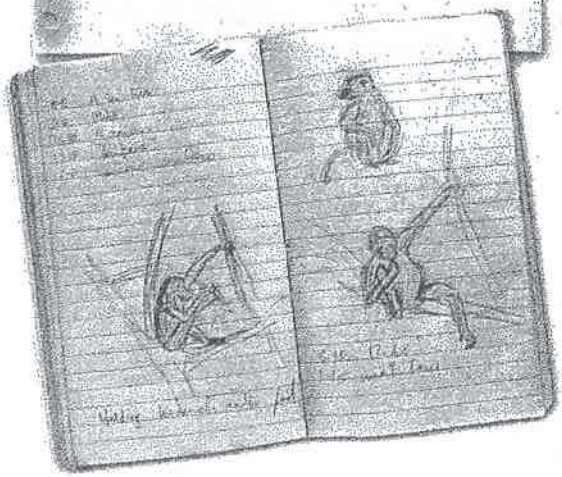


FIGURE 4
Classifying
Field notes like these contain many details about a chimp's daily activities. By grouping together all the information related to resting, climbing, or feeding, Jane can better understand the chimp's behavior.

Classifying

What do chimps do all day? To find out, Jane and her assistants followed the chimpanzees through the forest. They took detailed field notes about the chimps' behaviors. Figure 4 shows a short section of notes about Jomeo, an adult male chimp.

Suppose Jane wanted to know how much time Jomeo spent feeding or resting that morning. She could find out by classifying Jomeo's actions into several categories. **Classifying** is the process of grouping together items that are alike in some way. For example, Jane could group together all the information about Jomeo's feeding habits or his resting behavior. This would also make it easier to compare Jomeo's actions to those of other chimps. For instance, she could determine if other adult males feed or rest as much as Jomeo does.

You, too, classify objects and information all the time. Classifying things helps you to stay organized so you can easily find and use them later. When you put papers in a notebook, you might classify them by subject or date. And, you might have one drawer in your dresser for shirts and another for socks.

Reading Checkpoint **How is classifying objects useful?**

Climbing

Feeding

Making Models

How far do chimpanzees travel? Where do they go? Sometimes, Jane's research team would follow a particular chimpanzee for many days at a time. Figure 5 illustrates Jomeo's journey through the forest over the course of one day. The diagram is one example of a model. **Making models** involves creating representations of complex objects or processes. Models help people study and understand things that are complex or that can't be observed directly. Using a model like the one in Figure 5, Jane and her assistants could share information that would otherwise be difficult to explain.

Models are all around you. They include physical objects, such as globes or the sets used in filming your favorite TV show. Some models are generated by computer, like the ones some architects use to design new buildings. It's important to keep in mind that models are only representations of the real object or process. Because some information may be missing from a model, you may not be able to understand everything about the object or process the model represents.

Reading Checkpoint **What is a model?**

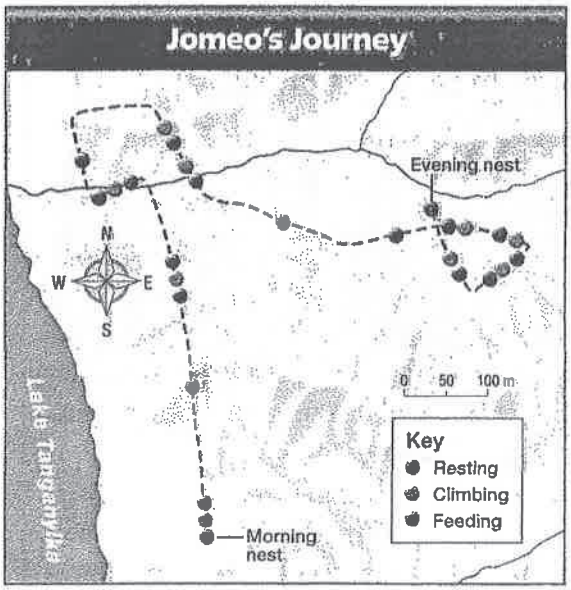


FIGURE 5
Making Models
This map is a model that traces Jomeo's journey through the forest. It represents information that would be hard to explain in words. **Interpreting Maps** *What is the total distance that Jomeo traveled between his morning and evening nests?*

FIGURE 6
Curiosity
Scientists are driven by a curiosity to learn more about what they are studying. This scientist is recording bird calls in a rain forest in Costa Rica.

Scientific Attitudes

Why has Jane Goodall devoted her life to studying chimps? Some people might say that she wants to contribute to "science." **Science** is a way of learning about the natural world. Science also includes all of the knowledge gained by exploring the natural world. **Successful scientists possess certain important attitudes, or habits of mind, including curiosity, honesty, open-mindedness, skepticism, and creativity.**

Curiosity An important attitude that drives scientists is curiosity. Successful scientists are eager to learn more about the topics they study. They stick with problems in spite of setbacks.

Honesty Good scientists always report their observations and results truthfully. Honesty is especially important when a scientist's results go against previous ideas or predictions.

Open-Mindedness and Skepticism Scientists need to be open-minded, or capable of accepting new and different ideas. However, open-mindedness should always be balanced by **skepticism,** which is having an attitude of doubt.

Creativity Whether scientists study chimps or earthquakes, problems may arise in their studies. Sometimes, it takes a bit of creativity to find a solution. Creativity means coming up with inventive ways to solve problems or produce new things.

Reading Checkpoint **What is skepticism?**

Section 1 Assessment

Target Reading Skill Asking Questions Use the answers to the questions you wrote about the headings to help you answer the questions below.

Reviewing Key Concepts

1. a. **Listing** Name five skills that are important in scientific thinking.
   b. **Comparing and Contrasting** How do observations differ from inferences?
   c. **Classifying** Is this statement an observation or an inference? *The cat must be ill.* Explain your reasoning.
2. a. **Identifying** What attitudes help scientists succeed in their work?
   b. **Explaining** Why is it important for scientists to balance open-mindedness and skepticism?
   c. **Making Judgments** Is it important to be both open-minded and skeptical in your everyday life? Explain.

Lab zone **At-Home Activity**

"Pastabilities" Collect pasta of various shapes and sizes. You and a family member should each devise a system to classify the pasta into three groups. How similar were your groupings?