Scientific Method

Isaac Newton, one of the greatest scientists of all time, once observed an apple thudding to the ground. This made him think, "Why doesn't the moon fall also?" Observation and experimentation led Newton to scientific discoveries about gravity, movement of the planets, light, and color. You can be a junior scientist and explore your world using the same scientific method he used.

Activity: Have you ever wondered . . . if green is really green?

Using a cotton swab, dab a tiny dot of green food coloring about 4 cm from one end of a strip of a paper towel. Hang the strip over a glass of water so that the strip is in the water, but the spot is above the waterline. Let the strip stand overnight. How did the green dot change?

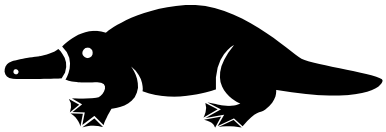
Lesson 1 Goals: You will learn

- that observation is a way to study your world.
- that it's important to follow a plan when doing investigations.
- what the scientific method is.

Lesson 1: Importance of the Scientific Method

Most people are curious about the world around them. They want to know what makes the weather change or why the leaves fall. They wonder why some plants grow better in warmer climates or why some animals prefer to live in cold climates. Look at the photo on this page. Suppose you saw these animals while you and your class were visiting the zoo. What kinds of things would you want to know about them, and how would you find out?

There are different ways to find answers to your questions. You can use your senses – touch, smell, hearing, sight, and taste – to find out more about some things. But for others, you have to follow a careful plan to find the information you want.



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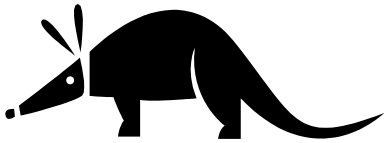

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Observation is one way to study your world. However, if you don't write down details about what you observe, you can't share the information you learn with others. If you don't record the steps you used to do an activity, you may not be able to tell someone else how to repeat them.

Let's look at the ways Jack and Carol used to find the answers to their questions.

Carol and the Geraniums

Carol wanted to find out whether geranium plants would grow better in sunlight or in shade. She thought the plants would grow better in sunlight. To begin her investigation, Carol found two geranium plants that were the same size. She placed one potted plant in a window that gets a lot of sun and the other in a shaded part of the house. She tried to remember to water the plants regularly, but sometimes she forgot. At other times, she gave more water to the shaded plant than to the other one in the window.

Carol was surprised to find that after two weeks, the shaded geranium had grown taller than the geranium in the sunny window. Carol was puzzled. What went wrong with the investigation? Why was the shaded geranium taller?

Jack and His Gerbil

Jack had a pet gerbil at home. He knew that some scientists do experiments to find out if animals prefer food of a certain color. Jack thought his gerbil would prefer food that is colored red because he had seen it gnaw on a red block of wood in the cage. Jack decided to try this experiment. He took 16 sunflower seeds and used food coloring to color four seeds yellow, four seeds red, and four seeds blue. He left four seeds in four containers of the same type. He put the containers where the gerbil could reach each of them easily. He was careful to make sure all other conditions remained the same inside the gerbil's cage.

What differences did you notice in the way Jack and Carol made their observations? Which method would probably produce the most useful information?

Scientists Ask Questions

Why is it important to use an orderly plan when looking for answers to questions? One reason that scientists use scientific methods when they investigate questions or problems is so that they can repeat the experiment many times. By repeating experiments, scientists can be sure that the answers they discover are correct. Also, sometimes other scientists want to do the same experiment. They can follow the steps in the experiment in the same order.

As part of their jobs, scientists ask questions that help them find answers. They collect information in organized ways to help them in their search for possible answers. We call this organized way to gather information the **scientific method**. There are six steps in the scientific method you will use this year, and you will study them in the next lesson.

Lesson Summary

- You use your senses to make observations of your world.
- It is important to use orderly steps when trying to find answers to questions.
- The scientific method is an organized way of asking questions, gathering information, and finding answers.

Lesson 1 Review Questions

1. How do you make daily observations?
2. Why do scientists use scientific methods?
3. Compare the experiments Carol and Jack did. Who followed orderly steps? How could the other experiment been improved?

Lesson 2 Goals: You will learn

- the steps of the scientific method.
- that scientists need a common language.
- to use the steps of the scientific method.

Lesson 2: Steps of the Scientific Method

Carlos observed that the plants by his classroom window grew tall and looked healthy. He also noticed that the plants in the darker part of the classroom looked different. The window plants had ten hours of bright light every day and looked much better than the plants that had less light. Carlos wondered if 24 hours of light would make healthier and taller plants. He decided to do an experiment to find an answer to his question. He chose bean plants for his experiment.

Carlos used a six-step plan in looking at his plants. Scientists often follow these same steps. You can use the same method to learn more about your world.

1. State the Problem (Ask a Question)

First, Carlos made an observation about the plants in his classroom. Plants near the light grow tall and look healthy. Then, he asked a question. Would bean plants grow taller and look healthier with 24 hours of light? This is the question Carlos wanted to answer.

2. Form a Hypothesis

Carlos made some observations about the classroom plants and suggested an answer to his question. His answer or **hypothesis** is a statement that tells what he expect will happen in his experiment. Carlos's hypothesis is:

> Plants that get 24 hours of light per day will grow taller and look healthier than plants that get ten hours of light per day.

3. Design the Experiment

Carlos needed to decide how to test his hypothesis. First, he made a list of steps he needed to follow. Next, he made a list of equipment he needed to do the experiment. Next, he would treat the plants the same (controls) except for the amount of light (**variable**). He decided that one group of plants would receive ten hours of light per day. The other group would receive 24 hours of light each day.

4. Record and Analyze the Data

Carlos collected the data by taking measurements and describing his observations in a journal. He measured the bean plants and recorded his information on a chart as data. **Data** are recorded facts or measurements from an experiment. Then he studied the data in his journal and on his chart to see what had happened to the plants.

5. Draw a Conclusion

When Carlos ended his experiment, he needed to draw a **conclusion**. He knew this conclusion would be the answer to his question. Based on his study of the data, Carlos concluded that ten hours of light produced taller, healthier bean plants. Then, Carlos asked himself two questions: What did I find out? (his **conclusion**) Is this what I thought would happen? (his **hypothesis**)

When he compared his conclusion to his hypothesis, he discovered new information. He found that his hypothesis was false. His hypothesis stated that bean plants with 24 hours of light per day will be taller and healthier. However, from his experiment, he found that ten hours of light per day was better for the plants.

Carlos can discuss his experiment with other people easily because he used a method to conduct his experiment. He used the same terms as scientists use. Carlos can talk about his observations, hypothesis, data, and conclusion.

6. Ask a New Question

Carlos enjoyed using the scientific method. He would like to do this experiment again. Next time, however, instead of observing four plants for ten days, he wants to observe 20 plants for 15 days. Do you think the outcome will be the same? How could he state the problem? What hypothesis could he use? How should he organize the data?

Many scientists retest other scientists' hypotheses. You might want to retest Carlos's hypothesis. Or, you can use your own observations to state a problem, form a hypothesis, design, and carry out an experiment using the scientific method.

The Steps to the Scientific Method	
1. State the Problem	Make an observation and ask a question.
2. Form a Hypothesis	Make your best guess about the answer to your question.
3. Design the Experiment	Decide how you will explore your question.
4. Record and Analyze the Data	List your observations and measurements. This is your data. Study the data to find out what has happened in your experiment.
5. Draw a Conclusion	Based on your analysis, decide what the data mean. The conclusion will be an answer to your question.
6. Ask a New Question	Form a related question to begin the process all over again.

Lesson Summary

- The six steps of the scientific method are: state the problem, form a hypothesis, design an experiment, record and analyze the data, and draw a conclusion.
- The detailed steps of the scientific method make it easier for us to share information with other people.
- You can use the scientific method to explore the world around you.

Lesson 2 Review Questions

1. What are the steps of the scientific method?
2. What was Carlos's question?
3. What conclusion did Carlos draw? How did it compare with his hypothesis?
4. If you were going to repeat Carlos's experiment, how would you set it up?

Lesson 3 Goals: You will learn

- how a scientist used the scientific method in her work.
- how the scientific method provided valuable information about saving the mountain gorillas.

Lesson 3: Application of Scientific Method to Life Science

In the previous lessons, you have learned how to use the scientific method to explore your world. You may have made some discoveries that have given you the answers to questions you've wondered about. By now, you probably realize that the scientific method is a valuable tool for solving problems.

One big problem that scientists are trying to solve has to do with animals. Some animals are having a hard time surviving in their habitats. One of these animals is the gorilla. Scientists are trying to find out why so many gorillas are dying. These scientists often go to live near the gorillas they are trying to save.

Dian Fossey was especially concerned about the mountain gorillas in Africa. They were disappearing from places where they had always lived, and she wanted to know why. Did they have enough food? How much space did a gorilla need to live? Fossey realized that she needed to see the problem close-up before she could find a solution. In 1967, she went to live in the Virunga Mountains in Africa to study the mountain gorillas.

What **question** did Fossey need to answer?

Dian Fossey needed to answer the question "What causes the number of mountain gorillas to keep decreasing?" Each year, there were fewer gorillas. Scientists predicted that within ten years, there might be no more mountain gorillas in the world. The Virunga Mountains had all that were left. To help answer this question, Fossey hypothesized that loss of habitat was an important reason for the decrease in gorillas.

What was Fossey's **hypothesis**?

Observing Gorilla Behavior

It's very hard to study animals in their natural habitat. Wild animals are usually afraid of people and will avoid them. First, Fossey had to find the gorillas. They lived in forests located on steep mountains. Other scientists had not been able to get close to them. She knew she would have to get close to the gorillas to study them and collect accurate data. For months and months, Fossey followed the gorillas. She could always hear them in the distance, but she only saw them for a moment now and then. They ran away whenever they saw her. But she was very patient, and finally the gorillas let her watch them from a distance.

What **observations** did Fossey make about the gorilla behaviors?

As she watched, Fossey observed some interesting gorilla behaviors. She observed that gorillas use special sounds to talk to each other. She observed that they make other sounds when they are eating. She became good at imitating these sounds.

She also imitated other gorilla behaviors. Because gorillas are knuckle walkers, they are not very tall when they walk. Fossey was very tall, so she bent over when she walked to make herself look shorter. Gorillas groom themselves to keep their fur neat and tidy. Fossey pretended to groom herself, too.

Slowly the gorillas learned to trust her and allowed her to come closer. She became their friend and was able to learn many things about them. One surprising thing she learned was that these large animals are gentle giants. She made careful observations and wrote down all of her data in her journals.

What did Fossey discover after **analyzing** her **data** about the gorillas?

As Fossey analyzed the data in her journals, she discovered many interesting patterns. She found that the gorilla habitat was being taken away by farmers. The cut down the trees and planted crops. Loss of habitat was a big problem. She discovered that an even problem was that people were setting illegal traps to catch the dear and other animals. Many gorillas died because they were caught in these traps.

After Fossey analyzed her data, she drew some conclusions. She concluded that there were fewer gorillas each year because 1.) they were losing their habitat to farmers, and 2.) they were being caught in traps. These conclusions help her to make a plan for saving the remaining mountain gorillas.

What were Dian Fossey's **conclusions**?

Dian Fossey shared her scientific study with the world. Laws were passed. Now farmers can't cut down the forests where the gorillas live. Traps are being collected and destroyed. People now realize how important it is to save these animals.