Section 1: Scientific Methods

Preview

• Bellringer
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• Observing
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• Organizing and Analyzing Data
Section 1: Scientific Methods

Preview, continued

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- Imagination and Creativity
Objectives

• **List** and describe the steps of the experimental method.
• **Describe** why a good hypothesis is not simply a guess.
• **Describe** the two essential parts of a good experiment.
• **Describe** how scientists study subjects in which experiments are not possible.
• **Explain** the importance of curiosity and imagination in science.
The Experimental Method

- Scientists make most of their discoveries using the experimental method.
- This method consists of a series of steps that scientists worldwide use to identify and answer questions.
Observing

- **Observation** is the process of obtaining information by using the senses as well as the information obtained by using the senses.
- Observing is the first step of the experimental method.
- Observations can take many forms, including descriptions, drawings, photographs, and measurements.
Hypothesizing and Predicting

- A **hypothesis** is a theory or explanation that is based on observations and that can be tested.
- Forming a hypothesis is the second step of the experimental method.
- A hypothesis is not merely a guess.
- A good hypothesis should make logical sense and follow from what you already know about the situation.
Hypothesizing and Predicting

- **Predictions** are statements made in advance that express the results that will be obtained from testing a hypothesis if the hypothesis is supported.

- A prediction is used to test a hypothesis.
Hypothesizing and Predicting

- It is important that any hypothesis can be disproved.
- Every time a hypothesis is disproved, the number of possible explanations for an observation is reduced.
- By eliminating possible explanations a scientist can zero in on the best explanation.
Experimenting

- **Experiments** are procedures that are carried out under controlled conditions to discover, demonstrate, or test a fact, theory, or general truth.

- An experiment is performed when questions that arise from observations cannot be answered with additional observations.

- Experiments should be designed to pinpoint cause-and-effect relationships.
Experimenting

- Good experiments have two essential characteristics: a single variable is tested, and a control is used.
- The **variable** is the factor that changes in an experiment in order to test a hypothesis.
- To test for one variable, scientists usually study two groups or situations at one time, with the variable being the only difference between the two groups.
Experimenting

- **The experimental group** is the group in the experiment that is identical to the control group except for one factor and is compared with controls group.

- **The control group** is the group in the experiment that serves as a standards of comparison with another group to which the control group is identical except for one factor.
Organizing and Analyzing Data

- **Data** is any pieces of information acquired through observation or experimentation.

- Organizing data into tables and graphic illustrations helps scientists analyze the data and explain the data clearly to others.

- Graphs are often used by scientists to display relationships or trends in the data.
Organizing and Analyzing Data

- Bar graphs are useful for comparing the data for several things in one graph.
Organizing and Analyzing Data

- Graphing the information makes the trends presented in tables easier to see.

<table>
<thead>
<tr>
<th>Pollutant Concentrations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

Graph showing Milligrams per liter of water for Sites 1, 2, and 3.
Drawing Conclusions

• Scientists determine the results of their experiment by analyzing their data and comparing the outcome of their experiments with their prediction.

• Ideally, this comparison provides the scientist with an obvious conclusion.
Drawing Conclusions

• But, often the conclusion is not obvious.
• In these cases, scientists often use mathematical tools to help them determine whether the differences are meaningful or are just a coincidence.
Repeating Experiments

- Scientists often repeat their experiments.
- The more often an experiment can be repeated with the same results, in different places and by different people, the more sure scientists become about the reliability of their conclusions.
- Scientists look for a large amount of supporting evidence before they accept a hypothesis.
Communicating Results

• Scientists publish their results, sometimes in scientific articles, to share what they have learned with other scientists.

• Scientific articles include the question the scientist explored, the reasons why the question is important, background information, a precise description of how the work was done, the data collected, and the scientist’s interpretation of the data.
The Correlation Method

• When the use of experiments to answer questions is impossible or unethical, scientists test predictions by examining correlations.

• Correlation is the linear dependence between two variables.
The Correlation Method

- An example is the relative width of a ring on a tree trunk is a good indicator of the amount of rainfall the tree received in a given year.
- Trees produce wide rings in rainy years and narrow rings in dry years.
- This method was used to help scientists investigate why the settlers at Roanake Island all died and why many died at the Jamestown Colony.
The Correlation Method

• The Scientists concluded that the settlers may have been the victims of unfortunate timing.
The Correlation Method

- Although correlation studies are useful, they do not necessarily prove cause-and-effect relationships between two variables.
- Scientists become more sure about their conclusions only if they find the same correlation in different places and as they continue to eliminate other possible explanations.
Scientific Habits of Mind

• Good scientists tend to share several key habits of mind, or ways of approaching and thinking about things.

• The first habit of mind is curiosity. Good scientists are endlessly curious which drives them to observe and experiment.

• The second habit of mind is skepticism. This means that good scientists don’t believe everything that they are told.
Scientific Habits of Mind

- The third habit of mind is an openness to new ideas. Good scientists keep an open mind to how the world works.

- Another habit of mind is intellectual honesty. A good scientist is willing to recognize the results of an experiment even though it may mean that his or her hypothesis was wrong.
Scientific Habits of Mind

- Lastly, good scientists share imagination and creativity.
- They are not only open to new ideas, but able to conceive new ideas themselves.
- They have the ability to see patterns where others do not or can imagine things that others cannot.
- This allows for good scientists to expand the boundaries we know.
Imagination and Creativity

• An example being when John Snow created a spot map which effectively pinpointed the source of a Cholera epidemic in 1854.