Observations and Experiments

Dana Desonie, Ph.D.

AUTHOR
Dana Desonie, Ph.D.

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CONCEPT 1

Observations and Experiments

- Explain how observations and experiments are used to answer scientific questions.

How do you test a hypothesis?

When you test a hypothesis, you must make observations or perform experiments. We could test the two hypotheses in the concept "Correlation and Causation" using the scientific literature because scientists who came before us collected that data using scientific method. If the question was new we would need to do the testing ourselves. How might you do the testing yourself?

Testing Hypotheses

If we were doing a scientific investigation we need to gather the information to test the hypotheses ourselves. We would do this by making observations or running experiments.

Observations

Observations of Earth's surface may be made from the land surface or from space. Many important observations are made by orbiting satellites, which have a bird's eye view of how the planet is changing.

Often, observation is used to collect data when it is not possible for practical or ethical reasons to perform experiments. Scientists may send devices to make observations for them when it is too dangerous or impractical for them to make the observations directly. They may use microscopes to explore tiny objects or telescopes to learn about the universe.

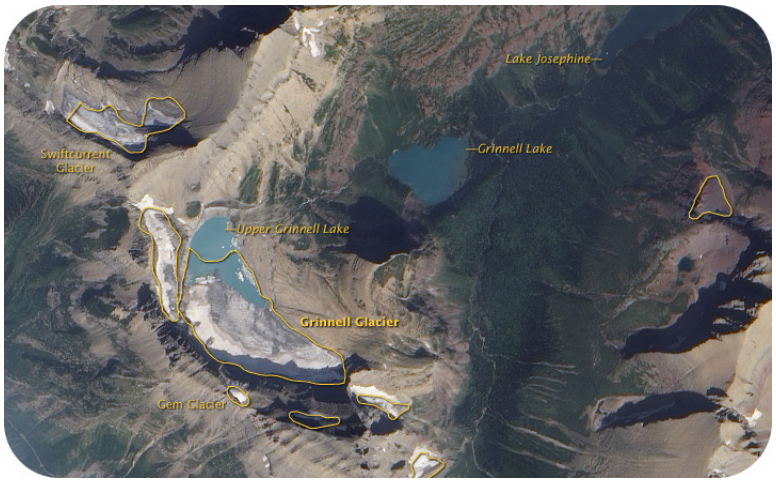

FIGURE 1.1

This satellite image shows how the extent of glaciers in Glacier National Park has changed in recent years.

FIGURE 1.2

Artist's concept of the Juno orbiter circling Jupiter. The mission is ongoing.

Experiments

Answering some questions requires **experiments**. An experiment is a test that may be performed in the field or in a laboratory. An experiment must always done under controlled conditions. The goal of an experiment is to verify or falsify a hypothesis.

In an experiment, it is important to change only one factor. All other factors must be kept the same.

- **Independent variable**: The factor that will be manipulated.
- **Dependent variable**: The factors that depend on the independent variable.

An experiment must have a **control group**. The control group is not subjected to the independent variable. For example, if you want to test if Vitamin C prevents colds, you must divide your sample group up so that some receive Vitamin C and some do not. Those who do not receive the Vitamin C are the control group.

Experimental Error

Scientists often make many measurements during experiments. As in just about every human endeavor, errors are unavoidable. In a scientific experiment, this is called **experimental error**. **Systematic errors** are part of the experimental setup, so that the numbers are always skewed in one direction. For example, a scale may always measure one-half of an ounce high. **Random errors** occur because a measurement is not made precisely. For example, a stopwatch may be stopped too soon or too late. To correct for this, many measurements are taken and then averaged. Experiments always have a margin of error associated with them.

In an experiment, if a result is inconsistent with the results from other samples and many tests have been done, it is likely that a mistake was made in that experiment. The inconsistent data point can be thrown out.

Vocabulary

- **control group**: A group in a scientific experiment in which the factor being tested, the independent variable, is not applied; used as a basis for comparison.
- **dependent variable**: The variable in an experiment that is being measured as the independent variable is changed.
- **experiment**: A trial made under controlled conditions to test the validity of a hypothesis.
- **experimental error**: Errors that are made due to problems with the experimenter.
- **independent variable**: The variable in an experiment that is controlled and changed by the researcher.
- **random error**: A mistake made by the person performing the experiment or from an event that occurs for no apparent reason.
- **systematic error**: Errors that are due to some problem in the system so that the results are always skewed in one direction.

Summary

- Testing a hypothesis requires data. Data can be gathered by observations or by experiments.
- Observations can be done simply by looking at and measuring a phenomenon, or by using advanced technology.
- Experiments must be well-designed. They must be done under controlled conditions and with the manipulation of only one variable.
- Guidelines must be followed when dealing with possible experimental errors.

Review

1. Under what circumstances would a scientist test a hypothesis using observations?
2. Under what circumstances would a scientist test a hypothesis using experiments?
3. What is the difference between an independent and a dependent variable in an experiment?

References

1. NASA image by Robert Simmon, using ALI data from the EO-1 team and Global Land Ice Measurements from Space. . Public Domain
2. Courtesy of NASA/JPL. . Public Domain