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Scientific Method Guided Notes – Teacher Edition

Scientific Method

The scientific method is a process used to investigate the unknown. It is the general process of scientific investigation. This process uses evidence and testing.

Scientists use the scientific method so they can find information. A common method allows all scientists to answer questions in a similar way. Scientists who use this method can reproduce another scientist's experiment.

Scientific method is a systematic way of solving a scientific problem or a question that can be answered through experimentation. Almost all versions of the scientific method include the following steps, although some scientists do use slight variations.

Make Observations and Ask a Question

As scientists conduct their research, they make observations and collect data. The observations and data often lead them to ask why something is the way it is. Scientists pursue answers to these questions in order to continue with their research. Once scientists have a good question to investigate, they begin to think of ways to answer it.

Form a Hypothesis

Based on their research and observations, scientist will often come up with a hypothesis. A hypothesis is a tentative solution to a problem. It is a statement that describes the relationship between two or more variables.

A hypothesis may be based on their own observations, existing theories, and information they gather from other sources.

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A hypothesis is a specific, testable prediction about what is expected to happen in a study. Though hypothesis is a prediction, it involves more than a guess. Most of the time, hypothesis begins with a question which is then explored through a background research. It is only at this point that researchers begin to develop a testable hypothesis.

There are four evaluation criteria that a hypothesis must meet.

First, it must state an expected relationship between variables. A hypothesis often follows a basic format of "If {this happens} then {this will happen}." One way to structure the hypothesis is to describe what will happen to the dependent variable if the independent variable is changed. The basic format might be: "If {these changes are made to a certain independent variable}, then we will observe {a change in a specific dependent variable}."

Second, it must be testable and falsifiable. In the scientific method, falsifiability is an important part of any valid hypothesis. In order to test a claim scientifically, it must be possible that the claim could be proven false.

Third, it should be consistent with the existing body of knowledge. Finally, it should be stated as simply and concisely as possible.

In many cases, researchers may find that the results of an experiment do not support the original hypothesis. When writing up these results, the researchers might suggest other options that should be explored in future studies.

Test the Hypothesis

Evidence is needed to test the hypothesis. Testing the hypothesis means conducting an experiment to gather data and determine whether the variables identified show relationship or not. Scientists can gather their data by observing the natural world, performing an experiment in a laboratory, or by running a model.

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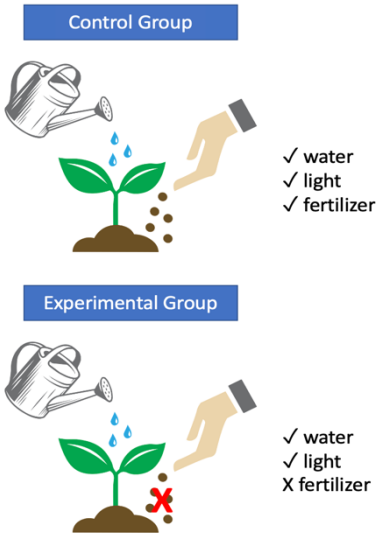
Scientists decide what strategy to use, often combining strategies. Then they plan a procedure and gather their data. They make sure the procedure can be repeated, so that other scientists can evaluate their findings.

Scientists organize their data in tables, graphs, or diagrams. If possible, they include relevant data from other sources. They look for patterns that show connections between important variables in the hypothesis they are testing.

When possible, scientists test their hypotheses using controlled experiments. It is a scientific test done under controlled conditions, meaning that just one factor is changed at a time, while others are kept constant.

> *For example, two identical plants were grown at the same location where light is sufficient, and water is provided to each plant. However, other plant receives fertilizer while the other one does not. After a week, the plant that receives fertilizer grew taller than the plant without fertilizer.*



In controlled experiment, there are two groups and they are identical except that one receives a treatment while the other does not. The group that receives the treatment in the experiment (with fertilizer) is called the experimental group, while the group that does not receive the treatment (without fertilizer) is called the control group. The control group provides a baseline that allows the scientists to see if the treatment has an effect.

Draw a Conclusion and Communicating Results

If a hypothesis and experiment are well designed, the results will indicate whether the hypothesis is true or false. If a hypothesis is true, scientists will often continue testing the hypothesis in new ways to learn more. Successfully proven hypotheses can lead to either scientific theories or scientific laws, which are similar in character but are not synonymous terms.

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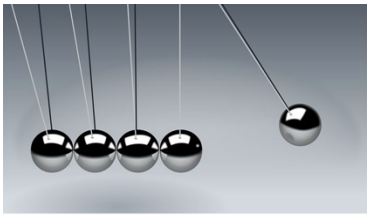
Albert Einstein's theory of relativity claims that massive objects (like the Earth) cause a distortion in space-time, which is experienced as gravity.

A scientific theory is a description of the natural world that scientists have proven through rigorous testing. As understood within the scientific community, a theory explains how nature behaves under specific conditions. Theories tend to be as broad as their supporting scientific evidence will permit. They seek to serve as a definitive explanation of some aspect of the natural world.

Like theories, scientific laws describe phenomena that the scientific community has found to be provably true. Generally, laws describe what will happen in a given situation as demonstrable by a mathematical equation, whereas theories describe how the phenomenon happens. Scientific laws develop from scientific discoveries and rigorously tested hypotheses, and new theories generally uphold and expand laws—though neither is ever held to be unimpeachably true.



Sir Isaac Newton's 1687 law of gravity describes the attractive forces between all forms of matter.

If a hypothesis is false, the results may be used to come up with and test a new hypothesis. A scientist will then communicate the results to the scientific community. This will allow others to review the information and extend the studies. The scientific community can also use the information for related studies. Scientists communicate their results in a number of ways. They may talk to small groups of scientists and give talks at large scientific meetings. They will also write articles for scientific journals. Their findings may also be communicated to journalists.

Importance of Scientific Method

The scientific method attempts to minimize the influence of bias or prejudice in the experimenter. Even the best-intentioned scientists can't escape bias. It results from personal beliefs, as well as cultural beliefs, which means any human filters information based on his or her own experience. Unfortunately, this filtering process can cause a scientist to prefer one outcome over another.

Scientific method provides an objective, standardized approach to conducting experiments and, in doing so, improves their results. By using a standardized approach in their investigations, scientists can feel confident that they will stick to the facts and limit the influence of personal, preconceived notions.

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