The Scientific Method

The **scientific method** is a process used by scientists to study the world around them. It can also be used to test whether any statement is accurate. You can use the scientific method to study a leaf, a dog, an ocean, or the entire Universe. We all have questions about the world. The scientific method is there to test if your answer is correct. You could ask, "Why do dogs and cats have hair?" One answer might be that it keeps them warm. A good scientist would then come up with an experiment to test whether the statement was accurate. BOOM! It's the scientific method in action.

1. IDENTIFY THE PROBLEM

The scientific method starts with identifying a problem and forming a question that can be tested. A **scientific question** can be answered by making **observations** with your five senses and *gathering evidence*. The question you ask needs to be something you can *measure*, so you can compare results you are interested in. For example, "*How does fertilizer affect plant growth?*" would be a testable scientific question. It's important to do **background research** to find out what's already written about your question before starting your experiment.

2. FORM A HYPOTHESIS

The second step in the scientific method is to form a hypothesis. A **hypothesis** is a possible *explanation* for a set of observations or an *answer* to a scientific question. A hypothesis must be *testable* and *measurable*. This means that researchers must be able to carry out investigations and gather evidence that will either support or disprove the hypothesis. Many trials will be needed before a hypothesis can be accepted as true. A hypothesis is written as an ***"If... then..."*** statement. For example, "*If I give my plants fertilizer in the spring, then they will produce more flowers*," is a simple hypothesis about how plants grow. In this example, you can measure the number of flowers.

3. DESIGN AN EXPERIMENT

The next step in the scientific method is to test the hypothesis by designing an experiment. This includes creating a list of **materials** and a **procedure**— a step-by-step explanation of how to conduct the experiment. Scientists must be careful in how they design an experiment to make sure that it tests exactly what the hypothesis states. A proper experiment compares two or more things but changes only one **variable**—factors that change in an experiment. This type of experiment is called a **controlled experiment**. For example, when testing the affects of fertilizer on plants, you would test an *experimental group* (with fertilizer) and a *control group* (without fertilizer). Then you would compare the results of the groups.

Types of Variables

- **Independent Variable**– the variable that is tested and changed by the scientist.
  - Ex. The amount of fertilizer used on your plants.
- **Dependent Variable**– the variable that is measured by the scientist and changes as a result of the independent variable.
  - Ex. How many flowers grow on the plant.
- **Controlled Variable**– the variables that are kept the same (constant) throughout the entire experiment.
  - Ex. Same type of plant, same amount of light and water

4. PERFORM AN EXPERIMENT

Keeping detailed, accurate records is an important part of the scientific method. Before you begin your experiment, create a table in which to record your data. **Data** are the facts, figures, and other evidence gathered through observations. A **data table** provides you with an organized way to collect and record your observations. For example, your data table should list the independent variable (amount of fertilizer) in the first column and the dependent variable (number of flowers) in the second column. Then you can use your table to create a graph. **Graphs** help you understand and use that data. Graphs make it easy to identify trends and make predictions. The **x-axis** of your graph represents the independent variable, while the **y-axis** of your graph represents the dependent variable.

5. ANALYZE THE DATA

The next step in the scientific method is to analyze the data. **Data analysis** is the process of interpreting the meaning of the data we have collected, organized, and displayed in the form of a table or graph. The process involves looking for **patterns**—similarities, differences, trends, and other relationships—and thinking about what these patterns might mean. The scientist then *summarizes* their findings and relates them to their hypothesis. For example, in your analysis of your plant experiment, you would refer to your table/graph to describe any relationships you observed between the plants with and without fertilizer.

6. COMMINCATE THE RESULTS

The last step of the scientific method is to communicate the results. After you gathered and analyzed your data, you draw a conclusion about your hypothesis. A **conclusion** is a summary of what you have learned from an experiment. In drawing your conclusion, you should ask yourself whether the data supports your hypothesis. For example, if you found that your experimental group produced 40 flowers and your control group produced 20 flowers, you could draw the conclusion that the fertilizer increased the number of flowers produced and your hypothesis is correct.