Steps of the Scientific Method

The Scientific Method involves a series of steps that are used to investigate a natural occurrence.

We shall take a closer look at these steps and the terminology you will need to understand before you start a science project.

Scientific Method

1. State the Problem
2. Gather Information
3. Form a Hypothesis
4. Perform Experiment
5. Analyze the data
6. Draw Conclusions and
7. Retest

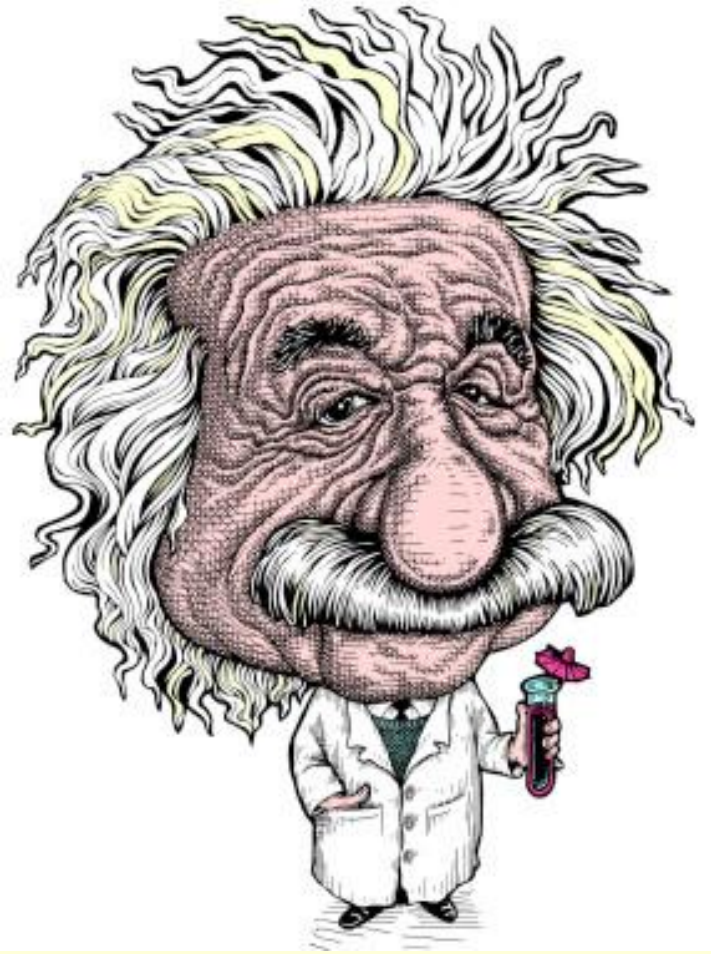
Steps of the Scientific Method

1. Problem/Question: Develop a question or problem that can be solved through experimentation.

Steps of the Scientific Method

2. Gather Information: Make observations and research your topic of interest.

Do you remember the next step?



Steps of the Scientific Method

3. Form a Hypothesis: Predict a possible answer to the problem or question.

Example: If soil temperatures rise, then plant growth will increase.

Steps of the Scientific Method

4. **Perform Experiment**: Develop and follow a procedure.

Include a detailed materials list.

The outcome must be measurable (quantifiable).

Steps of the Scientific Method

5. Analyze the data: Modify the procedure if needed.

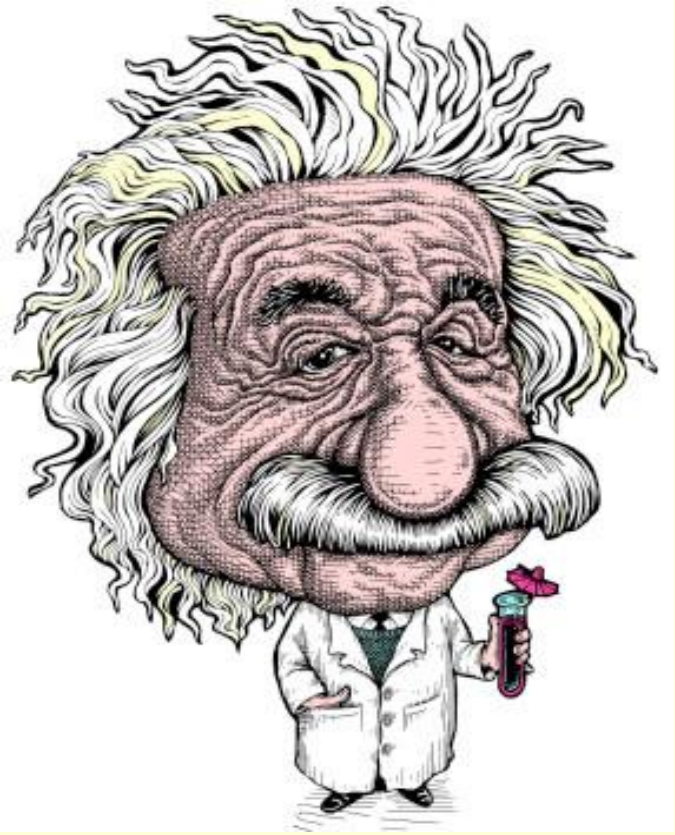
Include tables, graphs, and photographs.

Steps of the Scientific Method

6. **Draw Conclusions**: Include a statement that accepts or rejects the hypothesis.

- Confirm the results by retesting
- Make recommendations for further study and possible improvements to the procedure.

Think you can name all seven steps?



Collect Data
Form a Hypothesis
Test Hypothesis
Analyze Results
Draw Conclusions
Publish Results

Let’s put our knowledge of the Scientific Method to a realistic example that includes some of the terms you’ll be needing to use and understand.

Problem/Question

John watches his grandmother bake bread. He ask his grandmother what makes the bread rise.

She explains that yeast releases a gas as it feeds on sugar.

Problem/Question

John wonders if the amount of sugar used in the recipe will affect the size of the bread loaf?

Caution!

Be careful how you use effect and affect.

Effect is usually a noun and affect, a verb.

“ The effect of sugar amounts on the rising of bread.”

“How does sugar affect the rising of bread?”

Observation/Research

John researches the areas of baking and fermentation and tries to come up with a way to test his question.

He keeps all of his information on this topic in a journal.

Formulate a Hypothesis

After talking with his teacher and conducting further research, he comes up with a hypothesis.

“If more sugar is added, then the bread will rise higher.”

Variable

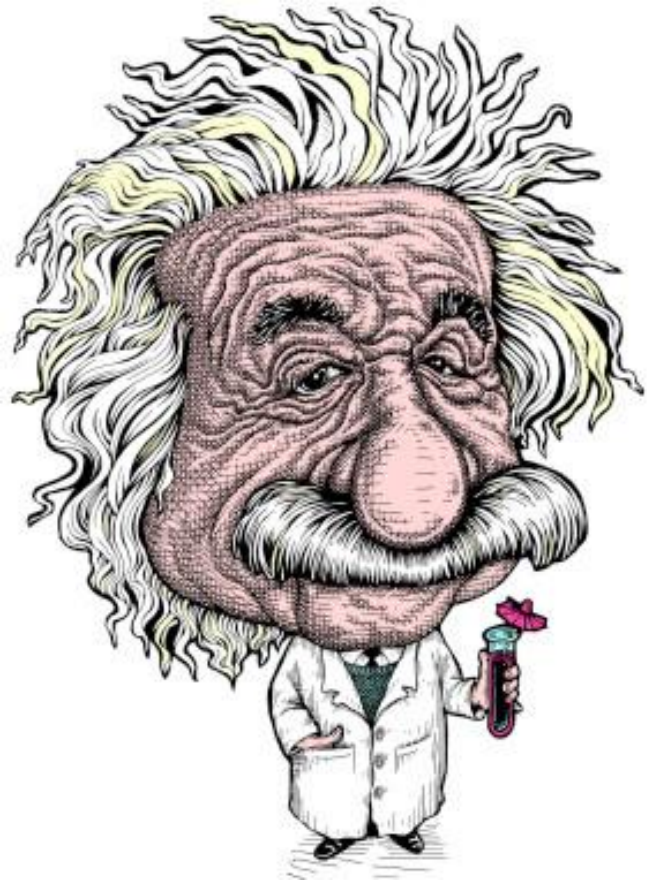
- A variable is any factor, trait, or condition that can exist in differing amounts or types

Hypothesis

The hypothesis is an educated guess about the relationship between the independent and dependent variables.

Note: These variables will be defined in the next few slides.

Do you know the difference between the independent and dependent variables?



Independent Variable

Independent variable is the one that is changed by the scientist. To ensure a fair test, a good experiment has only one independent variable. As the scientist changes the independent variable, he or she **observes** what happens.

John is going to use 25g., 50g., 100g., 250g., 500g. of sugar in his experiment.

Dependent Variable

The dependent, or responding variable, is the factor that may change as a result of changes made in the independent variable.

In this case, it would be the size of the loaf of bread.

Experiment

His teacher helps him come up with a procedure and list of needed materials.

She discusses with John how to determine the control group.

Control Group

In a scientific experiment, the control is the group that serves as the standard of comparison.

The control group is <u>NOT</u> exposed to testing.

Control Group

The control group is exposed to the same conditions as the experimental group, except for the variable being tested.

All experiments should have a control group.

Control Group

Because his grandmother always used 50g. of sugar in her recipe, John is going to use that amount in his control group.

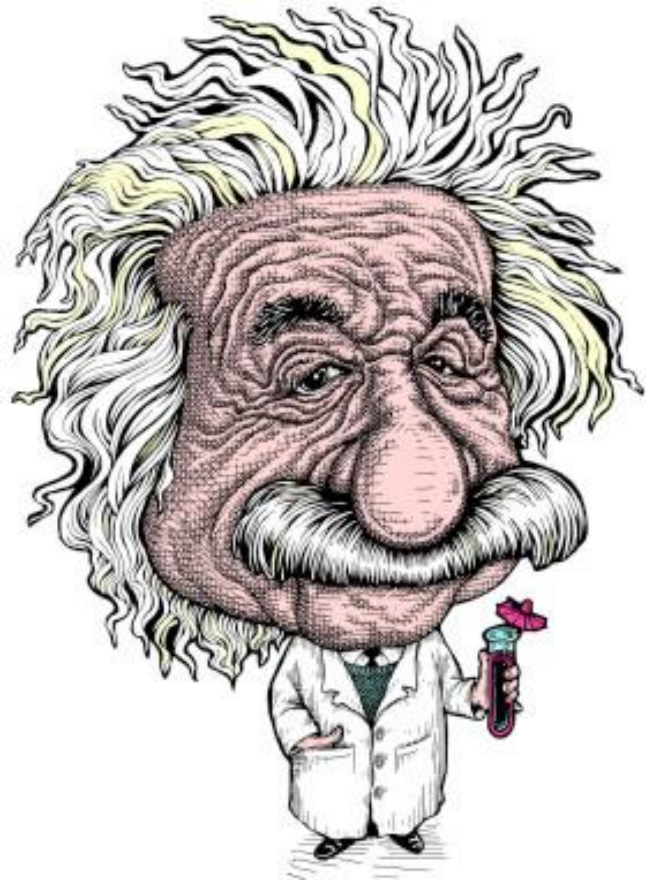
Constants

John’s teacher reminds him to keep all other factors the same so that any observed changes in the bread can be attributed to the variation in the amount of sugar.

Constants

The constants in an experiment are all the factors that the experimenter attempts to keep the same.

Can you think of some constants for this experiment?



Constants

They might include:

Other ingredients to the bread recipe, oven used, rise time, brand of ingredients, cooking time, type of pan used, air temperature and humidity where the bread was rising, oven temperature, age of the yeast…

Experiment

John writes out his procedure for his experiment along with a materials list in his journal. He has both of these checked by his teacher where she checks for any safety concerns.

Trials

Trials refer to replicate groups that are exposed to the same conditions in an experiment.

John is going to test each sugar variable 3 times.

Collect and Analyze Results

John comes up with a table he can use to record his data.

John gets all his materials together and carries out his experiment.

Size of Baked Bread (LxWxH) cm^3

	Size of Bread Loaf (cm^3) Trials			
Amt. of Sugar (g.)	1	2	3	**Average Size (cm^3)**
25	768	744	761	758
50 Control group	1296	1188	1296	1260
100	1188	1080	1080	1116
250	672	576	588	612
500	432	504	360	432

Collect and Analyze Results

John examines his data and notices that his control worked the best in this experiment, but not significantly better than 100g. of sugar.

Conclusion

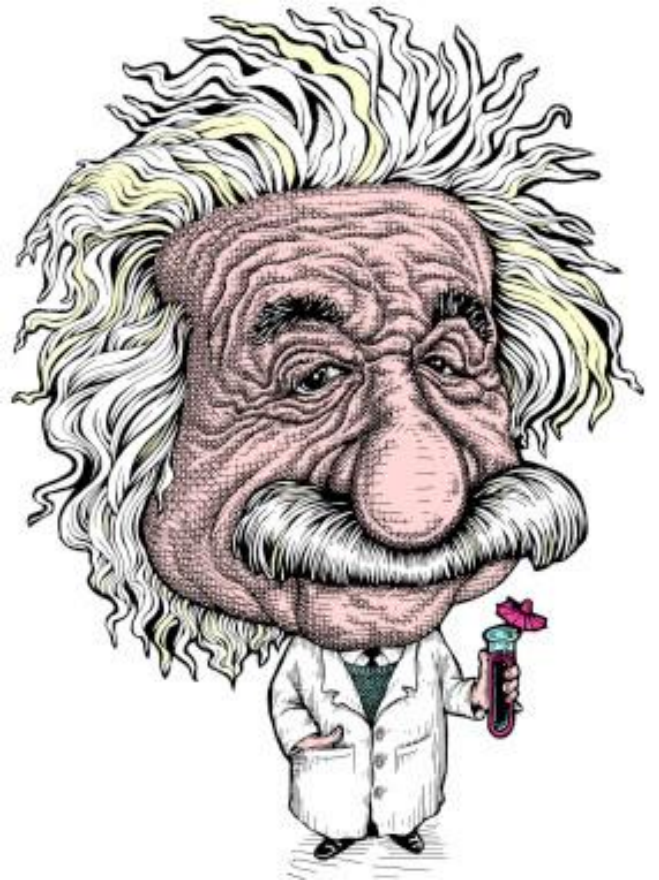
John rejects his hypothesis, but decides to re-test using sugar amounts between 50g. and 100g.

Experiment

Once again, John gathers his materials and carries out his experiment.

Here are the results.

Can you tell which group did the best?



Size of Baked Bread (LxWxH) cm^3

	Size of Bread Loaf (cm^3) Trials			
Amt. of Sugar (g.)	1	2	3	**Average Size (cm^3)**
50 Control group	1296	1440	1296	1344
60	1404	1296	1440	1380
70	1638	1638	1560	1612
80	1404	1296	1296	1332
90	1080	1200	972	1084

Conclusion

John finds that 70g. of sugar produces the largest loaf.

His hypothesis is accepted.

Communicate the Results

John tells his grandmother about his findings and prepares to present his project in Science class.