



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

Problem/Question

Observation/Research

Formulate a Hypothesis

Experiment

Collect and Analyze Results

Conclusion

Communicate the Results

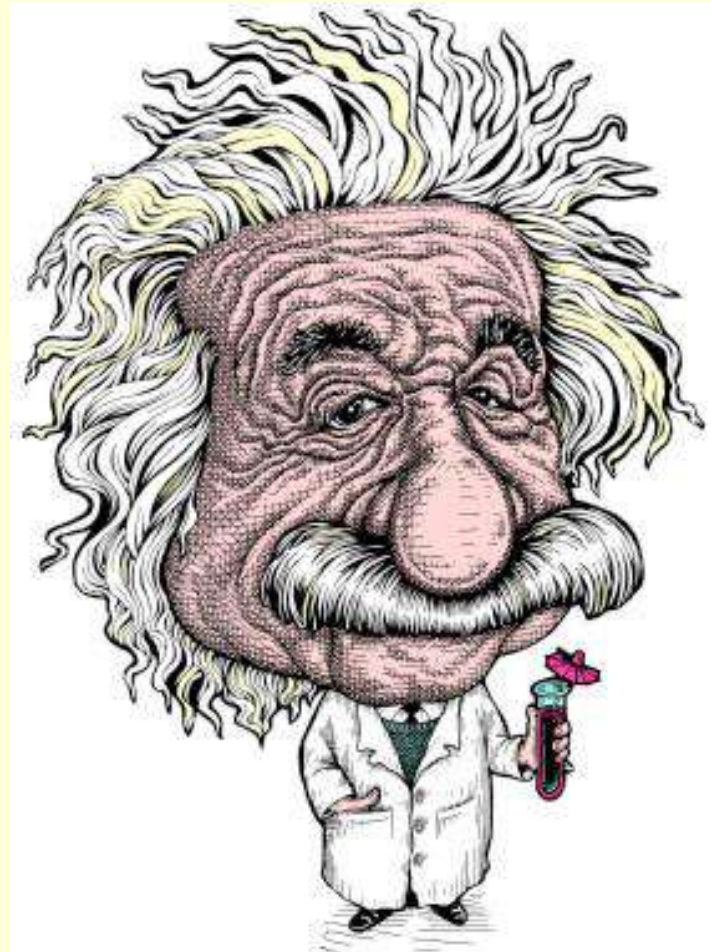
Steps of the Scientific Method

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

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2. Observation/Research: Make observations and research your topic of interest.

Do you remember the
next step?



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3. Formulate a Hypothesis:

Predict a possible answer to the problem or question.

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

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4. Experiment: Develop and follow a procedure.

Include a detailed materials list.

The outcome must be measurable (quantifiable).

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5. Collect and Analyze Results:

Modify the procedure if needed.

Confirm the results by retesting.

Include tables, graphs, and photographs.

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6. Conclusion: Include a statement that accepts or rejects the hypothesis.

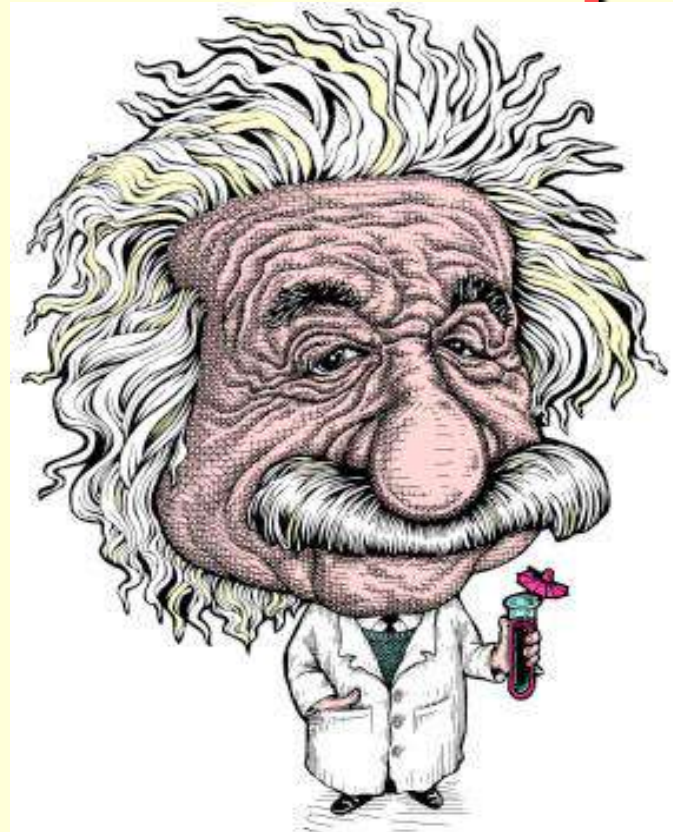
Make recommendations for further study and possible improvements to the procedure.

Steps of the Scientific Method

7. Communicate the Results: Be prepared to present the project to an audience.

Expect questions from the audience.

Think you can name all seven steps?



Cell Culture
Media Preparation
Cell Seeding
Incubation
Media Change
Harvesting
Analysis 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.



John talks with his teacher and she gives him a **Experimental Design Diagram** to help him set up his investigation.



General Layout for an Experimental Design Diagram

TITLE

The Effect of _____ (Independent Variable)
on _____ (Dependent Variables)

HYPOTHESIS

If _____ (planned change in independent variable),
then _____ (predicted change in dependent variables).

INDEPENDENT VARIABLE

LEVELS OF INDEPENDENT VARIABLE AND NUMBERS OF REPEATED TRIALS

| Level 1 (Control) | Level 2 | Level 3 | Level 4 |
|-------------------|------------------|------------------|------------------|
| Number of trials | Number of trials | Number of trials | Number of trials |

DEPENDENT VARIABLE AND HOW MEASURED

CONSTANTS

- 1.
- 2.
- 3.
- 4.

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.”

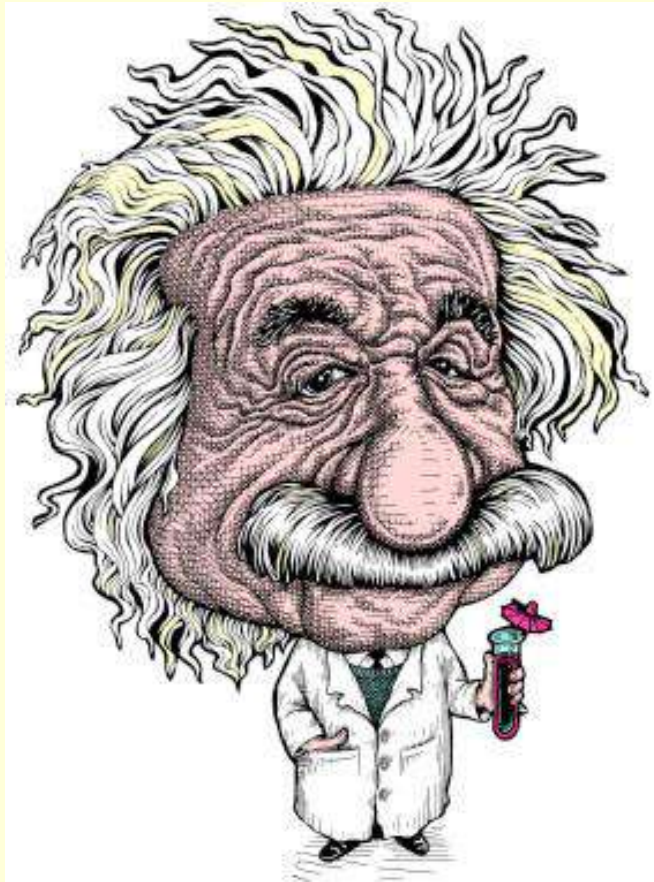


Hypothesis

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

The independent, or manipulated variable, is a factor that's intentionally varied by the experimenter.

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 may be a “no treatment” or an “experimenter selected” group.

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.

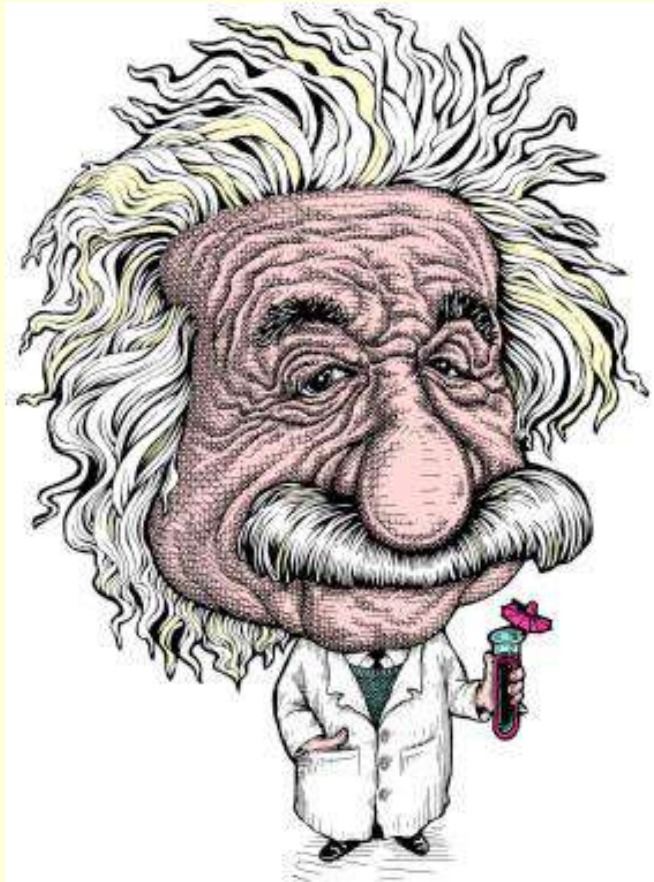


Constants

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) cm³

| 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.

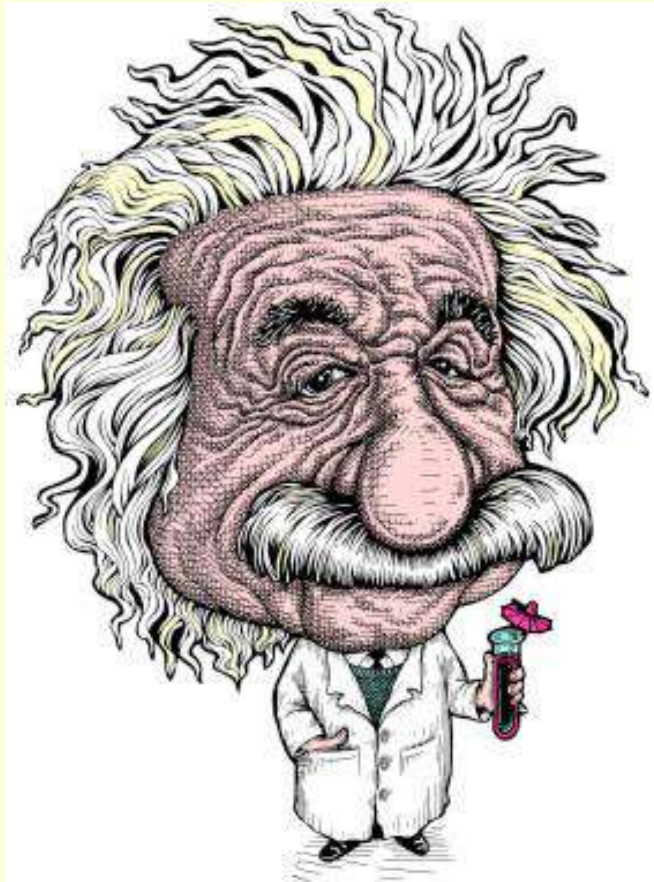


Experiment

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) cm³

| 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.



**Observe your
world and come
up with a question
to answer using the
Scientific Method!**