

THE SCIENTIFIC METHOD

Scientific Method

Involves a series of steps that are used to investigate a natural occurrence.



[SM Video](#)

- ## Scientific Method
1. Identify the Problem/State a Question
 2. Observation/Research/Gather Information
 3. Formulate a Hypothesis
 4. Design and Carry Out An Experiment
 5. Make Observations and Record Data
 6. Collect and Analyze Results
 7. State a Conclusion

- ## Steps of the Scientific Method
1. Identify the Problem/Ask a Question: Develop a question or problem that can be solved through experimentation.
- 
- (Make sure this is TESTABLE).



Steps of the Scientific Method



2. Observation/Research/Gather Information:

Make observations and research your topic of interest. Books, specialist, internet, etc.

Smell



Touch



Hearing



Sight



Taste

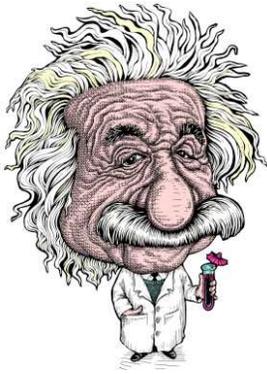


Observations

Observations can be **qualitative** or **quantitative**.

- ★ **Qualitative** observations involve characteristics that cannot be measured, such as color or texture.
 - Example- I don't feel well, my forehead is really **hot**.
 - Example- There are **red** birds in that tree.
- ★ ^{Numbers} **Quantitative** observations involve numbers.
 - Example- I have a fever of **102** degrees.
 - Example- **Two** of the red birds are female.

Do you remember the next step?



Steps of the Scientific Method



3. Formulate and State a Hypothesis:

Predict a possible answer to the problem or question.

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



"I've narrowed it to two hypotheses: it grew or we shrunk."



Steps of the Scientific Method

4. Design and Carry Out An Experiment: Develop and follow a procedure.

- Include a detailed materials list.
- The outcome must be measurable (quantifiable).



Steps of the Scientific Method

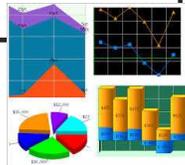
5. Make Observations and Record Data: Keep a detailed record of all observation made.

- Modify the procedure if needed.
- Confirm the results by retesting.



Steps of the Scientific Method

6. Organize and Analyze Data: Include tables, graphs, and photographs, and written observations (depending on experiment).



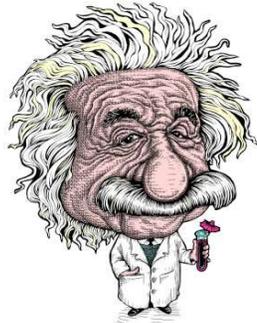
Steps of the Scientific Method

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

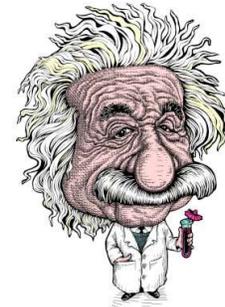
- Make recommendations for further study and possible improvements to the procedure.



Think you can name all seven steps?



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



Terms to Know:

Independent Variable

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

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

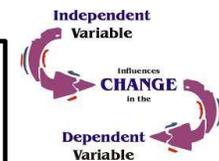


Terms to Know:

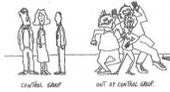
Dependent Variable

What you Measure....

Responding variable, is the factor that may change as a result of changes made in the independent variable.



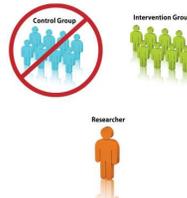
Ex: Size of the loaf of bread.



Terms to Know:

Control Group

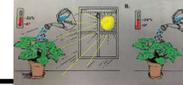
- The control group may be a “no treatment” or an “experimenter selected” group.
- Exposed to the same conditions as the experimental group, except for the variable being tested.
- Experimental groups are compared too.



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

Terms to Know:

Constants



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

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.

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...

What are some constants in this experiment?

Terms to Know:

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.

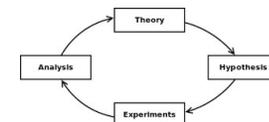


Terms to Know:



Scientific theory

- **Scientific Theories** are based on **knowledge gained from many experiments.**
- **NOT A GUESS!**
- **Lots and Lots of FACTS..**
- **Not yet a law**



Scientific Method realistic example

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.

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

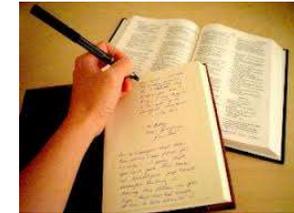


Problem/Question

Scientific Method realistic example

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.

Observation/Research



Scientific Method realistic example

After talking with his teacher and conducting further research, he comes up with the following:
"If more sugar is added, then the bread will rise higher."



Formulate a Hypothesis

Scientific Method realistic example

John talks with his teacher and she gives him ideas to help him set up his investigation.

Experimental Design Diagram



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

Amt. of Sugar (g.)	Size of Bread Loaf (cm ³)			Average Size (cm ³)
	Trials			
	1	2	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.



Size of Baked Bread (LxWxH) cm³

Amt. of Sugar (g.)	Size of Bread Loaf (cm ³)			Average Size (cm ³)
	Trials			
	1	2	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.



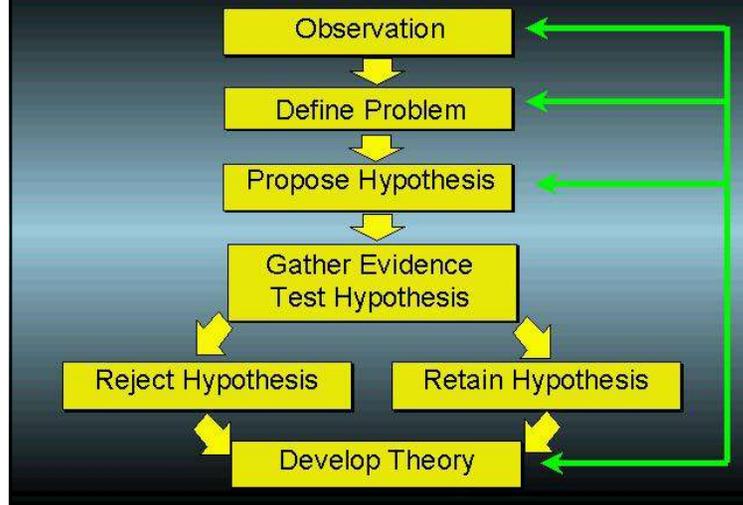
Communicate the Results

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



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The Scientific Method



PRACTICE:

1. An ecologist wants to investigate the effects of pollution on soybean plants. The scientist grows five groups of plants and exposes four groups to various pollutants. The fifth group is not exposed to any pollution. The ecologist observes the condition and growth of all the groups of plants over a period of time.

a) What is the control group?

Fifth group

b) What is the independent variable?

Pollution

c) What is the dependent variable?

Condition and growth

PRACTICE:

2. Tom wanted to test his hypothesis that plants grow better at room temperature than in cold temperatures. He placed an ivy plant in the refrigerator, which had no light source. He also placed a spider plant in the window in his room.

a) What is his independent variable?

temperature

b) What is his dependent variable?

Growth of plant

c) What is wrong with his experiment?

To many independent variables: Temperature, light, type of plants, and locations

PRACTICE:

3. Latoya wanted to discover if beans or corn would grow best in the soil in her garden. She planted beans in a corner under a tree, and planted corn in full sunlight.

a) What is her independent variable?

Type of plant

b) What is her dependent variable?

Growth of plant

c) What is wrong with her experiment?

To many independent variables: Type of plant and amount of sunlight

PRACTICE:

4. Raul wanted to see if Jiffy Pop or Von's brand of popcorn left fewer unpopped kernels. He poured some of each type of popcorn into two different types of pans containing oil. He popped the corn for three minutes each. He then recorded the number of unpopped kernels in each pan.

a) What is his independent variable?

Brand of popcorn

b) What is his dependent variable?

Amount of unpopped kernels

c) What is wrong with his experiment?

Two independent variables: Brand of popcorn and types of pans

PRACTICE:

5. Ms. Barajas's biology class is investigating what type of music plants respond to the best. They buy 3 plants for their experiment. Taylor Swift will be played for plant 1, Jay-Z will be played for plant 2 and plant 3 will not "listen" to any music at all. The height of each plant will be measured once a day for 5 days.

a.) What is the control group?

Plant 3

b. What is the independent variable?

Type of music

c.) What is the dependent variable?

Height of plant

d.) Name three constants in the experiment.

Type of plant, soil, water, sunlight, pot, location

SpongeBob and his Bikini Bottom pals have been busy doing a little research. Read the description for each experiment and answer the questions.

1 - Patty Power

Mr. Krabbs wants to make Bikini Bottoms a nicer place to live. He has created a new sauce that he thinks will reduce the production of body gas associated with eating crabby patties from the Krusty Krab. He recruits 100 customers with a history of gas problems. He has 50 of them (Group A) eat crabby patties with the new sauce. The other 50 (Group B) eat crabby patties with sauce that looks just like new sauce but is really just mixture of mayonnaise and food coloring. Both groups were told that they were getting the sauce that would reduce gas production. Two hours after eating the crabby patties, 30 customers in group A reported having fewer gas problems and 8 customers in group B reported having fewer gas problems.

Which people are in the control group?

What is the independent variable?

What is the dependent variable?

What should Mr. Krabbs' conclusion be?

Why do you think 8 people in group B reported feeling better?

2 - Slimotosis

Sponge Bob notices that his pal Gary is suffering from slimotosis, which occurs when the shell develops a nasty slime and gives off a horrible odor. His friend Patrick tells him that rubbing seaweed on the shell is the perfect cure, while Sandy says that drinking Dr. Kelp will be a better cure. Sponge Bob decides to test this cure by rubbing Gary with seaweed for 1 week and having him drink Dr. Kelp. After a week of treatment, the slime is gone and Gary's shell smells better.

What was the initial observation?

What is the independent variable?

What is the dependent variable?

What should Sponge Bob's conclusion be?

3 – Marshmallow Muscles

Larry was told that a certain muscle cream was the newest best thing on the market and claims to double a person's muscle power when used as part of a muscle-building workout. Interested in this product, he buys the special muscle cream and recruits Patrick and SpongeBob to help him with an experiment. Larry develops a special marshmallow weight-lifting program for Patrick and SpongeBob. He meets with them once every day for a period of 2 weeks and keeps track of their results. Before each session Patrick's arms and back are lathered in the muscle cream, while Sponge Bob's arms and back are lathered with the regular lotion.

Which person is in the control group?

What is the independent variable?

What is the dependent variable?

What should Larry's conclusion be?

Time	Patrick	SpongeBob
Initial Amount	18	5
After 1 week	24	9
After 2 weeks	33	17

4 – Microwave Miracle

Patrick believes that fish that eat food exposed to microwaves will become smarter and would be able to swim through a maze faster. He decides to perform an experiment by placing fish food in a microwave for 20 seconds. He has the fish swim through a maze and records the time it takes for each one to make it to the end. He feeds the special food to 10 fish and gives regular food to 10 others. After 1 week, he has the fish swim through the maze again and records the times for each.

Special Food Group (Time in minutes/seconds)			Regular Food Group (Time in minutes/seconds)		
Fish	Before	After	Fish	Before	After
1	1:06	1:00	1	1:09	1:08
2	1:54	1:20	2	1:45	1:30
3	2:04	1:57	3	2:00	2:05
4	2:15	2:20	4	1:30	1:23
5	1:27	1:20	5	1:28	1:24
6	1:45	1:40	6	2:09	2:00
7	1:00	1:15	7	1:25	1:19
8	1:28	1:26	8	1:00	1:15
9	1:09	1:00	9	2:04	1:57
10	2:00	1:43	10	1:34	1:30

What was Patrick's hypothesis?

Which fish are in the control group?

What is the independent variable?

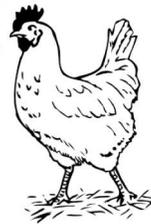
What is the dependent variable?

Look at the results in the charts. What should Patrick's conclusion be?

The Strange Case of BeriBeri

In 1887 a strange nerve disease attacked the people in the Dutch East Indies. The disease was beriberi. Symptoms of the disease included weakness and loss of appetite, victims often died of heart failure. Scientists thought the disease might be caused by bacteria. They injected chickens with bacteria from the blood of patients with beriberi. The injected chickens became sick. However, so did a group of chickens that were not injected with bacteria.

One of the scientists, Dr. Eijkman, noticed something. Before the experiment, all the chickens had eaten whole-grain rice, but during the experiment, the chickens were fed polished rice. Dr. Eijkman researched this interesting case and found that polished rice lacked thiamine, a vitamin necessary for good health.



1. State the Problem
2. What was the hypothesis?
3. How was the hypothesis tested?
4. Should the hypothesis be supported or rejected based on the experiment?
5. What should be the new hypothesis and how would you test it?

How Penicillin Was Discovered

In 1928, Sir Alexander Fleming was studying *Staphylococcus* bacteria growing in culture dishes. He noticed that a mold called *Penicillium* was also growing in some of the dishes. A clear area existed around the mold because all the bacteria that had grown in this area had died. In the culture dishes without the mold, no clear areas were present.

Fleming hypothesized that the mold must be producing a chemical that killed the bacteria. He decided to isolate this substance and test it to see if it would kill bacteria. Fleming transferred the mold to a nutrient broth solution. This solution contained all the materials the mold needed to grow. After the mold grew, he removed it from the nutrient broth. Fleming then added the nutrient broth in which the mold had grown to a culture of bacteria. He observed that the bacteria died which was later used to develop antibiotics used to treat a variety of diseases.

6. Identify the problem.
7. What was Fleming's hypothesis?
8. How was the hypothesis tested?
9. Should the hypothesis be supported or rejected based on the experiment?
10. This experiment led to the development of what major medical advancement?