Experimental Design

Chapter 1
1 Define the Problem

- What is it you want to find out?
- Sometimes called the Purpose or Question
- What are some problems scientists work on today?
2 Research

- Gather as much information as possible before experimenting

- Sometimes called collecting information
3 Form a Hypothesis

- Predict the outcome of your experimentation
- Sometimes called an educated guess
- Many times hypotheses are stated in the “If…… then…..” format
4 Experiment

- Develop a procedure to test the hypothesis.
- Change only one variable at a time and all other things as constants.
- Independent variable – the thing you change.
- Sometimes called test the hypothesis.
5 Analyze the Data

- Record the results of your experiment using charts, graphs, and taking notes

- Sometimes called analysis or conclusions
6 Conclusion

- Compare the hypothesis to the experiment’s conclusion and publish your results for others to see.

- Sometimes called communicate the results.

- Paul Revere Hates Eggs And Cheese.
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. he 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?
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.

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?
When Experiments are Testing for something they have …..

- **Independent variable (I.V.)**- the factor (or variable) that gets changed on purpose in an experiment while all others remain constant.

- I.V. – I changed it myself
Dependent Variable

- The factors (or variables) that get changed as a result of the independent variable in an experiment
- The thing you measure
- It depends or changes because of the I.V.
Constants

- The factors in an experiment that remain the same. They are not changed.
Control

- The group that has no variable acting upon it so that it can be compared with the results of the experiment.

- In drug tests, this group is given sugar pills (placebos) instead of the medicine. They are told it is medicine.
Types of Data

- Quantitative – has numbers, obtained by counting, measuring.

- Qualitative – descriptions that do not use numbers, including colors, tastes, smells, sound or textures
Qualitative or Quantitative

- The floor is shiny.
- There are 19 students in the class.
- The walls are white.
- The board is 1 meter high and 2 meters wide.
Krusty Krabs Breath Mints
Mr. Krabs created a secret ingredient for a breath mint that he thinks will “cure” the bad breath people get from eating crabby patties at the Krusty Krab. He asked 100 customers with a history of bad breath to try his new breath mint. He had fifty customers (Group A) eat a breath mint after they finished eating a crabby patty. The other fifty (Group B) also received a breath mint after they finished the sandwich, however, it was just a regular breath mint and did not have the secret ingredient. Both groups were told that they were getting the breath mint that would cure their bad breath. Two hours after eating the crabby patties, thirty customers in Group A and ten customers in Group B reported having better breath than they normally had after eating crabby patties.

1. Which people are in the control group?

2. What is the independent variable?

3. What is the dependent variable?

4. What should Mr. Krabs’ conclusion be?

5. Why do you think 10 people in group B reported fresher breath?
SpongeBob Clean Pants
SpongeBob noticed that his favorite pants were not as clean as they used to be. His friend Sandy told him that he should try using Clean-O detergent, a new brand of laundry soap she found at Sail-Mart. SpongeBob made sure to wash one pair of pants in plain water and another pair in water with the Clean-O detergent. After washing both pairs of pants a total of three times, the pants washed in the Clean-O detergent did not appear to be any cleaner than the pants washed in plain water.

6. What was the problem SpongeBob wanted to investigate?

7. What is the independent variable?

8. What is the dependent variable?

9. What should Sponge Bob’s conclusion be?
Squidward’s Symphony
Squidward loves playing his clarinet and believes it attracts more jellyfish than any other instrument he has played. In order to test his hypothesis, Squidward played a song on his clarinet for a total of 5 minutes and counted the number of jellyfish he saw in his front yard. He played the song a total of 3 times on his clarinet and repeated the experiment using a flute and a guitar. He also recorded the number of jellyfish he observed when he was not playing an instrument. The results are shown in the chart.

<table>
<thead>
<tr>
<th>Trial</th>
<th>No Music</th>
<th>Clarinet</th>
<th>Flute</th>
<th>Guitar</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>15</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>10</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>12</td>
<td>9</td>
<td>7</td>
</tr>
</tbody>
</table>

10. What is the independent variable?

11. What is the dependent variable?

12. What should Squidward’s conclusion be?

13. Are the results reliable? Why or why not?
Super Bubbles
Patrick and SpongeBob love to blow bubbles! Patrick found some Super Bubble Soap at Sail-Mart. The ads claim that Super Bubble Soap will produce bubbles that are twice as big as bubbles made with regular bubble soap. Patrick and SpongeBob made up two samples of bubble solution. One sample was made with 5 oz. of Super Bubble Soap and 5 oz. of water, while the other was made with the same amount of water and 5 oz. of regular bubble soap. Patrick and SpongeBob used their favorite bubble wands to blow 10 different bubbles and did their best to measure the diameter of each one. The results are shown in the chart.

<table>
<thead>
<tr>
<th>Bubble</th>
<th>Super Bubble</th>
<th>Regular Soap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>8</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>9</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>6</td>
</tr>
</tbody>
</table>

14. What did the Super Bubble ads claim?

15. What is the independent variable?

16. What is the dependent variable?

17. Look at the results in the chart.
   a. Calculate the average diameter for each bubble solution.

      Super Bubble = _____ cm  Regular Soap = ________ cm

   b. What should their conclusion be?

18. Are the results reliable? Why or why not?
Use the clues to help you fill in the puzzle.
Clues:
1. The __?__ is the part of an experiment that is not being tested and is used for comparison.
2. The __?__ describes the steps you use during an experiment.
3. After an experiment, scientists write a __?__ which summarizes their experiment and results.
4. The __?__ __?__ is a process used by scientists to find answers to questions or solve a problem.
5. The __?__ variable is the part of the experiment that is being tested or the part that is changed by the person doing the experiment.
6. The __?__ is an educated guess.
7. Scientists use their data to make charts and __?__ to communicate the results of an experiment.
8. After the scientist makes a hypothesis, they perform an __?__ to collect data.
9. The first step of the scientific method is to define or identify the __?__.
10. Sometimes scientists make a mistake, or __?__, and need to do an experiment again.
11. The __?__ variable is the part of the experiment that is affected by the independent variable.
12. After the experiment, scientists organize and __?__ the data.
13. The information collected during an experiment is called __?__.
14. Scientists make __?__ to help them make a hypothesis or collect data during an experiment.