Unit 1: The Scientific Method and Measurement

Lecture 1-2: A Closer Look at the Scientific Method

Variable - Any _____, trait, _____ that can exist in differing amounts or types

3 Types of Variables:

1) Independent Variable – Purposefully _____ by a _____ in order to _____ what happens

2) Dependent Variable – changes in _____ to the independent variable

3) Control Variable – is kept the _____ throughout the experiment and not allowed to change

Independent Variable (IV) = what the _____ changes

- Example of an IV is _____

Dependent Variable (DV) = what I _____

- Example of an DV is _____

Controls (CV) = amounts that are _____the same & ____allowed to change

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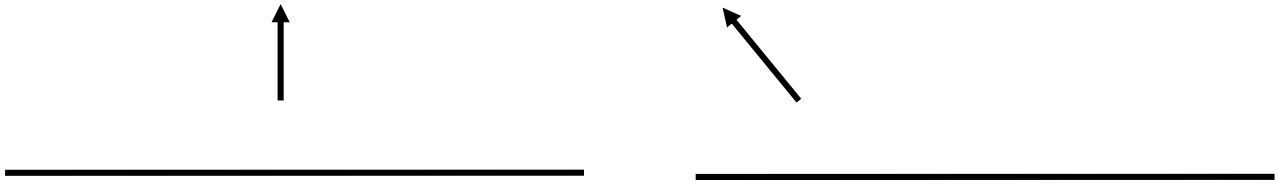
Recall: If ___(I do this), then _____(this) will happen



Hypothesis example:

If the _____ of a cup of water is _____,

Then the _____ ____ _____ will increase.

Elements of an Experiment

Identify the dependent and independent variables in the following examples. **Circle** the *dependent* variable and **<u>underline</u>** the *independent* variable.

1. Height of bean plants recorded daily for 2 weeks.

2. Guinea pigs are kept at different temperature for 6 weeks. Percent weight gain is recorded.

3. The diversity of algal species is calculated for a coastal area before and after an oil spill.

4. Light absorption by a pigment is measured for red, blue, green, and yellow light.

5. Batches of seeds are soaked in salt solutions of different concentrations, and Germination is counted for each batch.

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For each of the following examples, tell what an appropriate control treatment would be.

7. An investigator studies the amount of alcohol produced by yeast when it is incubated with different types of sugars.

Control Treatment:

8. The effect of light intensity on photosynthesis is measured by collecting oxygen produced by a plant.

Control Treatment:

9. A solution is made up to simulate stomach acid at pH 2. Maalox antacid is added to the solution in small amounts, and the pH is measured after each addition.

Control Treatment:

Sample Experiment.

An experiment was performed comparing the amount of time students spend studying chemistry per day to their average test scores.

Study Time (Minutes per Day)	Average Test Score
0	25%
20	40%
40	75%
60	88%
80	96%

1. Write a possible hypothesis that this experiment tested.

_____

_____

2. Which is the independent variable being tested?

_____

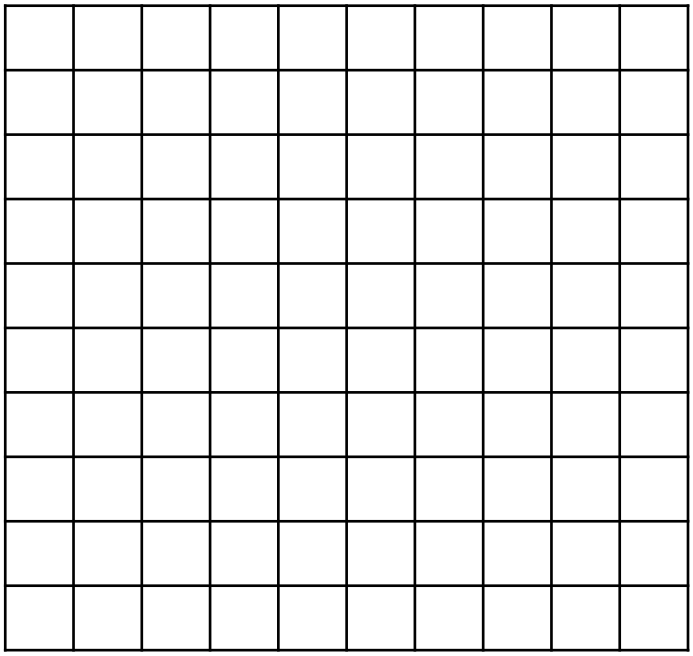
3. Which is the dependent variable being tested?

_____

4. Which study time group represents the control group?

_____

5. Graph the data above. Be sure to include a title, labels, and units.



Title:_____

6. Predict how much a student must study in order to make a passing grade of 70% on a chemistry test._____

7. Predict how much a student must study in order to make a 80% B on a chemistry test._____

8. Which time period showed the most improvement in test scores?

_____

9. Write a conclusion for this experiment.

Experiment 2:

An experiment is performed on 4 bean plants. Bean plant #1 is grown under a white light bulb (normal growth light), bean plant #2 is grown under a blue light, bean plant #3 is grown under a red light, and plant #4 was grown under a purple light bulb. After a 3 week period, plant growth was measured in centimeters. Bean plant #1 had grown 35cm. Bean plant #2 had grown 15cm. Bean plant #3 had grown 10cm. Bean plant #4 had grown 12 cm.

10. Which is the independent variable?_____

11. Which is the dependent variable?_____

12. What would be the controls in this experiment?_____

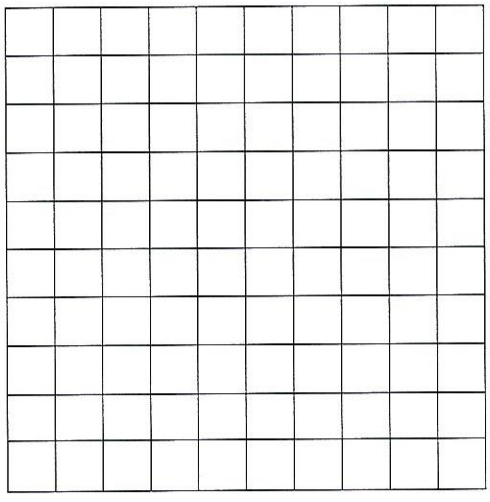
13. Which plant represented the control group?_____

14. Create a table and graph for experiment 2 data in the space provided.

15. By analyzing the graph, what conclusion can be made?_____

Table:

Graph:



Title:_____

Scientific Method Name _____
Controls and Variables – Part 1

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. Krabs' 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.

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

Which person is in the control group?

What is the independent variable?

What is the dependent variable?

What should Larry's conclusion be?

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)

Fish	Before	After
1	1:06	1:00
2	1:54	1:20
3	2:04	1:57
4	2:15	2:20
5	1:27	1:20
6	1:45	1:40
7	1:00	1:15
8	1:28	1:26
9	1:09	1:00
10	2:00	1:43

Regular Food Group
(Time in minutes/seconds)

Fish	Before	After
1	1:09	1:08
2	1:45	1:30
3	2:00	2:05
4	1:30	1:23
5	1:28	1:24
6	2:09	2:00
7	1:25	1:19
8	1:00	1:15
9	2:04	1:57
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?

WRITING A LAB REPORT

Every lab report includes each of the following parts:

- Title
- Introduction (Purpose and Hypothesis)
- Methods (Procedure)
- Results: Data table(s) and Graph(s)
- Discussion (Conclusion)
- Literature Cited (Ideas that you got from a source other than yourself)

Scientific writing is **brief**, **concise**, and **specific**. You can write an excellent report that includes all the necessary details in about 4 or 5 pages. That means you must explain what you did, and why, in terms that a typical high school student can understand.

Use these steps to build your report:

1. Write out your hypothesis.
2. Write out your methods (in your OWN WORDS, citing the lab manual as your source).
3. Fill in your data table(s).
4. Graph your results.
5. Write a BRIEF description of your results (use complete sentences).
6. Write a 1 - 2 sentence evaluation of your hypothesis (do the data support it, or do you reject it?).

HYPOTHESIS:

The hardest part of understanding your experiment is knowing:

- What hypothesis you tested.
- What the variables were.
- Whether your data support your hypothesis.

A hypothesis is a statement that **can be tested by conducting an experiment or collecting data**. A hypothesis is sometimes described as an "educated guess", but it is really a specific prediction. A hypothesis can be proven *false*, but it is NEVER PROVEN TRUE! A hypothesis is either accepted or rejected (refuted) based on the data collected.

Variables can be independent or dependent.

- The independent variable is the **tested** variable—the factor that you controlled.
- The dependent variable is the **measured** variable—the factor that you measured, or counted, or observed.

METHODS:

- Include enough detail so that your reader could repeat your experiment and test your hypothesis.
- Eliminate the unnecessary details. Your reader doesn't need to know everything you did, just enough to do the experiment. Ask yourself, "If I leave this out, will my reader be able to do the experiment and get the same results I did?" If so, then *leave it out!*
- **DO NOT** copy the methods from the lab manual. That is a **big mistake**! Write the methods **in your own words.**
- Keep it short and sweet. After you write the first draft of the methods, go back and look for ways to shorten it. Eliminate the unnecessary details.

RESULTS—DATA TABLES AND GRAPHS:

Data tables should be clear, neat, and properly labeled.
A good graph has:

- The independent variable on the x-axis (horizontal axis)
- The dependent variable on the y-axis (vertical axis)
- Each axis labeled with the name of the variable and the units of measure
- Different colors or symbol shapes for different data sets
- Axes that are scaled appropriately
- A descriptive caption or title

Here is an example of a good graph (DO NOT add the labels shown in red; they are just helpful notes):

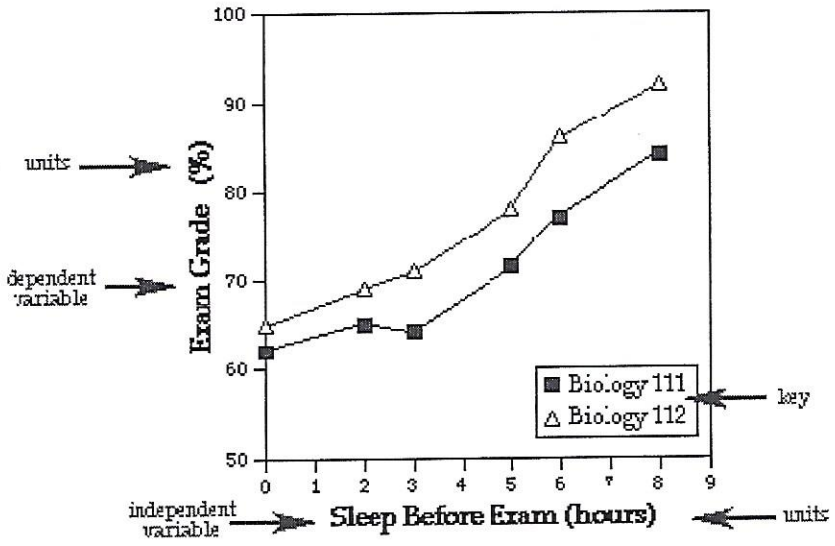


Figure 1. The influence of sleep on exam performance in biology class.

DISCUSSION (CONCLUSION):

The Discussion section is the hardest one to write, but it is the most important. You can't write a good discussion until you have the rest of your report in good shape. Make sure your discussion answers all the following questions:

- Was your hypothesis supported, or did you reject it?
- How do your data compare to the data collected by other students in the class? Were your results close to the average or very different? Why?
- Why did you get the results you did? What principles of science or scientific processes explain what happened?
- Did all students in the class test the same hypothesis? If not, what other hypotheses were tested? What were the results? How do these experiments fit with your experiment?
- What is the significance of this work?
- What experiment should be done next? (Science never ends). Can you think of ways to do this experiment over and get better results? Or can you think of other experiments that should be done? What hypotheses would you test next?

LITERATURE CITED

In your Literature Cited section, you must list every source you used in writing your report. The correct, general format is: Author, date, title, publication information.