SF Notebook: Part 2

Variables & Controls – Procedures – Materials

- In this section, you are going to start planning your experiment.
- You should already have an idea of how you are going to test your idea, but now is the time to truly plan it out.
- The **Variables & Controls** is an outline defining what you are changing in the experiment, what you are measuring, and what remains the same.
- The **Procedures** is a numbered list of every single step in the experiment.
- The **Materials** is a list of every item you need to run the experiment.

Variables & Controls

What is a variable? A factor that is being changed

- **Independent Variable**: a factor that is being changed but not influenced or affected by others in the experiment, such as:
  - *amount of sunlight a plant receives*
  - *the fingers that are being fingerprinted*
  - *the location of the water samples*
- **Dependent Variable**: a factor that relies on another and is being measured in the experiment, such as:
  - *The height or growth of the plant*
  - *the number of whorls in the fingerprints*
  - *the pH of the water*

Manipulated: the variable that you purposely manipulate (change)

Dependent: the variable that is being observed which changes in response to the manipulated (independent) variable.

Responding: a factor that acts or behaves in reaction to something

What is a Control? These are factors WHICH ARE NOT CHANGED

- **Control Group**: a separate experimental group in which you do NOT apply the experimental variable. In other words, the group that does NOT change, such as:
  - *the plant that is not moved from the sun*
  - *No control group for fingerprints*
  - *Using distilled water instead of tap water*
- **Controls**: everything that remains the same during the experiment
  - *same amount of water, same amount of light, same type of plant, same fertilizer…*

Independent Variable (Manipulated) CAUSE	Dependent Variable (Responding) EFFECT	Control (constant)
The 1 thing you are testing Can only 1 Exp.:Type of fertilizer used	The results of your experiment Can be 1 or more Exp.: Plant growth Number of leaves Amount of fruit on plant	Everything that you kept the same Exp. Amount and type of soil, Water, Sunshine

This is what you turn in:

1 page typed, outline form, containing these 4 parts:

I. **Independent Variable**:
   - This variable will be changed by…

II. Dependent Variable:
   - This variable will be measured by…

III. **Control Group**:

IV. Controls:

Rubric

I. Independent variable: This variable will be changed by…	0 2.5 5 0 2.5 5
II. Dependent Variable: This variable will be measured by…	0 2.5 5 0 2.5 5
III. Control Group	0 2.5 5
IV. Controls	0 2.5 5
Correct Formatting	0 2.5 5
Total Points	/35

Examples: Variables and Controls

I. **Independent Variable: Radiation that the Mealworms Receive**

- This variable will be changed by the ultraviolet radiation that the mealworms are irradiated with.

II. **Dependent Variable: The Percentage of Mutated Beetles**

- This variable will be measured by recording mutations in the exterior anatomy of the beetles such as deformed wings, legs, antennas, eyes, or wings.

III. **Control Group**

- The control group in this experiment is a batch of mealworms that will not be irradiated with ultraviolet radiation. This batch will be tested under the same parameters as the test group. Mutations in the control group will be recorded as will be in the test group. This group will test to see the difference in percentage of mutated beetles in irradiated and non-irradiated mealworms.

IV. **Controls**

- Same supplier of worms
- All containers containing worms will be cleansed
- Type of storage container that will be used
- Location that the groups of mealworms will be stored
- Temperature that mealworms will be stored at
- Humidity that they will be exposed to
- Natural sunlight that they will receive
- Same diet that the mealworms will receive
- Same feeding time
- Same checklist that will be followed

Variables and Controls

I. **Independent Variable**:
This variable will be changed by modifying the time of day (morning and afternoon) that the math test will be administered to each student

II. Dependent Variable:
This variable will be measured by comparing each subject's score on the test in the morning versus the afternoon

III. Control Group:
At least one class of students will be tested in the reverse order (e.g. in the afternoon for the first test; in the morning for the second test) than the other classes to control for improvement on the test by being re-exposed to the same questions a second time

IV. Controls:

* Same math multiplication problems in a different order on all tests
* Same amount of time allotted for each test-taking period (four minutes)
* Morning is the same timeframe every day (7:30 A.M. - 8:30 A.M.)
* Afternoon is the same timeframe every day (1 P.M. – 2 P.M.)
* Same students are assessed in the A.M. and P.M
* Same amount of problems on every test (40 problems)

VARIABLES AND CONTROLS (This is another format to set up your Variables & Controls)

I. Experimental Variables:

- The first experimental variable is the type of water in which the plastic samples will be tested.
  - This experiment uses fresh water from Miramar Lake in San Diego, California and salt water taken from the pier at the Scripps Institute of Oceanography.
- The second experimental variable is the type of plastic.
  - This experiment tests four types of plastic: high density polyethylene (HDPE), HDPE with an additive that speeds degradation, corn-based BioBag™, and wood cellulose-based NatureFlex™ cellophane.

II. Measured Variables:

- The variables that will be measured are the change in mass and appearance of the samples.
- Changes in mass will be measured by weighing each of the plastic samples weekly for the first five weeks of the experiment and then samples will be weighed on an alternating bi-weekly basis.
- Changes in appearance will be measured by observing color, stiffness, level of transparency, and dimensions.

III. Control Group:

- The control group consists of 10 samples of each type of plastic that are stored in file folders and not exposed to the water or elements.

IV. Controls:

- Test samples are all placed in fish tanks with water circulated by air stones to simulate the currents in the water.
- All fish tanks are exposed to the same conditions (weather and UV radiation).
- The same procedure is used for drying and weighing plastic samples.
- The specific gravity of the water in the salt water tanks is monitored and adjusted as needed on a weekly basis to maintain a constant level of salinity.

Procedures

- The procedures are one of the most important parts of the project.
- The way you plan & design your experiment will make or break your project.
- Judges look closely at procedures to see if experimental design really answered the question that you first wanted to solve.
- If you change steps during the actual experiment, you are expected to rewrite the procedures to include these changes.

Good Experimental Procedures…

- Use as much detail as possible. Include sketches, diagrams, amounts, brands, sizes, everything!
- Are a step-by-step list of everything you must do to perform your experiment.
- Tell how you will change the one & only experimental variable & how you will measure that change.
- Explain how you will measure the measured variable.
- Explain how the controlled variables will be maintained at a constant value.
- Specify how many times you intend to repeat the experiment, so that you can verify that your results are reproducible.
- Enables someone else to duplicate your experiment exactly!

Procedure Rules

Number each step (> 15 steps)
Complete sentences, include periods
Written in 3rd person: no Is or Yous
Single space within a step, double space between steps
Do not include steps involving library research, obtaining materials, or typing up the results.

Procedures Rubric

THOROUGH numbered list	0 5 10
Uses Detail: sizes, brands, volumes, quantities	0 5 10 15
Complete sentences	0 2.5 5
Specifies how many times experiment will be repeated	0 2.5 5
Written in 3rd person: No I's you's	0 2.5 5
Correct formatting: typed, numbered, single-spaced within a step, double-spaced between steps	0 2.5 5
	/45

Materials

- In a **numbered** list, describe every item you will need to run this experiment.
- Include quantities, sizes, brands, colors, shapes, tools, volumes.
- Use metrics when possible.
- Use diagrams or sketches if needed
- Add to this list as new items arise.
- **Attach any forms, tests, surveys**

Materials Rubric

Thorough list	0 2.5 5
Includes specifics: sizes, brands, volumes, quantities, etc.	0 2.5 5
Additional papers attached (if necessary)	0 2.5 5
Correct formatting: numbered list	0 2.5 5
Total Points	/20

Examples: (on 2 separate pages)

Materials

1.One HP printer
2. Sufficient ink for printer
3. About 225 sheets of printer paper
4. At least 100 students
5. Permission forms for students to sign
6. About 100 pencils (supplied by students)
7. Test answer keys for grading
8. Three red pens for grading tests
9. One digital timer that counts down in seconds

Procedures

Part I: Preparation for Testing

1. Explain the testing process to Mrs. Gillum.
2. Work with Mrs. Gillum to determine what dates the tests can be administered.
3. Design permission slips for students to sign that say that they can take part in this experiment.
4. Give permission slips to Mrs. Gillum to distribute.
5. Collect signed permission forms from Mrs. Gillum.
6. Design multiplication problems for math tests A and B (one version for the morning and one for the afternoon).
7. Design the front of the tests including self assessment questions about how tired the student is feeling and what time of day they think they perform best at.
8. Print out about 115 copies of test A and 115 copies of test B.
9. Design and instruction sheet for each set of tests that explains how to administer the tests.
10. Supply Mrs. Gillum with tests, instructions and timer.

Part II: During Testing

1. Collect the tests at the end of each day the tests are given.

Part III: After Testing

1. Grade every test and score the percent correct.
2. Record for each test the following: the period number and science number of the student, fatigue self assessment results, time of day performance self assessment results and percent of test questions correct.
3. Discard data from students with any missing information.
4. For each student, compare % of questions correct in the morning versus the afternoon and record the results.
5. Analyze data for trends including the self assessments and percent score on tests.

Materials

Radiation

1. Verilux Clean Wave UV-C Sanitizing Wand

Storage

1. Two Sterilite brand 3 drawer white storage containers (36.2cm x 28.3cm x 26.4cm)
2. Cardboard box (6cm x 21 cm)
3. Large Clear Storage Container

Test Subject and Staples

1. One thousand Jumbo mealworms
2. Slices of apple
3. Bran
4. Rolled Oats
5. Slices of Potatoes
6. Cup measurement

Both Materials and Procedures are on separate pages.

PLEASE NOTE FORMAT:

Materials:

Numbered list of materials.
Spacing is 1.5 between materials

Procedures

Procedure steps are numbered
It is single spaced within a step.
And 1.5 spacing between steps
If you are building something THAT needs to be drawn/photos taken, and procedures for that building are needed.

Procedures

Observations

1. Magnified glass

Part I: Quarantining the Mealworms

1. Clean a large storage container by wiping it down with a wet paper towel.
2. Place a layer of five parts bran one part rolled oats staple food at the bottom of the storage container.
3. Place one thousand mealworms into the cleaned storage container.
4. Place multiple slices of apple throughout the container.

Part II: Transferring Mealworms into Testing Drawers

1. Wipe down each of the test drawers with a wet paper towel.
2. Measure and mark 2 centimeters from the bottom of each drawer.
3. Select 100 healthy mealworms for each of the 3 test groups.
4. Select 100 healthy mealworms for each of the 3 control groups.
5. In each testing drawer, pour a mixture of five parts bran one part rolled oats, enough to cover two centimeters of the bottom of the drawer.
6. In each test drawer, place 10 slices of thinly sliced apple evenly spaced throughout the area of the drawer.
7. Place the selected worms into the drawers.

Part III: Maintaining the Mealworms

Every Day for Every Drawer:

1. Remove any perished worms and record.
2. Replace the 10 thin slices of apple with new ones.

Every Week for Every Drawer:

3. Refill the mixture of food to the two centimeter mark on the drawers

Part IV: Irradiating the Test Group with UV-C Radiation

Daily for each of the Three Test Groups:

1. Add a thin layer of bran, enough to cover the bottom of the cardboard box.
2. Transfer the mealworms from the test drawer to the cardboard box.
3. Place the Verilux UV-C Cleansing Wand over the cardboard box.
4. Irradiate the worms for one minute. (time subject to change)
5. Remove Cleansing Wand from the box.
6. Transfer the worms back into their original drawer and be sure to avoid moving any extra bran into the drawer as it could affect the results.

Part V: Terminating the Radiation

1. Each day, observe carefully for pupations in the worms.
2. Once a pupa is spotted, terminate radiation for ALL test groups, ensuring that all the mealworms were irradiated to the same amount of radiation.
3. Continue daily and weekly routines of replacing apple slices and food.

Part VI: Terminating the Food Supply

1. Observe each drawer everyday until all the mealworms have pupated.
2. Once all of the mealworms have pupated, terminate the daily and weekly food supply of bran, rolled oats, and apple slices.

Part VII: Cleaning out the Drawers after all the Mealworms have Pupated

1. Once all the mealworms in a drawer have pupated, remove the pupa from drawer and place them in the cardboard box temporarily.
2. Remove all the leftover food in the drawers and discard.
3. Wipe down the drawer with a damp paper towel and allow for time to air dry, preventing and mold from growing.
4. Measure and mark a one centimeter line from the bottom of the drawer.
5. Fill the drawer to the one centimeter line with the mixture of food. (bran and rolled oats)
6. Carefully transfer the pupa back into the storage container. Be careful not to damage any of the pupa as that could affect the results of this experiment.
7. Repeat steps 1-6 for every drawer once all the worms have pupated.