Environmental Systems and Societies

*How to Write the Planning Portion of a Lab*

**Introduction:** The section should introduce the reader to the problem or phenomenon you are investigating it should include the following:

* A description of a particular problem or phenomenon including relevant variables.
* Background information relevant to the identified problem.

**Science Question:**  The purpose of the investigation should be a clear statement or question defining the problem being investigated.

**Variables:** Clear identification of the variables to be manipulated and measured must be included.

**Hypothesis:** State the hypothesis related to the science question. The hypothesis should describe how you will manipulate the Independent variable and your prediction of how the dependent variable will be affected. Include a justification (explanation) of the hypothesis.

**Procedure:** This section includes several sub-sections, they should all work together to eliminate ambiguity in your experimental design. They include:

* Control group( note, not all experiments include a control group—If there is not a natural state for your independent variable, you will not have a control group):
	+ What is the natural state of your independent variable? How will you keep the independent variable in its natural state?
	+ How will you measure the changes in your dependent variable? When will you measure the changes in your dependent variable?
	+ What are the other variables that you will keep constant during the experiment? How will you keep them constant?
* Experimental group—this is the group on which you change the independent variable.
	+ How are you changing the independent variable? How many trials of the experiment will you do? How will you organize your subjects?
	+ How will you measure the changes in your dependent variable? When will you measure the changes in your dependent variable?
	+ What are the other variables that you will keep constant during the experiment? How will you keep them constant?
* Step-by-step instructions—complete description of how the experiment will be carried out. You do not need to include things like “record data” or “make graph”, these are understood.
* Equipment and Materials lists—each list should be bulleted, materials include items which will be used up like seeds, water, etc. Equipment includes items which can be used over and over such as scales, microscopes, beakers, etc.
* Safety concerns—bullet all possible safety concerns, this list is the opposite of the step-by-step instructions, you should list obvious concerns as well as hidden threats. You should include suggestions for addressing safety concerns.
* Diagrams—include diagrams explaining how you set up your equipment, animal traps, light sources, heat sources, ice baths, etc. The more detailed your diagrams the better. It is completely acceptable to have more than one diagram.

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*Example of Planning an Experiment*

**Introduction:** The sunflower plant (*Helianthus annuus* L.) is a native to the Americas. It has been developed as a crop because the oil in the seed is valuable. Currently 80% of the seeds that are harvested in the world are used to make sunflower oil (Putnam, P. 1) Even though the sunflower originated in the Americas it was spread throughout the world and actively cultivated in Russia, where it was bred for oil content.

There are several ways to measure the size of a plant, the mass, the height, the diameter of the seed head, even the number of seeds produced. This experiment will focus on the height of the plant. The ultimate goal of this research is to identify factors which might increase oil production of sunflower crops. If a relationship is established between height and fertilizer, we will then attempt to establish a relationship between height and seed production.

**Science question:** If I change the amount of fertilizer given to a plant, how does that affect the height of a plant?

**Hypothesis:** If I increase the amount of fertilizer given to a sunflower, then the sunflower will grow taller.

**Procedure:** *Control Group—*The independent variable is the amount of fertilizer added to the plant. The natural state is no commercial fertilizer added, so none will be added to the plant. The dependent variable is the height of the sunflower plant. This will be determined my measuring the plant weekly from the soil to the top of the plant. The variety of sunflower used is “Yellow Giant”. The seeds will be planted at a depth of 2cm. Each plant will receive 14 hours of sunlight provided by a 100 watt UVB grow light. Each plant will be watered with 50ml of tap water on Mondays and Thursdays. The temperature in the greenhouse where the plants are grown will be kept at 27˚ Celsius. No insects will be allowed in the green house. The plants will be inspected weekly for insects. Each plant will be grown in 20L ceramic containers which are filled with 15L of soil mix that is composed of 50% coffee compost, 10% sand and 40% peat moss. The relative humidity in the green house will be kept constant at 42% with the use of a Smart Fog MS100 automatic humidifier. The soil salinity will be kept at 3dS/m using electro conductivity testing administered weekly. There will be a weekly examination for the presence of other seedlings growing in the pots with the sunflowers, if any are found they will be removed.

*Experimental Groups*—the independent variable is the amount of fertilizer added to the plant, for this experiment there will be three experimental groups: The first will have 5ml of 10-10-10 fertilizer added bi-weekly, the second will have 10ml of 10-10-10 fertilizer added bi-weekly, and the third will have 15ml of 10-10-10 fertilizer added bi-weekly. There will be 3 trials performed of for each experimental group. The dependent variable is the height of the sunflower plant. This will be determined my measuring the plant weekly from the soil to the top of the plant. The variety of sunflower used is “Yellow Giant”. The seeds will be planted at a depth of 2cm. Each plant will receive 14 hours of sunlight provided by a 100 watt UVB grow light. Each plant will be watered with 50ml of tap water on Mondays and Thursdays. The temperature in the greenhouse where the plants are grown will be kept at 27˚ Celsius. No insects will be allowed in the green house. The plants will be inspected weekly for insects. Each plant will be grown in 20L ceramic containers which are filled with 15L of soil mix that is composed of 50% coffee compost, 10% sand and 40% peat moss. The relative humidity in the green house will be kept constant at 42% with the use of a Smart Fog MS100 automatic humidifier. The soil salinity will be kept at 3dS/m using electro conductivity testing administered weekly. There will be a weekly examination for the presence of other seedlings growing in the pots with the sunflowers, if any are found they will be removed.

Step one: Fill the ceramic pots with 15L of premixed soil.

Step two: Organize the pots in four rows of three.

Step three: Label the first row “control”, the second row “5ml”, the third row “10ml” and the fourth “15ml”.

Step four: Add one “Yellow Giant” seed to the center of each pot. Push the seed 2cm into the soil.

Step five: Place the grow light 15cm above the soil.

Step six: Add 50ml of water to each pot.

Step seven: Set humidifier to 42%.

Step eight: Add 50ml of tap water to each pot every Monday and Thursday.

Step nine: Every Monday morning measure the height of the sunflower from the soil to the top most point on the plant (see diagram 1).

Step ten: After measurements are taken, check for insects and weed saplings and remove if found.

Step eleven: After each weekly measurement, adjust light so it remains 15cm above the plant.



Measure Height



**Equipment List:**

* 12—30cm diameter ceramic pots which are 20cm deep
* 12—100 watt UVB grow lights
* 100ml graduated cylinder
* Tape measure
* Smart Fog MS 100 humidifier
* Pasco salinity probe
* Pasco weather probe

**Materials List:**

* 12 Yellow Giant sunflower seeds
* 180L of soil composed of 50% coffee compost. 10% sand and 40% peat moss
* 300ml of 10-10-10 fertilizer

**Safety Concerns:**

* Allergy concerns: be aware of allergies to certain pollens, soils, and insects.
* Fertilizer can be a breathing hazard wear a mask or respirator when applying.
* Electrical cords for the lights can be a tripping hazard or an electrical hazard if they come in contact with water.

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*Planning Portion of a Lab Rubric*

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| **Category** | **Criteria** | **Description** | **Total Points per Section** |
| Introduction | **Work is at a High Level****(10-8 points)** | Includes a description of a problem and includes relevant variables. Background information is relevant to the identified problem. |  |
| **Work is Satisfactory****(7-5 points)** | Identifies a problem. Includes information related to problem. |
| **Work Needs Improvement****(4-0 points)** | Does not identify a problem. Information not related to problem. |
| Science Question | **Work is at a High Level****(10-8 points)** | The purpose of the investigation is clear and includes both an independent variable and a dependent variable. |  |
| **Work is Satisfactory****(7-5 points)** | The purpose of the investigation is stated. |
| **Work Needs Improvement****(4-0 points)** | There is no purpose for the investigation stated. |
| Variables | **Work is at a High Level****(5-4 points)** | Identification of the independent variable and dependent variable. Includes explanation of how they will be manipulated and measured. |  |
| **Work is Satisfactory****(3-2 points)** | Identification of the independent variable and dependent variable.  |
| **Work Needs Improvement****(1-0 points)** | Incorrectly identifies the independent variable and dependent variable or omits the variables. |
| Hypothesis | **Work is at a High Level****(5-4 points)** | The hypothesis is related to the science question. It explains how the independent variable will be manipulated and includes how the dependent variable will be measured. |  |
| **Work is Satisfactory****(3-2 points)** | Hypothesis explains how the independent variable will be manipulated and includes how the dependent variable will be measured. |
| **Work Needs Improvement****(1-0 points)** | Hypothesis does not explain how the independent variable will be manipulated or how the dependent variable will be measured. |
| Control Group | **Work is at a High Level****(20-14 points)** | Identifies natural state of I.V. Explains how the I.V. will be controlled. Explains how and when the D.V. will be measured. Identifies other relevant variables and explains how they will be kept constant. |  |
| **Work is Satisfactory****(13-7 points)** | Identifies natural state of I.V. Explains how the D.V. will be measured. Identifies other relevant variables and makes an attempt to explain how they will be controlled. |
| **Work Needs Improvement****(6-0 points)** | Does not identify the natural state of I.V. or does not explain how the D.V. will be measured. Identifies and insufficient number of variables (or they are irrelevant) or does not explain how they will be controlled. |
| Experimental Groups | **Work is at a High Level****(20-14 points)** | Explains how the I.V. will be manipulated. Explains the number of trials needed for the experiment. Explains how and when the D.V. will be measured. Identifies other relevant variables and explains how they will be kept constant. |  |
| **Work is Satisfactory****(13-7 points)** | Explains how the I.V. will be manipulated. Explains how the D.V. will be measured. Identifies other relevant variables and makes an attempt to explain how they will be controlled. |
| **Work Needs Improvement****(6-0 points)** | Does not explain how the I.V. will be manipulated or does not explain how the D.V. will be measured. Identifies and insufficient number of variables (or they are irrelevant) or does not explain how they will be controlled. |
| Step-by-step Instructions | **Work is at a High Level****(10-8 points)** | Includes a complete description of how the experiment will be carried out. Does not include superfluous steps such as “record data”. |  |
| **Work is Satisfactory****(7-5points)** | Includes a complete description of how the experiment will be carried out. Does include superfluous steps such as “record data”. |
| **Work Needs Improvement****(4-0 points)** | Does not include complete description of how the experiment will be carried out or description is ambiguous or inaccurate. |
| Equipment and Materials List | **Work is at a High Level****(5-4 points)** | Includes a complete bulleted or numbered list separating materials from equipment. |  |
| **Work is Satisfactory****(3-2 points)** | Includes a complete list of materials and equipment. |
| **Work Needs Improvement****(1-0 points)** | Does not include a list of materials and equipment or list is incomplete. |
| Safety Concerns | **Work is at a High Level****(5-4points)** | Includes a complete bulleted or numbered list of relevant safety concerns. Includes suggestions for addressing safety concerns. |  |
| **Work is Satisfactory****(3-2 points)** | Includes a complete bulleted or numbered list of relevant safety concerns.  |
| **Work Needs Improvement****(1-0 points)** | Does not include a list of safety concerns or list is incomplete. |
| Diagrams | **Work is at a High Level****(10-8 points)** | Includes diagrams explaining how to set up. Includes diagrams for any ambiguous procedures. Diagrams include labels and measurements. |  | Total Points: |
| **Work is Satisfactory****(7-5 points)** | Includes diagrams explaining how to set up equipment. Diagrams include labels and measurements. |
| **Work Needs Improvement****(4-0 points)** | Does not include diagrams explain how to set up equipment. Or diagrams are incomplete. |