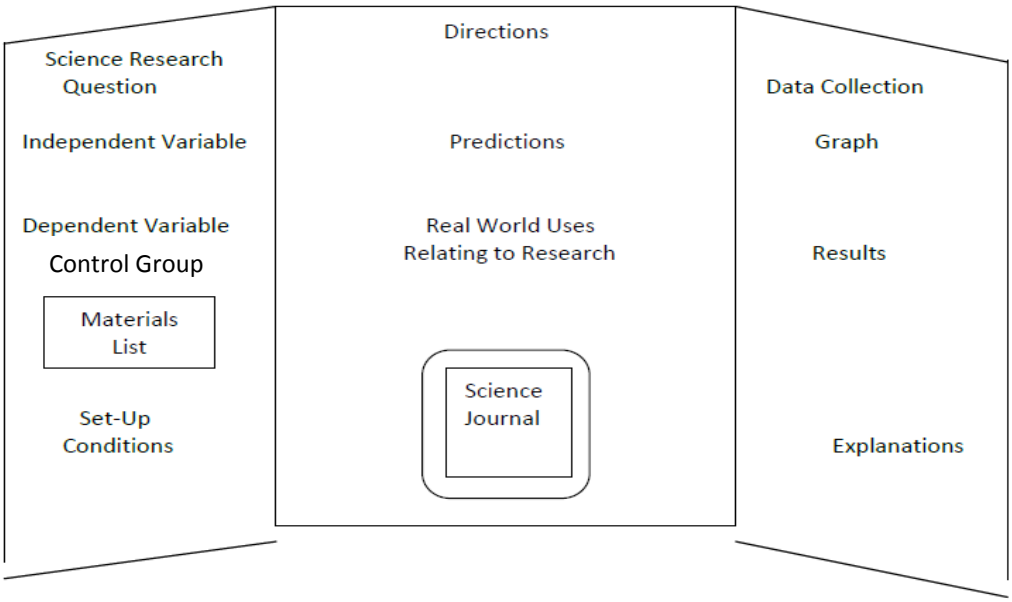
Science Inquiry Training Packet



Science Research Project Inquiry Guide

Science Research Question:

The science research question is made up of two components; the **Independent** Variable (the one thing that will be changed) and the **Dependent** Variable (the one thing you are measuring based on the change). The Science Research Question needs to be measurable. A suggested format for the Science Research Question is:

How does the _____ affect the _____?
(what you are changing) (what you are measuring)

If you are studying plants, an example of a Science Research Question could be:

- *Does the amount of liquid fertilizer (10, 20, 30 mL) affect the height of the plant (in cm)?*
- *How does the amount of fertilizer affect the height of the plant? Or*
- *What is the effect of different amounts of fertilizer on the height of the plant?*

Independent Variable:

The independent variable is the **one** thing that will be changed in the experiment. When graphing the data from the experiment, it is recorded on the X-axis (bottom of the graph). If you are studying plants, examples of independent variables could be the following:

- Amount of water used
- Type of water used (e.g. salt vs. fresh)
- Amount of fertilizer used

A sample independent variable could be: *The independent variable in the experiment is the amount of water that will be used to water the plants. The **experimental groups** will receive 10mL of water in one cup, and 20mL of water in another cup, and the **control group** cup will receive no water.* Ten trials of each group should be conducted for reliability and validity (10 cups with 10mL of water, 10 cups with 20mL of water and 10 cups with no water).

Dependent Variable:

The dependent variable is what will be measured based on the one change in the experiment. When graphing the data from the experiment, it is recorded on the Y-axis (vertical left side). If you are studying plants, examples of dependent variables could be the following:

- Number of leaves
- Height of the plant
- Size of the flowers

A sample dependent variable could be: *The dependent variable in the experiment is the height of the plants. The height of the plants will be measured and recorded in **metric units** and will be influenced by the independent variable.*

Control Group:
The control group is the group of trials in an experiment that do **not** experience a change or receive a "treatment." This group is used as a benchmark to measure how the other tested variables change. In many cases, the control group is defined by the scientist conducting the experiment. This would be the trials that would happen under normal conditions if the experiment was conducted in the real world. (Example: Watering the plant 10mL per day might be a similar amount of water to what would fall on the plant if it rained during the day.)

Materials List:

The materials list is a specific list of items that are necessary to conduct the experiment. The materials list can be thought of as a "grocery" list that needs to include the **size**, **quantity**, and **unit of measure** of each item. The materials list should include any additional details that are specific to the experiment. This list should be specific so that another scientist could conduct the exact experiment with the same materials. The unit of measure should be recorded in metric measurements.

An example and non-example of a materials list is provided below:

Non-Example	***Example***
Materials List:	***Materials List:***
Water	**Water**: 10mL in one cup, 20mL in one cup (amount used in watering daily)
Seeds	**Seeds**: (25) radish seeds in each cup
Cup	**Cup**: (3) 500mL, clear plastic cups

Set-Up Conditions:

The set-up conditions are the materials and variables that will be kept constant so the outcome of the experiment is not affected. The set-up conditions can also be referred to as the **constants.** Constants are the materials and variables that you keep the same in order to conduct a fair trial. The set-up conditions should be in list form.

A picture or diagram should be included to show others the set-up of the experiment. In this section, an explanation of how the materials were set up to conduct the experiment should be included along with the constants. (This is different from the directions.)

If studying plants, the set-up conditions could be the following:

If you decide to change **only** the amount of water given to the radish plant (independent variable), then you must keep everything else constant. These would include:

- ✓ Same temperature (How will temperature be the same?)
- ✓ Same soil type (specify soil type)
- ✓ Same soil amount (specify how much soil per cup or plant)
- ✓ Same amount of sunlight (How will sunlight be the same?)
- ✓ Same growing location (describe the location)
- ✓ Same size cups to plant seeds (specify size of cups)

The same type of plant was purchased and placed in the window of the classroom facing the Sun. Plants were watered by the same beaker at 2:00 each day.

Directions:

The directions are a step-by-step list of what you did with each item in the materials list, in the exact order in which they were done. The key to the directions is that someone should be able to read your directions and replicate **exactly** what you did throughout the experiment. **Be sure to reference your control group (e.g. seeds not receiving any changes-no water) and an experimental group (e.g. seeds receiving various amount of water).** The experiment should be conducted a minimum of 10 times and emphasize that increasing the number of trials will provide more valid data.

Non-Example	***Example***
Directions:	***Directions:***
1. water plants	1. gather materials necessary to conduct the experiment
2. measure plants	2. measure and add 250mL of soil to each of the three sets of cups
3. repeat steps 1 and 2	3. spread 25 radish seeds on top of the soil in each of the three sets of cups

This is not an exclusive direction list, the first steps are provided as a guide.

Predictions:

The predictions are a list of three possible outcomes of the experiment. Each prediction statement should include the independent and dependent variable. The first prediction should include the word **increase,** the second prediction should include the word **decrease**, and the third prediction should include **no effect**.

If you were studying plants, an example could be:

- ***Increasing*** *the amount of water will* ***increase*** *the height of the radish plant.*
- ***Increasing*** *the amount of water will* ***decrease*** *the height of the radish plant.*
- ***Increasing*** *the amount of water will have* ***no effect*** *on the height of the radish plant.*

After students make their three predictions, they should identify (**circle, highlight, or place an asterisk next to**) which prediction they think is most likely to occur. The word **hypothesis** was removed from the elementary science project process because the vocabulary word come from middle school standards.

Data Collection:

The data collection is where the results from the experiment are recorded using metric measurements. The data collection chart is used to organize the results from the experiment and will be used when creating a bar graph. Data needs to be collected from the ***control group*** (the group in which there is no change of the independent variable/item tested under normal conditions) and from the two **experimental groups** (groups in which there is an independent variable applied). When the results of the experiment are all recorded, find the average of the results. The average of the results will be used when creating the bar graph. **The experiment should be conducted a minimum of 10 times and emphasize that increasing the number of trials will provide more valid data.**

Example of a data collection chart:

Data Collection (in *Metric Measurement)*											
Item(s) Tested	**Trials** (Increasing the number of trials will provide more valid data)										
	1	2	3	4	5	6	7	8	9	10	Avg
Control Group- no water											
10mL of water											
20mL of water											

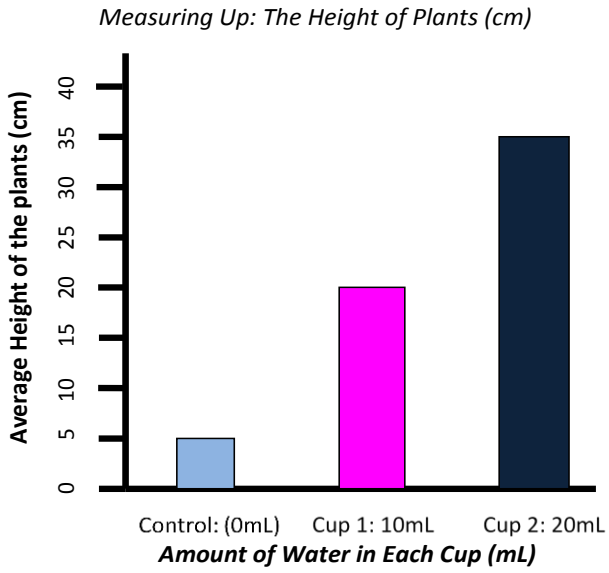
Graph:

When setting up the graph, data from the experiment should be displayed using a bar graph. Graph data should reflect the average number of trials.

The independent variable is recorded on the X-axis, along the bottom of the graph and the dependent variable is recorded on the Y-axis, vertically on the left-hand side of the graph.

Acceptable graphs **must** include a **descriptive title**; **labels on both the X-axis and Y-axis**; **appropriate units provided on each axis**; and the **scale needs to be appropriate for the data being displayed**.

An example of a graph could be:



Information recorded on this graph is not actual data. It is an example of what elements are required in creating a graph that accurately displays the data from the experiment.

Results:

The results statements share the data sets from the experiment. The results statements are taken from the data collection chart. Each result statement should focus on information from each set of trials including mathematical data comparisons from the data collection chart and graph. The results should describe the average for each trial and compare the data between the control group and the other experimental groups.

An example of results data:
The no water group of plants had an average height of 5 cm.
The 10 mL plants had an average height of 20 cm.
The 20 mL plants had an average height of 35 cm.
The plants grew a difference of 15 cm between the control group and the 10 mL plants and the 10mL plants and 20mL plants.

Avoid words that cannot be measured such as *healthier, better,* or *greener.*

Explanation:

The explanation determines whether the chosen prediction at the beginning of the experiment was correct or incorrect based on the scientific evidence and results of the experiment. The explanation will evaluate the effectiveness of the experiment and determine possibilities for further study. The explanation should further delve into the science that was driving the project. The explanation should explain why certain phenomenon occurred as a result of data collected. **Avoid saying "I proved."** No single experiment ever proves anything.

Real World Uses Relating to Research:

Based on research (Internet, books, reference materials, newspapers, etc), identify who in the real world might find the results from the experiment useful. Identify when, where, why or how they may use the information from the experiment. Link the real world uses to current events that are happening during the time of the experiment. This information can be written in paragraph or list form. Three different real-world uses should be included with an explanation of how each use relates to the experiment. Scientific evidence can be related to each use.

Science Journal:

The science journal is an ongoing record of each phase of the scientific process along with anecdotal records of observations and further wonderings. Each page should contain the date and specific details of record keeping either in the form of summary statements, numbers or diagrams. The science journal can be in the form of a spiral bound notebook, composition book or folder with notebook paper or the journal provided by the Science Department. Components that should be found within the science journal are the same as the requirements on the Science Showcase Rubric; research question, predictions, independent variable, dependent variable, control group, set-up conditions, materials list, directions, data collection, graph, results, explanation, and real world uses. Journals include handwritten notes. Typed copies of each section of the inquiry board should not be included.