

HOW TO DESIGN EXPERIMENTS

(and communicate your design to others)

A Simple Experiment: The effect of fertilizer on plants.

Description: A biology class was studying various ways to recycle materials, including the use of compost as fertilizer. The class investigated the effectiveness of various recycled materials in promoting plant growth. One lab group decided to compare the effect of compost and commercial fertilizer on plant growth. Three flats of bean plants (25 plants per flat) were grown for five days. The plants were then fertilized as follows: Flat A received 10 g of commercial fertilizer; Flat B received 10 g of aged compost; and Flat C received no fertilizer. The plants received the same amount of sunlight and water each day. At the end of 20 days, the students recorded the height of the plants in centimeters.



The key concepts of experimental design (with examples taken from above)

The Research Question: This is the question you want to answer. It is very important that it is clear and specific. This question often takes the form: "What effect does changing the IV have on the DV." It should mention the independent and dependent variable.



Independent variable(s) (IV): The variable that is purposely changed by the experimenter, for example, the type of fertilizer in the scenario above. It is also known as the **explanatory variable**, **manipulated variable**, **predictor variable** or **exposure variable**.

Dependent variable(s) (DV): The variable that responds to changes in the independent variable, for example, the height of the bean plants in the scenario above. It is also known as the **responsive variable**, **outcome variable**, or **measured variable**.



Hypothesis: A guess at the answer to the question in the problem statement. It usually takes this form: If the IV (increases, decreases or remains the same) the DV will, (increase, decrease, or remain the same).

Constant(s): All factors or conditions that are kept the same during the experiment, for example, the amount of light and water in the scenario above.



Control group: The standard for comparing experimental effects. It receives no treatment and is used to tell if other treated samples have changed. For example, the plants in Flat C that received 0g of fertilizer during the scenario above.

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Repeated trials: The number of objects/organisms undergoing treatment for each value of the independent variable, or the number of times the experiment is repeated, for example, during the scenario above, the 25 plants in each flat represent 25 trials.



Uncontrolled Factor(s): Factors or conditions that might affect the dependent variable, but are not kept constant.

The Experimental Design diagram (generic version)

Research Question:

IV:

Values of IV				
# of Trials				

DV:

Hypothesis:

Constants:

Uncontrolled Factors:

Here it is filled out for the scenario above.

Research Question: How does the type of fertilizer used affect the height of bean plants?

IV: type of fertilizer

Values of IV	No fertilizer (control)	10 g commercial fertilizer	10 g compost
# of Trials	25 plants	25 plants	25 plants

DV: height of plants

Hypothesis: If commercial fertilizer is applied to the plants, they will grow to a greater height than if compost is applied.

Constants: amount of water type of commercial fertilizer temperature
amount of sunlight mass of fertilizer amount of wind.
type of soil space to grow into (crowding)

Uncontrolled Factors: genetic mutation in the seed, disease in soil.