The goal of this tool is to assess how well students understand the basic principles of experimental design. Informed by Dasgupta et al. (1), we have identified three components (or dimensions) of experimental design to test:

1. An experiment is the measurement of a variable predicted by a hypothesis.
2. Independent variables are predicted to account for variation in dependent variables.
3. Confounders are variables that can affect independent or dependent variables.

It is difficult to disentangle some of these concepts from each other; indeed, a strong understanding of one of these dimensions will necessarily reference another dimension.

(1) Dasgupta et al., 2014. "Development and Validation of a Rubric for Diagnosing Students' Experimental Design Knowledge and Difficulties", CBE-Life Science Education, 13: 265-28

Variable names

Here we use the terms **independent** and **dependent** variables to refer to what are sometimes called predictor/explanatory/input variables and response/explained/output variables respectively.   These are known synonymously in the following non-comprehensive list of contexts:

- Statistical regression
    - regressor -> regressand
- Medicine
    - treatment -> outcome
- Machine learning
    - feature -> target

The language of the rubric can be adapted for the specific content associated to the chosen intervention or activity. For instance, an activity to design a clinical trial might replace **independent** with **treatment** variable and **dependent** with **outcome** variable in both the rubric and prompt.

Rubric

Dimension	[0] Evidence of incomplete understanding	[1] Evidence of sufficient understanding	[2] Evidence of strong understanding
1. An experiment is the measurement of a variable predicted by a hypothesis.	Does not measure a variable OR Measures a variable without reference to a hypothesis or prediction	Measures one or more variables AND Justifies the choice of variable(s) by reference to an experimental hypothesis or prediction	Explains how actual or proposed experimental results would lead to confirming or rejecting the hypothesis
2. Independent variables are predicted to account for variation in dependent variables.	Does not manipulate or measure the independent variable(s) OR Identifies an independent variable that is not measurable	Manipulates or observes different values of independent variables AND Measures changes in the dependent variable.	[1] AND Justifies the choice of independent variable(s) through its connection to an experimental hypothesis or prediction
3. Confounders are variables that **can** affect independent or dependent variables.	Does not consider variation in the dependent variable from sources other than the independent variables OR Only refers to **vague** sources of variation (e.g., user error, unnamed systematics) other than the independent variables	Acknowledges the existence of **specific** sources of variation in the dependent variable other than the independent variables.	[1] AND Ensures that potential sources of variation aside from the independent variables are held constant OR States **how** confounding variables could affect the dependent variable