Experiment
The process of forming scientific opinions is often placed within the framework of an experiment. An experiment is the process of following a well-defined procedure, where the outcome of following the procedure is not known prior to the experiment.

Population
The collection of all elements under investigation is called the population.

Sample
A sample is a collection of some elements of a population. There are several different categories of samples, depending on how the sample was obtained. A convenience sample is a collection of the elements that are easiest to obtain, such as "citizen on the street" interviews, or TV call-in surveys. It is not possible to obtain accurate estimates of population parameters from samples such as these. A probability sample on the other hand allows accurate statements to be made about the unknown population parameters. Probability samples require that every element in the population have a known, nonzero probability of being included in the sample.

The Target Population and the Sampled Population
The population about which information is wanted is called the target population. The population to be sampled is called the sampled population.

Definition 1 A sample of size \( n \) from a finite population is a random sample if each of the possible samples of that size was equally likely to be obtained.

Definition 2 A random sample of size \( n \) is a sequence of \( n \) independent and identically distributed random variables \( X_1, X_2, \ldots, X_n \).

Nominal Scale
The nominal scale of measurement uses numbers merely as a means of separating the properties or elements into different classes or categories. The number assigned to the observation serves only as a "name" for the category to which the observation belongs, hence the title "nominal".

Ordinal Scale
The ordinal scale of measurement refers to measurements where only the comparisons "greater", "less", or "equal" between measurements are relevant.
Interval Scale
The third scale, the *interval scale* of measurement, considers as pertinent information not only the relative order of the measurements as in the ordinal scale but also the size of the interval between measurements, that is, the size of the difference (in a subtraction sense) between two measurements. The interval distance involves the concept of a unit distance, and the distance between any two measurements may be expressed as some number of units.

Ratio Scale
Finally, the *ratio scale* of measurement is used when not only the order and interval size are important, but also the ratio between two measurements is meaningful.

**Definition 3** A statistic is a function that assigns real numbers to the points of a sample space, where the points of the sample space are possible values of some multivariate random variable. In other words, a statistic is a function of several random variables.

**Definition 4** The ordered statistic of rank $k$, $X^{(k)}$, is the statistic that takes as its value the $k$th smallest element $x^{(k)}$ in each observation $(x_1, x_2, \ldots, x_n)$ of $(X_1, X_2, \ldots, X_n)$.

**Definition 5** Let $X_1, X_2, \ldots, X_n$ be a random sample. The empirical distribution function $S(x)$ (called e.d.f. for short) is a function of $x$, which equals the fraction of $X_i$'s that are less than or equal to $x$ for each $x$, $-\infty < x < \infty$.

**Definition 6** Let $X_1, X_2, \ldots, X_n$ be a random sample. The $p$th sample quantile is that number $Q_p$ that satisfies the two conditions:

1. The fraction of the $X_i$s that are less than $Q_p$ is $\leq p$.
2. The fraction of the $X_i$s that exceed $Q_p$ is $\leq 1 - p$.

**Definition 7** Let $X_1, X_2, \ldots, X_n$ be a random sample. The sample mean $\bar{X}$ is defined by

$$\bar{X} = \frac{1}{n} \sum_{i=1}^{n} X_i$$

The sample variance $S^2$ is defined by

$$S^2 = \frac{1}{n} \sum_{i=1}^{n} (X_i - \bar{X})^2$$

**Definition 8** An estimator $\hat{\theta}$ is an unbiased estimator of a population parameter $\theta$ if $E(\hat{\theta}) = \theta$. 
Definition 9 The hypothesis is simple if the assumption that the hypothesis is true leads to only one probability function defined on the sample space. The hypothesis is composite if the assumption is true leads to two or more probability functions defined on the sample space.

Definition 10 A test statistic is a statistic used to help make the decision in a hypothesis test.

Definition 11 The critical region is the set of all points in the sample space that result in the decision to reject the null hypothesis.

Definition 12 A type I error is the error of rejecting a true null hypothesis.

Definition 13 A type II error is the error of accepting a false null hypothesis.

Definition 14 The level of significance, or $\alpha$, is the maximum probability of rejecting a true null hypothesis.

Definition 15 The null distribution of the test statistic is its probability distribution when the null hypothesis is assumed to be true.

Definition 16 The power, denoted by $1 - \beta$, is the probability of rejecting a false null hypothesis.

Definition 17 The $p$-value is the smallest significance level at which the null hypothesis would be rejected for the given observation.

1. A new teaching method is being tested to see if it is better than the existing teaching method.

   (a) What are the appropriate $H_0$ and $H_1$?

   (b) What does "level of significance" represent in this problem?

   (c) What does "power" represent in this problem?