# MATH 1342

Sections 6.2

# Designing Experiments

**Experimental units** are the individuals on which the experiment is done. When the units are people, they are called **subjects**.

A **treatment** is the specific experimental condition applied to the units.

**Factors** are the explanatory variables in an experiment. Note that factors may have several **levels**.

A **placebo** is a dummy treatment that can have no physical effect. When subjects respond to a placebo treatment, we call this the **placebo effect**.

# Control in an Experiment

The fundamental principle of experimental design is **control**.

There are three fundamental principles of control:

1. **comparison** — Compare the groups that received the experimental treatment (or several stages of treatment) and a group a received no treatment

2. **randomization** — Usually in the assignment of the groups, there will be a degree of randomization. (Either complete randomization or matching)

3. **blindness** (blind or double-blind) — Blind: participants do not know which group they are in (this may be done by not knowing what the factors are in the experiment)
Double-Blind: both the participants and the experimenter do not know who is assigned to each group.

# Creating Groups

We need a **control group** to manage the effects of **lurking variables**.

The control group either receives no treatment (or a placebo treatment). This is to ensure that the results wouldn't have occurred without any treatment

**Matching** is a technique where experimenters try to match treatment groups in a systematic way.

Pretests are done to make sure that assignment to treatment and control groups are evenly matched. This may be to have equal academic levels, equal health, equal experience, etc in each group

**Completely randomized** experiments use units allocated at random among all the treatments.

No consideration is made to groups being assigned equally. All assignments are done by complete randomization.

A **block** is a group of experimental units that are similar in ways that are expected to affect the response of the treatments

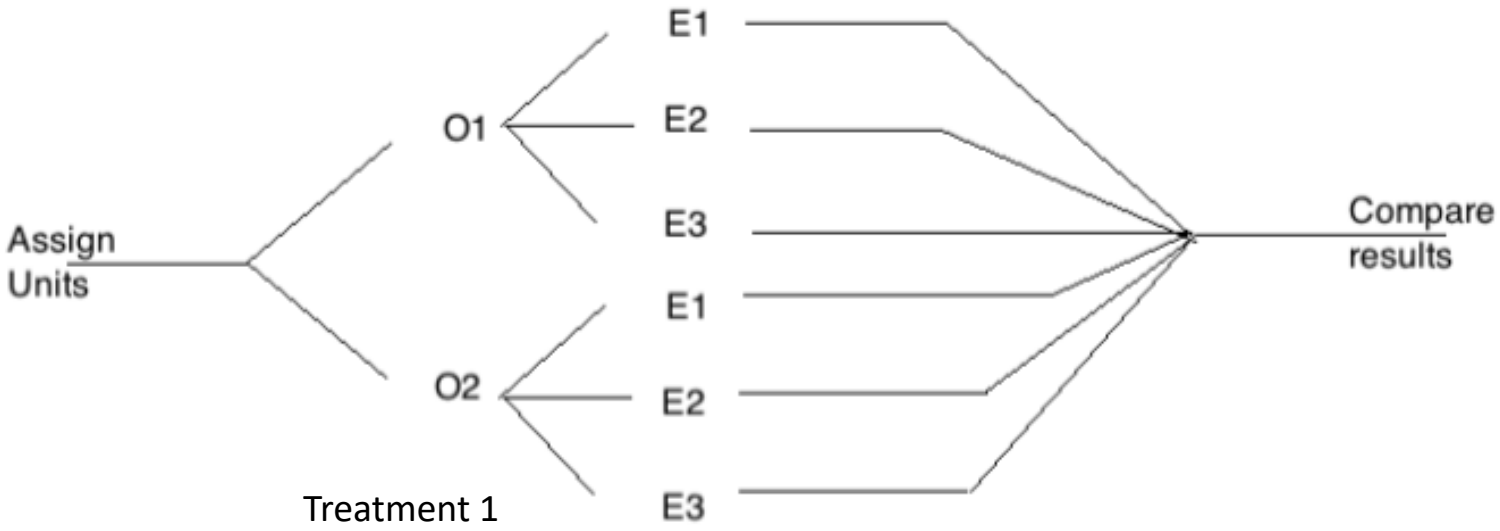
This is similar to a smaller experiment done within a larger experiment. It is a smaller group that would tested within the larger group (Main experiment: Is this medication effective? Block: Is it effective for people with a history of high blood pressure)

**Matched pairs design** is a form of block design with just two treatments.

An observed effect is **statistically significant** if it is too large to attribute plausibly to chance.

This would depend on the nature of the experiment. Most often, differences of a few percentage points are no considered significant, but differences of larger percents are.

# Diagraming an Experiment



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**Hidden Bias:** Deeply rooted attitudes that are part of your personality

(example: child abuse study)

**Confounding Variables:** An external variable (not part of the study) that can influence both the dependent and independent variable.

(example: time of day in aptitude test)

**Lack of Realism**: To conform to an experimental design, the situations presented are not similar to those encountered in real life.

(example: women in carjacking scenario study)

**Popper 19:**

Examples:

1. The editor of a magazine is wondering if the type of font used in the articles affects the reading speed of the subscribers of the magazine. He asks 10 subscribers to read 4 articles each with different fonts. If the reading speed increases with a particular font, he will use it in the next publication.

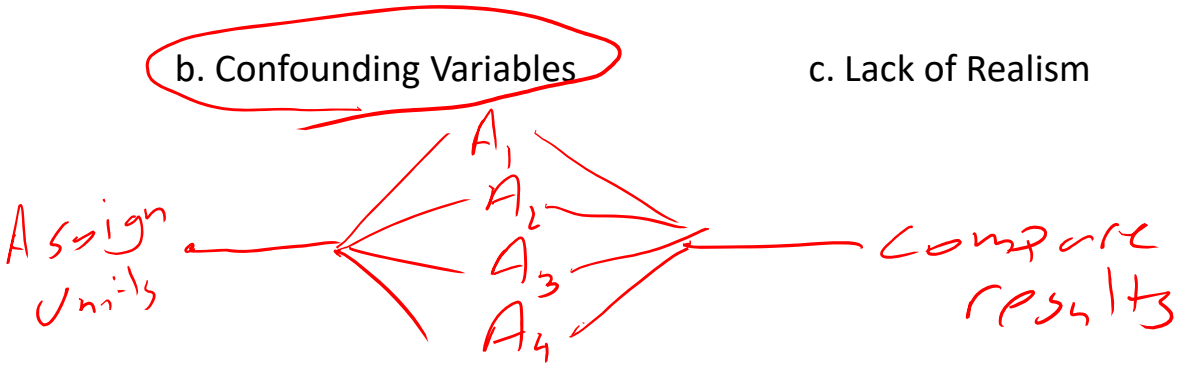
1. Is this an experiment or an observational study? a. Experiment b. Observation
2. If it is an experiment, is it randomized or block design? a. Randomized b. Block Design
3,4. If it is an experiment, identify the explanatory and response variables.
If this is an experiment, draw a diagram representing the levels and treatments.

3. Explanatory Variable: a. Reading Speed b. Font Size
4. Response Variable: a. Reading Speed b. Font Size

cause effect

5. If the text with smaller font size contained articles using more technical terminology, what kind of bias would this introduce?

a. Hidden Bias b. Confounding Variables c. Lack of Realism d. No Bias



2. Many colleges and universities have developed "calculus reform" courses which substantially alter the way that calculus is taught. The goal is that the reform courses help students to understand fundamental calculus concepts better than traditionally taught courses do.

   a. If you simply compare scores on a standardized calculus test between students in traditional classes and those in reform classes, would you be able to conclude that any differences you might find are attributable to the teaching style?
   b. Describe how you might design an experiment to assess whether the goal is being met.

a. You cannot simple at the end of the traditional/reform course and get an accurate description of how the teaching style affected the results. You would have no idea if students in different groups were starting at different levels.

b. You would have to do a Matching design. Based on grades in Precalc, you can accurately assign students to different groups so that the traditional and reform courses both had the same number of A, B, C, D, F students at the beginning of the course. Then their progress can be measured by the end of the course.