Welcome to September!
How to succeed in Mr. L's class

- What is an **advocate**?
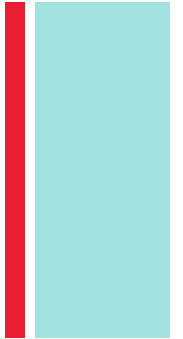
  Someone who supports you and tries to help you succeed

- What is an *adversary*?

  A rival; Someone who works against you and gets in the way

How to succeed in Mr. L's class

- I am here to be your **ADVOCATE**, please don't treat me as an *adversary*!

- When you take the time, and make the effort, **MATH** can help you succeed, so try to avoid thinking of math as your *adversary* as well.

- Be your own **ADVOCATE!**

Chapter 2: Collecting Data Sensibly & Designing Studies

adapted from The Practice of Statistics, 4th edition – For AP*

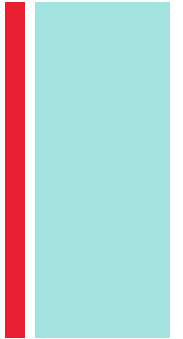# September HW Calendar - *revised* (*linked on website Homepage*)

AP Stats HW Sept 2020

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	31	**1** Red Chapter 1 Review **HW2** Sec1.4(p. 16) Prob. #13, 15, 19, 23, 29 **QUIZ 1 - Chap 1 & 2**	**2**	**3** Red Chapter 2 Review **HW 3** Sec2.1(p. 33) Prob. # 2, 4, 5, 6 **& Sec. 2.2 (p. 43)** # 15, 18, 23, 28, 32	**4** **KY Oaks Day** NO School	**5** **KY Derby Day**
6	**7** **Labor Day** NO School	**8** Virtual Open House	**9** Red **HW 4**: Sec. 2.3 (p 58) # 33 to 36, 39, 41 Sec. 2.4 (p. 64) # 49, 51, 55	**10**	**11** Red Finish Chap. 2 Intro Chapter 3 **HW 5**: Sec. 3.1 (p.88) Prob. # 2, 3, 8, 14	**12**
13	**14**	**15** Red Chapter 3 **HW 6**: Sec 3.2 (p. 96) Problems # 15, 17, 20, 21 & Sec 3.3 (p. 115) Prob. # 24, 28, 32, 36	**16** Crimson Schedule Chapter 3 E.C. **HW 7**: Sec 3.5 (p. 135) Prob. #47, 49, 50 **HW 8**: Review WS	**17**	**18** Red TEST Review Chapters 1 to 3 **HW 8**: Review WS Due Today!	**19**
20	**21**	**22** Red **TEST #1** Chapters 1 to 3 Homework CHECK #1 HW CHECK #1 - 8	**23** Crimson Schedule HW - Read Chapter 4 **HW #9** - 1 Page Chap Summary	**24**	**25** Red Chapter 4 **HW 10**: Sect 4.1 (p. 161) #1, 5, 6, 12 - 14 & Sect 4.2 (p. 169) #17-19, 25, 26, 31	**26**
27	**28**	**29** Red **FRAPPY Time!** Chapter 4.4 **HW 12**: Sec. 4.4 (p 185) # 38, 41, 43, 48, 50 **QUIZ # 3**	**30**	**1** October Red	**2** PD Day NO School	

Chapter 2 *(cont.) -* Collecting Data & Experimental Designs

Review of Sampling Methods
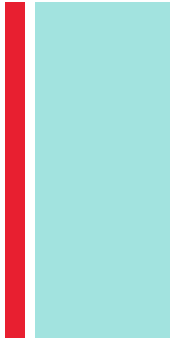
Statistical or Random Sampling Methods

- Simple Random Sample (SRS)

- Stratified Random Sample

- Cluster Sample

- Systematic Sample

Preferred methods

Non-Random Sampling *(often creates bias)*

- Convenience Samples
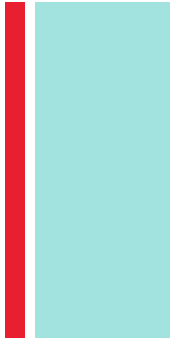
- Voluntary Response Samples

Suggested Additional resource:

Warm-UP – 9/3/2020
(Happy B-Day, しょ ま)

- What is the statistical symbol used for each concept:

  a) Sample mean

  b) population mean

  c) Sample size

- What is the most commonly referred to, and probably the most important *distribution* that is used in statistics?

Warm-UP – 9/3/2020

(Happy B-Day, しょ ま)
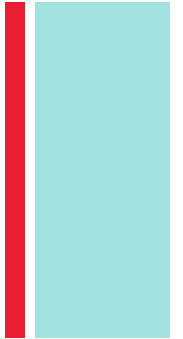
- What is the statistical symbol used for each concept:

  a) Sample mean $\overline{x}$ referred to as "x-bar"

  b) population mean μ Greek symbol "mu"

  c) Sample size $n \ (we \ usually \ want \ n \geq 30)$

- What is the most commonly referred to, and probably the most important *distribution* that is used in statistics?   **Normal distribution,** referenced with the symbol: $N(\boldsymbol{\mu}, \boldsymbol{\sigma})$ where N (pop. mean, *standard deviation*)

Quiz Questions commonly missed

- 6) A _**census**____ collects data from every individual in the defined population.

- 16) The characteristic or variable of a population is called a _**parameter** _.

- 22) The two main types of data are _**categorical** and _**numerical**_ (or *qualitative* and *quantitative*)

- #'s …Too many to list! ☺

Observational Study versus Experiment

In contrast to observational studies, experiments don't simply observe individuals or ask them questions. They actively impose some treatment in order to measure the response.

> **Definition:**
>
> An **observational study** observes individuals and measures variables of interest but does not attempt to influence the responses.
>
> An **experiment** deliberately imposes some treatment on individuals to measure their responses.

When our goal is to understand cause and effect, experiments are the *only* source of fully convincing data.

The distinction between observational study and experiment is one of the most important in statistics.

The Language of Experiments

An experiment is a statistical study in which we actually do something (a **treatment**) to people, animals, or objects (the **experimental units**) to observe the **response**. Here is the basic vocabulary of experiments.

Definition:

A specific condition applied to the individuals in an experiment is called a **treatment**. If an experiment has several explanatory variables, a treatment is a combination of specific values of these variables.

The **experimental units** are the smallest collection of individuals to which treatments are applied. When the units are human beings, they often are called **subjects**.

Sometimes, the **explanatory variables** in an experiment are called **factors**. Many experiments study the joint effects of several factors. In such an experiment, each treatment is formed by combining a specific value (often called a **level**) of each of the factors.

How to AVOID Experiment Badly

Experiments are the preferred method for examining the effect of one variable on another. By imposing the specific treatment of interest and controlling other influences, we can pin down cause and effect. Good designs are essential for effective experiments, just as they are for sampling.

Example

A high school regularly offers a review course to prepare students for the SAT. This year, budget cuts will allow the school to offer only an online version of the course. Over the past 10 years, the average SAT score of students in the classroom course was 1620. The online group gets an average score of 1780. That's roughly 10% higher than the long- time average for those who took the classroom review course. Is the online course more effective?

Students -> Online Course -> SAT Scores

How to AVOID Experiment Badly

- Many laboratory experiments use a design like the one in the online SAT course example:

Experimental Units	→	Treatment	→	Measure Response

In the lab environment, simple designs often work well.

Field experiments and experiments with animals or people deal with more variable conditions.

Outside the lab, badly designed experiments often yield worthless results because of confounding.

How to Experiment Well: The Randomized Comparative Experiment

- The remedy for confounding is to perform a *comparative experiment* in which some units receive one treatment and similar units receive a different. Most well designed experiments compare two or more treatments.

- Comparison alone isn't enough, if the treatments are given to groups that differ greatly, *bias* will result. The solution to the problem of bias is **random assignment.**

Definition:

In an experiment, **random assignment** means that experimental units are assigned to treatments at random, that is, using some sort of chance process.

The Randomized Comparative Experiment

Definition:

In a **completely randomized design**, the treatments are assigned to all the experimental units completely by chance.

Some experiments may include a **control group** that receives an inactive treatment or an existing baseline treatment.

```
Experimental Units → Random Assignment
    ↗ Group 1 → Treatment 1 ↘
                              Compare Results
    ↘ Group 2 → Treatment 2 ↗
```
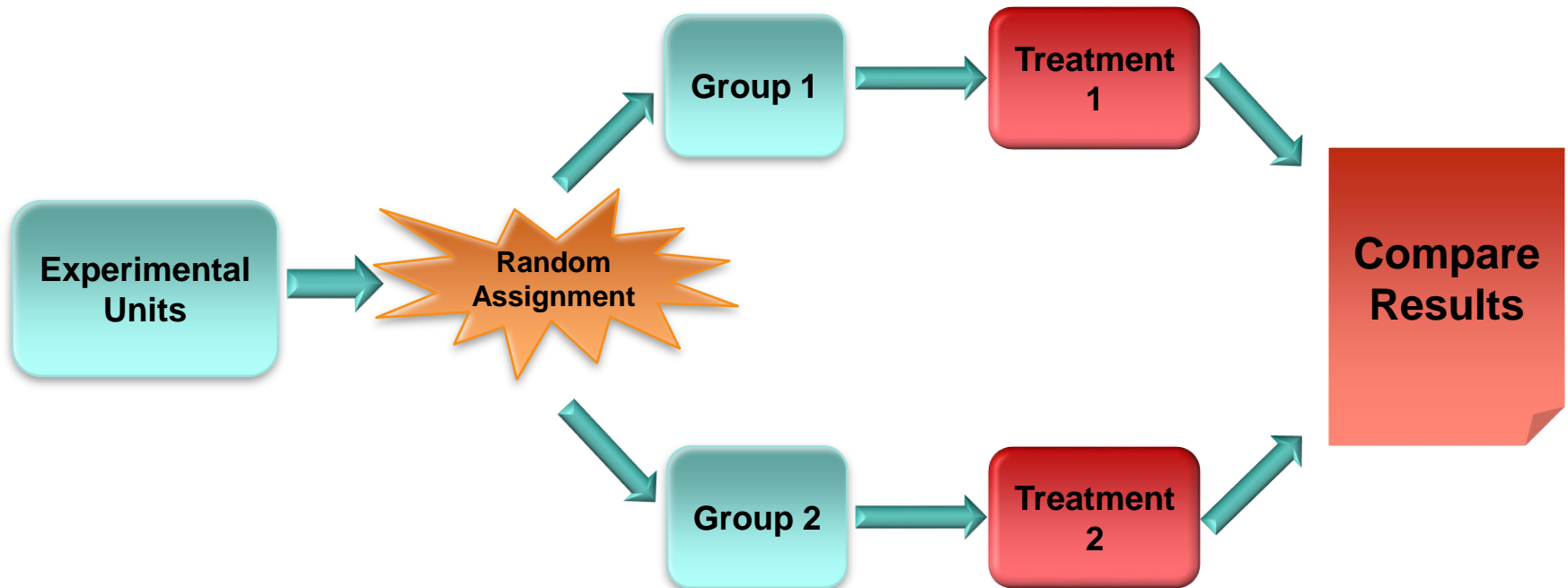
Four Principles of Experimental Design

■ Randomized comparative experiments are designed to give good evidence that differences in the treatments actually cause the differences we see in the response.

Principles of Experimental Design

1. **Blocking or Comparison:** Use a design that compares (blocks) two or more treatments.

2. **Control** for confounding variables that might affect the response: Use a comparative design and ensure that the only systematic difference between the groups is the treatment administered.

3. **Random assignment**: Use impersonal chance to assign experimental units to treatments. This helps create roughly equivalent groups of experimental units by balancing the effects of lurking variables that aren't controlled on the treatment groups.

4. **Replication**: Use enough experimental units in each group so that any differences in the effects of the treatments can be distinguished from chance differences between the groups.

Helicopter Design

- You have 3 minutes to design a helicopter using a ½ sheet of paper

- You may *not* use any **addition**

- You are allowed to use **subtraction**

- **Coloring** is optional

- Design augments/changes are welcomed after testing

Desired characteristics (response variables)
1. Rotation
2. Vertical descent (*or a decent vertical descent* ☺)

■ **Observational Study versus Experiment**

Observational studies of the effect of one variable on another often fail because of **confounding** between the explanatory variable and one or more extraneous variables, called **lurking variables.**

> **Definition:**
>
> A **lurking variable** is an additional variable, which is neither the explanatory or response variables in a study, but one that may influence the response variable.
>
> **Confounding** occurs when two variables are associated in such a way that their effects on a response variable cannot be distinguished from each other.

Well-designed experiments take steps to avoid confounding.

Extraneous variables: Lurking variable vs. Confounding variable
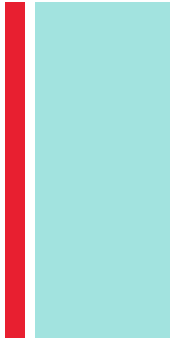
Earlier we mentioned that an issue with observational studies is that there may be other variables influencing the results. Two types of extraneous variables can influence the results of a study are: lurking variables and confounding variables. The difference between the two is in whether or not the variable was considered in the research study.

- **Lurking variable**: A variable that is not considered in an observational study that could influence the relationship between the variables in the study.

- **Confounding variable**: A variable that is considered in an experiment that could influence the relationship between the variables in the study

Lurking vs confounding variables

■ **Lurking variables** *are a common problem in observational studies when an apparent association between two variables is really just common response to a third unseen variable*.

EXAMPLE: A commonly cited example involves a **positive association** between *ice cream sales* and drownings. What is explanatory and what is response? Should we conclude that when people hear of drowning in the news, they are saddened and attempt to cheer up by eating ice cream? Or, more likely, that it's dangerous to each ice cream before you go swimming? In fact, the explanatory variable is probably summer heat, leading to both more ice cream sales and more drownings.

■ **Confounding** is a different issue, more often associated with experiments. Confounding arises when the response we see in an experiment is a least partially attributable to uncontrolled variables.
EX: A store's special promotion may increase video rentals but the marketing folks cannot be sure that's what did it if the weather was particularly bad during the trial period. Bad weather may have kept people indoors and induced them to rent more videos anyway. Any actual effect of the special promotion is confounded by the weather.

Example: The Physicians' Health Study

■ Read the description of the Physicians' Health Study on handout or page 243 (another text). Explain how each of the three principles of experimental design was used in the study.

Factor 2: Beta-carotene

	Yes	No
Yes	Aspirin Beta-carotene	Aspirin Placebo
No	Placebo Beta-carotene	Placebo Placebo

Factor 1: Aspirin

A **placebo** is a "dummy pill" or inactive treatment that is indistinguishable from the real treatment.

Experiments: What Can Go Wrong?

■ The logic of a randomized comparative experiment depends on our ability to treat all the subjects the same in every way except for the actual treatments being compared.

■ Good experiments, therefore, require careful attention to details to ensure that all subjects really are treated identically.

A response to a dummy treatment is called a **placebo effect**. The strength of the placebo effect is a strong argument for randomized comparative experiments.

Whenever possible, experiments with human subjects should be **double-blind**.

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Whenever possible, experiments with human subjects should be **double-blind**.

Definition:
In a **double-blind experiment,** neither the subjects nor those who interact with them and measure the response variable know which treatment a subject received.

Inference for Experiments

- In an experiment, researchers usually hope to see a difference in the responses so large that it is unlikely to happen just because of chance variation.

- We can use the laws of probability, which describe chance behavior, to learn whether the treatment effects are larger than we would expect to see if only chance were operating.

- If they are, we call them **statistically significant**.

Definition:
An observed effect so large that it would *rarely occur* by chance is called **statistically significant**.

A statistically significant association in data from a well-designed experiment does imply causation.