Name _____

Chapter 4 Learning Objectives	Section	Related Example on Page(s)	Relevant Chapter Review Exercise(s)	Can I do this?
Identify the population and sample in a statistical study.	4.1	210	R4.1	
Identify voluntary response samples and convenience samples. Explain how these sampling methods can lead to bias.	4.1	213	R4.2	
Describe how to obtain a random sample using slips of paper, technology, or a table of random digits.	4.1	214, 217	R4.3	
Distinguish a simple random sample from a stratified random sample or cluster sample. Give the advantages and disadvantages of each sampling method.	4.1	221	R4.4	
Explain how undercoverage, nonresponse, question wording, and other aspects of a sample survey can lead to bias.	4.1	226, 227	R4.5	
Distinguish between an observational study and an experiment.	4.2	235	R4.6	
Explain the concept of confounding and how it limits the ability to make cause-and-effect conclusions.	4.2	235	R4.6	
Identify the experimental units, explanatory and response variables, and treatments in an experiment.	4.2	237, 239	R4.7	
Explain the purpose of comparison, random assignment, control, and replication in an experiment.	4.2	243	R4.9	
Describe a completely randomized design for an experiment, including how to randomly assign treatments using slips of paper, technology, or a table of random digits.	4.2	246	R4.7, R4.10	
Describe the placebo effect and the purpose of blinding in an experiment.	4.2	247	R4.9	
Interpret the meaning of statistically significant in the context of an experiment.	4.2	249 (Activity)	R4.9	
Explain the purpose of blocking in an experiment. Describe a randomized block design or a matched pairs design for an experiment.	4.2	251, 254	R4.7, R4.10	
Describe the scope of inference that is appropriate in a statistical study.	4.3	267	R4.8	
*Evaluate whether a statistical study has been carried out in an ethical manner.	4.3	Discussion on 270	R4.11	

Introductory activity on discrimination

Suppose that at a certain company, 15 female employees and 10 male employees have expressed interest in serving on a 5 person committee to negotiate a new contract. The names of all 25 willing volunteers will be written on identical slips of paper, placed in a hat, mixed thoroughly, and drawn out one at a time until all 5 committee members have been identified. A day later, the results of the random drawing are announced; no women were chosen. The women who had wished to serve on the negotiating team cry foul. Do these results provide *convincing* evidence of discrimination?

HW: Read "To the Student" and "Overview: What is Statistics?" (pages xii–xiii, xx1–xxiii)

4.1 Sampling and Surveys

Over the course of the year, Tim has submitted several written assignments to his Comm. Arts teacher, Pam. Some assignments were done in class and some were done completely outside of class. Pam believes that Tim had someone else write his most recent paper. Pam decides to analyze Tim's paper by estimating the average word length in the questioned assignment and compare it to the average word lengths of Tim's other works that were completed in class.

Directions: The following passage is the opening paragraph of Tim's most recent essay on Shakespeare's *King Lear*. Choose 5 words from this passage, count the number of letters in each of the words you selected, and find the average word length. Share your estimate with the class and create a class dotplot.

> King Lear of Britain has decided to abdicate his throne. In order to bestow his kingdom between his three daughters; Goneril, Regan, and Cordelia, he calls them together. His intentions are to divide the kingdom among them based on each daughter's expression of love and devotion for him. The two oldest daughters sweetly talk their way into their father's heart and Lear decides to bequeath them sizable kingdoms. Cordelia however, the youngest and Lear's favorite, sees the sinister motivations of her sisters and reveals to her father her deep true feelings. Lear, not hearing the sweet words that he expected, is so dismayed that he banishes her. She leaves the country to marry the King of France.

Directions: Use a table of random digits or a random number generator to select a simple random sample (SRS) of 5 words from the opening passage to Tim's essay. Once you have chosen the words, count the number of letters in each of the words you selected and find the average word length. Share your estimate with the class and create a class dotplot. How does this dotplot compare to the first one? Can you think of any reasons why they might be different?

Number	Word	Number	Word	Number	Word
1	King	39	On	78	Sinister
2	Lear	40	Each	79	Motivation
3	Of	41	Daughter's	80	Of
4	Britain	42	Expression	81	Her
5	has	43	Of	82	Sisters
6	Decided	44	Love	83	And
7	To	45	And	84	Reveals
8	Abdicate	46	Devotion	85	To
9	His	47	For	86	Father
10	Throne	48	Him	87	Her
11	In	49	The	88	Deep
12	Order	50	Two	89	True
13	To	51	Oldest	90	Feelings
14	Bestow	52	Daughters	91	Lear
15	His	53	Sweetly	92	Not
16	Kingdom	54	Talk	93	Hearing
17	Upon	55	Their	94	The
18	His	56	Way	95	Sweet
19	Three	57	Into	96	Words
20	Daughters	58	Their	97	That
21	Goneril	59	Father's	98	He
22	Regan	60	Heart	99	Expected
23	And	61	And	100	Is
24	Cordelia	62	Lear	101	So
25	He	63	Decides	102	Dismayed
26	Calls	64	To	103	That
27	Them	65	Bequeath	104	He
28	Together	66	Them	105	Banishes
29	His	67	Sizable	106	Her
30	Intentions	68	Kingdoms	107	She
31	Are	69	Cordelia	108	Leaves
32	To	70	However	109	The
33	Divide	71	The	110	Country
34	The	72	Youngest	111	To
35	Kingdom	73	And	112	Marry
36	Among	74	Lear's	113	The
37	Them	75	Favorite	114	King
38	Based	76	Sees	115	Of
		77	The	116	France

Search the book or online to complete the tables on pages 3-6.

term	definition	US example	your own comments
Population		All Americans.	
Sample		A representative subset of Americans	
Census		Sample every American.	
Sampling Frame		A list of Americans that we can use to draw a sample, such as social security numbers, a list of MasterCard holders, or a phone book.	

term	definition	US example	your own comments
Bias		A failure of a sample to represent the Americans in some way, such as not including homeless, or overestimating income.	
Convenience Sample		Hang out at a park and survey the people who are there.	
Voluntary Response Sample		Ask all Americans to go to a website. This sample is the set of all those who actually do visit the site.	

term	definition	US example	your own comments
Simple Random Sample	A sample of size n in which each set of n elements in the population has an equal chance of selection.	Make a list of all Americans and have a computer select a random sample of 1000.	
Stratified Sample		Select 20 people from each state.	
Cluster Sample		Select all the residents of a randomly chosen state.	
Systematic Sample		Assemble a list of all Americans and randomly choose a starting point. Then select every 10,000th name from there on the list.	
Multistage Sample		Using a combination of methods to select a sample of Americans.	

term	definition	US example	your own comments
Parameter		A numerical attibute of all Americans, such as the median income, average age, or percent that are married.	
Statistic		A numerical attibute of a group of Americans, such as the median income, average age, or percent that are married.	

Read 209–211

The blue circle and triangle icons, like the one in the top-right corner of the example on page 210, indicate that the book's website has a video about the example.

Read 211–213 (How to Sample Badly)

These sampling methods are often biased!	Why?
Voluntary Response Samples	Those with extreme opinions are most likely to choose to respond.
Convenience Samples	The sample is usually not representative of the population.

Notice that the book has opportunities for you to… Check Your Understanding (like that on page 213)

Example: To estimate the proportion of the residents in the 17 counties in the metro area around St. Louis City that supports a proposed tax to support fine arts in St. Louis, individuals are surveyed as they enter Powell Symphony Hall, The Sheldon Concert Hall, and the St. Louis Art Museum on 3 randomly selected evenings this year. Explain how this plan will result in bias and how the bias will affect the estimated proportion.

HW #1: page 229 (1-11 odd)

4.1 Random Sampling Methods

Read 213–217

Some ways to choose a simple random sample (SRS) of n items/people:

Write all the names on identical papers in a hat, mix well, select n of them. The names you choose indicate your sample.	This is the best option for when you are asked to write a description on a test or the AP exam.
Number each item, using labels that are equal lengths (1-9, 01-99, 001 to 999, etc.) & then use a random number table to choose n unique ___ digit numbers. Your sample is the group of individuals linked to those numbers.	Be very familiar with this. You are often asked to carry out some procedure that is provided to you by using a table of random digits.
Number each item from 1 to some value & then use technology to choose n unique numbers. Your sample is the group of individuals linked to those numbers.	This works well when you are doing a sample for yourself, but this is not the one to rely on for tests or the AP exam.

Be careful with this!

Sampling with replacement	**Sampling without replacement**
Each individual is returned to the population and can be selected repeatedly.	Each individual chosen is removed from the population and can be selected repeatedly.
In a sequence of random numbers, 05 22 18 17 05 02, the second time that "05" appears, we *use* it, meaning the individual was returned the first time it appeared and so, the same individual was selected twice.	In a sequence of random numbers, 05 22 18 17 05 02, the second time that "05" appears, we *ignore* it, meaning the individual was removed the first time it appeared and is not available to be chosen again.
Select 5 cards from a deck, one at a time, replacing each card after it is inspected.	Select 5 cards from a deck, placing each card on the table as it is selected.

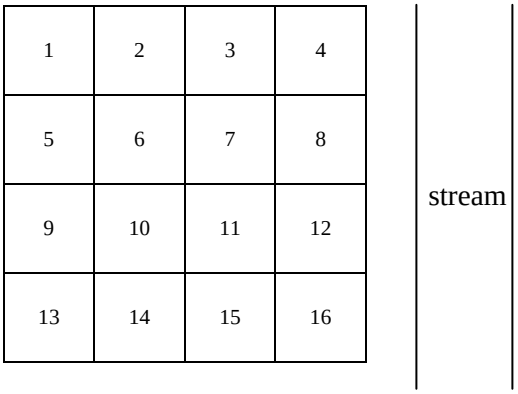
Committee

A principal wants to choose a random sample of 3 teachers to determine the best day to send out his weekly memo to staff. Use Table D at line 101 to select an SRS of size 3 teachers.

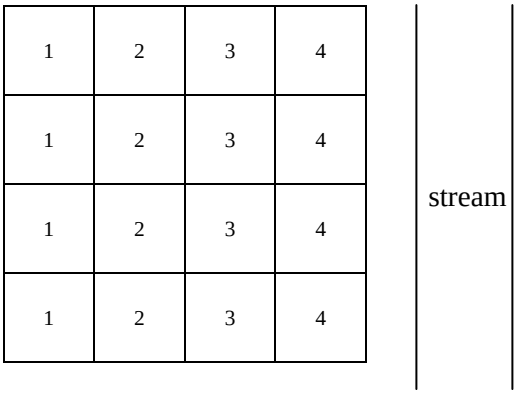
Mr. Able	Mr. Haskins	Mrs. Oliver
Miss Bean	Mrs. Ingleman	Ms. Pickering
Mrs. Cain	Ms. Jenkins	Miss Queensen
Mr. Daniels	Mr. Kasper	Ms. Rolfing
Mrs. Elfing	Mrs. Ludwig	Mr. Star
Mrs. Franklin	Mrs. Moore	Miss Thompson
Miss Goodall	Mr. Niehaus	Mr. Usinger

Tom raises peaches in an orchard on his farm in Calhoun County, Illinois. Suppose he wanted to estimate the total yield of his peach orchard. The orchard is square and divided into 16 equally sized plots (4 rows x 4 columns), with several peach trees in each plot. A stream runs along the eastern edge of the field. We want to take a sample of 4 plots.

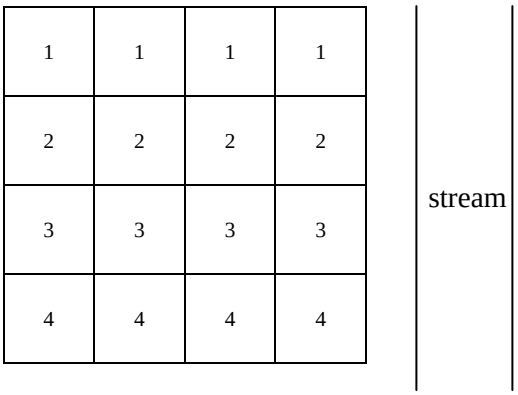
Using a random number generator, pick a simple random sample (SRS) of 4 plots. Place an X in the 4 plots that you choose.



Now, randomly choose one plot from each horizontal row. This is called a stratified random sample.



Finally, randomly choose one plot from each vertical column. This is also a stratified random sample.



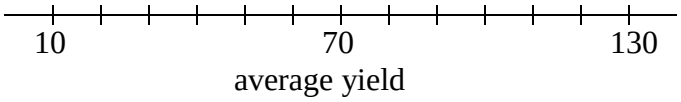
Which method do you think will work the best? Explain.

Now, its time for the harvest! The numbers below are the yield (pounds of peaches) for each of the 16 plots. For each of your three samples above, calculate the average yield per plot.

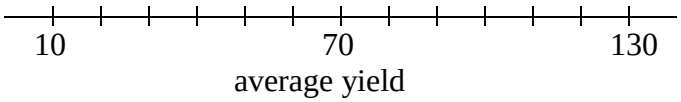
4	29	94	150
7	31	98	153
6	27	92	148
5	32	97	147

Graphing the results:

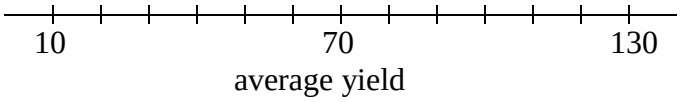
Simple Random Sample:



Stratified by Row:



Stratified by Column:



Read 219–220

simple random sample (SRS)	stratified random sample
Choose randomly with no other complicating steps. This is equivalent to drawing names from a hat.	Divide the population into groups (called strata) based on some variable & then choose randomly from each group or stratum.
Benefit: this is simple and all our formulas this year are based on a SRS.	Benefit: this avoids the chance that all individuals are from a single group or stratum. Stratify based on the variable that we believe may affect the variable we are measuring.

HW #2 page 230 (13, 15, 17, 18, 19)

4.1 More about Sampling

Read 221–219

Why would we use a cluster sample? Because it is easy and quick since usually the groups (clusters) already exist & are representative of the population.

Cluster sample	Stratified random sample
Groups (clusters) usually already exist	We separate the population into groups (strata)
Within a cluster, the individuals are varied	Within a stratum, the individuals are similar in some way
Any 2 clusters are similar	Any 2 strata are varied in some key way

The owner of an independent bookstore wants to know the average number of pages in all the books in the store. The store has 8,000 books, arranged by type (fiction, biography, history, and so on) in shelves that hold about 40 books each.
(a) Explain how to select a simple random sample of 400 books.

(b) Explain how to select a stratified random sample of 400 books. Explain your choice of strata and one reason why this method might be chosen.

(c) Explain how to select a cluster sample of 400 books. Explain your choice of cluster and one reason why this method might be chosen.

(d) Discuss a potential drawback with each of the methods described above.

Read 223–225
Inference is drawing a conclusion based on a sample or experiment.

A **margin of error** is an estimate of how far off we are in using some average or percent to estimate a population parameter, if we did repeated samples/experiments.

Note that if we increase the sample size, we have more info about the population. This decreases variation from one sample to another.

Read 225–227
A **sampling frame** is the list of all members of population that are available to be sampled.

Undercoverage occurs when certain groups in the population are underrepresented. Undercoverage is a problem when the opinions of those left out differ in some important way from those we do include.

Nonresponse is when people don't respond. It becomes a problem when those who do respond and those who do not differ in some important way.

This is different from **voluntary response** (where people are *eager* to respond).

Response bias is when people provide false information either because they are lying or because they forgot.

HW #3: page 231 (21-35 odd)
4.2 Observational Studies and Experiments

Early Reading Interventions linked to lower rate of Advanced Placement Coursework

> *In a certain Midwest suburban school district, students who were identified in first grade as having difficulty reading were later found to have a lower-than-average number of Advanced Placement courses on their high school transcript. The students identified as having reading problems in first grade were given an intensive reading intervention program and successfully exited the program after a year. At the end of the high school years, those students were found to be less likely than their peers to have taken at least one AP course in high school.*

Based on this study, should we conclude that early reading difficulty *causes* a student to avoid AP courses or to not successfully earn credit in AP courses? Explain.

Explain the concept of confounding in the context of this study.

Is there any way to *prove* that early reading difficulty leads to AP coursework difficulty or avoidance?

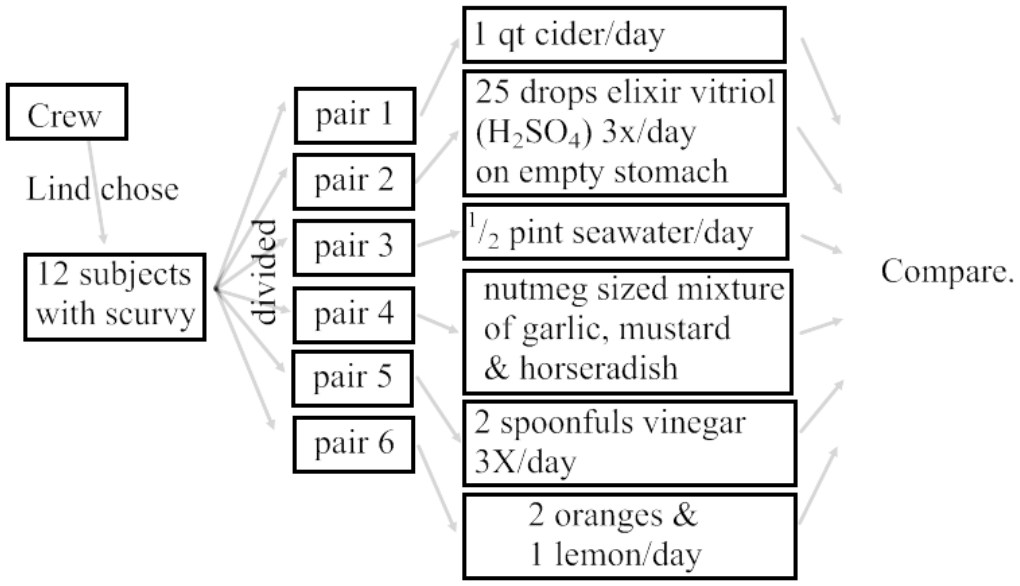
Read 234–236

Observational Studies		Experiments
No intervention No treatment	Surveys Knowingly respond	Intervention or treatment

Explanatory variable	Response variable
Independent variable	Dependent variable
x	y
Factor	outcome

Page 237: Check Your Understanding

Designing Experiments
When: 1747
Where: The HM Bark Salisbury
Who: James Lind, the ship's surgeon
What: Used a controlled experiment on pairs of crew members who "were as similar as I could have them" to develop a cure for scurvy.
How: 2 week treatment as follows:



Result: The men given citrus fruits recovered dramatically within a week. One returned to duty after 6 days & the other became nurse to the rest. The others experienced some improvement, but nothing was comparable to the citrus fruits, which were proved to be substantially superior to the other treatments.

Four Key Elements of Experiments:	How was this in Lind's experiment? If not there, say so.
Comparison: Design so we can compare 2 or more treatments.	
Control: Keep other potentially important variables the same for all groups.	
Replication: Use enough experimental units that effects can be distinguished from chance differences between groups.	
Randomization: Use chance assignment to treatments to create roughly equivalent groups by balancing effects of other variables among groups.	

Some also use the term "Replication" if repeating an experiment. (As in, "Are the results replicable?")

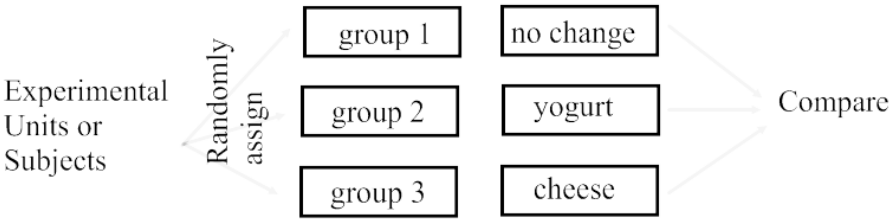
Other experiment vocabulary:	How was this in Lind's experiment? If not there, say so.
Treatment: Condition applied to individuals in an experiment.	
Experimental units: Smallest collection of individuals to which treatments are applied.	
Subjects: Experimental units that are humans.	
Factor: An explanatory variable in an experiment.	
Level: Varying amounts, durations, or intensities of a factor.	
Outcome: The response variable in an experiment.	

HW #4: page 233 (37–42) page 253 (45–55 odd)

How can we randomize (randomly assign n individuals to a treatment)?

Write all the names on identical papers in a hat, mix well, select n of them. The names you choose indicate those assigned to the treatment.	This is the best option for when you are asked to write a description on a test or the AP exam.
Number each item, using labels that are equal lengths (1-9, 01-99, 001 to 999, etc.) & then use a random number table to choose n unique ___ digit numbers. The individuals linked to those numbers are assigned to the treatment.	Be very familiar with this. You are often asked to carry out some procedure that is provided to you by using a table of random digits.
Number each item from 1 to some value & then use technology to choose n unique numbers. The individuals linked to those numbers are assigned to the treatment.	This works well when you are doing a sample for yourself, but this is not the one to rely on for tests or the AP exam.

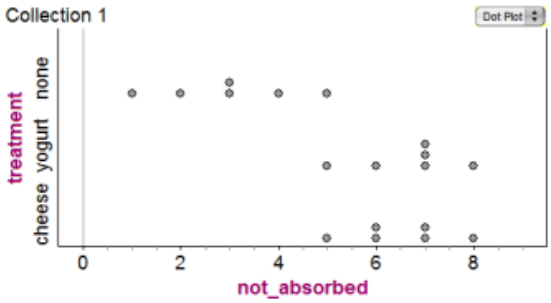
Example of a **completely randomized design**: (Read 239–243)
Does yogurt help prevent the body from absorbing fat? A study randomly assigned subjects to one of 3 groups. One group had no dietary changes, the second group added 2 cups of yogurt to their diet each day, & the third group added 2 ounces of cheese to their diet each day. Researchers collected stool from all subjects throughout the month-long study and compared the amount of fat excreted (and therefore not absorbed) for the 3 groups.

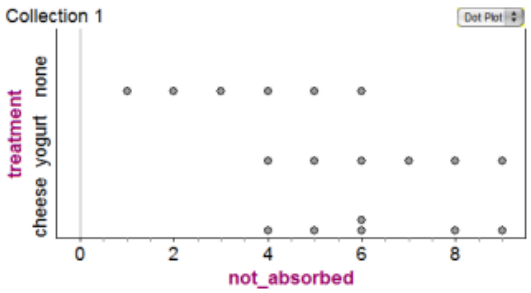


So, in a **completely randomized design**, experimental units are just randomly assigned to treatment groups or directly to treatments.

"Control" means holding other variables constant for each member of both treatment groups in order to prevent those variables from becoming confounded with the explanatory variable and from bringing in additional variability to the distribution of the response variable.

We also want to reduce variability. The amount of dairy consumed is important to consider because it may affect fat absorption. If we let subjects in the cheese and yogurt groups eat any amount they want, the changes in fat absorption will be more variable than if we made sure each subject ate the same amount. The added variability will make it harder to see any effect of the dairy (i.e., our study will have less power). To see this, consider the two sets of dotplots shown. The top one has results of a well-done experiment, in which the amount of dairy consumed is made the same for each subject. The second shows the results of an experiment where subjects were allowed to eat as much (or as little) dairy as they pleased. The additional variability in fat absorbed makes the evidence for dairy less convincing.





Is the weight of subjects a confounding variable in this experiment?

Single-Blind - when either subjects or evaluators don't know which group subjects were assigned to.

Double-Blind - when neither subjects nor evaluators know which group subjects were assigned to.

Placebo - treatment (in medical studies) contains no medication, used in "blind" studies.

Placebo Effect - when placebo affects response variable

Control Group - receives no treatment or a placebo

Note: Not all experiments have a control group or use a placebo as long as there is comparison. For example, if you are testing a new drug, it is usually compared to the currently used drug, not a placebo. Also, you can do an experiment to compare four brands of paint without using a placebo.

Does the fat absorption study have a control group?
Could the fat absorption study be conducted as single-blind?

Could the fat absorption study be conducted as double-blind?

SUMMARY: With randomization, replication, and control, each treatment group should be nearly identical, and the effects of other variables should be about the same in each group. Now, if changes in the explanatory variable are associated with changes in the response variable, we can attribute the changes to the explanatory variable *or the chance variation in the random assignment*.

Read 243–249

HW #5: page 259 (57, 59, 61, 63, 65)

Complete the table with information about: A food scientist studying the acid level of yogurt has 4 fermentation times and 2 kinds of milk (based on fat content).

Factor(s)	
# of Levels	
# of Treatments	
Single-blind possible?	
Double-blind possible?	

Quick check: Identify factor(s), # of levels, # of treatments, and whether single- or double- blind is possible.
1. An arthritis drug comes in 2 strengths and we also want a control group.

2. Drug A comes in 2 strengths. Drug B comes in 3 strengths. No control group is needed, but we want to look at the effect of combining these drugs for treating Alzheimer's Disease.

3. One of 3 fungicides will be used when seeds are planted and a plant fertilizer will be applied in one of 4 concentrations to look at how well the plants yield.

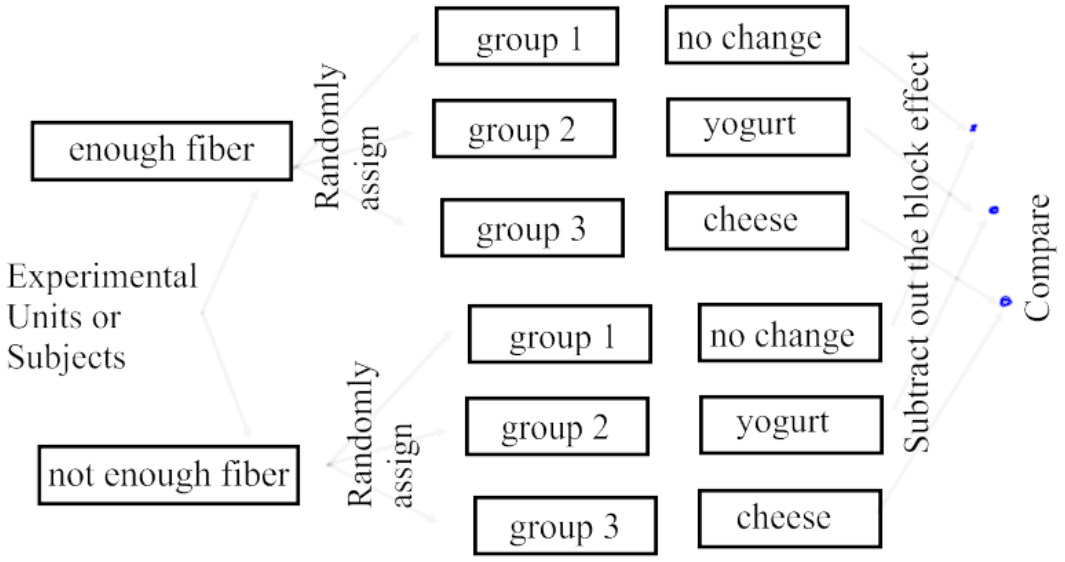
Read 249
The results of an experiment are called statistically significant if they are unlikely to occur by random chance. That is, if it is unlikely that the results are due to the possible imbalances created the random assignment. (significant ≠ important; significant = meaningful)

For example, if dairy really has no effect on fat absorption rates, then the average amount of fat not absorbed in the groups should be exactly the same. However, because the results will vary depending on which subjects are assigned to each group, the average change in the groups will probably differ slightly. So, whenever we conduct an experiment and find a difference between groups, we need to determine if this difference could be attributed to the chance variation in random assignment or because there really is a difference in effect of the treatments.

To determine if the results of our experiment are statistically significant, we look to see if the probability of seeing such a difference (or outcome) is very low.

HW #6: page 259 (67, 69, 71, 73)
4.2 Blocking
Read 251–255

Suppose, in the fat absorption example earlier, that researchers are concerned about whether the fiber content of food consumed affects fat absorption from other food. That's not far-fetched; fiber affects how fast food travels through the body and therefore might affect how much fat is absorbed. This wasn't considered in the completely randomized experiment. What if the people randomly placed in the two dairy groups had different fiber intake levels than the group that had no change in the diet? To prevent fiber from becoming confounded with dairy, we need to make sure that members of all treatment groups get the same amount of fiber. How can we design an experiment to control for fiber intake?

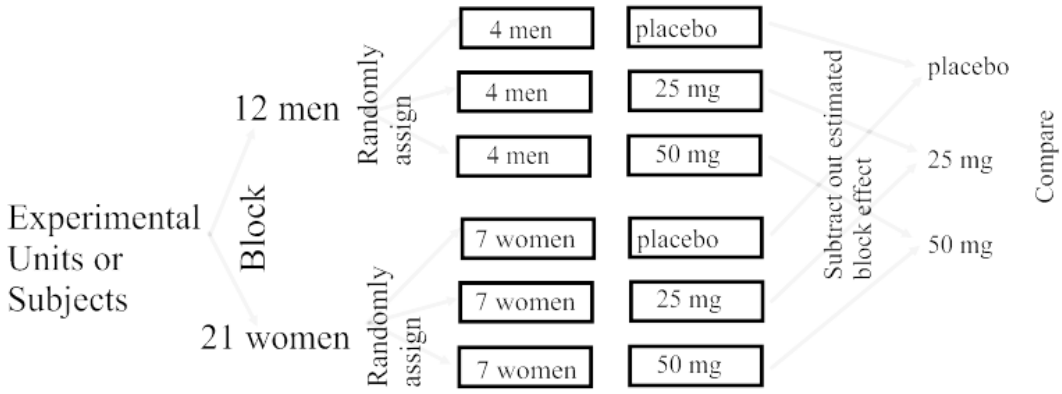


Be very careful with this vocabulary! Blocking and stratifying are the same idea and we do them for the same reason, but the terminology is specific to the kind of study being done:

Experiments
Blocking

Samples
Stratifying

Researchers are testing a new cholesterol-lowering drug on 33 volunteers, 12 men and 21 women. There is reason to believe that the drug may affect men and women differently, so they block on gender. 1/3 of the men and 1/3 of the women are randomly assigned to each of 3 groups. One group gets a placebo; the other 2 groups get 1 of 2 different doses of the drug.



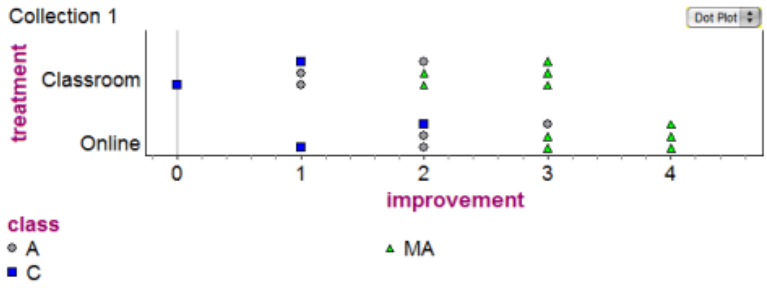
Lots of students take ACT prep courses. Twenty students who took the ACT one time volunteered for an experiment comparing online and classroom prep courses.

1. Describe a completely randomized design experiment for comparing online and classroom ACT prep courses.

2. Among the 20 volunteers, 10 of are in Math Analysis, 6 are in Algebra 2, and 4 are in Calculus. What problem does this cause? How can we address this problem?

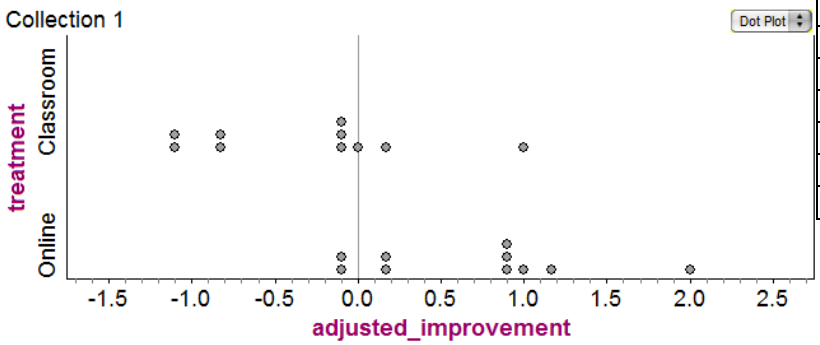
3. Here are the results of the experiment. Based on the dotplots, does there appear to be convincing evidence that the online course is better?

4. The dotplots in #3 ignored the fact that we blocked by math level. Here is the dotplot again, using different symbols for students in each math level.



Class	Treatment	Improvement	Adjusted improvement
MA	Online	4	
MA	Online	4	
MA	Online	3	
MA	Online	3	
MA	Online	4	
MA	Classroom	2	
MA	Classroom	2	
MA	Classroom	3	
MA	Classroom	3	
MA	Classroom	3	
A	Online	2	
A	Online	3	
A	Online	2	
A	Classroom	1	
A	Classroom	2	
A	Classroom	1	
C	Online	1	
C	Online	2	
C	Classroom	0	
C	Classroom	1	

Notice that within each math level, the online students clearly did better. We couldn't see this difference when we ignored the blocks. The average improvement for students in Math Analysis was $\bar{x}_{MA} = 3.1$, the average improvement for students in Algebra 2 was $\bar{x}_{A} = 1.83$, and the average improvement for students in Calculus was $\bar{x}_{C} = 1$. How can we use this information to account for the variability created by differences in class level?



Blocking in experiments is similar to stratification in sampling.

- Blocking accounts for a source of variability, just like stratifying. This means that blocking is a good way to increase power (the ease of seeing that one treatment is more effective than another).
- Blocks should be chosen like strata: the units within the block should be similar, but different than the units in the other blocks. You should only block when you expect that the blocking variable is associated with the response variable.
- Blocks, like strata, are not formed at random!

What are some variables that we can block for in the fat absorption experiment?

In general, the best way to plan for blocking is to choose a variable, that we think *may* affect the response variable (dependent variable or outcome).

Example: A popcorn lover wants to know if it is better to use the "popcorn button" on her microwave oven or use the amount of time recommended on the bag of popcorn. To measure how well each method works, she will count the number of unpopped kernels remaining after popping. She goes to the store and buys 10 bags each of 4 different varieties of microwave popcorn (movie butter, light butter, natural, and kettle corn), for a total of 40 bags.

Explain why a randomized block design might be preferable to a completely randomized design for this experiment.

Outline a randomized block design for this experiment.

Now write a description of how you would conduct the experiment. (A sketch like you have just done does not earn you points on tests or the AP exam; you have to be able to express yourself in writing.)

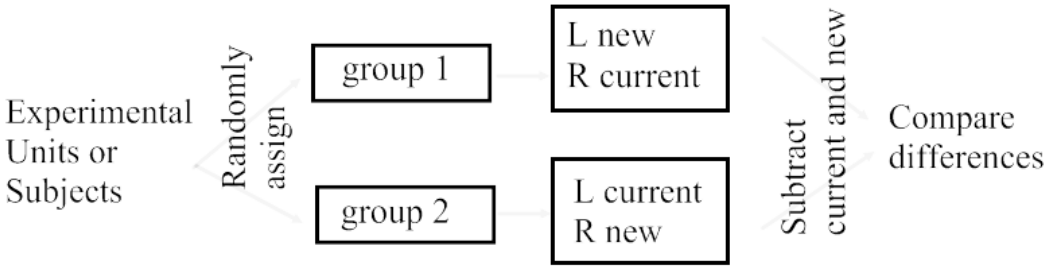
A **matched pairs design** is a specific type of block design done by pairing.
Examples:

- left vs. right
- husband vs. wife
- before vs. after
- twins studies
- sorting or ranking, then pairing

HW #7: page 257 (75–85 odd)

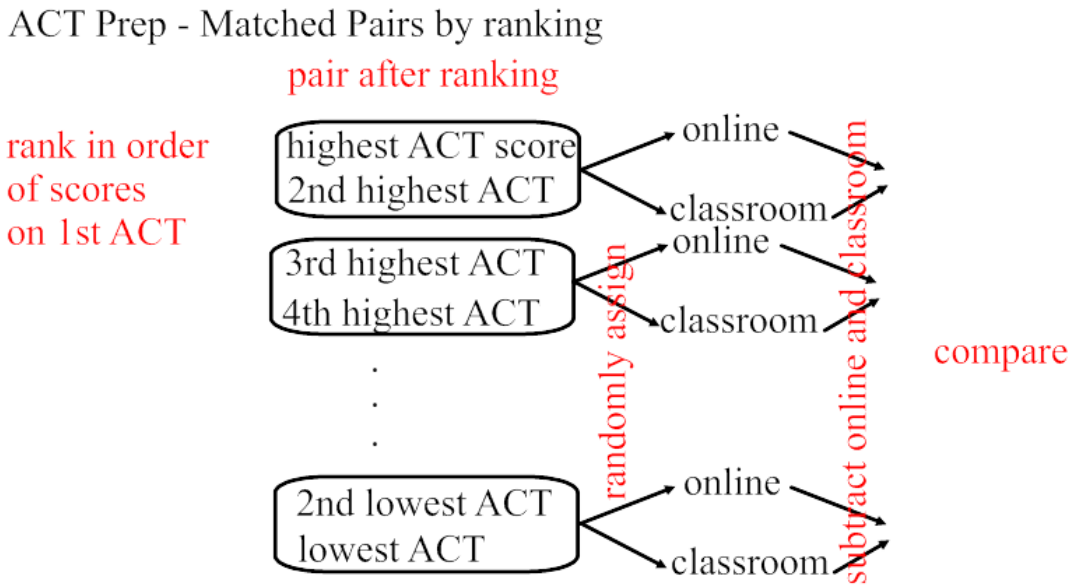
Comparing 2 fabrics - Matched Pairs by left vs. right

Textile researchers have developed a new fabric that insulates better than a currently popular fabric used in gloves. However, they want to see if the new fabric wears as well when woven as thin as the current fabric. For 3 winter months, 60 volunteers in Fond du Lac, Wisconsin are given a pair of gloves each. Randomly within each pair, one is made of the new fabric and one of the current fabric. After 3 months, the gloves are examined for wear.

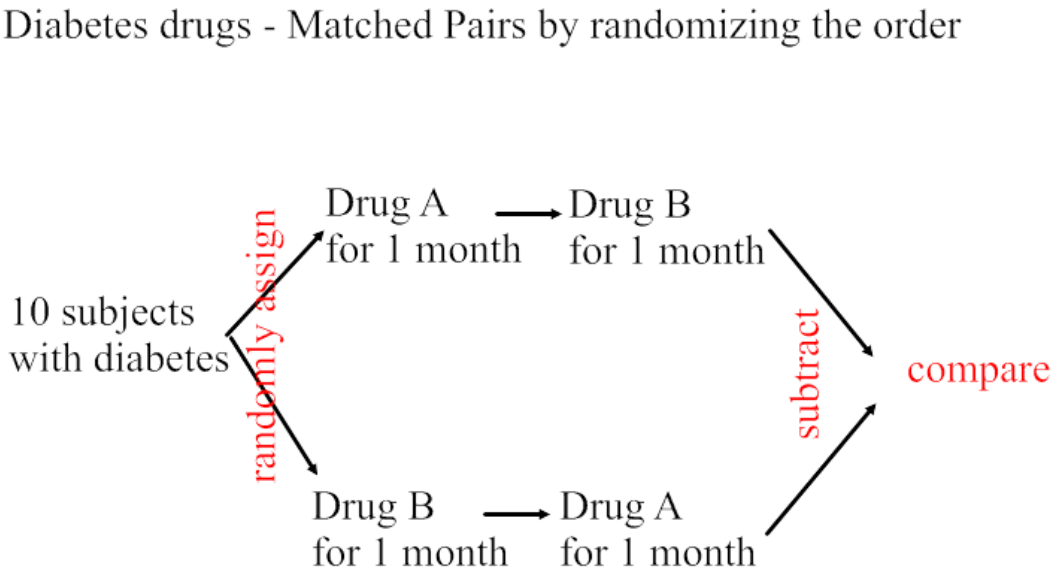


Example:

We want to decide whether there is a difference in effectiveness of an ACT prep course taken online vs. the classroom-based version from the same company. We can take an even number of volunteers who have taken the ACT just once before and rank them according to their scores. Of the 2 highest scoring students, randomly assign one to take the ACT prep course online and the other takes the classroom version. Of the next 2 highest scoring students, likewise randomly assign one to each format of the ACT prep course. Repeat this random assignment all the way down to the students who had the lowest scores on their first ACT taken. After the prep course is completed, all the students take the ACT a second time and we then find the difference in their scores on the ACT within each pair, subtracting the ACT score for the online-prepped student and the ACT score for the classroom-prepped student.



Example:
To determine which of two diabetes drugs is more effective, we take 10 volunteers who have diabetes and randomly assign 5 to each of 2 groups. One group is then given drug A for a month, followed by drug B for month. The other group takes drug B for one month, followed by drug A for one month. Daily records of their blood sugar levels are recorded and at the end of the study, we compare the blood sugar levels while on drug A to the blood sugar levels while on drug B.



4.3 Using Studies Wisely

Read 266–268

The scope of inference refers to the type of inferences (conclusions) that can be drawn from a study. The types of inferences we can make (inferences about the population and inferences about cause-and-effect) are determined by two factors in the design of the study:

		Were individuals randomly assigned to groups?	
		Yes	No
Were individuals randomly selected from a population?	Yes	Inferences about the population: Yes Inferences about cause and effect: Yes	Inferences about the population: Yes Inferences about cause and effect: No *Some observational studies are in this category.*
	No	Inferences about the population: No Inferences about cause and effect: Yes *Most experiments are in this category.*	Inferences about the population: No Inferences about cause and effect: No *Some observational studies are in this category.*

Many students insist that they study better when listening to music. A teacher doubts this claim and suspects that listening to music actually hurts academic performance. Here are four possible study designs to address this question at your school. In each case, the response variable will be the students' GPA at the end of the semester.

1. Get all the students in your AP Statistics class to participate in a study. Ask them whether or not they study with music on and divide them into two groups based on their answer to this question.
2. Select a random sample of students from your school to participate in a study. Ask them whether or not they study with music on and divide them into two groups based on their answer to this question.
3. Get all the students in your AP Statistics class to participate in a study. Randomly assign half of the students to listen to music while studying for the entire semester and have the remaining half abstain from listening to music while studying.
4. Select a random sample of students from your school to participate in a study. Randomly assign half of the students to listen to music while studying for the entire semester and have the remaining half abstain from listening to music while studying.

For each design, suppose that the mean GPA for students who listen to music while studying was significantly lower than the mean GPA of students who didn't listen to music while studying. What can we conclude for each design?

Read 268–271 (The Challenges of Establishing Causation, Data Ethics)

HW #8: page 264 (87–94), page 273 (97–104)

FRAPPY! (page 275)

HW #9: page 278 (R4.1-R4.10)

Review

HW #10: page 279 (Chapter 4 AP Statistics Practice Exam)

Chapter 4 Test