

# Sampling and Experimental Design

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## How could the following questions be answered using data?

Are coffee drinkers more likely to be female? Are females more likely to drink coffee than males? (What is the difference between these two questions?)

Does the new ebola vaccine work?

Do males have a better reaction time than females?

Do cell phones cause cancer?

How often do people wash their hands after using the restroom?

Can index finger lengths predict risk of prostate cancer?

Is autism onset related to childhood vaccinations?

Do diets work?

Will people drink blue soda?

Do people who text while driving have more accidents?

Is a larger snood in male turkeys related to perceived “toughness” by other male turkeys?

How many birds do cats kill each year?

How great is the placebo effect with depression drugs?

Are statins safe in the long run?

Are vitamins good for you?

Does getting seven or more hours of sleep help prevent colds?

Who will win the election?

## Random Rectangles Activity:

1. Your  $w$  \_\_\_\_\_  $g$  \_\_\_\_\_ of the average area: \_\_\_\_\_

mean of class: \_\_\_\_\_ standard deviation of class: \_\_\_\_\_

2.  $P$  \_\_\_\_\_  $f$  \_\_\_\_\_, then find the average area: \_\_\_\_\_

mean of class: \_\_\_\_\_ standard deviation of class: \_\_\_\_\_

3.  $R$  \_\_\_\_\_, then find the average area: \_\_\_\_\_

mean of class: \_\_\_\_\_ standard deviation of class: \_\_\_\_\_

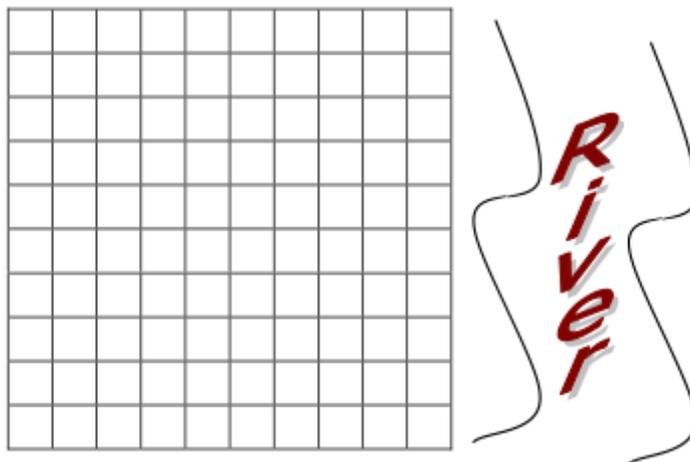
(A similar activity is “Jelly Blubbers.” See [noblestatman.com](http://noblestatman.com))

## An Exercise in Sampling: Rolling Down the River

A farmer has just cleared a new field for corn. It is a unique plot of land in that a river runs along one side. The corn looks good in some areas of the field but not others. The farmer is not sure that harvesting the field is worth the expense. He has decided to harvest 10 plots and use this information to estimate the total yield. Based on this estimate, he will decide whether to harvest the remaining plots.

### A. Method Number One: Convenience Sample

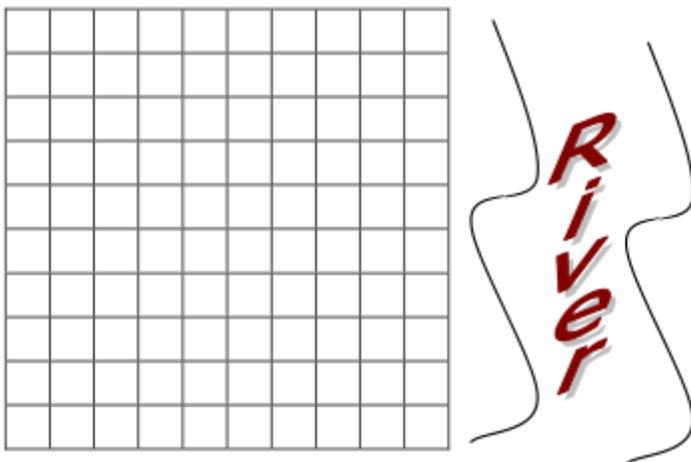
The farmer began by sampling plots easy to access. He drove his tractor out of the barn and sampled 10 contiguous plots, driving only horizontally or vertically. He may have driven over previously sampled plots, but he did not travel through a plot without sampling it. Mark 10 plots the farmer may have used.



Since then, the farmer had second thoughts about this selection and has decided to come to you (knowing that you are an AP statistics student, somewhat knowledgeable, but far cheaper than a professional statistician) to determine the approximate yield of the field. You will still be allowed to pick 10 plots to harvest early. Your job is to determine which of the following methods is the best one to use – and to decide if this is an improvement over the farmer's original plan.

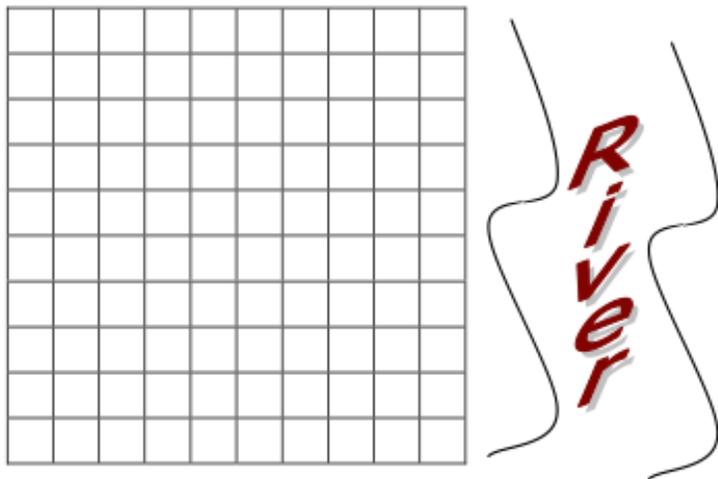
### B. Method Number Two: Simple Random Sample

Use your calculator or a random number table to choose 10 plots to harvest. Mark them on the grid below, and describe your method of selection.



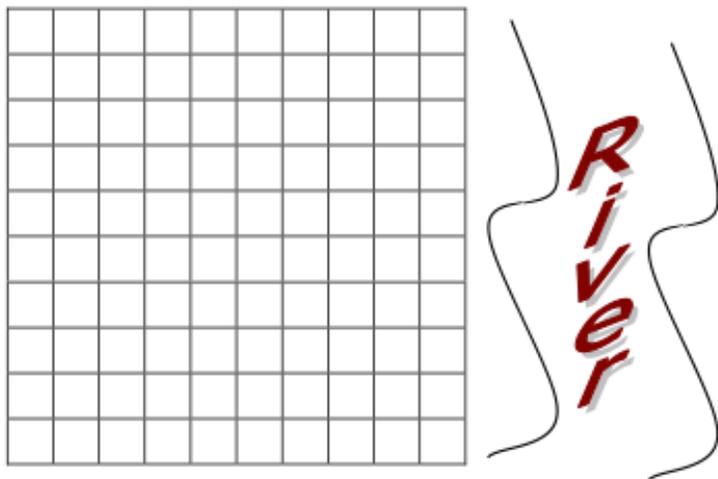
**C. Method Number Three: Stratified Sample**

Consider the field as grouped in vertical columns (called strata). Using your calculator or a random number table, randomly choose one plot from each vertical column and mark these plots on the grid.



**D. Method Number Four: Stratified Sample**

Consider the field as grouped in horizontal rows (also called strata). Using your calculator or a random number table, randomly choose one plot from each horizontal row and mark these plots on the grid.

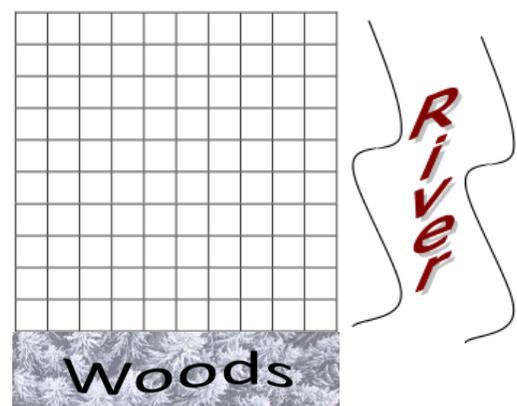


OK, the crop is ready. Your teacher will show you the actual yields in the field. Estimate the average yield per plot based on each of the four sampling techniques.

Sampling Method	Sum of 10 plots	Estimate of field
Convenience		
SRS		
Vertical strata		
Horizontal strata		

- 1) You have looked at four different methods of choosing plots. Is there a reason, other than convenience, to choose one method over another?
- 2) How did your estimates vary according to the different sampling methods you used?
- 3) Which sampling method should you use? Why do you think this method is best?
- 4) What might a cluster sample look like in this activity? Would it be helpful or not? Explain.

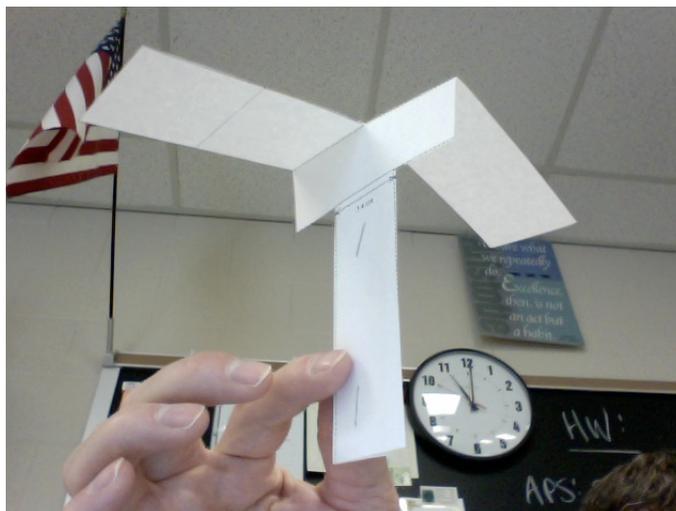
5) What design changes might be needed in the scenario depicted in this diagram?



# Paper Helicopter Experiment

Name: \_\_\_\_\_

1. Make a paper helicopter according to the directions and the photo below. You will need scissors, two staples, and a template from which to cut out the helicopter.



Type	Height	Distance from target				Mean	SD
Long rotor	(Low)						
Short rotor	(Low)						
Long rotor	(Medium)						
Short rotor	(Medium)						
Long rotor	(High)						
Short rotor	(High)						

2. Using three different heights (low, medium and high—you choose the distances) and two different helicopters (short rotor and long rotor), launch helicopters and measure how far they land from a target point on the floor. Conduct four launches at each position for each type of helicopter. This will give you 24 total launches. Collect the data in the table below, and answer the questions on the next page.

(Long rotor helicopter pictured above.)

# Helicopter Activity Questions

1. The 24 distances you recorded were not all exactly the same—there was a lot of variation. What were some of the sources (causes) of this variation?
2. These sources of variation can be categorized into three broad types. What are they?
3. How could you have “accounted for” the two “non-expected” general sources of variation?
4. What are the factors in the experiment?
5. What are the levels of each factor?
6. How many total treatments did you have? \_\_\_\_\_

# Unique Concepts/Terms in Experiments

Blocking (know how and why to block!)

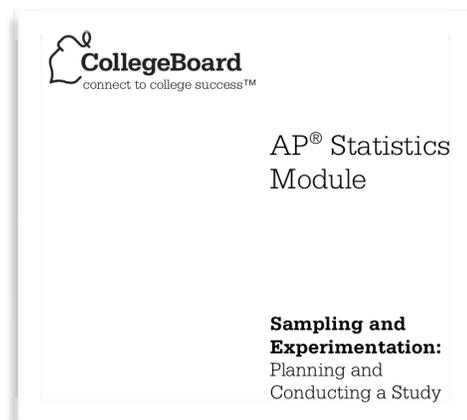
Confounding (this is a confusing and often misinterpreted concept!)

Generalizability of studies

Ramsey and Schafer (2002) :

		Assignment of Units to Groups		
		By Randomization	Not by Randomization	
Selection of units	At random	A random sample is selected from one population; units are then randomly assigned to different treatment groups.	Random samples are selected from existing distinct populations.	<b>Inferences to the populations can be drawn.</b>
	Not at random	A group of study units is found; units are then randomly assigned to treatment groups.	Collections of available units from distinct groups are examined.	
		<b>Causal inferences can be drawn.</b>		

The entire document can be found at AP Central:



Placebo and placebo effect

(See YouTube video from 60 minutes: Treating Depression: Is there a placebo effect?)

Blinding (single and double)

Three Types of Experiments (by name):

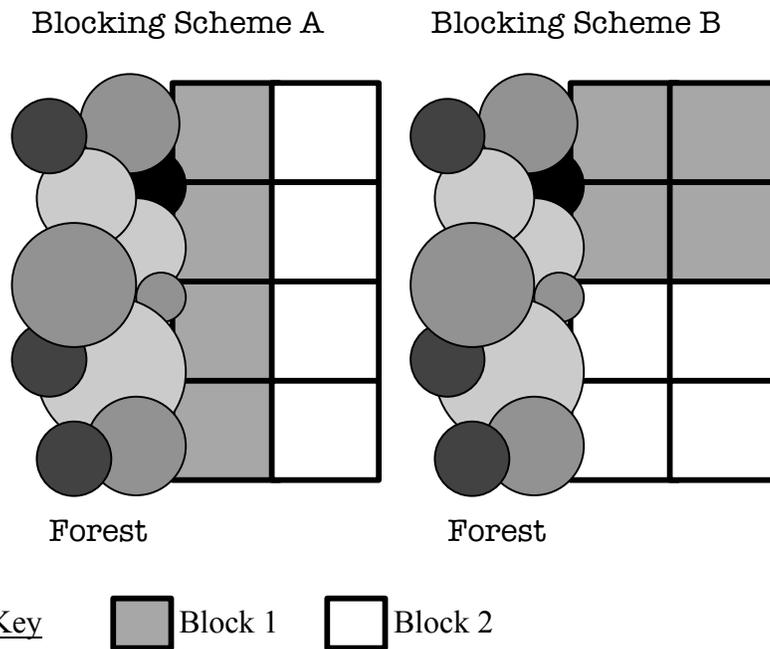
**Find the definition of blocking in your textbook and re-express it in your own words (“elaboration”):**

# Experimental Design:

## Blocking: Fruit Trees

1. Students are designing an experiment to compare the productivity of two varieties of dwarf fruit trees. The site for the experiment is a field that is bordered by a densely forested area on the west side. The field has been divided into eight plots of approximately the same area. The students have decided that the test plots should be blocked. Four trees, each of two varieties, will be assigned at random to the four plots within each block, with one tree planted in each plot.

The two blocking schemes shown below are under consideration. For each scheme, one block is identified by the white region and the other block indicated by the grey region in the figures.



- a. Which of the blocking schemes , A or B, is better for this experiment? Explain.
  
  
  
  
  
  
  
  
  
  
- b. Even though the students have decided to block, they must randomly assign the varieties of the trees to the plots within each block. What is the purpose of this randomization in the context of the experiment?

## Helicopter Activity: Possible answers

- 1 & 2: **“Time-based:”** Helicopter fatigue, launcher-person fatigue, increased/decreased drop skill, increased/decreased measuring skill, AC/air turned on, etc.  
**“Lack of Control-based:”** Launch height, measuring technique, construction accuracy, drop technique, different sizes of targets, etc.  
**“Planned:”** rotor length, drop height
3. For “time-based,” we could have randomized the order of the launches using a die. Let “1” stand for “Long, Low,” “2” stand for “Short, Low,” etc. Then any “time-based” variation would be spread out randomly among all six treatment groups and essentially “cancel out,” leaving only the variation caused by the treatments.  
For “lack of control-based,” we could have built some sort of helicopter launcher that would give us the exact same launch position. We could have had strict quality control on the construction: One large paper clip, cut exactly on the lines, two staples, etc. We could have defined exactly how to measure the distance of the helicopter from the target. We could have given each group a dime to use as a target.
4. There were two factors, rotor length and drop height.
5. There were two levels of rotor length: short and long. There were three levels of drop height: low, medium and high.
6. There were six treatments: Long/Low, Short/Low, Long/Medium, Short/Medium, Long/High, Short/High.

A veterinary researcher wants to test the effectiveness of a new mineral supplement in cat food to see if it causes faster weight gain than the existing supplement. Kittens in this experiment will be weighed when weaned, and will be weighed again at regular intervals for two years. In this design, the researchers would like to lessen the variability due to some of the naturally occurring growth rates found in cats. Which strategy below would be the most appropriate?

- (A) Stratify on cat breed. Then randomly sample cats within each breed. Then assign cats by breed to one of the two treatments.
- (B) Stratify on gender. Then randomly sample cats within each gender. Then assign cats by gender to one of the two treatments.
- (C) Stratify by the area of the state from which the cats live. Then sample cats from each area. Then assign cats by area to one of the two treatments.
- (D) Block by the area of the state from which cats live. Then randomly assign cats to the two treatment groups.
- (E) Block by cat breed. Then randomly assign cats to the two treatment groups.

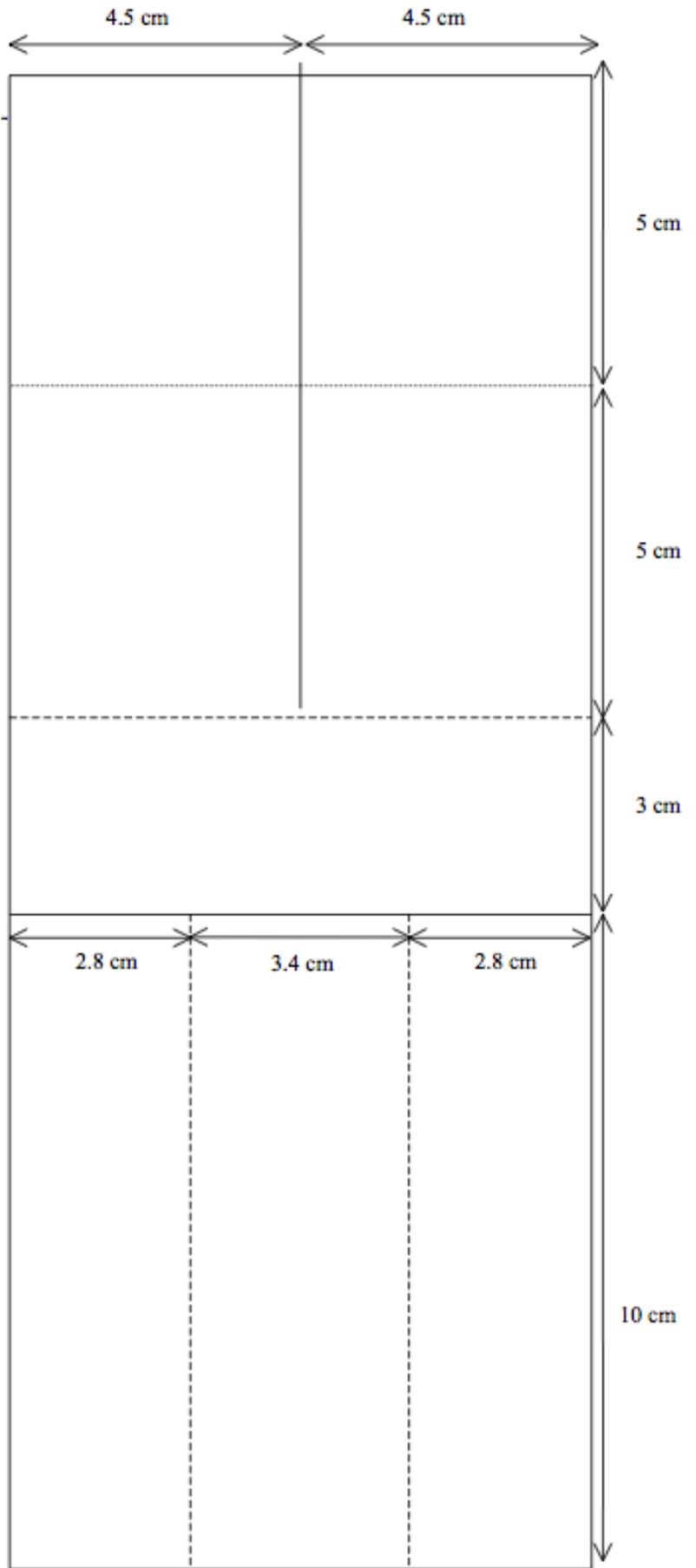
Answer: E

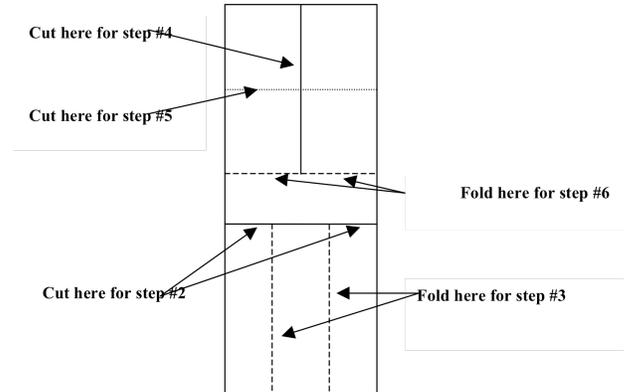
See [noblestatman.com](http://noblestatman.com) for document summarizing several vocabulary games.

A Brainscape flashcard set is here:

<https://www.brainscape.com/packs/4327749/invitation?referrer=714956>

Quizlet Live is also a great vocabulary review tool using flashcards!





1. Cut out the rectangular shape of the helicopter on the solid lines.
2. Cut one-third of the way in from each side of the helicopter to the vertical dashed lines on the solid line.
3. Fold both sides toward the center creating the base. The base can be stapled at the top and bottom. Try to be consistent about where the staples are placed. Use a paper clip to add some weight to the body.
4. For long-rotor helicopters, cut down from the top along the solid center line to the horizontal dashed line.
5. For short-rotor helicopters, proceed as in step 4, but cut the rotors off along the horizontal line marked.
6. Fold the rotors in opposite directions.