Freeport AP Statistics

Chapter 4: Designing Studies

4.1 Sampling Surveys

OBJECTIVE(S):

- ***Students will learn how to identify the population and sample in a sample survey.***
- ***Students will learn how to identify voluntary response samples and convenience samples. Explain how these bad sampling methods can lead to bias.***
- ***Students will learn how to distinguish between a simple random sample from a stratified random sample or cluster sample. Give advantages and disadvantages of each sampling method.***
- ***Students will learn how to use Table D to select a simple random sample (SRS).***
- ***Students will learn how undercoverage, nonresponse, and question wording can lead to bias in a sample survey.***

Population –

Sample –

Sample survey –

Convenience sample –

Bias –

Voluntary response sample –

Simple random sample (*SRS*) –

Table of random digits –

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1. An archaeological dig turns up large numbers of pottery shards, broken stone tools, and other artifacts. Students working on the project classify each artifact and assign it a number. The counts in different categories are important for understanding the site, so the project director chooses 2% of the artifacts at random and checks the students' work. Identify the population and the sample.

2. A department store mails a customer satisfaction survey to people who make credit card purchases at the store. This month, 45,000 people made credit card purchases. Surveys are mailed to 1000 of these people, chosen at random, and 137 people return the survey form. Identify the population and the sample.

3. You are on the staff of a member of Congress who is considering a bill that would provide government-sponsored insurance for nursing-home care. You report that 1128 letters have been received on the issue, of which 871 oppose the legislation. "I'm surprised that most of my constituents oppose the bill. I thought it would be quite popular," says the congresswoman. Are you convinced that a majority of the voters oppose the bill? How would you explain the statistical issue to the congresswoman?

4. In June 2008, *Parade* magazine posed the following question: "Should drivers be banned from using all cell phones?" Readers were encouraged to vote at parade.com. The July 13, 2008, issue of *Parade* reported the results: 2407 (85%) said "Yes" and 410 (15%) said "No."
    a. What type of sample did the *Parade* survey obtain?

    b. Explain why this sampling method is biased. Is 85% probably higher or lower than the true percent of all adults who believe that cell phone use while driving should be banned? Why?

5. You have probably seen the mall interviewer, approaching people passing by with clipboard in hand. Explain why even a large sample of mall shoppers would not provide a trustworthy estimate of the current unemployment rate.

6. You are planning a report on apartment living in a college town. You decide to select three apartment complexes at random for in-depth interviews with residents. Use an SRS method to randomly choose 3 complexes and justify your method.

Ashley Oaks	Chauncey Village	Franklin Park	Richfield
Bay Pointe	Country Squire	Georgetown	Sagamore Ridge
Beau Jardin	Country View	Greenacres	Salem Courthouse
Bluffs	Country Villa	Lahr House	Village Manor
Brandon Place	Crestview	Mayfair Village	Waterford Court
Briarwood	Del-Lynn	Nobb Hill	Williamsburg
Brownstone	Fairington	Pemberly Courts	
Burberry	Fairway Knolls	Peppermill	
Cambridge	Fowler	Pheasant Run	

7. The local genealogical society in Coles County, Illinois, has compiled records on all 55,914 gravestones in cemeteries in the county for the years 1825 to 1985. Historians plan to use these records to learn about African Americans in Coles County's history. They first choose an SRS of 395 records to check their accuracy by visiting the actual gravestones.
    a. Explain how you would use technology or Table D to choose the SRS. Your description should be clear enough for a classmate to obtain your results.

    b. Use your method from above to choose the first 3 gravestones.

Stratified Random Sample v. Cluster Sample

Inference –

Margin of error –

Sampling frame –

8. Accountants often use stratified samples during audits to verify a company's records of such things as accounts receivable. The stratification is based on the dollar amount of the item and often includes 100% sampling of the largest items. One company reports 5000 accounts receivable. Of these, 100 are in amounts over $50,000; 500 are in amounts between $1,000 and $50,000; and the remaining 4400 are in amounts under $1,000. Using these groups as strata, you decide to verify all the largest accounts and to sample 5% of the midsize accounts and 1% of the small accounts. How would you label the two strata from which you will sample? Use Table D, starting at line 115, to select only the first 3 accounts from each of these strata.

9. A hotel has 30 floors with 40 rooms per floor. The rooms on one side of the hotel face the water, while rooms on the other side face a golf course. There is an extra charge for the rooms with a water view. The hotel manager wants to survey 120 guests who stayed at the hotel during a convention about their overall satisfaction with the property.
    a. Explain why choosing a stratified random sample might be preferable to an SRS in this case. What would you use as strata?

    b. Why might a cluster sample be a simpler option? What would you use as clusters?

Undercoverage –

Nonresponse –

Response bias –

Wording of questions –

10. It is common in telephone surveys to use random digit dialing equipment that selects the last four digits of a telephone number at random after being given the exchange (the first three digits). Explain how this sampling method results in undercoverage that could lead to bias.

11. Which of the following are sources of sampling error and which are sources of nonsampling error? Explain your answers.
    a. The subject lies about past drug use.

    b. A typing error is made in recording the data.

    c. Data are gathered by asking people to mail in a coupon printed in a newspaper.

12. A common form of nonresponse in telephone surveys is "ring-no-answer." That is, a call is made to an active number but no one answers. The Italian National Statistical Institute looked at nonresponse to a government survey of households in Italy during the periods January 1 to Easter and July 1 to August 31. All calls were made between 7 and 10 p.m., but 21.4% gave "ring-no-answer" in one period versus 41.5% "ring-no-answer" in the other period. Which period do you think had the higher rate of no answers? Why? Explain why a high rate of nonresponse makes sample results less reliable.

13. A study in El Paso, Texas, looked at seat belt use by drivers. Drivers were observed at randomly chosen convenience stores. After they left their cars, they were invited to answer questions that included questions about seat belt use. In all, 75% said they always used seat belts, yet only 61.5% were wearing seat belts when they pulled into the store parking lots. Explain the reason for the bias observed in responses to the survey. Do you expect bias in the same direction in most surveys about seat belt use?

14. Comment on each of the following as a potential sample survey question. Is the question clear? Is it slanted toward a desired response?
    a. Which of the following best represents your opinion on gun control?
        i. The government should confiscate our guns.
        ii. We have the right to keep and bear arms.

    b. A freeze in nuclear weapons should be favored because it would begin a much-needed process to stop everyone in the world from building nuclear weapons now and reduce the possibility of nuclear war in the future. Do you agree or disagree?

Freeport AP Statistics

Chapter 4: Designing Studies

4.2 Experiments

OBJECTIVE(S):

- ***Students will learn how to distinguish between an observational study and an experiment.***
- ***Students will learn how to explain how a lurking variable in an observational study can lead to confounding.***
- ***Students will learn how to identify the experimental units or subjects, explanatory variables (factors), treatments, and response variables in an experiment.***
- ***Students will learn how to describe a completely randomized design for an experiment.***
- ***Students will learn how to avoid the placebo effect in an experiment.***
- ***Students will learn how to explain the meaning and the purpose of blinding in an experiment.***
- ***Students will learn how to distinguish between a completely randomized design and a randomized block design.***
- ***Students will learn how to explain why random assignment is an important experimental design principle.***
- ***Students will learn how to explain in context what "statistically significant" means.***
- ***Students will learn how to know when a matched pairs experimental design is appropriate and how to implement such a design.***

Observational Study –

Experiment –

Lurking Variable –

Confounding –

Treatment –

Experimental Units –

Subjects –

Factors –

Level –

15. A study of child care enrolled 1364 infants and followed them through their sixth year in school. Later, the researchers published an article in which they stated that "the more time children spent in child care from birth to age four-and-a-half, the more adults tended to rate them, both at age four-and-a-half and at kindergarten, as less likely to get along with others, as more assertive, as disobedient, and as aggressive."
    a. Is this an observational study or an experiment? Justify your answer.

b. What are the explanatory and response variables?

c. Does this study show that child care causes children to be more aggressive? Explain.

16. An educator wants to compare the effectiveness of computer software for teaching biology with that of a textbook presentation. She gives a biology pretest to each of a group of high school juniors, and then randomly divides them into two groups. One group uses the computer, and the other studies the text. At the end of the year, she tests all the students again and compares the increase in biology test scores in the two groups.
    a. Is this an observational study or an experiment?

    b. If the group using the computer has a much higher average increase in test scores than the group using the textbook, what conclusions, if any, could the educator draw?

17. A common definition of "binge drinking" is 5 or more drinks at one sitting for men and 4 or more for women. An observational study finds that students who binge drink have lower average GPA than those who don't. Identify a lurking variable that may be confounded with the effects of binge drinking. Explain how confounding might occur.

18. For the experiment described below, identify the experimental units or subjects, the explanatory variables (factors), the treatments, and the response variables.

    a. "You can use Voice over Internet Protocol (VoIP) to make long-distance telephone calls over the Internet. One of the most popular VoIP services is Skype. How will the appearance of ads during calls affect the use of this service? Researchers design an experiment to find out. They recruit 300 people who have not used Skype before to participate. Some people get the current version of Skype with no ads. Others see ads whenever they make calls. The researchers are interested in the frequency and length of phone calls."

b. Most American adolescents don't eat well and don't exercise enough. Can middle schools increase physical activity amount their students? Can they persuade students to eat better? Investigators designed a "physical activity intervention" to increase activity in physical education classes and during leisure periods throughout the school day. They also designed a "nutrition intervention" that improved school lunches and offered ideas for healthy home-packed lunches. Each participating school was randomly assigned to one of the interventions, both interventions, or no intervention. The investigators observed physical activity and lunchtime consumption of fat.

c. A student project measured the increase in the heart rates of fellow students when they stepped up and down for three minutes to the beat of a metronome. The step was either 5.75 or 11.5 inches high and the metronome beat was 14, 21, or 28 steps per minute. Thirty students participated in the experiment. Five students stepped at each combination of height and speed.

Random Assignment –

Completely Randomized Design –

Control Group –

19. When is it required and not required to include a control group?

20. What are the three basic principles for designing experiments?

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21. Will cash bonuses speed the return to work of unemployed people? A state department of labor notes that last year 68% of people who filed claims for unemployment insurance found a new job within 15 weeks. As an experiment, this year the state offers $500 to people filing unemployment claims if they find a job within 15 weeks. The percent who do so increases to 77%. What flaw in the design of this experiment makes it impossible to say whether the bonus really caused the increase? Explain.

22. Figure 4.2 (page 239) displays the 6 treatments for a two-factor experiment on TV advertising. Suppose we have 150 students who are willing to serve as subjects. Describe how you would randomly assign the subjects to the treatments.

23. The changing climate will probably bring more rain to California, but we don't know whether the additional rain will come during the winter wet season or extend into the long dry season in spring and summer. Kenwyn Suttle of the University of California at Berkeley and his coworkers carried out an experiment to study the effects of more rain in either season. They randomly assigned plots of open grassland to 3 groups: added water equal to 20% of annual rainfall either during January to March (winter) or during April to June (spring), and no added water (control). Thirty-six circular plots of area 70 square meters were available, of which 18 were used for this study. One response variable was total plant biomass, in grams per square meter, produced in a plot over a year.
    a. Outline the design of the experiment. What is this type of design called?

    b. Explain how you would randomly assign the experimental units to the three groups.

24. Elementary schools in rural India are usually small, with a single teacher. The teachers often fail to show up for work. Here is an idea for improving attendance: give the teacher a digital camera with a tamperproof time and date stamp and ask a student to take a photo of the teacher and class at the beginning and end of the day. Offer the teacher better pay for good attendance, verified by the photos. Will this work? Researchers obtained permission to use 120 rural schools in Rajasthan for an experiment to find out.
    a. Explain why it would not be a good idea to offer better pay for good attendance to the teachers in all 120 schools and then to compare this year's attendance with last year's.

    b. Describe how you would design this experiment.

DAY 5

Placebo Effect –

Double-Blind –

Statistically Significant –

25. Fizz Laboratories, a pharmaceutical company, has developed a new drug for relieving chronic pain. Sixty patients suffering from arthritis and needing pain relief are available. Each patient will be treated and asked an hour later, "About what percent of pain relief did you experience?"
    a. Why should Fizz not simply administer the new drug and record the patients' responses?

    b. Should the patients be told whether they are getting the new drug or a placebo? How would this knowledge probably affect their reactions?

26. As men age, their testosterone levels gradually decrease. This may cause a reduction in lean body mass, an increase in fat, and other undesirable changes. Do testosterone supplements reverse some of these effects? A study in the Netherlands assigned 237 men aged 60 to 80 with low or low-normal testosterone levels to either a testosterone supplement or a placebo. The report in the *Journal of the American Medical Association* described the study as a "double-blind, randomized, placebo-controlled trial." Explain each of these terms to someone who knows no statistics.

27. Dr. Linda Stern and her colleagues recruited 132 obese adults at the Philadelphia Veterans Affairs Medical Center in Pennsylvania. Half of the participants were randomly assigned to a low-fat diet. Researchers measured each participant's change in weight and cholesterol level after six months and again after one year. Subjects in the low-carb diet group lost significantly more weight than subjects in the low-fat diet group during the first six months of the study. At the end of a year, however, the average weight loss for subjects in the two groups was not significantly different.
    a. Why did researchers randomly assign the subjects to the diet treatments?

    b. Explain to someone who knows little statistics what "lost significantly more weight" means.

c. The subjects in the low-carb diet group lost an average of 5.1 kg in a year. The subjects in the low-fat diet group lost an average of 3.1 kg. Explain how this information could be consistent with the fact that weight loss in the two groups was not significantly different.

DAY 6

Block –

Randomized Block Design –

28. When do we need to choose a Randomized Block Design instead of a Randomized Comparative Design?

29. Don't confuse the language of experiments with the language of sampling. What's the difference between a stratified random sample and randomized block design?

30. The progress of a type of cancer differs in women and men. Researchers want to design an experiment to compare three therapies for this cancer. They recruit 500 male and 300 female patients who are willing to serve as subjects.
    a. What are the blocks in this experiment?

    b. What are the advantages of a randomized block design over completely randomized design using these 800 subjects?

    c. Suppose the researchers had 800 male and no female subjects available for the study. What advantage would this offer? What disadvantage?

31. Twenty overweight females have agreed to participate in a study of the effectiveness of four weight-loss treatements: A, B, C, and D. The researcher first calculates how overweight each subject is by comparing the subject's actual weight with her "ideal" weight. The subjects and their excess weights in pounds are as follows:

Birnbaum	35	Hernandez	25	Moses	25	Smith	29
Brown	34	Jackson	33	Nevesky	39	Stall	33
Brunk	30	Kendall	28	Obrach	30	Tran	35
Cruz	34	Loren	32	Rodriguez	30	Wilansky	42
Deng	24	Man	28	Santiago	27	Williams	22

The response variable is the weight lost after 8 weeks of treatment. Previous studies have shown that the effects of a diet may vary based on a subject's excess weight.

a. Explain why a randomized block design would be better than a completely randomized design in this setting.

b. Should researchers form blocks of size 4 based on subjects' last names in alphabetical order or by how overweight the subjects are? Explain.

c. How can we randomize?

Matched Pairs Design -

32. Cardiologists at Athens Medical School in Greece wanted to test whether chocolate affected blood flow in the blood vessels. The researchers recruited 17 healthy young volunteers, who were each given a 3.5-ounce bar of dark chocolate, either bittersweet or fake chocolate. On another day, the volunteers switched which type of bar they ate. The subjects had no chocolate outside the study, and investigator didn't know whether a subject had eaten the real or the fake chocolate. An ultrasound was taken of each volunteer's upper arm to see the functioning of the cells in the walls of the main artery. The investigator found that blood vessel function was improved when the subjects ate bittersweet chocolate, and that were no such changes when they ate the placebo (fake chocolate).

a. What type of design did the investigators use in their study?

b. Explain why the investigators chose this design instead of a completely randomized design.

c. Why is it important to randomly assign the order of the treatments for the subjects?

33. Does listening to music while reading a story help or hinder recall of factual details? Describe how you would design and carry out an experiment to answer this question using 30 students at your school who have agreed to participate.

DAY 7

Freeport AP Statistics

Chapter 4: Designing Studies

4.3 Using Studies Wisely

OBJECTIVE(S):

- ***Students will learn to determine the scope of inference for a statistical study.***

34. What is the difference between *inference about a population* v. *inference about cause and effect*?

35. Will storing batteries in a freezer make them last longer? To find out, a company that produces batteries takes a random sample of 100 AA batteries from its warehouse. The company statistician randomly assigns 50 batteries to be stored in the freezer and the other 50 to be stored at room temperature for 3 years. At the end of that time period, each battery's charge is tested. *Result*: Batteries stored in the freezer have a higher average charge, and the difference between the groups was statistically significant. What conclusions can we draw from this study? Explain.

36. One of the better studies of the effect of regular attendance at religious services gathered data from a random sample of 3617 adults. The researchers then measured lots of variables, not just the explanatory variable (religious activities) and the response variable (length of life). A news article said: "Churchgoers were more likely to be nonsmokers, physically active, and at their right weight. But even after health behaviors were taken into account, those not attending religious services regularly still were about 25% more likely to have died." What conclusion can we draw from this study? Explain.

37. A psychologist wants to study the effects of failure and frustration on the relationships among members of a work team. She forms a team of students, brings them to the psychology lab, and has them play a game that requires teamwork. The game is rigged so that they lose regularly. The psychologist observes the students through a one-way window and notes the changes in their behavior during an evening of game playing. Can the psychologist generalize the results of her study to a team of employees that spends months developing a new product that never works right and is finally abandoned by their company? Explain.