9.6 Let's Investigate

A Solidify Understanding Task

When we want to draw conclusions about some population, there are at least two different statistical ideas to consider. We learned about sampling in Would You Like to Try a Sample, since it is usually more practical to sample the population rather than somehow measure everyone or everything in the population.

The second thing to consider is how to measure the parameter of interest, the thing we want to know about the population. Sometimes it’s obvious, like if you want to know the average weight of a population, you determine a sample and then put each of the subjects on a scale. Three other techniques are the following:

- **Surveys**: When they want to know how people feel, what their preferences are, what they own, how much they make, etc., researchers often construct a survey to ask the people in the sample about the parameter of interest.

- **Observational Studies**: In this type of study, researchers observe the behavior of the participants/subjects without trying to influence it in any way so they can learn about the parameter of interest.

- **Experiments**: In an experiment, researchers manipulate the variables to try to determine cause and effect.

1. Imagine that you want to know whether a new diet plan is effective in helping people lose weight. You might choose any of the three methods to determine this.

   - If you used a survey, you could simply ask people that had tried the diet plan if they lost weight.
   - If you used an observational study, you might monitor volunteers that try the diet plan and measure how much weight they lost (or gained).
   - If you used an experiment, you might randomly assign participants to two groups. One group (the control group) eats as they normally would and the other group (the experimental group) eats according to the diet plan. At the end of two months, the two groups are compared to see the average weight gain or loss in each group.
Based on these three examples,

a. What are some possible advantages and disadvantages of surveys?

b. What are some possible advantages and disadvantages of observational studies?

c. What are some possible advantages and disadvantages of experiments?

2. Identify which method is illustrated by each example:

a. To determine whether drinking orange juice prevents colds, researchers randomly assigned participants to a group that drank no orange juice or a group that drank two glasses of orange juice a day. They measured the number of colds that each group had over the course of the year and compared the results of the two groups.

b. To determine whether exercise reduces the number of headaches, researchers randomly selected a group of participants and recorded the number of hours each participant exercised and the number of headaches each participant experienced.

c. To determine the effectiveness of a new advertising campaign, a restaurant asked every tenth customer if they had seen the advertisement, and if it had influenced their decision to visit the restaurant.

d. To determine if a new drug is an effective treatment for the flu, researchers randomly selected two groups of people that had the flu. One group was given a placebo (a sugar pill that has no physical effect) and one group was given the new drug. Researchers measured the number of days that participants experienced flu symptoms and compared the two groups to see if they were different.

e. To determine if higher speed limits cause more traffic fatalities, researchers compared the number of traffic deaths on randomly selected stretches of highway with 65 mph speed limits to the number of traffic deaths on an equal number of randomly selected stretches of highway with 75 mph speed limits.
3. Describe how you might select a sample and use a survey to investigate which soft drink people prefer: Fizzy Pop or Kooky Kola.

4. Describe how you might select a sample and use an observational study to investigate which soft drink people prefer: Fizzy Pop or Kooky Kola.

5. Describe how you might select a sample and use an experiment to investigate if consuming large quantities of Kooky Kola is associated with having headaches.

6. Describe the method you would use to determine if excessive texting is associated with bad grades. Explain why you chose that method and what conclusions could be drawn from the study.
9.6 Let's Investigate – Teacher Notes

A Solidify Understanding Task

Purpose:
The purpose of the task is for students to learn to identify three methods of investigating a parameter of interest: survey, observational study, and experiment. The task begins with an explanation of the three methods including an example of each. Students are then asked to identify which method is illustrated by some other examples and to consider the advantages and disadvantages of each method. Finally, students are given a situation and asked to design an investigation including selecting a sampling method and a method of investigating the parameter of interest.

Core Standards Focus:
S.I.C.3: Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

Related Standards: S.I.C.1

Standards for Mathematical Practice:
SMP 7 – Look for and make use of structure

Vocabulary: survey, observational study, experiment, control group, experimental group

The Teaching Cycle:
Launch (Whole Class):
Begin the task by reading through the description of the three investigation methods with the class and discussing the examples. Gives students a chance to ask questions and clarify the differences between each of the three types.
Give students a few minutes to think about the advantages and disadvantages of each type and then discuss their answers. During this discussion, include the idea that the validity of the results will partially depend on how the sample was selected as well as the method of the study. For instance, surveys have the advantage of being easy to gauge opinions. A disadvantage may be the difficulty in writing questions that accurately measure the parameter of interest. No matter how good the survey questions are, the survey may not yield useful results if it is not based on a representative sample of the population. After discussing the ideas of each method, then ask students to complete the task.

**Explore (Small Group):**
Listen to students as they are working to see that they are noticing the distinguishing characteristics of each method. Students often have difficulty with the difference between an observational study and an experiment. Be prepared to help them understand that it is not an experimental design if there is not a control group and an experimental (treatment) group. Try to identify students to present each of the three methods as a study design for #6.

**Discuss (Whole Class):**
Begin the discussion by quickly identifying the method for each of the examples in #2. For each example, clarify the distinguishing features of that method.

Turn the discussion to question #3. Ask a student to present how they might select a sample and design a survey. Ask the class what questions they might ask to obtain an unbiased result. Have a student present their design for question #4. Ask students how they can ensure that the study participants’ preferences are not influenced by the observer or other factors.

Ask students to present their experimental design for question #5. How will students select the two groups so they are comparable? What will be the treatment? How will they maintain the control group?
Finally, discuss question #6. If you have identified students to present each of the three methods, then ask them to share their thinking and have the class critique their design including the sampling method. If there is a method that was not used by any student in the class, facilitate a discussion with the whole class to design a study together using that method.

Aligned Ready, Set, Go: Statistics 9.6
## Study Designs

<table>
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<th></th>
<th>Survey</th>
<th>Observation</th>
<th>Experiment</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
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The following data represents a random sample of boys and girls and how many prefer cats or dogs. Use the information to answer the questions below.

<table>
<thead>
<tr>
<th></th>
<th>Cats</th>
<th>Dogs</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>Boys</td>
<td>32</td>
<td>68</td>
<td>100</td>
</tr>
<tr>
<td>Girls</td>
<td>41</td>
<td>11</td>
<td>52</td>
</tr>
<tr>
<td>Total</td>
<td>73</td>
<td>79</td>
<td>152</td>
</tr>
</tbody>
</table>

1. \( P(B) = \)
2. \( P(G) = \)
3. \( P(C) = \)
4. \( P(D) = \)
5. \( P(C|G) = \)
6. \( P(C \text{ or } B) = \)
7. \( P(D|B) = \)
8. \( P(B \cap D) = \)

9. If this is a random sample from a school, what total percent of boys in this school do you think would prefer dogs?
10. What percent of students at the school would prefer cats?
11. If you sampled a different 152 students, would you get the same percentages? Explain.
12. What would happen to your percentages if you used a larger sample size?

For the following scenarios, identify each situation as a survey, observational study, or an experiment.

13. To determine if a new pain medication is effective, researchers randomly assign two groups of people to use the pain medication in group 1 and a placebo in group 2. Both groups are asked to rate their pain and the results are compared.

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14. Officials want to determine if raising the speed limit from 75 mph to 80 mph will have an impact on safety. To determine this, they watch a stretch of the highway when the speed limit is 75 and see how many accidents there are. Then they observe the number of accidents over a period of time on the same stretch of highway for a speed limit of 80 mph. They then compare the difference.

15. To determine if a new sandwich on the menu is preferred more than the original, the manager of the restaurant takes a random sample of customers that have tried both sandwiches and asks them which sandwich they like best.

16. A newspaper wants to know what its customer satisfaction is. It randomly selects 500 customers and asks them.

Mrs. Goodmore wants to know if doing homework actually helps students do better on their unit exams.

17. Describe how Mrs. Goodmore could carry out a survey to determine if homework actually helps. Explain the role of randomization in your design.

18. Describe how Mrs. Goodmore could carry out an observational study to determine if homework helps test scores.

19. Describe how Mrs. Goodmore could carry out an experiment to determine if homework helps test scores. Explain how you will use randomization in your design and how you will use a control.

20. If Mrs. Goodmore wants to determine if homework causes test scores to rise, which method would be best? Why?
The average resting heart rate of a young adult is approximately 70 beats per minute with a standard deviation of 10 beats per minute. Assuming resting heart rate follows a Normal Distribution, answer the following questions.

21. Draw and label the Normal curve that describes this distribution. Be sure to label the mean, and the measurements 1, 2, and 3 standard deviations out from the mean.

22. What percent of people have a heart rate between 55 and 80 beats per minute? Label these points on your Normal curve above and shade in the area that represents the percent of people with heartbeats between 55 and 80 beats per minute.

23. If a resting heart rate above 80 beats per minute is considered unhealthy, what percent of people have an unhealthy heart rate?