

Goal 3: Data Analysis & Probability

Designing Samples/Simple Random Samples

OBJECTIVE	CORE LEARNING GOALS
<ul style="list-style-type: none"> The student will consider the advantages and disadvantages of various sampling techniques. The student will define a Simple Random Sample and identify possible sources of bias in other types of samples. 	<p>3.1.1 The student will design and/or conduct an investigation that uses statistical methods to analyze data and communicate results.</p>
<p>DRILL Systematic error caused by bad sampling methods may lead to a biased study favoring certain outcomes.</p> <p>Identify possible sources of bias in each survey.</p> <ol style="list-style-type: none"> Customers at a supermarket are sampled to determine their opinion about a controversial political issue. <i>(Supermarket shoppers may share characteristics that differ from those of the general public. To include only these people in a sample you may not get the full range of public opinion.)</i> Television viewers are invited to call an 800 number to report their opposition to a bill to increase state gasoline taxes. <i>(This is an example of a voluntary response sample. To include in a sample only those that volunteer, one may tend to get only the opinions of those who feel very strongly about certain issues.)</i> A large company selects names from a telephone book to sample for a survey on household spending habits. <i>(Those with unlisted phone numbers or without phones will not be included in the sample. These people may have significantly different spending habits than those contacted.)</i> 	<p>MATERIALS Activities: “Designing Samples,” “Simple Random Samples,” and “Examining Sample Designs” Answer Keys</p>
<p>CALCULATOR SKILLS None</p>	

ACTIVITIES

1. **Drill.** This activity introduces students to the concept of bias. Students need to recognize when bias is present in sampling design. Results from biased samples should not be used to estimate population percentages.
2. **Exploration.** As mentioned earlier, not all samples will yield good estimates for a population percentage. These activities require students to analyze sampling methods and to consider sources of bias that may corrupt sample results. Under-representation of certain groups in a population or poorly worded questions can significantly alter sample results.
3. **Class Discussion.** At this point students should see that the size of the sample must be relatively large and that the sample should be unbiased and representative of the population. **Simple Random Sample** techniques ensure that each member of the population has an equal chance of being selected for the sample.
4. **Additional problems.** “Examining Sample Designs”

ASSESSMENT

Summary Questions:

1. What is a simple random sample?
(A simple random sample ensures that each member of the population is equally likely to be chosen and the members of the sample are chosen independently of each other.)
2. Identify characteristics of good sample designs.
(Sample should be large with respect to the population. They should be representative of the population, and they should be selected in a random fashion.)

HOMEWORK

“Examining Sample Designs”

Designing Samples

The Student Government at Central High School wants to determine which activity students would most enjoy: a dance, an ice cream social, a carnival, or a movie night. The SGA has one week to survey students and gather the input it needs to make a decision. Because Central High has a large student body of over 2,000, contacting each student is not reasonable, so members of the SGA agree to contact a sample of students.

1. Several students have ideas on how to gather this information. Consider each of the following suggestions. Comment on the advantages and disadvantages of each method.
 - a. Sally suggests that the thirty Student Government members should vote on which activity is most favorable.
 - b. Anthony suggests that each member ask five friends which activity they prefer. Therefore, 150 students would be sampled.
 - c. Jae Hi suggests placing a comment box in the cafeteria, so that any student can participate in the sample.
 - d. Antoine thinks that the SGA should select several teachers at random and survey students in their homeroom.
 - e. Melanie knows that the computer in the main office can select students at random who can be included in the sample.
2. Describe a *different* method that could be used to generate a sample of Central High students to vote on which activity they prefer. Use what you know about sampling to justify your answer.

3. For each of the following sampling methods, identify the groups in the population that are *underrepresented*.
- a. To obtain a sample of households, a consumer reporter dials numbers taken at random from a telephone directory.
 - b. A car manufacturer wishes to survey a sample of drivers, so he randomly selects the names of car owners from a list of vehicle registrations.
 - c. A college professor wants to know what percentage of young adults, ages 18 to 22, consider education a top priority. He obtains a list of all students on campus from the registrar and randomly selects names from the list.
 - d. A radio station wishes to examine the proportion of its listeners who voted in the last presidential election. They conduct a poll by asking listeners to call the station.

Simple Random Samples

A sample is a simple random sample if

- each member of the population is equally likely to be chosen and
 - the members of the sample are chosen independently of one another.
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1. Determine whether or not the following sampling methods produce a simple random sample from a class of 30 students. Use principles of simple random sampling to justify your answers.
 - a. A teacher wants to select five students from the class. She selects the first five students that enter the room.
 - b. A teacher wants to select ten students from the class. She lists students in alphabetical order, then selects every third student.
 - c. A teacher wants to select six students from the class. She writes each student's name on an index card, places the index cards in a box, mixes the cards, then chooses six cards from the box.
2. Occasionally, random sampling yields a sample that is not *representative* of the population. Suppose there are fifteen boys and fifteen girls in a math class. Each student's name is placed in a hat and the names are thoroughly mixed. Seven names are drawn and all names correspond to the boys in the class.
 - a. Did the sampling method produce a simple random sample? Use principles of simple random sampling to justify your answer.
 - b. Is this a *representative* sample? Use mathematics to justify your answer.

Examining Sample Designs

1. A high school's class rings that were ordered have arrived and are ready to be given out. The principal must determine whether students would prefer to receive their rings at an assembly during school or at a dance in the evening. The principal does not have time to contact every member of the class, so she will obtain a sample of 50 students to survey.
 - Describe a method the principal should use to select the students to survey. Use principles of simple random sampling to justify your answer.

2. Every Sunday night a popular radio station plays new music performed by local bands. At the end of the segment the deejay asks listeners to call in with their reactions: "Dump it" or "Pump it." One Sunday night 60% of the 100 callers voted to "Dump it" after hearing a song performed by a particular band.
 - Do you think 60% is a reasonable estimate for the percentage of all listeners who did not like the music? Use mathematics to justify your answer.

3. Ten randomly selected adults were asked the following question: "Do you feel fulfilled in your present career?" Three of the adults responded, "no."
 - Based on this data, what is the probability that a randomly selected adult would respond no to the question?

 - Is this probability a reasonable estimate of the percent of the population that would respond no? Use mathematics to justify your answer.

Designing Samples

Answer Key

1.
 - a. The opinions of the Student Government members do not necessarily reflect the opinions of the entire student body, so the sample would most likely under-represent many groups of students in the school. Although the members could make a decision quickly by casting their own votes, this technique may not fairly reflect the views of all students.
 - b. Selecting 150 students will certainly generate a large enough sample, but again, the sampling design may systematically favor the views of certain groups of students. This technique may not fairly reflect the views of all students.
 - c. To include in a sample only those that volunteer, the student government may get only the opinions of those who feel very strongly about certain activities. This technique may not fairly reflect the views of all students, although it is a very convenient method for collecting data.
 - d. Antoine's idea to select teachers at random is a good one. However, not all groups of students will have the same opportunity to be included in the sample. For example, it's possible that all of the school's gym teachers are selected, therefore only students taking gym will get to vote. This technique may not fairly reflect the views of all students.
 - e. Selecting students randomly is the best technique because it gives each student an equal chance of being selected. However, random samples are often very difficult to obtain without the use of a computer or other random device.

2. Answers will vary. Samples should be large and selected randomly. For example, each student could receive a raffle ticket or other type of ticket stub with unique numbers. Place all tickets in a box and mix them thoroughly. Draw a handful of tickets (between thirty and fifty should be plenty) and ask the students with these ticket numbers to participate in the survey.

3.
 - a. Not all phone numbers are listed in a telephone directory, so households with unlisted numbers will not be included in the sample. Also, households without phones will not be included. Some households have multiple phone lines, which increases the chances of being included in a sample.
 - b. Not all drivers own vehicles or have vehicles registered in their names. These drivers (for instance, teenagers) would be excluded from the sample.
 - c. The professor is only selecting the young adults at his university. Young adults not attending school or attending other colleges are excluded from his survey.
 - d. Not all of the station's listeners will be listening at the time of the poll. These listeners won't have the opportunity to be included in the sample. Voluntary response samples often exclude listeners with moderate views or opinions.

Simple Random Samples Answer Key

1.
 - a. Not a simple random sample. Students that get to class early may have views that are systematically different from those students who come to class later.
 - b. Not a simple random sample. The members of the sample are not chosen independently of each other. For example, two students whose names appear next to each other alphabetically, will never be in the same sample.
 - c. Simple random sample. Each student and each combination of students is equally likely.

2.
 - a. Yes. Each student is equally likely to be chosen and the students are chosen independently of each other.
 - b. No. It's possible to obtain a sample of all boys, even if the method used produces a simple random sample. One way to avoid non-representative samples is to take a large sample. Unfortunately, it is not always possible to tell if the sample is not representative of a population unless we already know about the population. But if we already knew about the population, we would not need to sample from it. This is a paradox that all statisticians face.

Examining Sample Designs Answer Key

1. Answers will vary. One possible sampling technique would be to assign all students, who ordered rings, a number label. Then select these numbers using a random device. This method would work because each student that ordered a ring is equally likely to be chosen and the students are chosen independently of each other

2. 60% is probably *not* a good estimate because the station will most likely get the responses of listeners with very strong opinions from the voluntary response survey. This group may be very small compared to a group of listeners with moderate views, who may actually like the music.

3.
 - a. $3/10 = 0.30$
 - b. The sample size is very small compared to the population of working adults, so the probability is not a good estimate.