2. An administrator at a large university wants to conduct a survey to estimate the proportion of students who are satisfied with the appearance of the university buildings and grounds. The administrator is considering three methods of obtaining a sample of 500 students from the 70,000 students at the university.

   (a) Because of financial constraints, the first method the administrator is considering consists of taking a convenience sample to keep the expenses low. A very large number of students will attend the first football game of the season, and the first 500 students who enter the football stadium could be used as a sample. Why might such a sampling method be biased in producing an estimate of the proportion of students who are satisfied with the appearance of the buildings and grounds?

   (b) Because of the large number of students at the university, the second method the administrator is considering consists of using a computer with a random number generator to select a simple random sample of 500 students from a list of 70,000 student names. Describe how to implement such a method.

   (c) Because stratification can often provide a more precise estimate than a simple random sample, the third method the administrator is considering consists of selecting a stratified random sample of 500 students. The university has two campuses with male and female students at each campus. Under what circumstance(s) would stratification by campus provide a more precise estimate of the proportion of students who are satisfied with the appearance of the university buildings and grounds than stratification by gender?

---

3. Each full carton of Grade A eggs consists of 1 randomly selected empty cardboard container and 12 randomly selected eggs. The weights of such full cartons are approximately normally distributed with a mean of 840 grams and a standard deviation of 7.9 grams.

   (a) What is the probability that a randomly selected full carton of Grade A eggs will weigh more than 850 grams?

   (b) The weights of the empty cardboard containers have a mean of 20 grams and a standard deviation of 1.7 grams. It is reasonable to assume independence between the weights of the empty cardboard containers and the weights of the eggs. It is also reasonable to assume independence among the weights of the 12 eggs that are randomly selected for a full carton.

   Let the random variable X be the weight of a single randomly selected Grade A egg.

   i) What is the mean of X ?

   ii) What is the standard deviation of X ?

AP® STATISTICS
2013 SCORING GUIDELINES

Question 2

Intent of Question

The primary goals of this question were to assess a student's ability to (1) recognize and explain why a particular sampling method is likely to be biased; (2) describe a method for selecting a simple random sample from a population using a computer random number generator; and (3) demonstrate an understanding of the principle of stratification by describing circumstances in which one stratification variable would be better than another.

Solution

Part (a):

The first 500 students who enter the football stadium were not likely to be representative of the population of all students at the university. In other words, these 500 students were likely to differ systematically from the population with regard to many variables. For example, these 500 students might have more school pride than the population of students as a whole, which might be related to their opinions about the appearance of university buildings and grounds. Perhaps their school pride is related to having more positive opinions about the appearance of university buildings and grounds, in which case the sample proportion of students who were satisfied would be biased toward overestimating the population proportion of students who were satisfied.

Part (b):

Obtain a list of all 70,000 students at the university. Assign an identification number from 1 to 70,000 to each student.

Then use a computer to generate 500 random integers between 1 and 70,000 without replacement. The students whose ID numbers correspond to those numbers were then selected for the sample.

Part (c):

Stratifying by campus would be more advantageous than stratifying by gender provided that opinions about appearance of university buildings and grounds between the two campuses differ more than the opinions about appearance of university buildings and grounds between the two genders.

Scoring

Parts (a), (b), and (c) were scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored as follows:

Essentially correct (E) if the response correctly includes the following three components:

1. Provides a reasonable explanation for why the sample might not be representative of the population;
2. Mentions a link between the nonrepresentative nature of the convenience sample and the variable of interest (opinion about appearance of university buildings and grounds);

Question 2 (continued)

3. Indicates a plausible direction for the bias of the estimator by:
   - Explicitly identifying the direction of the bias in the estimate of the population proportion of students satisfied with the appearance of the buildings and grounds,

   OR
   - Stating or implying that the students in the sample were more (or less) likely to be satisfied with the appearance of the buildings and grounds than those not in the sample.

Partially correct (P) if the response correctly provides exactly two of the three components listed above.

Incorrect (I) if the response correctly provides one or none of the three components listed above.

Part (b) is scored as follows:

Essentially correct (E) if the response correctly includes the following three components:

1. Assigns numbers to the student names;
2. Uses a computer random number generator to randomly generate 500 distinct/unique numbers between 1 and 70,000;
3. Selects students whose names correspond to the 500 random numbers for the sample.

Partially correct (P) if the response correctly includes two of the three components listed above (with the exception of the second reason given for an (I) below).

Incorrect (I) if the response correctly includes no more than one of these three components;
OR
if the response proposes implementing a sampling method other than simple random sampling (for example, systematic sampling).

Part (c) is scored as follows:

Essentially correct (E) if the response correctly notes that the circumstance described requires more variability in opinions about appearance of university buildings and grounds between the two campuses than between the two genders.

Partially correct (P) if the response says that the circumstance described requires considerable variability in opinions about appearance of university buildings and grounds between the two campuses without explicitly comparing to variability between the two genders,
OR
if the response only says that the circumstance described requires more variability between the two campuses than between the two genders without referring to opinions about appearance of university buildings and grounds,
OR
if the response notes that the circumstance described requires homogeneity of opinions about appearance of university buildings and grounds within the two campuses.

Incorrect (I) if the response does not meet the criteria for E or P.