2. A local school board plans to conduct a survey of parents' opinions about year-round schooling in elementary schools. The school board obtains a list of all families in the district with at least one child in an elementary school and sends the survey to a random sample of 500 of the families. The survey question is provided below.

   A proposal has been submitted that would require students in elementary schools to attend school on a year-round basis. Do you support this proposal? (Yes or No)

   The school board received responses from 98 of the families, with 76 of the responses indicating support for year-round schools. Based on this outcome, the local school board concludes that most of the families with at least one child in elementary school prefer year-round schooling.

   (a) What is a possible consequence of nonresponse bias for interpreting the results of this survey?

   (b) Someone advised the local school board to take an additional random sample of 500 families and to use the combined results to make their decision. Would this be a suitable solution to the issue raised in part (a) ? Explain.

   (c) Suggest a different follow-up step from the one suggested in part (b) that the local school board could take to address the issue raised in part (a).

GO ON TO THE NEXT PAGE.

3. A local arcade is hosting a tournament in which contestants play an arcade game with possible scores ranging from 0 to 20. The arcade has set up multiple game tables so that all contestants can play the game at the same time; thus contestant scores are independent. Each contestant's score will be recorded as he or she finishes, and the contestant with the highest score is the winner.

   After practicing the game many times, Josephine, one of the contestants, has established the probability distribution of her scores, shown in the table below.

Josephine's Distribution				
Score	16	17	18	19
Probability	0.10	0.30	0.40	0.20

   Crystal, another contestant, has also practiced many times. The probability distribution for her scores is shown in the table below.

Crystal's Distribution			
Score	17	18	19
Probability	0.45	0.40	0.15

   (a) Calculate the expected score for each player.

   (b) Suppose that Josephine scores 16 and Crystal scores 17. The difference (Josephine minus Crystal) of their scores is -1. List all combinations of possible scores for Josephine and Crystal that will produce a difference (Josephine minus Crystal) of -1, and calculate the probability for each combination.

   (c) Find the probability that the difference (Josephine minus Crystal) in their scores is -1.

   (d) The table below lists all the possible differences in the scores between Josephine and Crystal and some associated probabilities.

Distribution (Josephine minus Crystal)						
Difference	-3	-2	-1	0	1	2
Probability	0.015			0.325	0.260	0.090

   Complete the table and calculate the probability that Crystal's score will be higher than Josephine's score.

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Question 2

Intent of Question

The primary goals of this question were to assess a student's ability to (1) identify a potential source of nonresponse bias and recognize a possible consequence for interpreting the results of a survey; (2) recognize that increasing sample size does not remove bias; and (3) recommend an appropriate course of action to solve a practical problem with the use of a survey.

Solution

Part (a):

Responses were received from only 98 of the 500 (or 19.6 percent) of the randomly selected families. In other words, 80.4 percent of the randomly selected families did not respond to the survey. To obtain a nearly unbiased estimate of the proportion of families with at least one child in elementary school in this school district who support year-round school, we would need to assume that the families that did not respond would have a similar level of support for year-round school as those who did respond. This would not be the case, for example, if families who support year-round school were more likely to respond than families who do not support year-round school. In such a case, the estimate of the proportion of families who support year-round school calculated from the responses would tend to be higher than the population proportion of families who favor year-round school.

Part (b):

No, the nonresponse bias still exists. Combining the results from the original sample with a new random sample of 500 families will not solve the problem. Regardless of what happens in the second sample, the problem of nonresponse bias will still exist in the combined sample because there would be at least 402 nonresponses included from the original sample.

Part (c):

Contact the 402 families from whom responses were not received and ask their opinion on the proposal. This may require additional mailings or telephone calls, but it will provide better information about support for year-round school among all families in the school district with at least one child in elementary school.

OR

Take a new random sample or take a census and use an alternative strategy, such as telephone calls or in-person interviews, to help increase the response rate.

Scoring

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

Part (a) is scored as follows:

Essentially correct (E) if the student clearly links the effect of nonresponse to biased estimation by explaining why population support for year-round school would be overestimated (or underestimated) from the sample results.

Question 2 (continued)

Partially correct (P) if the student describes a reasonable consequence in the context of the study *OR* describes a difference related to the issue between families who are likely to respond and families who are not likely to respond.

Incorrect (I) otherwise.

Part (b) is scored as follows:

Essentially correct (E) if the student says no, taking another sample will not solve the problem with nonresponse bias *AND* explains that nonresponse bias in the original sample would result in nonresponse bias in the combined sample regardless of the results from the second sample.

Partially correct (P) if the student says no, taking another sample will not solve the problem with nonresponse bias, but provides a weak explanation *OR* says that the second sample will produce similar results to the first sample.

Incorrect (I) if the student says yes, combining results from the original sample and a new random sample will solve the problem *OR* says no but provides no explanation or an incorrect argument *OR* does not respond to the question.

Part (c) is scored as follows:

Essentially correct (E) if the student provides an explicit description of a reasonable strategy for reducing nonresponse in a new survey or census or by following up with families who did not respond to the original study.

Partially correct (P) if a student suggests that nonresponse should be reduced or response should be mandatory without providing an explicit description of a reasonable strategy.

Incorrect (I) if the student does not provide a strategy to increase response rates or suggests a strategy that would result in other biases.

4 Complete Response

All three parts essentially correct

3 Substantial Response

Two parts essentially correct and one part partially correct

2 Developing Response

Two parts essentially correct and no parts partially correct

OR

One part essentially correct and one or two parts partially correct

OR

Three parts partially correct