Algebra 2/Pre-Calculus

Name_____

Introduction to Experimental Design (Day 14, Statistics)

Many people use data to make erroneous conclusions. In this handout, we will explore some basic errors in the use of data and statistical methods. *Note:* Answers for all problems are included **at the end** of this assignment.

Very important: The problems on this handout don't involve a lot of calculations, but that doesn't mean you should rush through them. Please write carefully and thoughtfully. Answers will require a few sentences. Do not expect to get credit for overly terse or poorly explained answers.

1. Students were debating which college is hardest to get into. Some students said it was Harvard. Others said it was MIT. One student googled the acceptance rates at both schools and reported, "The acceptance rate at Harvard is 6% but the acceptance rate at MIT is 9%. Therefore, it's tougher to get accepted at Harvard."

   a. Explain the flaw in this student's argument.

   b. Is there any easy way to answer the question that the students were debating? Explain.

2. A high school offers an SAT prep course. The mean SAT score of students who took the prep course was 80 points higher than the school average. The school concluded that taking the prep course caused students to score higher on the SAT.
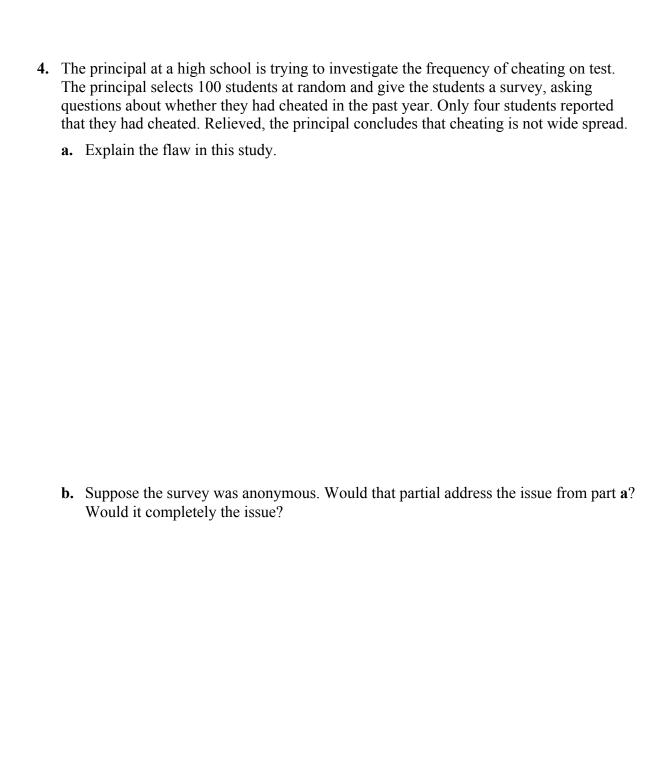
    a. Explain the flaw in this argument.

    b. Design a study that would test whether the prep course helped students to improve their scores. ***Big hint:*** You will need a treatment group and a control group and you will need to assign students to each group randomly. (These terms are explained on page 255 in the textbook.)

3. The Governor of Oregon declares that taxes are too high and are hurting the economy. Legislation is passed lowering all state taxes. The next year, the percent of unemployed people in the state drops from 9% to 7%. The Governor declares that lowering taxes resulted in lower unemployment.

   a. Explain the flaw in this argument.

   b. Some researchers were trying to determine whether lowering taxes did in fact help to mitigate unemployment. They found two counties on the border between Oregon and Washington. One county was in Oregon and one was in Washington. Both had 9% unemployment and similar taxes. Then Oregon lowered it taxes but Washington did not. A year later, the researchers compare the unemployment rates for the two counties.

   Explain why this approach addresses some of the problems you raised in part **a**.

4. The principal at a high school is trying to investigate the frequency of cheating on test. The principal selects 100 students at random and give the students a survey, asking questions about whether they had cheated in the past year. Only four students reported that they had cheated. Relieved, the principal concludes that cheating is not wide spread.

    a. Explain the flaw in this study.

    b. Suppose the survey was anonymous. Would that partial address the issue from part **a**? Would it completely the issue?

5. Here's a claim: "Playing an instrument causes students to do better in math."

To test this claim, a researcher compared the average MCAS scores for students who played instruments to students who did not play instruments. The researcher found that students who did play instruments had higher average MCAS scores than those who did not. The researcher concluded that playing an instrument did in fact lead to higher MCAS scores.

Explain the flaw in this argument.

6. Read the section **Historical Perspective: Political Polling** on page 259 of the textbook.

    a. What was the problem with the Literary Digest poll? Why was its prediction so far off? ***Hint:*** How did they select and contact the people they were polling?

    b. What challenges are inherent in conducting a poll successfully? How would you design a poll to address these issues?

Answers!

1. **a.** We don't know whether the group of students applying to Harvard are as strong as the group of students applying to MIT. (Perhaps there are more weak students who apply to Harvard, whereas only strong students apply to MIT.) Based on the information we are given, we cannot make a conclusion regarding which school is harder to get into.

    b. There is no easy way to answer this question. If we were to randomly assign one group of students to apply to MIT and randomly assign another group of students to apply to Harvard, we could determine the answer to this question, but this approach is not feasible in practice. Perhaps the best approach would be only to consider students who applied both to Harvard and MIT.

2. **a.** We do not know that the group of students who took the prep course are a representative sample of the school population. (It is possible that the students who took the prep course were stronger to begin with, so we cannot conclude that the difference in scores was due to the course.)

    b. If we were to randomly assign a group of students to take the prep course and then compare their scores to the students who didn't take the prep course, we could determine whether the course actually helped.

3. **a.** We cannot conclude that the decrease in unemployment was caused by the change in taxation, as it is impossible to rule whether any other factors contributed to this change. (Perhaps the economy improved for the country as a whole and the unemployment numbers in Oregon would have improved regardless.)

    b. Since both counties are in roughly the same place and both started with the same unemployment rate, it is less likely (but not impossible) that the difference in the unemployment rate could be attributed to some other factor.

4. **a.** Student might not tell the truth.

    b. This partially addresses the issue, as students may be more likely to answer honestly if they are permitted to answer anonymously. (There may still be students who do not tell the truth.)

5. The students who play instruments are not necessarily a representative sample of all students. (It is possible, for example, that the students who play instruments are more highly motivated in general and that is why they did better in math class.)

6. **a.** The Literary Digest Poll in 1932 only contacted people who owned a car, a telephone, or who had a subscription to their magazine. Furthermore, the poll only included people who responded to survey.

    b. It is very challenging to achieve a random sample in practice. (Calling people, emailing people, and going door to door are all fraught with potential sources of bias.) Furthermore, voluntary response/non-response bias creates a further impediment to generating reliable data. Finally, small changes in wording can have a big impact on the way people respond.