

## Teacher Notes for Investigation #1: Did You Wash Your Hands?

THIS INVESTIGATION BUILDS ON THE TWO HAND-WASHING STUDIES THAT WERE DISCUSSED in the Introduction. The questions posed here are designed to get students thinking about statistics in practice and to provoke discussion in the classroom. We try to alert students to several important issues, such as:

The way in which data are produced affects the kinds of conclusions that can be drawn. Only well-designed experiments can be used to make cause-and-effect conclusions.

An estimate we obtain from a sample could differ greatly from the truth about the population if:

Our sample doesn't represent the population well

The question we asked is unclear or misleading

People don't respond accurately or honestly

Some people refuse to respond

The observer influences the observed

### Prerequisites

Students should be able to determine from a narrative description whether data were produced with a survey, an experiment, or an observational study.

### Learning Objectives

As a result of completing this investigation, students should be able to:

Decide which method of producing data—a survey, experiment, or observational study—is most appropriate for answering a given research question

Describe how certain practical difficulties may affect the results of surveys, experiments, and observational studies

Define a research question

### Teaching Tips

Consider whether you want students to answer the questions in this first investigation individually or with a partner. Either way, be sure to allow time for class discussion of the questions.

### Suggested Answers to Questions

Many of the questions do not have “right” or “wrong” answers. Students should be encouraged to defend their answers with specific evidence, much as an attorney would in a legal case.

**1.** Answers will vary. Students might focus on the unsanitary or disgusting nature of not washing hands after using the bathroom. There are also health-related implications. According to the Harris Interactive news release from the hand-washing study, “Infectious diseases, many caused by unclean hands, are the leading causes of death and disease

worldwide and the third leading cause of death in the United States. The Centers for Disease Control and Prevention (CDC) says that hand washing is the single most important means of preventing the spread of infection.”

**2.** (a) Those who do not have telephones. Also, if calls were placed only to landlines, then those who only have cellphones would be left out.

(b) Answers will vary. Here’s one possible answer. As adults who do not have telephones would tend to be poor, perhaps even homeless, they might not have access to proper facilities for washing their hands after using the bathroom. Without these people’s behaviors represented in the survey, the 91% estimate would be too high.

(c) Answers will vary. Here’s one possible answer. Some people would be embarrassed to admit that they don’t usually wash their hands after using the bathroom, and so might refuse to answer. Other individuals might feel that they are too busy to participate in a survey.

(d) Since this survey asks about a potentially embarrassing issue, it seems likely that some people will give a socially acceptable “always” answer, even if this is not the truth. It is also possible that some individuals will have inaccurate recollections of their hand-washing habits.

**3.** (a) Answers will vary. Here’s one possible answer. When others are present in the bathroom, some people might be more likely to wash their hands due to implicit “peer pressure.” If that’s the case, then a hidden camera would have revealed fewer than 83% who washed their hands.

(b) Answers will vary. Here’s one possible answer. People may be generally more likely to follow societal expectations to wash their hands when they are in public than when they are at home. If so, then a hidden camera study would reveal less than 83% who washed their hands at home.

**4.** (a) Answers will vary. Here’s one possible answer. From these two studies, it certainly appears that a higher percent of adults claim to wash their hands after using the bathroom than the percent who actually do so when observed. However, the survey and the observational study involved different groups of people. It is possible that the difference in the results of the two studies (91% who claimed they washed their hands versus 83% who actually did) is due to differences in hygiene habits between the people in these two groups, and not from people’s tendency to overestimate their hand-washing tendencies. After all, if researchers had observed a different group of 6,336 adults in the same public restrooms on a different day, the percent who were seen washing their hands would probably not have been exactly 83%. Likewise, if researchers had surveyed another sample of 1,013 adults by telephone, it is unlikely that exactly 91% would say they always washed their hands after using the restroom. The difference in the results of these two studies may just be due to the natural variability that occurs from one sample to another.

(b) Answers will vary. Here's one possible answer. Conduct a hidden camera observational study of a sample of individuals in public restrooms. Then survey those same individuals about their hand-washing habits after the bathroom visit.

**5.** It's always important to know who sponsored (paid for) a statistical study. In this case, the sponsoring agency would likely be hoping to encourage people to do a better job of washing their hands after using the bathroom, thereby using more soap. A study that reveals a lower percent of people washing their hands would suit this agency's purpose.

**6.** (a) For example, "What percent of teenagers always wash their hands after using the bathroom?"

(b) A survey or an observational study would both be reasonable methods for producing data. An experiment wouldn't be appropriate, as the goal of the study is to record teenagers' normal hand-washing tendencies, not to try to do something to influence those tendencies.

(c) Answers will vary. Here's one possible answer. Teenagers tend to pay less attention to personal hygiene and health than adults do, so the percent of teenagers who always wash their hands after using the bathroom would probably be lower.

**7.** (a) A survey. Since it would be difficult to actually observe teenagers brushing their teeth, an observational study wouldn't be practical. Because the goal of the study is to record teenagers' normal tooth-brushing habits, not to try to do something to influence those habits, an experiment would not be appropriate. If possible, the teens who participate in the survey should be selected at random from the population of teens in the area. Note that it may be necessary to obtain parental permission before surveying teenagers.

(b) An experiment. If researchers deliberately give drug A to one group of individuals and drug B to another, then they can compare the differences in the percent in each group who experience nausea following their migraine headaches. If the decisions about which individuals get drug A and which drug B are made at random, then researchers can determine whether the difference in the percents who experience nausea is sizable enough to suggest a difference in the effectiveness of drug A and drug B. (By assigning the drugs at random to the migraine sufferers, researchers help ensure that the group of individuals taking drug A and the group taking drug B are fairly balanced in all ways that might affect their response to the drug treatments. If the two groups are similar to begin with, then any sizable differences that emerge between the two groups after the drugs are administered can be attributed to the effects of the drugs themselves.)

Note that a comparative observational study using two groups of people—one group who have used drug A and the other group who have used drug B—would not allow researchers to establish any kind of cause-and-effect relationship between the drug administered and people's tendency to have nausea later. Since people have chosen

whether to use drug A or drug B, it is possible that the two groups of individuals differ systematically in other ways that might affect their likelihood of becoming nauseated after having a migraine.

(c) Either an observational study or a survey. Asking a (random) sample of males and a (random) sample of females to report how many numbers are stored in their phones will allow for direct comparison of the average number of contacts for the two genders. However, some individuals may report inaccurate values. Actually observing the phone lists of the randomly selected people might result in more reliable data. An experiment would not be appropriate since we only want to observe what is true, not try to influence the state of affairs.

(d) Observational study. Watching the actual behavior of drivers at the stop sign in question would be more effective than asking them whether they stop. It would be best if observers could watch without being noticed by the drivers, since the presence of an observer may influence the behavior of the driver. An experiment would not be appropriate because we are simply trying to observe and record whether drivers stop completely, not to influence whether they stop.

(e) An experiment, with half of the customers receiving a bill with suggested tip amounts at the bottom and half of the customers receiving no suggested tip amounts. Ideally, the determination of which customers get the bills with suggested tip amounts should be made at random so that the two groups of customers will be as similar as possible in every respect that might influence the amount they decide to tip other than the intended “treatment”—suggested tip amounts on the bill versus no suggested tip amounts on the bill. Then, any substantial difference that emerges between the average tip amounts in the two groups could be attributed to whether suggested tip amounts were printed on the restaurant bill.

**8.** Answers will vary. The survey results from the two years were very similar—91% of respondents said they always washed their hands after using the bathroom in 2005, compared with 92% in 2007. However, the observational study results from the two years were quite different. In 2005, 83% of those observed washed their hands after using the bathroom. In the 2007 observational study, only 77% washed their hands after using the bathroom. One possible explanation for this decrease is the decline in the percent of men who washed their hands—from 75% in 2005 to 66% in 2007.

### Possible Extensions

Ask students to develop a research question that would best be answered by (a) an observational study, (b) a survey, (c) an experiment.

Have students locate an article describing the results of a survey in printed or electronic media. Then ask them to identify the research question, the population, the sample, and any concerns they have about the results reported in the article.



## Investigation #1: Did you wash your hands?



1. Why should we care whether people wash their hands after using the bathroom?

Corresponds to pp. 4-9  
in Student Module

2. In the Harris Interactive survey, people were contacted by telephone. One of the questions the interviewers asked was, “How often do you wash your hands after using a public restroom?”

(a) Which U.S. adults were not included in this study?

(b) The survey estimated that 91% of all U.S. adults would claim that they always wash their hands after using the bathroom. Do you think this estimate is too high, too low, or about right given your answer to (a)? Explain.

(c) Several people refused to participate in the survey. Give a reason that this might happen.

(d) In any survey, it is possible that some people will not answer a question accurately or honestly. Thinking about the hand-washing survey, do you think this is likely to happen? Explain your answer.

**3.** The observational study of hand washing was conducted at a baseball field in Atlanta, a museum and an aquarium in Chicago, a bus and train terminal in New York, and a farmers' market in San Francisco.

(a) Observers in the public bathrooms combed their hair or put on make-up at one of the available sinks while they were watching individuals' hand-washing behaviors. If the observation had been done by hidden camera instead (with no observer present), do you think the percent who washed their hands would have been greater than, less than, or about the same as 83%? Justify your answer.

(b) Suppose the observational study had been conducted using hidden cameras in the homes of the same 6,336 adults. Do you think the percent of these individuals who washed their hands would have been greater than, less than, or about the same as 83%? Justify your answer.

4. (a) Comment on the conclusion reached in the newspaper headline: “More People Claim to Wash Their Hands than Who Actually Do.”

(b) Describe a study design involving only one group of people that might help us better evaluate the validity of the quoted claim in part (a).

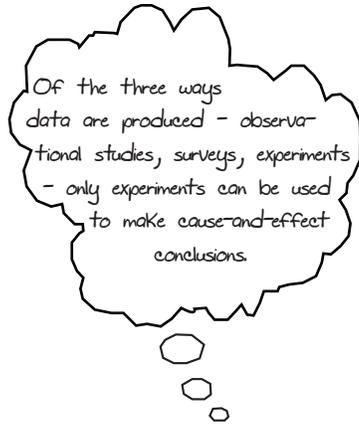
**5.** Both studies were paid for by the American Society for Microbiology and the Soap and Detergent Association. Should you take this information into account when interpreting the results of the studies? If so, how?

**6.** You have been asked to help design a study to investigate how often teenagers wash their hands after using the bathroom.

(a) Define a research question for your study.

(b) Would you recommend using a survey, an observational study, or an experiment to produce the data? Explain.

(c) Do you think the percent of teenagers who always wash their hands after using the bathroom is higher than, lower than, or about the same as the percent of adults who do so? Justify your answer.



7. For each of the following research questions, decide which method of data production—a survey, an experiment, or an observational study—would be most appropriate. Justify your choice of method.

(a) What percent of teenagers leave the water running while they brush their teeth?

(b) Which of two drugs is more effective at preventing nausea following the onset of a migraine headache?

(c) Do male teenagers or female teenagers tend to have more numbers stored in their cell phones?

(d) What percent of drivers come to a complete stop at a stop sign near a local elementary school?

(e) Does printing suggested tip amounts on the bottom of a restaurant bill increase the average amount that customers leave in tips?

**8.** A follow-up study conducted in 2007 by Harris Interactive revealed that while 92% of adults said that they always washed their hands after using the bathroom, only 77% of the adults observed in public restrooms actually did. According to Harris Interactive's Hand Washing Fact Sheet, "The overall decline in hand washing observations is largely due to males. The percentage of males observed washing their hands fell from 75% in 2005 to 66% in 2007. Overall, the percentage of females observed washing their hands is down slightly from 90% in 2005 to 88% in 2007."

Did people's hand washing habits improve or get worse from 2005 to 2007? Justify your answer with specific evidence from the reports describing the Harris Interactive studies.

