Chapter One

An Introduction to Statistics and Research Design

Note to Instructors

This chapter is essential to understanding concepts used repeatedly throughout the text. Therefore, instructors should spend extra time on this material to ensure a smooth transition to future chapters. In particular, emphasize the differences between inferential and descriptive statistics, independent and dependent variables, and the different kinds of variables (e.g., nominal vs. interval), all of which students will need to understand when working with the exercises and examples in the text. These foundational concepts need to be discussed and reviewed to give students every advantage in mastering statistics. To best illustrate the meanings and applications of these concepts, use a number of everyday examples. You’ll find that the discussion questions and class exercises have been designed to help you in this process.

Outline of Resources

I. The Two Branches of Statistics
   - Discussion Question 1-1 (p. 2)
   - Classroom Activity 1-1: Statistical Jeopardy (p. 2)

II. How to Transform Observations into Variables
   - Discussion Question 1-2 (p. 5)
   - Classroom Activity 1-2: A Stroop Task (p. 5)

III. Variables and Research
   - Discussion Question 1-3 (p. 6)
   - Discussion Question 1-4 (p. 6)

IV. Introduction to Hypothesis Testing
   - Discussion Question 1-5 (p. 7)
   - Discussion Question 1-6 (p. 7)
   - Classroom Activity 1-3: Newspaper Experiment (p. 8)
   - Classroom Activity 1-4: Article Examination (p. 8)
V. Next Steps: Outlier Analysis
- Classroom Activity 1-5: In the Media (p. 8)
- Additional Reading (p. 9)
- Online Resource (p. 9)

VI. Handouts and Transparency Masters
- Handout 1-1: Newspaper Experiment (p. 10)
- Handout 1-2: Article Examination (p. 11)
- Handout 1-3: In the Media (p. 12)
- Transparency Master 1-1: Statistical Jeopardy Scoreboard (p. 13)
- Transparency Master 1-2: Statistical Jeopardy: Answers (p. 14)

CHAPTER GUIDE

I. The Two Branches of Statistics
1. The two branches of statistics are descriptive statistics and inferential statistics. Descriptive statistics organize, summarize, and communicate a group of numerical observations, whereas inferential statistics use sample data to make general estimates about the larger population.

2. When discussing inferential statistics, we must distinguish between a sample and a population. A sample is a set of observations drawn from a population of interest that should be representative of that population of interest. In contrast, a population refers to all possible observations about which we’d like to know something. Samples are more commonly used because it is generally difficult to obtain data from an entire population. In other words, using data from a population often would take too much time and money or might be too vast to obtain based on the research question.

> Discussion Question 1-1

*What is the difference between a sample and a population? Why do you think that using a sample is more common when using inferential statistics?*

Your students’ answers should include:
- A population includes all possible observations, whereas samples include sets of observations drawn from the population of interest.
- Using a sample is more common with inferential statistics because of the time needed to gather the data and to complete the study, the funding considerations of the study, and the usefulness of the study once it is completed.

Classroom Activity 1-1

Statistical Jeopardy

This activity will help your students to master the basic statistical definitions. It also makes good use of classroom response system (“Clicker”) technology in your lecture. (For more information, visit www.iclicker.com.)
Instructions

- Just as on the popular game show, the answer is provided to the contestants (students), who must then provide the question that directly corresponds to the answer. Their response must be in the form of a question.
- Transparencies: You may display the game on an overhead projector by photocopying them onto acetate. Or you may use PowerPoint by scanning them into your computer.
- How to play: Two options:

  Option 1: Have your students pick which question they want to try to answer; or, depending on the size of your class, you may prefer to have your students work in teams and for the teams to choose which questions to answer. Use Transparency Master 1-2 only to read off the “answers” to the student or group, and display Transparency Master 1-1 to the students. Both transparencies can be found at the end of this chapter. Your students can respond with their i-clicker remotes if you use i-clicker in your classroom.

  Option 2: You can be in charge of assigning “answers” to students. If keeping score, to be fair, assign the answers according to seating arrangements, such as by row. Use Transparency Master 1-2 both to display to the students as well as to read the answers to the students.

- On the transparency master, check off the completed items for the students as the game progresses.
- You can designate a scorekeeper if you are playing in teams; otherwise have the students keep track of their scores.
### STATISTICAL JEOPARDY:
RESPONSES (QUESTIONS) TO THE ANSWERS
(These are responses the students should provide.)

#### Statistics Basics
- **100** Sample
- **200** Population
- **300** Descriptive
- **400** Inferential

#### Variables
- **100** Variable
- **200** Continuous variable
- **300** Nominal
- **400** Interval

#### Experimental Design
- **100** Random Assignment
- **200** Correlational
- **300** Within-groups design
- **400** Confounding variable
II. How to Transform Observations into Variables

1. Regardless of whether we are using descriptive or inferential statistics, we will need to transform our data into variables or observations of physical, attitudinal, and behavioral characteristics that can take on different values.

2. When we create variables from our data, they can be either discrete (only specific values and no other values can exist between these numbers) or continuous (can take a range of values where an infinite number of potential values exist).
   a. Discrete variables can take two forms. Nominal variables use categories or names for their values. Ordinal variables refer to values that are ranked.
   b. Continuous variables can also take two forms. Interval variables take numerical form, and the distance between pairs of consecutive numbers is assumed to be equal. Interval variables do not have a meaningful zero point. In contrast, ratio variables work just like interval variables except that they do have a meaningful zero point.
   c. Many statistical programs treat ratio and interval variables similarly and refer to them both as scale variables or variables that meet the criteria for an interval or ratio variable.

> Discussion Question 1-2

What are some everyday examples of nominal, ordinal, interval, and ratio variables?

Your students’ answers may include:
- For nominals: Any group of objects or people likely to be studied, such as men and women, or various physical characteristics such as height, age, weight, or hair color.
- For ordinals: Any group that has ranking, such as from the tallest person to the shortest person.
- For intervals: A group of objects that are spaced the same distance apart, such as oranges lined up an equal distance from each other, or half-steps in a chromatic musical scale; and in time-measured tests, the time it takes participants to react to certain stimuli.
- For ratios: The scores of a group of sprinters or the amount of time it takes persons in a group to react to a request.

Classroom Activity 1-2

A Stroop Task

The research on levels of processing indicates that we learn better when the information we are trying to acquire has meaning to us. In order to make data analysis meaningful and learn statistics, have your students complete the Stroop experiments at the following link:
http://www.snre.umich.edu/eplab/demos/st0/stroopdesc.html.
Have your students collect their individual time data for each of the three tasks: word, color, color not word. Have your students note their errors for each of these measures.

Collect the data and enter it into SPSS (Statistical Package for the Social Sciences) as a group. Run the basic descriptive statistics on each variable. This data set can be used later in the course as well, when discussing correlated $t$ tests or repeated-measures analysis. You can also gather grouping information (e.g., gender or those who read more than 10 hours per week versus those who read less) to use for $t$ tests and analysis of variance.

III. Variables and Research

1. **Levels** are the discrete values or conditions that variables can take on.

2. There are three main types of variables used in research. **Independent variables** must have at least two levels that we either manipulate or observe in order to determine the effects on the **dependent variable**, which is the outcome variable that we are measuring and that we hypothesize to be related to or aroused by changes in the independent variable. A good mnemonic is that the dependent variable depends on the independent variables. As researchers we want to minimize the presence of the monkey-wrenching **confounding variables**, which are variables that systematically vary with the independent variables so that we cannot determine which variable is at work.

> **Discussion Question 1-3**

*What would be an example of some confounding variables in an experiment whose aim is to test the effectiveness of an investigational medication to treat depression?*

Your students’ answers may include:

- For confounding variables: Other required medications that the participants were taking at the time of the experiment and variations in diet and exercise among participants.

3. Whenever we make observations, we want to make sure that our instruments are both **reliable**, or consistent, and **valid**, or accurate; in other words, that they measure what they are intended to measure.

> **Discussion Question 1-4**

*Imagine a scale that reads “5.0 pounds” each time you place a 10-pound bag of potatoes on it. Is this scale reliable? Is this scale valid? Why or why not?*

Your students’ answers should include:

- The scale is reliable because, each time, it consistently weighs the potatoes at the same weight, 5.0 pounds.
- The scale is not valid because the potatoes do not weigh in at their actual weight.
IV. Introduction to Hypothesis Testing

1. In hypothesis testing, we draw conclusions about whether or not a particular relation between variables is supported by the evidence.

2. Before we can do any hypothesis testing, we need to make sure that we have developed operational definitions for our variables. In other words, we must specify operations or procedures used to measure or manipulate a variable.

3. One way to test a hypothesis is to perform a correlational study. A correlation is an association between two or more variables.

4. An experiment is a study in which participants are randomly assigned to a condition or level of one or more independent variables.

5. When conducting an experiment, we can use random assignment so that every participant has an equal opportunity to be assigned to any condition. Random assignment allows us to control for confounding variables.

> Discussion Question 1-5

*Why would we want to use random assignment in an experiment? What would this accomplish?*

Your students’ answers should include:
- Random assignment controls the effects of biases or confounds by distributing them among each condition, or group, in a study. It creates an initial equality between groups and allows a fair, unbiased test of the hypothesis.

6. Experiments can take two forms: between-groups or within-groups research design. In a between-groups design, participants experience only one level of the independent variable. In contrast, in a within-groups design, participants experience all levels of the independent variable.

7. We cannot use random assignment in all designs. When participants cannot be randomly assigned to all conditions, our design must become correlational.

> Discussion Question 1-6

*What would be an example of a within-groups design? What would be an example of between-groups design?*

Your students’ answers may include:
- Within-groups design: A drug study where the participants’ reactions to a drug are tested before and after the administering of the drug.
- Between-groups design: Two groups of participants where one group receives the drug and another group receives a placebo.
- Within-groups design: Have participants take surveys measuring their attitudes toward police before and after they see two movies: movie A that depicts the police positively and movie B that depict the police negatively.
Between-groups design: Have two different groups of participants watch either movie A or movie B.

Classroom Activity 1-3
Newspaper Experiment
Design an experiment to examine how regularly reading a newspaper would affect participants’ vocabulary levels. Generate and answer some basic questions. See Handout 1-1 at the end of this chapter for examples of questions to ask. This exercise will reinforce learning through students’ application of the knowledge gained from Chapter 1.

Classroom Activity 1-4
Article Examination
As budding psychology researchers, students must have exposure to the psychological literature and gain practice reading, understanding, and critiquing articles. This exercise is designed to encourage such intellectual development and to help students integrate the knowledge gained from reading this chapter. Have students read the following article: Bushman, B.J. (2005). Violence and sex in television programs do not sell products in advertisements. *Psychological Science, 16,* 702–708. (To view or purchase this article, go to your local library or visit Blackwell Publishing online at http://www.blackwellpublishing.com.)

Briefly, participants watch television programs with either violence or sexual content, both violence and sexual content, or no violence or sexual content. While watching the program, participants were exposed to 12 ads. Exposure to either violence or sexual content in programming negatively affected participants’ attitudes and behavior for the product. See Handout 1-2 at the end of this chapter.

V. Next Steps: Outlier Analysis
1. An outlier is an extreme score that is either very high or very low in comparison with the rest of the scores in the example.
2. We can conduct an outlier analysis or a study that examines observations that do not fit the overall pattern of the data, in an effort to understand the factors that influence the dependent variable.

Classroom Activity 1-5
In the Media
Newspapers are a great resource for exploring how research is relayed to the larger population. For this exercise, either obtain recent science news articles or ask students to obtain them instead. Find newspaper articles on the same subjects. Based on the description of the research in the science journals, have students try to identify different concepts from the chapter. See Handout 1-3 at the end of this chapter for questions to ask the class.
Additional Reading
This is a straightforward, easy-to-understand, yet comprehensive dictionary that is also suitable for students.

Online Resource
*Statistics Education Research Journal* is a free online journal that publishes twice per year. The mission of the journal is to improve the teaching and learning for statistics.
http://www.stat.auckland.ac.nz/~iase/publications.php?show=serjarchive
HANDOUT 1-1: NEWSPAPER EXPERIMENT

Directions: Design an experiment to examine how reading a newspaper regularly would affect participants’ vocabulary levels.

1. What is the procedure? What is the actual design of your study?

2. What is/are the independent variable(s)?

3. What is the dependent variable?

4. What are possible confounding variables?

5. Is this a between-groups or within-groups design? How do you know?
HANDOUT 1-2: ARTICLE EXAMINATION


1. Summarize the procedure and results of the study.

2. What is/are the independent variable(s)?

3. What are some of the dependent variables that were measured?

4. What confounding variables did the researchers control for?

5. Is this a between-groups or within-groups design? How do you know?
HANDOUT 1-3: IN THE MEDIA

Directions: Using a newspaper article, try to identify the following concepts described in the chapter.

1. Summarize the research that was conducted by the researcher(s). What did the researcher(s) actually do? What were the findings?

2. What kind of study is this?

3. Can you identify any potential confounding variables in this particular design?

4. Was the author successful in communicating the main points of the research conducted? How could it have been improved?

5. If possible, find the primary source of this research (i.e., the study published in a scientific journal rather than summarized in a newspaper). Does the primary source match the main points of the newspaper article? Were there elements left out of the newspaper article? Why might the two sources be different?
## Statistical Jeopardy Scoreboard

<table>
<thead>
<tr>
<th>Statistics Basics</th>
<th>Variables</th>
<th>Experimental Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>400</td>
<td>400</td>
<td>400</td>
</tr>
</tbody>
</table>
### Statistical Jeopardy: Answers

<table>
<thead>
<tr>
<th>Statistics Basics</th>
<th>Variables</th>
<th>Experimental Design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>100:</strong> A set of some observations</td>
<td><strong>100:</strong> Any observation that can take on different values</td>
<td><strong>100:</strong> Every participant has an equal chance to be assigned to any group</td>
</tr>
<tr>
<td><strong>200:</strong> All possible observations in a study</td>
<td><strong>200:</strong> A variable that can take on a full range of values (including decimals)</td>
<td><strong>200:</strong> When looking for an association between two or more variables</td>
</tr>
<tr>
<td><strong>300:</strong> Numbers that are organized and that summarize information</td>
<td><strong>300:</strong> A variable that has categories but no rankings</td>
<td><strong>300:</strong> A variable that systematically varies with the independent variable</td>
</tr>
<tr>
<td><strong>400:</strong> Numbers (estimates) that hopefully can be generalized back to the population</td>
<td><strong>400:</strong> A variable with equally distant values but no true zero</td>
<td><strong>400:</strong> Participant experiences all the levels of the independent variable</td>
</tr>
</tbody>
</table>

Nolan/Heinzen: *Statistics for the Behavioral Sciences, 2e*
© 2012, 2008 by Worth Publishers