Instructor's Manual and Test Bank

for

Statistical Concepts for the Behavioral Sciences

Fourth Edition

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Preface

The authors of the text have prepared this Instructor's Manual to provide suggestions and ideas for activities for a course in behavioral statistics using *Statistical Concepts for the Behavioral Sciences* (4^{th} ed.). The Instructor's Manual is composed of a general introduction to the course material, and specific ideas and suggestions for each chapter of the text.

Introduction

The introduction reviews a variety of ideas and suggestions useful for teaching behavioral statistics. References are given for further detail on the activities suggested. A number of links to online resources are also included. We have taken every effort to ensure these links are correct and will provide useful information for you, however, we offer this list only for informational purposes and cannot verify the accuracy of the information provided on each of the sites.

Ideas and Suggestions for Each Chapter

For each chapter of the text, we have included ***Goals and Objectives***, a ***Chapter Outline***, ***Key Terms and Symbols***, and ***Discussion Questions***.

Goals and Objectives

The goals and objectives list the important knowledge and skills students should acquire from each chapter of the text. Given that higher level cognitive processes are the cornerstone of the text, the objectives go beyond rote learning and memorization, and include the application and evaluation of statistical concepts.

Chapter Outline

The chapter outline is based on the key information from the textbook. The outline follows the order of presentation in the textbook. Critical terms for each chapter, including the marginal definitions from the text, are underlined and defined within the outline.

Key Terms and Symbols

The important terms and symbols from the chapter are identified and listed. They are identical to the key terms and symbols that are listed near the end of each chapter.

Discussion Questions

The discussion questions have been selected to focus on areas where students are most likely to experience challenges, and thus may benefit from additional practice. Most questions require students to not only identify the critical concepts covered in each chapter, but to take that knowledge and apply it in a manner that requires the integration of concepts from multiple sections of the textbook. The discussion questions may be used to augment the *Testing Your Knowledge*, *Review Questions*, and *Integrating Your Knowledge* sections of the textbook to ensure that students have the ability to integrate and apply the important concepts of each chapter. There are a number of ways in which the questions may be used. For example, a question could be used for a quick quiz at the beginning or ending of a class to assess students' mastery of objectives. The questions could also serve as essay questions on exams, or they could be used as a form of a study guide to assist students to prepare for an upcoming exam. Students may also benefit from working in small groups during class time, and by using these questions, students may not only evaluate the quality of their understanding, but may also obtain the benefit that comes from having to articulate statistical concepts. These questions can also be used for in-class or out-of-class writing assignments. As we indicate in the Introduction of the Instructor's Manual, writing about statistical concepts can be very beneficial to students. Finally, in the Instructor's Manual, you will find a brief introduction to a pedagogical practice referred to as Interteaching. The discussion questions have been written following the criteria for Interteaching questions and thus may be useful in preparing for an Interteaching activity.

Additional Supplemental Materials for the Instructor

The text is also accompanied by a ***Test Bank***, ***Exercises and Assignments for Students***, and ***PowerPoint®*** slides.

Test Bank

The test bank provides a number of multiple choice questions for each chapter. The questions are presented in the order in which the information necessary for answering the questions appear in the text. The page upon which information is initially presented is listed with each question. In some cases, particularly with more complex questions, students may need to integrate information from multiple pages in order to answer the question, though not all pages are listed with the question.

Many questions assess knowledge level learning and are indicated with a **K**. Following Bloom's taxonomy of learning objectives (e.g., see Clark, 1999), knowledge questions include the direct recall of information. Typical learning outcomes of knowledge questions include defining, identifying, knowing, or recognizing concepts. Other questions require students to apply information to answer the question and are indicated with an **A**. Application questions require students to apply knowledge of concepts to arrive at answers to the questions. Typical learning outcomes of application questions include applying, computing (though not the selecting of proper statistics or the interpretation of statistical results), predicting, and relating of concepts. Questions that require students to evaluate a problem, including the selection, calculation, and interpretation of a statistic, are indicated with an **E**. Evaluation questions require students to make judgments about information presented in the question. These questions will often require that students select the proper statistic as well as having to interpret statistical results. Typical learning outcomes of evaluation questions include comparing, contrasting, critiquing, selecting, interpreting, and summarizing.

The questions fall under three different categories of difficulty: 1, 2, or 3. Questions labeled with a **1** are of the lowest level of difficulty and answers can most often be found in a marginal definition or directly in the textbook. As such level 1 questions typically involve a single concept. Answers labeled with a **2** are at an intermediate level of difficulty. Level 2 questions often involve a single concept, but the wording of the question often requires additional interpretation from students (i.e., it is not verbatim from the textbook). Answers labeled with a **3** typically require the knowledge or the integration of two or more concepts in order for students to successfully answer the question. Level **3** questions also often require students to complete multiple steps (e.g., selecting the proper statistic, calculating it, and making a decision based on the statistic).

Exercises and Assignments for Students

The exercises and assignments for students provide a set of printable exercises. Depending on the chapter content, the exercises include practice in learning and understanding terms and concepts, and data sets for calculation of statistics introduced in the chapter. Answers are provided for all exercises requiring calculations. A set of 15 multiple choice questions, similar to those in the test bank, is also included for each chapter. The exercises and assignments are designed to provide additional practice for students in targeted areas. They are intended to augment the assignments found in the textbook under *Testing Your Knowledge*, *Review Questions*, and *Integrating Your Knowledge*. In addition to using the exercises and assignments for graded or nongraded homework assignments, these exercises can be used as test or quiz questions, or for in-class activities.

PowerPoint® Slides

PowerPoint® slides are provided for each chapter of the textbook. Critical terms and their definitions along with general statistical concepts are covered in these slides. In earlier chapters, where numerous new concepts are introduced, the PowerPoint® presentations include examples to assist students in better conceptualizing the information. The material in the slides corresponds to the presentation style and order of information occurring in the textbook.

To avoid creating very complex presentations, we generally did not create slides showing statistical computations, especially for later chapters where calculations may become rather extensive. If you wish to demonstrate calculations, one method of doing so would be to use one of the problems given in the *Assignments and Exercises for Students* as an in-class example.

Acknowledgments

The authors would like to acknowledge the assistance of a number of people who brought this Instructor's Manual to fruition. Angela Pickard, Supplements Editor for Psychology at Allyn & Bacon Publishers, provided guidance and encouragement on all aspects of preparation of these supplementary materials, including the test bank and PowerPoint® slides. We thank her for her assistance and patience. Joshua Sandry and Christopher Poherence, students of Bonnie A. Green, were instrumental in providing feedback through the preparation of the material. Edwin Henriquez and Dianne Gasiewski aided us with typing assistance, and Kathy Perrine provided administrative support throughout the preparation process.

Introduction

Teaching Ideas and Suggestions

Students often approach introductory statistics with both concern and apprehension. They may doubt their own mathematical skills and also be skeptical of the potential value of the course to them. How should an instructor deal with these apprehensions and concerns? One approach is to acknowledge these issues in the first class meeting. For example, Dillon (1982, p.117) suggests opening the course by asking students to respond to a brief questionnaire such as:

"When I think of taking this course in statistics, I feel __."

and

"When I look at this formula,

$$t = \frac{\overline{X} - \mu}{s_{\overline{X}}}$$

I feel __."

A discussion of the responses allows students to recognize that their concerns and feelings are shared by others in the class and that you are aware of them. This discussion also presents an opportunity for you to suggest how students can approach the course to achieve maximum success. Knowledge in statistics is cumulative, a student can't understand the *t* test if he or she doesn't know what a mean is or how it is found. Thus it is important for students to stay current in the course and daily study is a necessity. Students should also be encouraged to ask questions. To this end it is important to allow sufficient time for questions and to answer all questions fully. Our teaching suggestions for Chapter 1 present several exercises allowing students to address their apprehensions about the course and to develop strategies for success in the course.

It is also worth discussing how students should use the supplementary materials provided in the course, whether they are materials provided with the text, or other materials provided by the instructor either as hard copy or online. In addition there are many Internet sites that also provide materials that students can use to test their knowledge of the material. Yet, several studies have indicated that many students may use these questions ineffectively, using online quizzes as the major learning vehicle for the material rather than as feedback mechanisms to test their understanding of study of the text. For example, Brothen and Wambach (2001) found evidence that students who used online quizzes in a “quiz-to-learn” strategy rather than as feedback to test their study of the text had poorer performance on course exams than those students who prepared by studying the text and then using the quizzes to test their preparation.

To encourage students to use online quizzes, instructors may award extra credit for completion of these materials, such as in the Brothen and Wambach (2001) study. This approach, however, may lead students to view the quizzes as an alternative to studying the text. Grimstead and Grabe (2004) offered students voluntary access to an online test bank where course credit was not offered for completion of any of the online materials. They then categorized students into “users” and “nonusers” of the online test materials. Their results indicated that for all three of their course exams, users of the online test bank scored significantly higher than the nonusers. This study, however, is correlational in nature, thus it offers no explanation of whether the online activities lead to better exam performance or simply if the voluntary users of the online materials were also the students who studied their text more diligently.

The use of in-class quizzes verses online quizzes was investigated in a study by Daniel and Broida (2004). They found that specific conditions had to be implemented to prevent “cheating” on the online quizzes. When such conditions were employed they found in-class quizzes and online quizzes to be about equally effective and both were associated with improved performance compared to a no-quiz control group. Clearly, then, it is important for instructors to carefully consider how they will use the supplementary materials in the course and to structure conditions for successful use of such materials. Brothen, Daniel, and Finley (2004) provide a discussion of best practices for online quizzing.

Activities and Demonstrations

Many instructors have observed that engaging students in the study of statistics is a challenging task. We know of no foolproof solutions for this problem, however, one component of a successful course is the use of realistic examples and numerous class activities. We have tried to incorporate examples in the text drawn from actual research in a variety of areas of behavioral science that are likely to be of interest to students. Yet, textbook problems cannot be as meaningful to students as problems and data generated by students themselves. Several suggestions for activities and data generation are offered below.

Thompson (1994) suggests obtaining data for class analysis by having students help design a questionnaire for distribution to other students. This exercise can introduce some of the basic ideas of behavioral science research into the course, including the necessity of asking answerable questions, and formulating and testing research hypotheses. A variety of questions such as the student's age, height, weight, gender, daily amount of time spent studying, typical amount of sleep per night, or the typical number of hours worked per week can be asked. Provided the questionnaire is used for class assignment purposes, is anonymous, does not ask questions about illegal or sensitive personal behaviors, and is given to students 18 years old or older, it is exempt from the requirement of obtaining informed consent from respondents (American Psychological Association, 2003), although individual institutional review boards may have more stringent requirements. The ethical guidelines for using such questionnaires may be found on the American Psychological Association website, http://www.apa.org/ethics.

Responses to this questionnaire can provide data sets to illustrate various statistical procedures throughout the course. Thompson (1994) reports students find this approach considerably more interesting than using artificial data sets. Using such a questionnaire also allows the instructor to develop the concept that statistical methods are tools used by behavioral scientists to answer research questions. Similar approaches are described by Stedman (1993) and Wolfe (1992).

Data sets can also be obtained from archival data such as newspaper obituaries. Morgan (2001) describes an exercise of having students use obituaries to obtain data sets such as age at death and the number of children of the deceased. She points out that using data such as these leads to students having to deal with the difficulties often encountered when analyzing real data, such as missing data points and outliers. In addition, questions such as whether there is a difference in the typical or average age of death between males and females can be posed and answered with these data.

Kolar and McBride (2003) describe an approach having students collaboratively create word problems and data sets for various statistical tests. They give an example of one student-created problem comparing the number of minutes it takes cats and dogs to eat their food. The students then solve the problems and share them with their classmates.

To increase student involvement in a statistics course, Perkins and Saris (2001) suggest using a "jigsaw classroom" exercise with student worksheets. In this exercise, small groups of students each complete different steps for the solution of a problem. After each group completes its portion of the problem, the groups collaborate to solve the whole problem. Perkins and Saris (2001) report that students perceived this approach very positively and performed well on exams on the material. The technique has the added benefit of using class time devoted to problem solutions very efficiently.

Four different learning enhancement activities: peer mentoring, clear and not clear sessions, consult corners, and applied projects are described by Harlow, Burkholder, and Morrow (2006). Peer mentors were students who had recently completed the course. Clear and not clear sessions involved students working outside class to identify clear and unclear lecture points. The instructor shared these summaries with the class. For consult corners, small groups of students consulted with one another in class to solve an instructor provided problem. Finally, all students were required to conducted an applied project outside of class and give a report to other class members. A pre-test, post-test design was used to test student response to the activities. The evaluation indicated a decrease in reported student anxiety, an increase in reported self-efficacy in quantitative methods, and a generally positive response to the activities.

If you are in fine voice and feel like singing in class, Wilson VanVoorhis (2002) recommends using jingles as mnemonic devices for remembering specific statistical facts. She presents jingles for facts about the standard deviation, the normal curve, and standard scores. A comparison of a class in which the jingles were sung against a class in which definitions were simply recited aloud indicated better retention of the relevant concepts for the jingles class. Given the interest of many students in music, this exercise could be broadened to have students create their own jingles for statistical concepts.

Getting students up and moving is often an energizing activity in any course. Connor (2003) describes several exercises that use students' bodies in the classroom. She describes a first-class exercise in which she reads a list of reasons why students might take the course. Students are to indicate their level of agreement with the reason by how high they raise their hands. The last reason is "because the course is required" and always generates a high level of agreement. Connor uses this exercise to both break the ice in the course and to introduce the nature of variables and methods of obtaining information. She also presents descriptions of other exercises in which students form human frequency distributions and scatterplots.

There are a number of valuable resources for additional activities and ideas in teaching statistics. Mark E. Ware and Charles L. Brewer have edited two handbook: *Handbook of Demonstrations and Activities in Teaching of Psychology, Volume 1: Introductory, Statistics, Research Methods, and History* (1996), and the *Handbook for Teaching Statistics and Research Methods* (1999). These handbooks are oriented toward teaching statistics in the behavioral sciences. A number of the references we have cited here are reprinted in these volumes. A more recent book is *Best Practices in Teaching Statistics and Research Methods in the Behavioral Sciences* edited by Dana S. Dunn, Randolph A. Smith, and Bernard C. Beins (2007).

The *Journal of Statistics Education* (www.amstat.org/publications/jse), an electronic journal published by the American Statistical Association, is also an excellent source of teaching ideas. Current and archived articles are available online. The journal *Teaching of Psychology*, published by the Society for the Teaching of Psychology, also contains numerous articles related to teaching behavioral science statistics. *Teaching of Psychology* (teachpsych.org/top/topindex.php) also provides a variety of online resources. *Teaching Statistics: An International Journal for Teachers* (http://www.rsscse.org.uk/ts/index.htm) offers a number of archived articles describing activities and examples useful in the classroom.

Writing About Statistics

As authors, we have often noted that writing about statistical concepts has enhanced and clarified our understanding of those materials. In this vein, several authors have suggested writing assignments for statistics classes. These assignments have the goal of aiding students in understanding statistical topics.

Dunn (2000) suggests an exercise where students are required to write a letter to a peer in the course. The letter is to explain one thing or concept about statistics and to indicate why it is important for a psychology student to know it. Recipients of the letter are required to write a response within a week requesting clarification if needed. Students report this exercise useful in evaluating their understanding of statistical concepts, and some even reported that it was fun. Dunn (1996) also suggests a collaborative writing exercise with peer review.

An approach suggested by Beins (1993) involves students writing press releases free of statistical jargon and terminology. The press releases are based on data sets generated in class or taken from popular sources such as almanacs. Beins reports that this exercise improved students' capabilities to interpret the results of statistical tests. This approach is also discussed by Dolinsky (2001). Smith (1995) describes a writing exercise in which students are asked to use critical interpretation skills in comparing data in the context of a professional communication.

Interteaching

Interteaching is a pedagogical method in which an instructor constructs a preparation guide for students with a variety of questions on the course material (Boyce & Hineline, 2002; Saville, Zinn, & Elliot, 2005; Saville, Zinn, Neef, Van Norman, & Ferreri, 2006). Students form groups of two although some professors have tried groups of three as well. In the groups, students are expected to discuss the questions during a portion of a class period. The instructor moves from group to group in this time to help clarify information, answer questions, and informally assess students' understanding. After the discussion period, the students complete a feedback form creating three lists: (1) a list of all topics or questions each member of the group completely understands, (2) a list of specific questions identifying points that need clarification, and (3) a list of topics or questions they find confusing. The instructor uses this information to prepare a short lecture either finishing the class period or for the next class meeting. In general, students spend about 60% – 70% of class time working in groups, while the professor spends 30% – 40% of class time in direct teaching. In the chapter materials that follow, we have included questions that could be used in preparing an interteaching preparation guide for each chapter.

The Controversy Over Statistical Hypothesis Testing

As most statistics instructors are aware, there has been a lively controversy over the use of statistical hypothesis testing in the last several years culminating in the American Psychological Association appointing a Task Force on Statistical Inference. Rejoinders to the report of the task force were published in the August 2000 *American Psychologist* (Volume 55, Number 8, pages 960 to 966). We discuss this controversy and the report of the task force (Wilkinson & the Task Force on Statistical Inference, 1999) in Chapter 9 of the text.

One concern of the task force is that the increasing availability and ease of using computer programs for data analysis may lead researchers to use statistical methods which they may not fully understand and which may be inappropriate for the data being analyzed. It is for this reason we have stressed introducing statistics in the text with definitional formulas and using those formulas to work through a problem. We believe this approach provides students with a better conceptual understanding of the statistical method being discussed. Thus, we encourage instructors to thoroughly develop the conceptual understanding of a statistic before having students use a computer program to calculate it.

Definitional vs. Computational Formulas

We have removed all computational formulas from the fourth edition of the text. The focus of all editions of the text has been to develop statistics conceptually using definitional formulas. Computational formulas were included in previous editions only because definitional formulas often lead to clumsy and error prone computations with actual data. But computational formulas provide no value in understanding the nature and function of a statistic. They are a product of a pre-computer age when computations were done with paper and pencil. Today, however, it is highly unlikely that students will use them unless required by an instructor. It seems senseless, then, to use valuable text pages to present a feature that will be rarely, if ever, used by students. Guttmannova, Shields, and Caruso (2005) argue that instructors should place an emphasis on definitional formulas and offer guidelines on constructing data sets for use with definitional formulas.

Using the Internet in Teaching Statistics

The rapid growth and development of the Internet along with the increasing ease of creating online materials has lead to its use as a teaching resource in almost all areas of education. One of the difficulties in discussing the Internet and specific resources on it is that the Uniform Resource Locators (URLs) used to identify and locate websites often change as the site is changed or revised. Thus it is difficult to provide totally accurate lists of websites dealing with statistical issues, and we cannot guarantee that the URLs we give will be functional at the time you are reading this.

Just-in-Time Teaching (JiTT)

Just-in-Time Teaching (JiTT) is a new teaching approach using the immediacy of the Internet. Benedict and Anderton (2004) describe this approach as providing students with short answer or multiple choice questions online. Students are required to answer the questions and submit them to the instructor no later than several hours before class. The instructor then uses the student responses to structure class discussion. Students responded favorably to this approach and scored higher on the final exam than students in a control group who were not exposed to the JiTT method. The JiTT (http://jittdl.physics.iupui.edu/jitt/) website provides more detail on this approach as well as sample materials for a statistics course. (http://psychweb.cisat.jmu.edu/jitt/pcqsite.htm)

Online Resources for Instructors and Students

The URLs listed below provide a variety of online resources for the statistics teacher and student. Each site offers numerous links to additional statistics resources on the Internet, including online texts, computational applets, tutorials, email lists and listservs, data bases, instructor manuals, statistics-related articles, and online experiments. This list, however, represents only a sample of the vast variety of material on statistics available on the Internet. We offer this list only for informational purposes and cannot verify the accuracy of the information provided on each of the sites. The URLs provided were accurate at the time of publication of this manual, but they may have changed in the interim.

Teaching of Psychology. (teachpsych.org/top/topindex.php)

Journal of Statistics Education. (www.amstat.org/publications/jse)

Teaching Statistics. An International Journal for Teachers. (http://www.rsscse.org.uk/ts/index.htm)

Chance. (http://www.dartmouth.edu/~chance/)
The website for the Chance course on quantitative literacy by J. Laurie Snell, Peter Doyle, Joan Garfield, Tom Moore, Bill Peterson, and Ngambal Shah. The site contains a newsletter of articles useful for class examples, video and audio materials, and an extensive Teacher's Guide.

Statistics and Statistical Graphics Resources. (http://www.math.yorku.ca/SCS/StatResource.html)
A listing of over 580 links to statistical resources on the Internet prepared by Michael Friendly of York University.

Robin Lock's Page. (http://it.stlawu.edu/~rlock/)
This link is to materials prepared by Robin Lock of St. Lawrence University. The website includes a number of links to online course materials, texts, and demonstrations.

WISE: Web Interface for Statistics Education. (http://wise.cgu.edu/)
This site is maintained by the Claremont Graduate University. It has links to a number of tutorials and statistics applets. There are also several online quizzes available.

Virtual Laboratories in Probability and Statistics©. (http://www.math.uah.edu/stat/)
This site is maintained by Kyle Siegrist at the University of Alabama in Huntsville. Materials include explanations of various statistical topics, data sets, and biographical information on well-known statisticians.

Social Psychology Network©. (http://www.socialpsychology.org/)
This site is maintained by Scott Plous of Wesleyan University. The URL given is to the homepage of the site. Links for statistics can be obtained by clicking on *Links by Psychology Area* and then on *Research Methods and Statistics* links. Links to online texts, data analysis calculators, and power analysis are provided.

Psych Web. (http://www.psychwww.com/)
Psych Web is a large collection of resources for psychology in general maintained by Russ Dewey. Resources for statistics are reached by clicking on *Scholarly Resources* and then *Statistics for Psychologists*.

World Lecture Hall. (http://web.austin.utexas.edu/wlh/)
Links to online materials for courses in a variety of areas. Statistics courses can be found under Education, Psychology, Sociology, and, of course, Statistics. The site is maintained by the University of Texas.

Psychological Research on the Net. (http://psych.hanover.edu/research/exponnet.html)
This site, prepared and maintained by John Krantz of Hanover College, provides a listing of behavioral science experiments on the Internet.

Probability Web. (http://www.mathcs.carleton.edu/probweb/probweb.html)
This site, maintained by Bob Dobrow of Carleton College, contains a variety of resources for instructors seeking additional information on teaching probability.

Yahoo!, Inc.© listing of statistics sites. (http://dir.yahoo.com/Science/Mathematics/Statistics)

Galaxy.com© listing of statistics sites. (http://www.galaxy.com/directory/14879/Statistics.htm)

The next section provides suggestions and ideas for each of the chapters of the text. We hope these materials will be helpful to you.

Chapter 1

Making Sense of Variability: An Introduction to Statistics

Part A: ***Overview and Suggestions***

The first chapter presents the idea that there is both consistency and variability in the events that surround our lives to introduce the need for the study of statistics. Following the initial introduction the next section of the text focuses on helping the student become acclimated to studying behavioral statistics and the use of the textbook. The four most critical piece of information in this section are (a) the benefit of adopting a "Growth Mindset" (e.g., Dweck, 2006), (b) helpful vs. distracting behaviors (e.g., Gurung, 2005), (c) the benefits of self testing (e.g., Roediger & Karpicke, 2006), and (d) being intellectually engaged in and out of class.

Four major uses of statistics in the behavioral sciences are introduced: (a) summarizing or describing data; (b) making inferences about population values from sample data; (c) statistical hypothesis testing to analyze data from experiments; and (d) determining if two sets of scores are related, and how related scores form the basis for predictions from regression equations. The last section of the chapter stresses that the common thread among these uses is the problem of dealing with variability in behaviors and events.

Students should understand that statistics are used to describe sets of scores and that information from a sample can be used to make inferences about larger populations. One way to help students appreciate these concepts is to ask them to relate the chapter content to their everyday lives. For example, in what ways have they observed behavior to be variable? Is there also consistency to be found among this variability? One such example could be what does a typical first day of class look like, as certain activities are consistent (e.g., handing out a syllabus) while other activities vary widely depending on the professor or class (e.g., having class dismissed, with the real learning beginning during the second class or beginning the first class with a lecture or the discussion of the first major assignment). Students also may be asked to identify populations they are members of, and what is the common characteristic of each of these populations. Examples of descriptive statistics familiar to students may be used for class discussion purposes. For example, grade point averages (GPA) and average incomes by occupational category are descriptive statistics that usually are familiar to students.

A topic from social psychology, how we form impressions of others, provides an interesting analogy for discussion of the problem of making inferences from sample data. First impressions of others simply are samples from the population of behaviors of a person. Students can then consider how well first impressions serve to provide information about what a person is actually like.

The example of first impressions also can be used when introducing the experimental method. Discuss how first impressions may lead to hypotheses about a person and how such hypotheses can be tested by subsequent information about the person. You also can ask students to suggest other research hypotheses about behavior, identifying the independent variable and the behavior they think it acts upon. The class can then discuss designing a simple experiment to test one of these hypotheses.

The topic of correlation and prediction can be brought to a very personal level by pointing out that most students have made a prediction of how they expect to do in the course. What information was used to make this prediction? How certain are students of its correctness? Other examples of variables expected to covary, such as SAT scores and freshmen college grades, or the number of hours studied per week and course performance, may be introduced here also. If you are planning to collect information about students using a questionnaire, you might ask which variables students anticipate covarying.

The last section of Chapter 1 stresses that variability among individuals and behavior underlies the need for statistics. In this respect, ask students to consider whether people are more alike than they are different, or whether they are more different than they are alike. Point out that some behavioral researchers look for similarities and consistencies among people in search of general principles of behavior that hold for all individuals; these researchers often use the experimental method and tend to look at the average scores for a group. In contrast, other researchers are more interested in exploring how people differ from each other and tend to use correlational statistics in their research.

Part B: ***Goals and Objectives***

Goal 1.1
Students will recognize behaviors and attitudes that will maximize their success in behavioral statistics.

> Objective 1.1.a.
> Students will implement attitudes and behaviors that increase the likelihood of success in a behavioral statistics class (e.g., adopting a growth mindset and helpful behaviors associated with academic success, practicing self testing, and being intellectually engaged in and out of class).

Goal 1.2
Students will understand that statistics is a method of gaining understanding of variability in data.

> Objective 1.2.a.
> Students will define data and identify examples of data used in behavioral research.
>
> Objective 1.2.b.
> Students will be able to define and identify examples of statistics used in behavioral research.
>
> Objective 1.2.c.
> Students will define and identify examples of variability and variables in their life and in the behavioral sciences.
>
> Objective 1.2.d.
> Students will possess a basic understanding that statistics can aid in the understanding of variability seen in behavioral science variables.

Goal 1.3
Students will know four common uses of statistics.

> Objective 1.3.a.
> Students will identify, define, and provide an example of the four common uses of statistics: descriptive, inferential, hypothesis testing, and finding associations.
>
> Objective 1.3.b.
> Students will recognize that different statistics have different uses, and that each statistic brings with it information it can provide and information it cannot provide.
>
> Objective 1.3.c.
> Students will understand that some uses of statistics require different research methodology than other uses of statistics.

Goal 1.4
Students will know and appropriately use terminology and symbols in statistics.

> Objective 1.4.a.
> Students will define, and when appropriate, provide examples of the terminology and symbols necessary for mastering the objectives listed in this chapter.

Part C: ***Chapter Outline***

- Making sense of variability
  - Variable
    - Any environmental condition or event, stimulus, personal characteristic or attribute, or behavior that can take on different values at different times or with different people
- Success in behavioral statistics
  - Benefit of adopting a "growth mindset"
  - Helpful vs. distracting behaviors
  - Benefits of self testing
  - Being intellectually engaged
- What is statistics?
  - Data
    - Scores or measurements of behavior or characteristics obtained from observations of people or animals
    - Quantifying a variable, putting the variable into numbers
  - Statistics
    - Methods or procedures used to summarize, analyze, and reach conclusions from a set of data
    - Used to understand consistency and variability in data
- Building the foundation for understanding statistics
  - Statistics
    - Helps us to find patterns of consistency in seeming randomness
    - Like tools in a toolbox
      - Each has its own purpose
      - In order to be able to use the different tools you must be able to understand their strengths and limitations
- Using statistics: four examples
  - Plain yet mighty: descriptive statistics
  - Making sense of the world from a little piece: inferential statistics
  - More than a chance difference: statistical hypothesis testing
  - Finding associations between variables: correlation and regression
- Plain yet mighty: descriptive statistics
  - Descriptive statistics
    - Often called a statistic
    - Single number used to describe or analyze a set of data from a sample
    - Describes data objectively
    - Only to illustrate what is going on in the sample
    - Cannot use to draw conclusions
  - Sample
    - Subset of the population.
  - Population
    - A complete set of people, animals, objects, or events that share a common characteristic
- Making sense of the world from a little piece: inferential statistics
  - Inferential statistics
    - Taking information that we obtained from the sample and using it to draw inferences about the population
    - Inferring what is going on with the population given what is observed in the sample data
  - Random sample
    - Subset of the population where
      - Every member of the population has an equal chance of being selected
      - Every member is selected independently
  - Parameter
    - A number used to capture or characterize the entire population
    - Seldom known because an entire population is rarely measured

- More than a chance difference: statistical hypothesis testing
  - <u>Statistical hypothesis testing</u>
    - Purpose is to determine the anticipated size of chance differences between groups in an experiment
    - Used to analyze data and tell whether there is a difference between two or more groups
    - Statistic tests whether an observed difference is a chance difference or a statistically significant difference
  - <u>Hypothesis</u>
    - Logically deduced statement about the relationship between two or more variables
    - A statement of an expected or predicted relationship between two or more variables
  - <u>Experiment</u>
    - A type of research method that makes use of random assignment so we can test if changes in the independent variable are causing changes in the dependent variable
  - <u>Independent variable</u>
    - A variable manipulated in an experiment to determine its effect on the dependent variable
  - <u>Dependent variable</u>
    - The variable in an experiment that depends on the independent variable
    - In most instances it is some measure of a behavior
  - <u>Subjects or participants</u>
    - The people or animals participating in the research study
  - <u>Equivalent groups</u>
    - Groups of subjects that are not expected to differ in any consistent or systematic way prior to receiving the independent variable of the experiment
  - <u>Random assignment</u>
    - A method of assigning subjects to treatment groups
      - Any individual selected for the experiment has an equal probability of assignment to any of the groups
      - Assignment of one person to a group does not affect the assignment of any other individual to that same group
    - Aids in obtaining equivalent groups
  - <u>Between subject design</u>
    - A research design in which two or more groups are created
  - <u>Score</u>
    - The measurement value obtained on the subject's performance of a task
  - <u>Raw data</u>
    - The scores obtained from all the subjects before the scores have been analyzed statistically
  - <u>Chance difference</u>
    - A difference between equivalent groups due to random variation
- Finding associations between variables: correlation and regression
  - <u>Association</u>
    - Looking for relationship between variables
      - Just because there is a relationship between variables does not mean one variable causes the other
  - <u>Subject variable</u>
    - A characteristic or attribute of a subject that can be measured but not manipulated by the researcher
  - <u>Covary</u>
    - A change in one variable is related to a consistent change in the other variable
  - <u>Correlation coefficient</u>
    - The measure of the association or relationship between two variables
    - A statistic that provides a numerical description of the extent of the relatedness of two sets of scores and the direction of the relationship
  - <u>Regression analysis</u>
    - The use of statistical methods to predict one set of scores from a second set of scores.

Part D: ***Key Terms and Symbols***

between-subjects design
chance difference
correlation coefficient
covary
data
dependent variable
descriptive statistic
descriptive statistics
equivalent groups
independent variable
parameter
participant
population
random assignment
random sample
raw data
regression analysis
research hypothesis
sample
score
statistic
statistical hypothesis testing
statistical inference
statistics
subject
subject variable
variable

Part E: ***Discussion Questions***

The following questions can be assigned to students for homework or can be used for an interteaching activity, assessment, or discussion.

1. What is statistics? What can statistics tell a researcher?
2. What are some techniques discussed in the book that you can use to maximize your success in behavioral statistics?
3. What are four common uses for statistics? How are they similar? How are they different?
4. What is the difference between using statistics to describe vs. infer?
5. What is an experiment? What use of statistics is often associated with an experiment? What information can you obtain from conducting an experiment and using the right kind of statistics?
6. When conducting an experiment, why can't researchers just look at descriptive statistics and if they see a small difference in the values, accept that the independent variable caused the difference in the dependent variable? When answering this question make sure to use the term "chance difference" and define what it means.
7. What are the similarities and differences between an independent variable and a subject variable?
8. If you have two subject variables how could you use statistics to understand how they are related?
9. In finding associations between two variables, what conclusion can a researcher not reach from this type of statistic?
10. What type of information does regression analysis provide us? What type of information does it not provide?

Chapter 1

MAKING SENSE OF VARIABILITY
AN INTRODUCTION TO STATISTICS

1-1 A ___ is any environmental condition or event, stimulus, personal characteristic or attribute, or behavior that can take on different values at different times.
a. statistic
* b. variable
c. datum
d. population

Information p 2, K, 1

1-2 ___ was a 19th century professor who attempted to characterize the "average" man.
a. Gaston
b. Talbert
c. Quincy
* d. Quetelet

Information: p 3, K, 1

1-3 ___ refers to the scores or measurements obtained by a behavioral scientist.
a. Statistics
b. A sample
* c. Data
d. A parameter

Information: p 6, K, 1

1-4 ___ refers to the procedures used to summarize, analyze, and draw conclusions from data.
* a. Statistics
b. Parameters
c. Sampling
d. Hypotheses

Information: p 7, K, 1

1-5 The process of summarizing, analyzing, and reaching conclusions from numerical measurements uses ___ methods.
* a. statistical
b. sampling
c. hypothesis generation
d. parameter estimation

Information: p 7, K, 1

1-6 A single number used to describe data from a sample is a ___.
a. variable
b. sample
c. parameter
* d. statistic

Information: p 7, K, 1

1-7 A statistic is __.
a. a population
b. a sample
* c. a single number used to describe a set of data
d. always difficult to calculate

Information: p 7, K, 1

1-8 A ___ is a complete set of people, animals, objects, or events sharing a common characteristic.
a. sample
b. statistic
* c. population
d. variable

Information: p 7, K, 1

1-9 A population is ___.
a. the same as a sample
* b. a complete set of people, animals, objects, or events that share a common characteristic
c. selected from a sample
d. a complete set of people, animals, objects, or events possessing a variety of different characteristics

Information: p 7, K, 1

1-10 A(n) ___ is a subset, or subgroup, selected from a population.
a. dependent variable
b. equivalent group
c. subject
* d. sample

Information: p 7, K, 1

1-11 A sample is ___.
a. larger than a population
b. a complete set of people, animals, objects, or events that share a common characteristic
* c. selected from a population
d. the same as a population

Information: p 7, K, 1

1-12 A professor surveys a sample of 25 students to find how many hours per week they work at a job. She finds the typical number of hours reported is 15. The value of 15 hours is a(n) ___.
a. parameter
b. inference
* c. statistic
d. estimate

Information: p 7, K, 1

1-13 Population values inferred from statistics of a sample are called ___.
a. independent variables
b. dependent variables
c. hypotheses
* d. parameters

Information: p 9, K, 1

1-14 A characteristic of a population is called a(n) ___.
a. independent variable
* b. parameter
c. statistic
d. research hypothesis

Information: p 9, K, 1

1-15 A parameter is ___.
* a. a characteristic of a population
b. a characteristic of a sample
c. the same as a statistic
d. measured on a sample

Information: p 9, K, 1

1-16 In an experiment, the variable that is manipulated to determine its effect on behavior is called the ___ variable.
a. extraneous
b. dependent
* c. independent
d. subject

Information: p 10, K, 1

1-17 An independent variable is ___ in an experiment.
a. presented to participants
b. the variable that affects an individual's responding
c. manipulated by an experimenter
* d. all the above

Information: p 10, K, 2

1-18 A dependent variable is ___ in an experiment.
a. a placebo
* b. the behavior measured
c. the conditions manipulated
d. none of the above

Information: p 10, K, 1

1-19 In an experiment, the behavior that is expected to be affected by some manipulation is called the ___ variable.
a. random
b. extraneous
c. independent
* d. dependent

Information: p 10, K, 1

1-20 If a researcher used an experiment to assess whether or not a certain drug would increase reading comprehension scores, then the independent variable would be the ___.
* a. amount of the drug given to participants
b. age of the participants
c. gender of the participants
d. reading comprehension scores

Information: p 10, A, 2

1-21 If a researcher used an experiment to assess whether or not a certain drug would increase reading comprehension scores, then the dependent variable would be the

a. gender of the participants
b. age of the participants
* c. reading comprehension scores
d. amount of the drug given to participants

Information: p 10, A, 2

1-22 If a researcher used an experiment to test two different methods of teaching geometry, then the independent variable would be the ___.

* a. type of teaching method
b. gender of the students
c. geometry test scores obtained by participants
d. grade level of the participants

Information: p 10, A, 2

1-23 If a researcher used an experiment to test two different methods of teaching geometry, then the dependent variable could be the ___.

a. teaching methods
b. gender of the students
* c. geometry test scores obtained by participants
d. correlation coefficient

Information: p 10, A, 2

1-24 An experimenter created two different groups of participants and gave each group a different instructional program on the anatomy of the eye. After the instructional program each group was given a multiple choice test to assess their knowledge of the eye. In this experiment, the instructional program condition was the ___ variable.

* a. independent
b. dependent
c. subject
d. extraneous

Information: p 10, A, 3

1-25 An experimenter created two different groups of participants and gave each group a different instructional program on the anatomy of the eye. After the instructional program each group was given a multiple choice test to assess their knowledge of the eye. In this experiment, the multiple choice test used to assess the participant's knowledge was the ___ variable.

a. independent
* b. dependent
c. subject
d. extraneous

Information: p 10, A, 3

1-26 Which of the following best describes an experiment?

a. The dependent variable is manipulated and then the independent variable is measured.
* b. The independent variable is manipulated and then the dependent variable is measured.
c. The independent and dependent variables are measured at the same time.
d. The dependent variable is measured first and then the independent variable is measured.

Information: p 10, K, 3

1-27 The term *equivalent groups* means that ___.

a. the independent variable affects all groups equally
b. the dependent variable is the same among all groups
c. only chance factors influence differences among groups after the independent variable has been manipulated
* d. the groups of participants do not differ in any systematic way prior to the manipulation of the independent variable

Information: p 10, K, 2

1-28 Groups of subjects that are not expected to differ in any systematic way before the independent variable is presented in an experiment are called ___ groups.

a. equal
* b. equivalent
c. population
d. between-subjects

Information: p 10, K, 2

1-29 An experiment that creates two or more groups uses a(n) ___ design.
- a. across-subjects
- b. equal-subjects
- c. within-subjects
- * d. between-subjects

Information: p 10, K, 1

1-30 A(n) ___ experiment uses two or more equivalent groups.
- * a. between-subjects
- b. across-subjects
- c. within-subjects
- d. equal-subjects

Information: p 10, K, 2

1-31 A between-subjects experiment uses two or more ___ groups.
- a. equal
- b. population
- c. nonequivalent
- * d. equivalent

Information: p 10, K, 1

1-32 A measurement obtained from a participant in an experiment is called a(n) ___.
- a. independent variable
- b. parameter
- * c. score
- d. statistic

Information: p 10, K, 1

1-33 A(n) ___ is a statement of the expected or predicted relationship between two or more variables.
- a. dependent variable
- * b. research hypothesis
- c. independent variable
- d. correlation coefficient

Information: p 11, K, 1

1-34 In an experiment, a research hypothesis is a ___.
* a. predicted relationship between an independent and a dependent variable
  b. statement of a sample value
  c. prediction of a population parameter
  d. prediction of how a dependent variable will affect an independent variable

Information: p 11, K, 1

1-35 People who participate in research studies often are called ___.
  a. parameters
  b. data
* c. subjects or participants
  d. associates

Information: p 11, K, 1

1-36 A chance difference refers to ___.
* a. a difference between equivalent groups that occurs because of random variation
  b. differences between equivalent groups due to the effect of the independent variable
  c. the fact that equivalent groups will be exactly equal in all ways
  d. the fact that statistics differ from each other

Information: p 11, K, 2

1-37 A(n) ___ allows a researcher to estimate the possibility of chance differences between groups.
  a. independent variable
* b. statistical hypothesis test
  c. population parameter
  d. sample statistic

Information: p 11, K, 2

1-38 When an observed difference between two groups on the dependent variable is attributed to the effect of the independent variable through statistical hypothesis testing, then we know that ___.
* a. it is unlikely that the difference would occur by chance alone
  b. the raw data have been refined
  c. the groups were not equivalent before the independent variable was introduced
  d. it is likely that the difference would occur by chance alone

Information: p 11, A, 3

1-39 If two variables change consistently in relation to each other, they are said to ___.
* a. covary
b. be independent
c. represent equivalent groups
d. be random samples

Information: p 12, K, 1

1-40 A psychologist finds that performance on learning a poem decreases as room temperature increases above 72°F. In this instance, learning of the poem and room temperature ___.
a. are independent
* b. covary
c. are both independent variables
d. do not vary

Information: p 12, A, 2

1-41 A ___ is a number indicating the relatedness of two sets of scores and the direction of the relationship.
a. research hypothesis
b. population parameter
* c. correlation coefficient
d. descriptive statistic

Information: p 12, K, 2

1-42 The correlation coefficient may range in value from ___.
a. -10.00 to +10.00
b. 0.00 to +10.00
c. 0.00 to +100
* d. -1.00 to +1.00

Information: p 12, K, 1

1-43 Which of the following gives a numerical description of the extent and direction of the relationship between two sets of scores?
a. A sample.
b. A parameter.
* c. A correlation coefficient.
d. A score relation.

Information: p 12, E, 1

1-44 A ___ is used to predict one set of scores from a different set of scores.
a. parameter
b. statistical hypothesis test
c. statistical revision process
* d. regression analysis

Information: p 13, K, 2

1-45 Statistics are necessary in behavioral research because ___.
* a. of variability in behaviors among people
b. raw data cannot be reliably interpreted
c. population parameters are so variable
d. people are almost all alike on many different characteristics

Information: p 13, A, 1

Chapter 2

Statistics in the Context of Scientific Research

Part A: ***Overview and Suggestions***

This chapter opens with an overview of scientific research. The goal is to convey the point that behavioral scientists seek to answer questions. Answering those questions requires the use of statistics. Thus, to understand statistical methods, a student must know at least the fundamentals of research methodology.

Having students construct a questionnaire allows for a discussion and application of many of the concepts presented in the beginning of this chapter. The need for empirically testable questions and explicit research hypotheses can be stressed. Discuss what it means to evaluate a hypothesis and why a hypothesis that cannot be refuted by empirical data is not scientifically useful. Have students provide examples of untestable hypotheses and how such hypotheses might be reformulated into statements that would be empirically testable.

In discussing research methods, the idea of conducting ethical research should be discussed. Several sources exist on the Tuskegee Syphilis Research project conducted from 1932 to 1972 in the United States. This study and its ethical failures tend to be concrete enough for students to comprehend the real threat of unethical research and its impact on human subjects. For further information on the Tuskegee syphilis research project, see the Centers for Disease Control and Prevention website http://www.cdc.gov/tuskegee/timeline.htm or the Online Ethics Center website http://www.onlineethics.org/CMS/edu/precol/scienceclass/sectone/cs3.aspx. Nova (1993) produced a 60-minute video called the "Deadly Deception" which contains personal statements by subjects and researchers involved in the Tuskegee syphilis research project. By showing a brief clip of this study, students can be encouraged to discuss the ethical responsibilities of behavioral scientists.

If students are asked to formulate research hypotheses, then a discussion of measurement follows naturally. To help understand measurement, it is beneficial to ask students to suggest alternative ways of measuring the same behavioral concept. For instance, how might the humor of a set of cartoons be measured? One approach simply might be to identify the cartoons as belonging to one of two categories--humorous or not humorous. Or, the cartoons could be rank ordered from the most humorous to the least humorous. As another approach, subjects might complete a 7-point rating scale on a dimension from 1--not at all humorous to 7--extremely humorous for each cartoon. Finally, we could time the length of laughter of a person to each cartoon.

Students relate easily to the idea of rank ordering that characterizes ordinal measurement. Ordinal measurement is illustrated by a common elementary school experience--lining up according to height. Other examples of ordinal scales are class ranks determined from grade point averages, or college grades, such as A, B, C, D, and F. To initiate a discussion of characteristics of an ordinal scale, ask students to consider that if student 1 receives an A, student 2, a B, and student 3, a C for statistics, what does this tell you about their performance in the course? Or suppose you know that the top ten disease-related causes of death in rank order are: heart disease, cancer, stroke, lung disease, diabetes, pneumonia and flu, kidney disease, blood poisoning, liver disease, and hypertension. What does this knowledge tell you about how likely someone is to die of diabetes? Ordinal scaling often is presented in articles found in newspapers or magazines, such as the top ten areas in which to retire or live, the top three cars in owner satisfaction, or the top five causes of death.

As discussed in the text, many measures used in the behavioral sciences (for example, psychological test scores, rating scales) seem to lie in a "gray" area; that is, they appear to convey more quantitative information than ordinal measurement, but it is difficult to argue that they achieve interval measurement. The distinguishing characteristic of an interval scale is that it possesses an arbitrary zero point; thus a value of zero on an interval scale does not represent the absence of the characteristic being measured. Examination scores provide a convenient example for discussion. For example, does a score of zero on an exam mean the total absence of knowledge of the material?

Exam scores also can be used to illustrate the distinction between discrete and continuous variables. For example, a student may receive a score of 84 or 85 on a multiple choice examination, but in most instances a score of 84.37 cannot be given. Thus, the exam score exists at specific and discrete values and values between those points do not exist. A continuous variable is easy to describe using height and weight. Ask the class to consider the case of two people who both report their height as 6 feet. Is it likely that either or both are exactly 6 feet tall? Students will realize that although both individuals were assigned the same value, some small but real difference probably exists between them. An argument can then be introduced about the accuracy of measurements and that a continuous variable can be defined as a variable that could theoretically be measured to finer and finer levels of accuracy.

In the discussion of continuous measurement, the idea of real limits is important. An example that most students can understand is what constitutes and A, B, C, etc. So, even if an A is defined as a 90% or above, what grade do most students expect to receive if they earn an 89.5%? Of course, it is best to use the grades and percentages used on your campus in this example.

Part B: *Goals and Objectives*

Goal 2.1
Students will identify what constitutes science.

Objective 2.1.a.
Students will define and identify examples of scientific pursuit of knowledge.

Objective 2.1.b.
Students will define and identify the role of the hypothesis in scientific research.

Goal 2.2
Students will identify uses and limitations of major types of research.

Objective 2.2.a.
Students will identify and define six different types of research methods: case study, naturalistic observation, archival research, survey, experiment, quasi-experiment.

Objective 2.2.b.
Students will identify the uses and limitations for six different types of research methods.

Objective 2.2.c.
Students will identify the basic role of the hypothesis and application of statistics in each of the six types of research methods.

Objective 2.2.d.
Students will understand that some uses of statistics require different research methodology than other uses of statistics.

Objective 2.2.e.
Students will identify the importance and the impact of ethical decisions on scientific research with humans and animals.

Goal 2.3
Students will understand basic issues with regard to measurement in statistics.

Objective 2.3.a.
Students will identify, define, and provide an example of the four scales of measurement: nominal, ordinal, interval, and ratio.

Objective 2.3.b.
Students will identify, define, and provide an example of qualitative and quantitative data.

Objective 2.3.c.
Students will further classify quantitative data as being either discrete or continuous.

Objective 2.3.d.
Students will comprehend the role of the real limit in continuous data.

Goal 2.4
Students will know and appropriately use terminology and symbols in statistics.

Objective 2.4.a.
Students will define, and when appropriate, provide examples of the terminology and symbols necessary for mastering the objectives listed in this chapter.

Part C: ***Chapter Outline***

- What is science
    - One method for the acquisition of knowledge
- Scientific method
    - Scientific question
        - Allows answer to be obtained through collection of empirical data
        - Empirical data
            - Score or measurement obtained from observations
    - Research hypothesis
        - Statement of expected or predicted relationship between two or more variables Research methods
        - Approach scientists use to collect data in order to develop or evaluate a research hypothesis
        - Used to empirically test hypothesis
        - Select the type of research method based on question/hypothesis
    - Collect data
    - Analyze data
    - Reach conclusion
- Types of research methodsCase study
        - Fully detailed examination of a single case
        - Used for rare or new conditions/situations
        - Used for hypothesis building
    - Naturalistic observation
        - Unobtrusive examination of organisms in their natural habitat
        - Used to find associations between variables
        - Used for hypothesis building and non-causal hypothesis testing
    - Archival records
        - Use of data collected at a different time for a different purpose to test a current non-causal hypothesis
        - Answering questions by examining data from existing records
        - Can be used for hypothesis building and testing
    - Survey research
        - Obtaining data through oral interviews or paper and pencil tasks
        - Test non-causal hypotheses
        - Of special note
            - Survey's are easy to design, but hard to design well
            - Measurement error can be a real issue
    - Experiment
        - Researcher has control over the independent variable
        - Subjects are randomly assigned to receive different levels of the independent variable
        - Independent variable (IV)
            - Variable manipulated (controlled) by experimenter
            - Used in experiments to see whether it causes changes DV
        - Dependent variable (DV)