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INTRODUCTION TO SCIENTIFIC THINKING

CHAPTER SUMMARY

1.1 Science as a Method of Knowing

Science is one way of knowing about the world. The word *science* comes from the Latin *scientia*, meaning knowledge, and from a broad view, science is any systematic method of acquiring knowledge apart from ignorance. To use the **scientific method**, we make observations that can be directly or indirectly observed.

1.2 The Scientific Method

To engage in the scientific method, the process used to acquire knowledge is organized into six steps:

- Identify a problem. Identify an area of interest to you, and then review the scientific literature, typically using online search engines, to identify what is known and what can still be learned about your area of interest. After conducting a literature review, identify new ideas in your area of interest by making a statement of prediction called a **research hypothesis**.
- Develop a research plan. Once a research hypothesis is stated, you need a plan to test that hypothesis. Identify the **variables** being tested and define them in terms of how they will be measured (i.e., state an **operational definition**). Identify a **population** of interest and determine how to select a **sample** of participants to observe from this larger population. Then select a research strategy and a design for your study; also evaluate ethical implications of the research design and obtain institutional approval to conduct the research.
- Conduct the study. Execute the research plan by conducting the research study.
- Analyze and evaluate the data. Typically we analyze and evaluate numeric **data**. Once the data are analyzed, concisely report the data in the text of a paper, in tables, or in a figure or graph.
- Communicate the results. The most typical ways of sharing the results of a study are orally, in written form, or as a poster. Written research reports conform to the style and formatting guidelines provided in the *Publication Manual of the American Psychological Association* (APA, 2010), also called the *Publication Manual*.

CHAPTER LEARNING OBJECTIVES

1. Define science and the scientific method.
2. Describe six steps for engaging in the scientific method.
3. Describe five nonscientific methods of acquiring knowledge.
4. Identify the four goals of science.
5. Distinguish between basic and applied research.
6. Distinguish between quantitative and qualitative research.
7. Delineate science from pseudoscience.

- Generate more new ideas. The study you complete can be informative. If you find support for your research hypothesis, then you can use it to refine and expand on your ideas. If the results do not support your research hypothesis, then you need to propose a new idea and begin again.

1.3 Other Methods of Knowing

Five nonscientific ways of knowing are tenacity, intuition, authority, rationalism, and empiricism. **Tenacity** is a method of knowing based largely on habit or superstition. **Intuition** is an individual's subjective hunch or feeling that something is correct. **Authority** is knowledge accepted as fact because it was stated by an expert or respected source in a particular subject area. **Rationalism** is any source of knowledge that requires the use of reasoning or logic. Finally, **empiricism** is knowledge acquired through observation. The nonscientific ways of knowing may be used during the scientific process; however, they are only used in conjunction with the scientific method.

1.4 The Goals of Science

The four goals of science are to describe, to explain, to predict, and to control. To *describe* refers to understanding the behaviors and events we study. To *explain* refers to identifying the conditions within which behaviors and events operate. To *predict* refers to foretelling the occurrence of behaviors or events in the future. To *control* means that we can make a behavior occur and not occur. The four goals of science serve to direct scientists toward a comprehensive knowledge of the behaviors and events they observe.

1.5 Approaches in Acquiring Knowledge

Basic research is used to address theoretical questions regarding the mechanisms and processes of behavior. **Applied research** is used to address questions that can lead to immediate solutions to practical problems.

Quantitative research restricts observations to categories and numeric measurements to obtain statistical results. **Qualitative research** does not include statistical results; instead, researchers draw conclusions that provide a series of interpretations for the observations they make. Quantitative and qualitative research can be effectively used to study the same behaviors, so both types of research have value.

1.6 Delineate Science From Pseudoscience

Pseudoscience is a set of procedures that are not scientific, and it is part of a system or set of beliefs that try to deceptively create the impression that the knowledge gained represents the "final say" or most reliable knowledge on its subject matter. Being able to delineate science from pseudoscience can be difficult, and the demarcation between science and pseudoscience is still debated among philosophers and scientists alike.

CHAPTER SUMMARY ORGANIZED BY LEARNING OBJECTIVE

LO 1: Define science and the scientific method.

- **Science** is the acquisition of knowledge through observation, evaluation, interpretation, and theoretical explanation.

- Science is specifically the acquisition of knowledge using the **scientific method**, which requires the use of systematic techniques, each of which comes with a specific set of assumptions and rules that make it *scientific*.

LO 2: Describe six steps for engaging in the scientific method.

- The scientific process consists of six steps:

Step 1: Identify a problem: Determine an area of interest, review the literature, identify new ideas in your area of interest, and develop a research hypothesis.

Step 2: Develop a research plan: Define the variables being tested, identify participants or subjects and determine how to sample them, select a research strategy and design, and evaluate ethics and obtain institutional approval to conduct research.

Step 3: Conduct the study: Execute the research plan and measure or record the data.

Step 4: Analyze and evaluate the data: Analyze and evaluate the data as they relate to the research hypothesis, and summarize data and research results.

Step 5: Communicate the results: Results can be communicated orally, in written form, or as a poster. The styles of communication follow standards identified by the APA.

Step 6: Generate more new ideas: Refine or expand the original hypothesis, reformulate a new hypothesis, or start over.

LO 3: Describe five nonscientific methods of acquiring knowledge.

- **Tenacity** is a method of knowing based largely on habit or superstition. A disadvantage of tenacity is that the knowledge acquired is often inaccurate.
- **Intuition** is a method of knowing based largely on an individual's hunch or feeling that something is correct. A disadvantage of intuition is that the only way to determine the accuracy of an intuition is to act on that belief.
- **Authority** is a method of knowing accepted as fact because it was stated by an expert or respected source in a particular subject area. A disadvantage of authority is that there is typically little effort to challenge authority, leaving authoritative knowledge largely unchecked.
- **Rationalism** is a method of knowing that requires the use of reasoning and logic. A disadvantage of rationalism is that it often leads to erroneous conclusions.
- **Empiricism** is a method of knowing based on one's experiences or observations. Disadvantages of empiricism are that not everyone experiences or observes the world in the same way, perception is often illusory, and memory is inherently biased.

LO 4: Identify the four goals of science.

- The four goals of science are to **describe** or define the variables we observe and measure, **explain** the causes of a behavior or event, **predict** when a behavior or event will occur in the future, and **control** or manipulate conditions in such a way as to make a behavior occur and not occur.

LOs 5–6: Distinguish between basic and applied research, and between quantitative and qualitative research.

- **Basic research** uses the scientific method to answer questions that address theoretical issues about fundamental processes and underlying mechanisms related to the behaviors and events being studied. **Applied research** uses the scientific method to answer questions concerning practical problems with potential practical solutions.
- **Quantitative research** is most commonly used in the behavioral sciences and uses the scientific method to record observations as numeric data. **Qualitative research** uses the scientific method to make nonnumeric observations, from which conclusions are drawn without the use of statistical analysis.

LO 7: Delineate science from pseudoscience.

- **Pseudoscience** is a set of procedures that are not scientific, and it is part of a system or set of beliefs that try to deceptively create the impression that the knowledge gained represents the “final say” or most reliable knowledge on its subject matter.
- Being able to delineate science from pseudoscience can be difficult, and the demarcation between science and pseudoscience is still a subject of debate among philosophers and scientists alike.

TIPS AND CAUTIONS FOR STUDENTS

Identify an Area of Interest

Too often students tend to choose the first idea that comes to their mind when choosing a research topic. Keep in mind that research is a commitment that can take a substantial amount of time. Even for a project in class, this can mean months of commitment. If you have an opportunity to choose an area of interest, make an effort to explore what aspects of human behavior interest you. You can identify and explore your areas of interest by performing an initial web search in Google or conducting a literature review. Type in keywords, such as *addiction*, *dieting*, or *spirituality*, and have fun searching the different types of behaviors that may interest you. Once you identify an area of interest, you can follow the remaining steps of the scientific process introduced in this chapter—and throughout the book.

Data Are Plural for Usage in APA-Style Writing

For example, say “The data *are* significant,” not “The data *is* significant.” *Datum* is singular, although this term is more typically called a *score* or *raw score*. Keep note of this distinction.

Empiricism Versus the Scientific Method

Empiricism can often be confused with scientific observation because empiricist knowledge is acquired through *observation*. Keep in mind that empiricism is any type of observation. As an example, two people may walk by and you “see” that they are happy. However, you do not necessarily measure your observation. Strictly speaking, simply “seeing” two people being happy is empiricism. However, in science, you will need to specifically define how “happy” is measured; for example, we can define it as the time in seconds spent laughing. Our observations will then be

guided by how we define the behavior we are measuring—that is, being “happy.” Hence, empiricism can be any type of observation, whereas in science, observation is limited to only those phenomena that can be specifically measured.

PRACTICE QUIZ

1. Science is specifically the acquisition of knowledge using:
 - a. The scientific method
 - b. A random observation
 - c. Good study habits
 - d. A multiple-choice test
2. Which of the following is not a step of the scientific method?
 - a. Identify a problem
 - b. Use empiricism
 - c. Conduct the study
 - d. Analyze and evaluate the data
3. A researcher defines the variables being tested, identifies participants, and determines how to sample them. She then selects a research strategy, evaluates the ethics of her design, and obtains institutional approval to conduct research. Which step of the scientific method does this describe?
 - a. Communicate the results
 - b. Conduct the study
 - c. Identify a problem
 - d. Develop a research plan
4. Which of the following is a method of communication?
 - a. Oral presentation
 - b. Written manuscript
 - c. Poster presentation
 - d. All of the above
5. Which of the following is the initial step in the scientific process?
 - a. Conduct the study
 - b. Develop a research plan
 - c. Identify a problem
 - d. Generate more new ideas
6. Which of the following is an example of a research hypothesis?
 - a. If people are nice, then are they also helpful?
 - b. Nice people can be so helpful sometimes.
 - c. People who are nice will also be more helpful.
 - d. Being nice and being helpful: Do the two go hand in hand?
7. Which of the following is not an example of a variable?
 - a. The value of π
 - b. Duration of time
 - c. Height in inches
 - d. Calories in a meal

8. A researcher explained that location was measured as the distance (in feet) of an object from the target location. In this example, the definition of location is an example of:
 - a. A dictionary definition
 - b. An operational definition
 - c. A semantic definition
 - d. A nondefinition
9. Of a full class of 30 students, a professor selects 10 students to come to the front of the class. If the class itself is the only group of interest to the professor, then how many students in this class are in the sample?
 - a. 10
 - b. 20
 - c. 30
 - d. 0
10. Which of the following is true about a population?
 - a. It is a set of all individuals, items, or data of interest.
 - b. It is the group about which scientists will generalize.
 - c. It can constitute a large group or a small group.
 - d. All of the above
11. Data are measurements or observations that are typically:
 - a. Vague
 - b. Unclear
 - c. Numeric
 - d. Not measured at all
12. To generate more new ideas, we can:
 - a. Refine or expand the original hypothesis
 - b. Reformulate a new hypothesis
 - c. Start over
 - d. All of the above
13. A method of knowing based largely on habit or superstition is called:
 - a. Intuition
 - b. Tenacity
 - c. Authority
 - d. Rationalism
14. A method of knowing based on one's experiences or observations is called:
 - a. Empiricism
 - b. Scientific
 - c. Authority
 - d. Rationalism
15. A teacher states that students do not care about being in school because they are not paying attention in class. Which of the following nonscientific ways of knowing is illustrated in this example?
 - a. Intuition
 - b. Empiricism
 - c. Tenacity
 - d. Rationalism

16. Which of the following identifies the four goals of science?
 - a. Describe, create, explain, control
 - b. Evaluate, explain, predict, control
 - c. Describe, explain, predict, control
 - d. Evaluate, create, explain, control
17. The four goals of science serve to:
 - a. Direct scientists toward a comprehensive knowledge of the behaviors and events they observe
 - b. Identify the areas in which science is flawed and needs to improve in order to become a valuable method of knowing
 - c. Illustrate that science has indisputably answered most questions about human behavior
 - d. All of the above
18. Which of the following uses the scientific method to answer questions that address theoretical issues about fundamental processes and underlying mechanisms related to the behaviors and events being studied?
 - a. Basic research
 - b. Applied research
19. A researcher records the number of hours a sample of children spent watching television in Study 1. Another researcher records how a child describes his experiences while watching television in Study 2. _____ is an example of qualitative research; _____ is an example of quantitative research.
 - a. Study 1; Study 2
 - b. Study 2; Study 1
20. Which of the following is an example of pseudoscience?
 - a. A psychologist performs a study and unknowingly analyzes the data incorrectly, then reports erroneous conclusions that are incorrect because of her mistake.
 - b. A psychologist makes a series of impromptu observations, then constructs an explanation for her observations as if her conclusions were scientific.
 - c. A psychologist reports that she has a personal belief and faith in God, and she believes that such faith is important.

CHAPTER EXERCISE

Matching

Match the following items.

- | | |
|--|---|
| __ 1. Observable (directly or indirectly) and measurable | A. Sometimes used as a synonym for instincts |
| __ 2. American Psychological Association | B. Style of communication in psychology |
| __ 3. Applied research | C. Doing something because that is “just how it is always done” |
| __ 4. Basic research | D. The goal of science related to identifying the causes of behaviors or events |
| __ 5. Quantitative | E. A study testing if a new traffic law has effectively made a highway safer |
| __ 6. Intuition | F. Comes from the Latin word <i>scientia</i> |
| __ 7. Describe | G. A study testing a mechanism for learning |
| __ 8. Tenacity | H. The goal of science related to defining behaviors or events we study |
| __ 9. Explain | I. Most research conducted in the behavioral sciences is ____ |
| __ 10. Science | J. Requirements for a scientific variable |

Questions

- Describe the basic requirements for a variable to be regarded as scientific. Why are these requirements important?
- Identify the six steps of the scientific method. Explain why this process is cyclic, not linear.