Practical Research
PLANNING AND DESIGN

NINTH EDITION

Paul D. Leedy
Late of American University

Jeanne Ellis Ormrod
University of Northern Colorado (Emerita)
University of New Hampshire

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PART ONE The Fundamentals

1 What Is Research?

In virtually every subject area, our knowledge is incomplete and problems are waiting to be solved. We can address the holes in our knowledge and those unresolved problems by asking relevant questions and then seeking answers through systematic research.

The word *research* as it is used in everyday speech has numerous meanings, making it a decidedly confusing term for students, especially graduate students, who must learn to use the word in a narrower, more precise sense. From elementary school to college, students hear the word *research* used in the context of a variety of activities. In some situations, the word connotes finding a piece of information or making notes and then writing a documented paper. In other situations, it refers to the act of informing oneself about what one does not know, perhaps by rummaging through available sources to retrieve a bit of information. Merchandisers sometimes use the word to suggest the discovery of a revolutionary product when, in reality, an existing product has been slightly modified to enhance the product's sales appeal. All of these activities have been called research but are more appropriately called other names: information gathering, library skills, documentation, self-enlightenment, or an attention-getting sales pitch.

The word *research* has a certain mystique about it. To many people, it suggests an activity that is somehow exclusive and removed from everyday life. Researchers are sometimes regarded as aloof individuals who seclude themselves in laboratories, scholarly libraries, or the ivory towers of large universities. The public is often unaware of what researchers do on a day-to-day basis or of how their work contributes to people's overall quality of life and general welfare.

To identify and define important terms included in this chapter, go to the Activities and Applications section in Chapter 1 of MyEducationalResearchLab, located at www.myeducationlab.com. Complete Activity 1: Defining Key Terms.

The purpose of this chapter is to dispel such myths and misconceptions about research. In the next few pages, we describe what research *is not* and then what it *is*.

What Research Is Not

We have suggested that the word *research* has been so widely used in everyday speech that few people have any idea of its true meaning. Following are several statements that describe what research is not. Accompanying each statement is an example that illustrates a common misconception about research.

1. *Research is not mere information gathering.* A sixth grader comes home from school and tells her parents, "The teacher sent us to the library today to do research, and I learned a lot about black holes." For this student, research means going to the library to glean a few facts. This may be *information discovery*; it may be learning *reference skills*; but it certainly is not, as the teacher labeled it, research.

2. *Research is not mere transportation of facts from one location to another.* A college student reads several articles about the mysterious "Dark Lady" in the sonnets of William Shakespeare and then writes a "research paper" describing various scholars' suggestions of who she might have been. Although the student does, indeed, go through certain activities associated with formal

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research—collecting information, organizing it in a certain way for presentation to others, referencing statements properly, and so on—these activities still do not add up to a true research paper. The student has missed the essence of research: the interpretation of data. Nowhere in the paper does the student say, in effect, "These facts that I have gathered seem to indicate *this* about the Dark Lady." Nowhere does the student interpret and draw conclusions from the facts. This student is approaching genuine research; however, the mere compilation of facts, presented with reference citations and arranged in a logical sequence—no matter how polished and appealing the format—misses genuine research by a hair. A little further, and this student would have traveled from one world to another: from the world of mere transportation of facts to the world of interpretation of facts. The difference between the two worlds is the distinction between transference of information and genuine research, a distinction that is critical for novice researchers to understand.

Unfortunately, many students think that looking up a few facts and presenting them in a written paper with benefit of references constitutes research. Such activity might more realistically be called *fact transcription, fact organization,* or *fact summarization*.

3. *Research is not merely rummaging for information.* The house across the street is for sale. You consider buying it, and so you call your realtor to find out for how much your present home would sell. "I'll have to do some research to determine the fair market value of your property," the realtor tells you. What the realtor calls doing "some research" means, of course, reviewing information about recent sales of properties comparable to yours; this information will help the realtor zero in on a reasonable asking price for your current home. Such an activity involves little more than rummaging through files to discover what the realtor previously did not know. Rummaging, whether through one's personal records or at the public or college library, is not research. It is more accurately called an *exercise in self-enlightenment*.

4. *Research is not a catchword used to get attention.* The morning mail arrives. You open an envelope and pull out its contents. A statement in colorful type catches your eye:

Years of Research Have Produced a New Car Wash!
Give Your Car a Miracle Shine with Soapy Suds!

The phrase "years of research" catches your attention. The product must be good, you reason, because years of research have been spent on developing it. You order the product, and what do you get? Dishwashing detergent! No research, merely the clever use of a catchword that, indeed, fulfilled its purpose: to grab your attention. "Years of research"—what an attention-getting phrase, yet how misleading!

As we define the term, research is entirely different from any of the activities listed previously. We describe its essential nature and characteristics in the following section.

What Research Is

Research is a systematic process of collecting, analyzing, and interpreting information (data) in order to increase our understanding of a phenomenon about which we are interested or concerned. People often use a systematic approach when they collect and interpret information to solve the small problems of daily living. Here, however, we focus on *formal research*, research in which we intentionally set out to enhance our understanding of a phenomenon and expect to communicate what we discover to the larger scientific community.

Although research projects vary in complexity and duration, research typically has eight distinct characteristics:

1. Research originates with a question or problem.
2. Research requires clear articulation of a goal.

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3. Research requires a specific plan for proceeding.
4. Research usually divides the principal problem into more manageable subproblems.
5. Research is guided by the specific research problem, question, or hypothesis.
6. Research accepts certain critical assumptions.
7. Research requires the collection and interpretation of data in an attempt to resolve the problem that initiated the research.
8. Research is, by its nature, cyclical or, more exactly, helical.

To enhance your understanding of formal research, go to the Activities and Applications section in Chapter 1 of MyEducationalResearchLab, located at www.myeducationlab.com. Complete Activity 2: Understanding Formal Research.

Each of these characteristics is discussed in turn so that you can appreciate more fully the nature of formal research.

1. *Research originates with a question or problem.* The world is filled with unanswered questions and unresolved problems. Everywhere we look, we see things that cause us to wonder, to speculate, to ask questions. And by asking questions, we strike the first spark igniting a chain reaction that leads to the research process. An inquisitive mind is the beginning of research; as one popular tabloid puts it, “Inquiring minds want to know!”

Look around you. Consider the unresolved situations that evoke these questions: What is such-and-such a situation like? Why does such-and-such a phenomenon occur? What does it all mean? These are everyday questions. With questions like these, research begins.

In Chapter 3, we will discuss the research problem at greater length. The problem and its statement are important because they are the point of origin of formal research.

2. *Research requires clear articulation of a goal.* A clear, unambiguous statement of the problem is critical. This statement is an exercise in intellectual honesty: The ultimate goal of the research must be set forth in a grammatically complete sentence that specifically and precisely answers the question, “What problem do you intend to solve?” When you describe your objective in clear, concrete terms, you have a good idea of what you need to accomplish and can direct your efforts accordingly.

3. *Research requires a specific plan for proceeding.* Research is not a blind excursion into the unknown, with the hope that the data necessary to answer the question at hand will somehow fortuitously turn up. It is, instead, a carefully planned itinerary of the route you intend to take in order to reach your final destination—your research goal. Consider the title of this text: *Practical Research: Planning and Design*. The last three words are the important ones. Researchers plan their overall research design and specific research methods in a purposeful way so that they can acquire data relevant to their research problem. Depending on the research question, different designs and methods will be more or less appropriate.

Therefore, in addition to identifying the specific goal of your research, you must also identify how you propose to reach your goal. You cannot wait until you’re chin deep in the project to plan and design your strategy. In the formative stages of a research project, much can be decided: Where are the data? Do any existing data address themselves to the research problem? If the data exist, are you likely to have access to them? And if you have access to the data, what will you do with them after they are in your possession? We might go on and on. Such questions merely hint at the fact that planning and design cannot be postponed. Each of the questions just listed—and many more—must have an answer early in the research process.[1]

4. *Research usually divides the principal problem into more manageable subproblems.* From a design standpoint, it is often helpful to break a main research problem into several subproblems that, when solved, will resolve the main problem.

Breaking down principal problems into small, easily solvable subproblems is a strategy we use in everyday living. For example, suppose you want to get from your hometown to a town 50 miles away. Your principal goal is to get from one location to the other as

[1] It should be apparent from the questions in this paragraph that we are using the word *data* as a plural noun (for instance, we ask “Where *are* the data?” rather than “Where *is* the data?”). Contrary to popular usage of the term as a singular noun, *data*, which was originally a Latin word, refers to more than one piece of information. A single piece of information is known as a *datum*, or sometimes as a *data point*.

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expeditiously as possible. You soon realize, however, that the problem involves several subproblems:

Main problem:	How do I get from Town A to Town B?
Subproblems:	1. What is the most direct route?
	2. How far do I travel on the highway?
	3. Which exit should I take to leave the highway?

What seems like a single question can be divided into at least three smaller questions that must be addressed before the principal question can be resolved.

So it is with most research problems. By closely inspecting the principal problem, the researcher often uncovers important subproblems. By addressing each of the subproblems, the researcher can more easily address the main problem. If researchers don't take the time or trouble to isolate the lesser problems within the major problem, their research projects can become cumbersome and difficult to manage.

5. *Research is guided by the specific research problem, question, or hypothesis.* Having stated the problem and its attendant subproblems, the researcher usually forms one or more hypotheses about what he or she may discover. A **hypothesis** is a logical supposition, a reasonable guess, an educated conjecture. It provides a tentative explanation for a phenomenon under investigation. It may direct your thinking to possible sources of information that will aid in resolving one or more subproblems and, in the process, the principal research problem.

Hypotheses are certainly not unique to research. They are constant, recurring features of everyday life. They represent the natural working of the human mind. Something happens. Immediately you attempt to account for the cause of the event by making a series of reasonable guesses. In so doing, you are hypothesizing. As an example, let's take a commonplace event: You come home after dark, open the front door, and reach inside for the switch that turns on a nearby table lamp. Your fingers find the switch. You flip it. No light. At this point, you begin to construct a series of reasonable guesses—hypotheses—to explain the lamp's failure:

1. The bulb has burned out.
2. The lamp is not plugged into the wall outlet.
3. A late afternoon thunderstorm interrupted the electrical service.
4. The wire from the lamp to the wall outlet is defective.
5. You forgot to pay your electric bill.

Each of these hypotheses hints at a direction you might proceed in order to acquire information that may resolve the problem of the malfunctioning lamp. Now you go in search of information to determine which hypothesis is correct. In other words, you look for data that will support one of your hypotheses and enable you to reject others.

1. You go out to your car, get a flashlight, find a new bulb, and insert the new bulb. The lamp fails to light. (Hypothesis 1 is rejected.)
2. You glance down at the wall outlet and see that the lamp is plugged into it. (Hypothesis 2 is rejected.)
3. You look at your neighbors' homes. Everyone has electrical power. (Hypothesis 3 is rejected.)
4. You go back into your house and lift the cord that connects the lamp to the wall outlet. The lamp lights briefly and then goes out. You lift the cord again. Again, the lamp lights briefly. The connecting cord is defective. (Hypothesis 4 is supported. Furthermore, because you clearly do have an active electric current, you can reject hypothesis 5—you did pay your last electric bill.)
5. Fortunately, hypothesis 4 solved the problem. By repairing or replacing the cord, you can count on adequate light from the lamp in the near future.

Hypotheses in a research project are as tentative as those just formed for the malfunctioning lamp. For example, a biologist might speculate that certain human-made chemical compounds increase the frequency of birth defects in frogs. A psychologist might speculate that certain

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personality traits lead people to show predominantly liberal or conservative voting patterns. A marketing researcher might speculate that humor in a television commercial will capture viewers' attention and thereby increases the odds that viewers will buy the advertised product. Notice the word *speculate* in all of these examples. Good researchers always begin a project with open minds about what they may—or may *not*—discover in their data.

Even with the best of data, however, hypotheses in a research project are rarely proved or disproved beyond the shadow of a doubt. Instead, they are either *supported* or *not supported* by the data. If the data are consistent with a particular hypothesis, the researcher can make a case that the hypothesis probably has some merit and should be taken seriously. In contrast, if the data run contrary to a hypothesis, the researcher *rejects* the hypothesis and turns to others as being more likely explanations of the phenomenon in question.

Over time, as particular hypotheses are supported by a growing body of data, they evolve into theories. A **theory** is an organized body of concepts and principles intended to explain a particular phenomenon. Like hypotheses, theories are tentative explanations that new data either support or do not support. To the extent that new data contradict a particular theory, a researcher will either modify it to better account for the data or reject the theory altogether in favor of an alternative explanation.

Once one or more researchers have developed a theory to explain a phenomenon of interest, the theory is apt to drive further research, in part by posing new questions that require answers and in part by suggesting hypotheses about the likely outcomes of particular investigations. For example, one common way of testing a theory is to make a prediction (hypothesis) about what should occur *if the theory is a viable explanation of the phenomenon under study*. As an example, let's consider Albert Einstein's theory of relativity, first proposed in 1915. Within the context of his theory, Einstein hypothesized that light passes through space as photons—tiny masses of spectral energy. If light has mass, Einstein reasoned, then it should be subject to the pull of a gravitational field. A year later, Karl Schwarzchild predicted that, based on Einstein's reasoning, the gravitational field of the sun should bend light rays considerably more than Isaac Newton had predicted many years earlier. In May 1919, a group of English astronomers traveled to Brazil and North Africa to observe how the sun's gravity distorted the light of a distant star now visible due to an eclipse of the sun. After the data were analyzed and interpreted, the results clearly supported the Einstein–Schwarzchild hypothesis and, thus, Einstein's theory of relativity.

For practice in identifying the hypothesis or research question in a research study, go to the Activities and Applications section in Chapter 1 of MyEducational ResearchLab, located at www.myeducationlab.com. Complete Activity 3: Identifying the Hypothesis or Research Question.

At this point, we should return to a point made earlier, this time emphasizing a particular word: The researcher *usually* forms one or more hypotheses about what he or she may discover. Hypotheses—predictions—are an essential ingredient in certain kinds of research, especially experimental research (see Chapter 10). To a lesser degree, they guide most other forms of research as well, but they are intentionally *not* identified in the early stages of some kinds of qualitative research (e.g., see the discussion of *grounded theory* research in Chapter 7). Yet regardless of whether researchers form specific hypotheses in advance, they must, at a minimum, use their research problem or question to focus their efforts.

6. *Research accepts certain critical assumptions.* In research, assumptions are equivalent to axioms in geometry—self-evident truths, the *sine qua non* of research. The assumptions must be valid or else the research is meaningless. For this reason, careful researchers—certainly those conducting research in an academic environment—set forth a statement of their assumptions as the bedrock upon which their study must rest. In your own research, it is essential that others know what you assume to be true with respect to your project. If one is to judge the quality of your study, then the knowledge of what you assume as basic to the very existence of your study is vitally important.

An example may clarify the point. Imagine that your problem is to investigate whether students learn the unique grammatical structures of a language more quickly by studying only one foreign language at a time or by studying two foreign languages concurrently. What assumptions would underlie such a problem? At a minimum, the researcher must assume that

- The teachers used in the study are competent to teach the language or languages in question and have mastered the grammatical structures of the language(s) they are teaching.
- The students taking part in the research are capable of mastering the unique grammatical structures of any language(s) they are studying.
- The languages selected for the study have sufficiently different grammatical structures that students could learn to distinguish between them.

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Whereas a hypothesis involves a prediction that may or may not be supported by the data, an **assumption** is a condition that is taken for granted, without which the research project would be pointless. In the Einstein example presented earlier, we assume that the astronomers who went to observe the star's light were competent to do so and that their instruments were sensitive enough to measure the slight aberration caused by the sun's gravitational pull.

Assumptions are usually so self-evident that a researcher may consider it unnecessary to mention them. For instance, two assumptions underlie almost all research:

- The phenomenon under investigation is somewhat lawful and predictable; it is *not* comprised of completely random events.
- Certain cause-and-effect relationships can account for the patterns observed in the phenomenon.

Aside from such basic ideas as these, careful researchers state their assumptions so that others inspecting the research project may evaluate it in accordance with their *own* assumptions. For the beginning researcher, it is better to be overly explicit than to take too much for granted.

7. *Research requires the collection and interpretation of data in an attempt to resolve the problem that initiated the research.* After a researcher has isolated the problem, divided it into appropriate subproblems, posited reasonable questions or hypotheses, and identified the assumptions that are basic to the entire effort, the next step is to collect whatever data seem appropriate and to organize them in meaningful ways so that they can be interpreted.

Events, observations, and measurements are, in and of themselves, *only* events, observations, and measurements—nothing more. The significance of the data depends on how the researcher extracts *meaning* from them. In research, data uninterpreted by the human mind are worthless: They can never help us answer the questions we have posed.

Yet researchers must recognize and come to terms with the subjective and dynamic nature of interpretation. Consider the myriad of books written on the assassination of U.S. President John F. Kennedy. Different historians have studied the same events: One may interpret them one way, and another may arrive at an entirely different conclusion. Which one is right? Perhaps they both are; perhaps neither is. Both may have merely posed new problems for other historians to try to resolve. Different minds often find different meanings in the same set of facts.

Once we believed that clocks measured time and that yardsticks measured space. In one sense, they still do. We further assumed that time and space were two different entities. Then came Einstein's theory of relativity, and time and space became locked into one concept: the time–space continuum. What is the difference between the old perspective and the new perspective? The way we think about, or interpret, the same information. The realities of time and space have not changed; the way we interpret them has.

Underlying and unifying any research project is its methodology. The research methodology directs the whole endeavor: It controls the study, dictates how the data are acquired, arranges them in logical relationships, sets up an approach for refining and synthesizing them, suggests a manner in which the meanings that lie below the surface of the data become manifest, and finally yields one or more conclusions that lead to an expansion of knowledge. Thus, research methodology has two primary functions:

1. To dictate and control the acquisition of data
2. To corral the data after their acquisition and extract meaning from them

The second of these functions is what we mean by the phrase *interpretation of the data*.

Data demand interpretation. But no rule, formula, or algorithm can lead the researcher unerringly to a correct interpretation. Interpretation is inevitably subjective: It depends entirely on the researcher's hypotheses, assumptions, and logical reasoning processes. In later chapters, we will present a number of potentially useful methods of organizing and interpreting data.

Now think about how we began this chapter. We suggested that certain activities cannot accurately be called research. At this point, you can understand why. None of those activities demands that the researcher draw any conclusions or make any interpretation of the data.

8. *Research is, by its nature, cyclical or, more exactly, helical.* The research process follows a cycle and begins simply. It follows logical, developmental steps:

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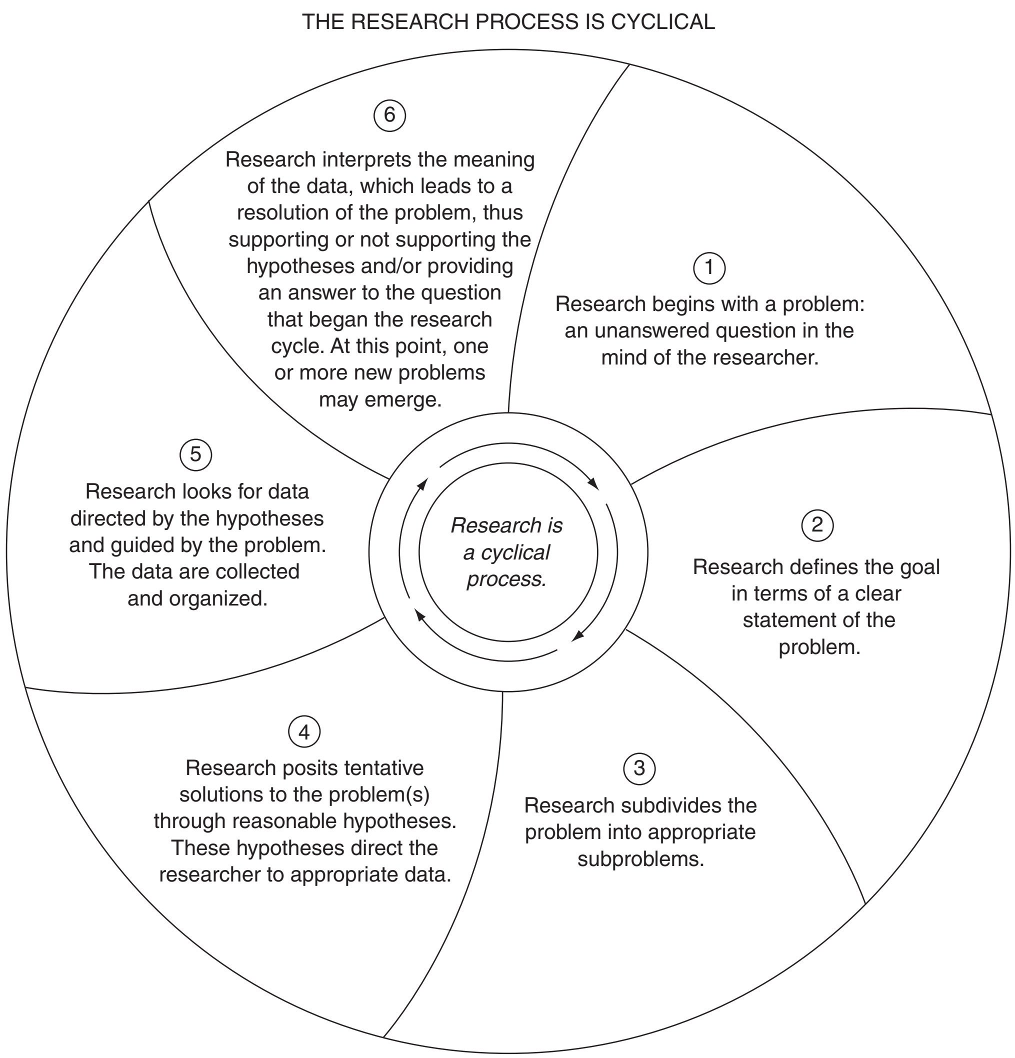
a. A questioning mind observes a particular situation and asks, Why? What caused that? How come? (This is the subjective origin of research.)
b. One question becomes formally stated as a problem. (This is the overt beginning of research.)
c. The problem is divided into several simpler, more specific subproblems.
d. Preliminary data are gathered that appear to bear on the problem.
e. The data seem to point to a tentative solution of the problem. A guess is made; a hypothesis or guiding question is formed.
f. Data are collected more systematically.
g. The body of data is processed and interpreted.
h. A discovery is made; a conclusion is reached.
i. The tentative hypothesis is either supported by the data or is not supported; the question is either answered (partially or completely) or not answered.
j. The cycle is complete.

For practice in identifying steps in the research process, go to the Building Research Skills section in Chapter 1 of MyEducationalResearchLab, located at www.myeducationlab.com.

The resolution of the problem or the tentative answer to the question completes the cycle, as is shown in Figure 1.1. Such is the format of all research. Different academic disciplines merely use different routes to arrive at the same destination.

But the neatly closed circle of Figure 1.1 is deceptive. Research is rarely conclusive. In a truer sense, the research cycle might be more accurately conceived of as a *helix*, or spiral, of research. In exploring an area, one comes across additional problems that need resolving, and so the process must begin anew. Research begets more research.

FIGURE 1.1
The research cycle



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To view research in this way is to invest it with a dynamic quality that is its true nature—a far cry from the conventional view, which sees research as a one-time act that is static, self-contained, an end in itself. Here we see another difference between true research and the nonexamples of research with which this chapter opened. Every researcher soon learns that genuine research yields as many problems as it resolves. Such is the nature of the acquisition of knowledge.

Exploring Research in Your Field

Earlier in the chapter, we mentioned that academic research is popularly seen as an activity far removed from everyday living. Even graduate students working on theses or dissertations may consider their task to be meaningless busywork that has little or no relevance to the world beyond the university campus. This "busywork" conception of an academic program's research requirement is simply not accurate. Conducting the research required to write an acceptable thesis or dissertation is one of the most valuable educational experiences a person can have. Furthermore, a good research project adds to our knowledge about our physical and social environments and so can ultimately promote the welfare and well-being of ourselves and the planet as a whole.

Even if you plan to become a practitioner rather than a researcher—say, a nurse, social worker, or school principal—knowledge of strong research methodologies and appropriate ways to collect and analyze data is essential for keeping up with advances in your field. The alternative—that is, *not* being well versed in sound research practices—can lead you to base important professional decisions on faulty data, inappropriate interpretations and conclusions, or unsubstantiated personal intuitions. Truly competent and effective practitioners base their day-to-day decisions and long-term priorities on solid research findings in their field.

As a way of getting your feet wet in the world of research, take some time to read articles in research journals in your own academic discipline. You can do so by spending an hour or two in your local college or university library; you may also be able to find some relevant journals on the Internet.

Browsing the Periodicals Section of the Library

The library of any college or university houses numerous professional journals that describe a wide range of research studies in virtually any field of study. To find research studies related to a particular topic, you might begin with the paper indexes in the library's reference section or the online databases available through the library's computer system (more about such resources in Chapter 4). The research journals themselves are typically kept in a periodicals section of the library. Following are examples of what you might find there:

American Educational Research Journal
American Historical Review
American Journal of Distance Education
Child Development
Early Childhood Research Quarterly
Environmental Research
Hispanic Journal of Behavioral Sciences
Journal of Anthropological Research
Journal of Black Studies
Journal of Business Research
Journal of Experimental Psychology
Journal of Management
Journal of Physical Education, Recreation, and Dance
Journal of Research in Crime and Delinquency
Journal of Speech, Language and Hearing Research
Organizational Dynamics
Professional Geographer
Research in Consumer Behavior
Research in Nursing and Health
Research in Social Problems and Public Policy
Sex Roles
Sociology and Social Research
Training and Development

Some libraries organize these journals alphabetically by title. Others organize them using the Library of Congress classification system, which allows journals related to the same topic to be placed close together (more about the Library of Congress system in Chapter 2).

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Your professors should have suggestions about journals that are especially relevant to your academic discipline. Reference librarians can be helpful as well. In addition, especially if you are shy about asking other people for advice, you can get insights about important journals by scanning the reference lists in textbooks in your discipline.

Browse the journals related to your field just to get acquainted with them. Go first to those that pique your interest and skim a few studies that relate to particularly intriguing topics. Then, get acquainted with as many of the journals in your discipline as you can. Competent researchers have general knowledge of the resources available in their field.

Finding Journals on the Internet

USING TECHNOLOGY

The **Internet** is a sprawling collection of computer networks linking millions of computers all over the world. With each passing year it becomes an increasingly ubiquitous and essential aspect of daily life. And as most of our readers undoubtedly know, it is a powerful way to access a wide variety of information on an almost limitless number of topics.

If for some reason you have not yet "traveled" on the Internet, this is definitely the time to start! If you do not have a personal computer that allows you Internet access, your college or university should have many computers in its library and elsewhere through which you can quickly get online. Ask a friend to look over your shoulder and guide you as you take your first steps into cyberspace. With practice, using the Internet will soon become second nature, and you'll wonder how you ever got along without it.

As you read later chapters of this book, you will learn about a wide variety of resources that the Internet can offer to both novice and expert researchers. For now, we'll limit our discussion to **online journals**, which are available in electronic form—either, instead of, or in addition to paper form. Many journals are accessible online only for a subscription fee or through the online databases to which many university libraries subscribe (more about such databases in Chapter 2). But some online journals are available free of charge to anyone with Internet access. Here are several examples of easily accessed online journals and their Internet addresses:

Folklore
www.folklore.ee/folklore

Online Journal of Peace and Conflict Resolution
www.trinstitute.org/ojpcr

Sociological Research Online
www.socresonline.org.uk

For practice in using the Internet to locate journal articles, go to the Activities and Applications section in Chapter 1 of MyEducationalResearchLab, located at www.myeducationlab.com. Complete Activity 4: Using the Internet to Locate Journal Articles.

Keep in mind that the quality of research you find in your explorations of the library and the Internet may vary considerably. One rough indicator of the quality of a study is whether it has been juried or nonjuried. A **juried** (or *refereed*) research report has been judged by respected colleagues in one's field and deemed to be of sufficient quality and importance to warrant publication. For instance, the editors of many academic journals send submitted manuscripts to one or more reviewers who pass judgment on the manuscripts, and only manuscripts that meet certain criteria are published in the journal. A **nonjuried** (or *nonrefereed*) report is one that appears in a journal or on the Internet without first being screened by one or more experts. Some nonjuried reports are excellent, but others may not be.

PRACTICAL APPLICATION Evaluating the Research of Others

An important skill for any researcher is the ability to review the work of others and evaluate the quality of their methods, results, and conclusions. In some cases, this is quite easily accomplished; in other cases, it is more difficult. By developing your ability to evaluate other researchers' work, you get a better sense of how to improve your own research efforts. We suggest that you begin to sharpen your evaluation skills by locating several research articles relevant to your interests. As you read and study the articles, consider the questions in the following checklist.

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CHECKLIST

Reflective Questions to Consider When Evaluating Research

_____ 1. In what journal or other source did you find the research article? Was it reviewed by experts in the field before it was published? That is, was the article in a *juried* (refereed) publication?

_____ 2. Does the article have a stated research question or problem? That is, can you determine the focus of the author's work?

_____ 3. Does the article describe the collection of new data, or does it describe and synthesize previous studies in which data were collected?

_____ 4. Is the article logically organized and easy to follow? What could have been done to improve its organization and readability?

_____ 5. Does the article contain a section that describes and integrates previous studies on this topic? In what ways is this previous work relevant to the research problem?

_____ 6. If the author explained procedures that were followed in the study, are these procedures clear enough that you could repeat the work and get similar results? What additional information might be helpful or essential for you to replicate the study?

_____ 7. If data were collected, can you describe how they were collected and how they were analyzed? Do you agree with what was done? If you had been the researcher, what additional things might you have done?

_____ 8. Do you agree with the interpretation of the results? Why or why not?

_____ 9. Finally, reflect over the entire article. What is, for you, most important? What do you find most interesting? What do you think are the strengths and weaknesses of this article? Will you remember this article in the future? Why or why not?

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GUIDELINES Benefiting From Others' Research

As you begin to evaluate selected articles by using the questions in the checklist, it may be wise to keep three guidelines in mind:

1. *Keep a running record of helpful articles in a notebook or computer document.* Include bibliographic information such as

- The author's name
- The title of the article
- The name of the journal and the year, volume and issue numbers, and page numbers
- Keywords and phrases that capture the focus of the article
- If applicable, the Internet address at which you found the article

You may think that you will always be able to recall where you found an article and what you learned from it. However, our own experiences tell us that you probably *will* forget a good deal of what you read unless you keep a written record of it.

2. *Whenever you review someone else's work, take time to consider how you can improve your own work because of it.* Ask yourself, What have I learned that I would (or would not) want to incorporate into my own research? Perhaps it is a certain way of writing, a specific method of data collection, or a particular approach to data analysis. You should constantly question and reflect on what you read.

3. *Finally, don't read only one or two articles and think that you are done.* Get used to reading and evaluating; for a researcher, this is a lifelong endeavor. Always, always look for additional things you can learn.

For Further Reading

Anglin, G. J., Ross, S. M., & Morrison, G. R. (1995). Inquiry in instructional design and technology: Getting started. In G. Anglin (Ed.), *Instructional technology: Past, present, and future* (pp. 340–347). Englewood, CO: Libraries Unlimited.

Bouma, G. D., & Ling, R. (2004). *The research process* (5th ed.). New York: Oxford University Press.

Davitz, J. R., & Davitz, L. L. (1996). *Evaluating research proposals: A guide for the behavioral sciences.* Upper Saddle River, NJ: Prentice Hall.

Goodwin, C. J. (2007). *Research in psychology: Methods and design* (5th ed.). New York: Wiley.

Howe, R., & Lewis, R. (1994). *A student guide to research in social science.* New York: Cambridge University Press.

Leedy, P. (1981). *How to read research and understand it.* New York: Macmillan.

Luczun-Friedman, M. E. (1986). Introduction to research: A basic guide to scientific inquiry. *Journal of Post Anesthetic Nursing*, *1*, 64–75.

McMillan, J. H., & Wergin, J. F. (2006). *Understanding and evaluating educational research* (3rd ed.). Upper Saddle River, NJ: Merrill/Prentice Hall.

Priest, S. H. (1996). *Doing media research: An introduction.* Thousand Oaks, CA: Sage.

Rosnow, R. L., & Rosenthal, R. (2008). *Beginning behavioral research: A conceptual primer* (6th ed.). Upper Saddle River, NJ: Prentice Hall.

Now go to MyEducationalResearchLab at www.myeducationlab.com to take a quiz to evaluate your mastery of chapter concepts. Review, Practice, and Enrichment exercises are also available to help you master the chapter. Feedback for these exercises is provided so that you can see why your answers are correct or incorrect.

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2 Tools of Research

Every worker needs tools. The carpenter needs a hammer and a saw; the surgeon, a scalpel and forceps; the tailor, pins and scissors; and the researcher, an array of means by which data can be collected and made meaningful. The tools of research facilitate the ultimate goal of research itself: to derive conclusions from a body of data and discover what was hitherto unknown.

Every artisan—and more generally, every professional—needs specialized tools in order to work effectively. Without hammer and saw, the carpenter is out of business; without scalpel or forceps, the surgeon cannot practice. Every profession has its own particular equipment for carrying out the specific work it has to do. Researchers, likewise, have their own kit of tools to carry out their plans.

To identify and define important terms included in this chapter, go to the Activities and Applications section in Chapter 2 of MyEducationalResearchLab, located at www.myeducationlab.com. Complete Activity 1: Defining Key Terms.

The tools that researchers use to achieve their research goals may vary considerably depending on the discipline. The microbiologist needs a microscope and culture media; the attorney, a library of legal decisions and statute law. We do not discuss such discipline-specific tools in this chapter. Rather, our concern here is with the general tools of research that the majority of researchers, regardless of discipline and situation, typically need to collect data and derive meaningful conclusions.

General Tools of Research

We should be careful not to equate the *tools* of research with the *methodology* of research. A **research tool** is a specific mechanism or strategy the researcher uses to collect, manipulate, or interpret data. The **research methodology** is the general approach the researcher takes in carrying out the research project; to some extent, this approach dictates the particular tools the researcher selects.

Confusion between the tool and the research method is immediately recognizable. Such phrases as "library research" and "statistical research" are telltale signs and largely meaningless terms. They suggest a failure to understand the nature of formal research, as well as a failure to differentiate between tool and method. The library is merely a place for locating or discovering certain data that will be analyzed and interpreted later in the research process. Likewise, statistics merely provide ways to summarize and analyze data, thereby allowing us to see patterns within the data more clearly.

Following are six general tools of research:

1. The library and its resources
2. The computer and its software
3. Measurement techniques
4. Statistics
5. The human mind
6. Language

Volumes have been written on each of these tools. In this text, we simply introduce them to help our readers begin to use them more effectively.

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The Library and Its Resources as a Tool of Research

For thousands of years, the library served primarily as a repository of books and manuscripts—a kind of literary mausoleum where documents were kept and added to as more information and literature became available. It was, for the most part, only a slowly expanding universe of knowledge, one that could be comfortably contained within masonry walls.

In the latter half of the 20th century, the role of the library changed. People's knowledge about their physical and social worlds increased many times over. Research altered old ideas in almost every domain of human interest. Libraries had to come to grips with two important facts. First, they certainly could not hold all of the world's information within their walls. Second, and perhaps more important, library patrons were becoming more sophisticated in their needs and desires and placed increasing priority on ease and speed of access to information. In response, libraries began acquiring new technologies for storing vast amounts of information (e.g., microforms, compact disks, online databases) to augment the shelves of books and periodicals that lined their walls.

In the future, the library must continue to evolve. With advances in telecommunications, libraries may eventually exist, literally, without limits. Imagine using a computer, cellular telephone, or other electronic device to access a "virtual" library in which you can "walk" up and down the rows of books and pick selections from all available sources and languages known—all the while sitting in your home, office, classroom, car, or remote mountain cabin. These selections contain not only textual materials but also all forms of pictures, video, and audio media. If you want a "hard" copy, you can print it out. If you want to browse the shelves for related works, you can do so. If you want to access a specific bit of information quickly, you can search the entire collection in a matter of milliseconds. All of these capabilities are already available to some extent.

When some doctoral student in the 21st century writes a dissertation on the information revolution of the 20th century and early 21st century, the most interesting section will probably be about the speed with which that revolution occurred. The shock waves associated with it have reached every segment of contemporary society. Directly above its epicenter, the college and university library has perhaps felt its strongest jolts.

The Library of the Quiet Past

Imagine, if you will, that you were a student in the 1950s or 1960s. When you went to the library to gather information, you headed straight to the card catalog—a series of drawers containing three index cards for each book in the library—and sorted through, card by card, the titles and content descriptions of the books in each category of interest. You jotted down call numbers to help you find the titles most likely to contain the information you needed. Next, you went to the stacks to inspect the volumes you had selected.

Meanwhile, the periodical indexes were a primary means through which you found journal and newspaper articles about your topic. Ponderous volumes arranged in long rows on the reference shelves, they contained cross-indexed references to current literature and had titles such as *Readers' Guide to Periodical Literature*, *Education Index*, *New York Times Index*, *Business Periodicals Index*, and *Psychological Abstracts*. You worked your way through each sizable volume until you found material on your area of interest, and then you made notes about the article: author, title, periodical, volume number, pages, and date. With such details in hand, you roamed long corridors in the periodicals section, tracking down specific issues of specific journals. Finally, you found a few nuggets of information and carefully jotted them down on a notepad or index cards.

Such was the acquisition of knowledge in the library of the quiet past. It was a laborious, time-consuming process that simply could not work efficiently under the sudden, torrential onrush of the information revolution.

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The Library of the Stormy Present

In today's college library, a student's plan of attack is entirely different. In place of a card catalog are rows of computer terminals where users can quickly generate lists of the library's holdings related to particular authors, titles, topics, or call numbers. The terminals also provide access to online databases that enable users to find journal articles on virtually any topic about which people have written.

Not only has the college library hardware changed, but the conventional view of knowledge has also changed. Looking at a typical college course catalog, you might infer that human knowledge is an accumulation of separate disciplinary studies, each neatly boxed and bearing such labels as "anthropology," "chemistry," "economics," and "physical education." In the typical college or university, these little boxes of knowledge are called "departments." Yet the quest for knowledge knows no boundaries or artificial departmentalization. Modern research does not operate within the confines of a particular academic field. Rather, it has become increasingly interdisciplinary in both its problems and its methodologies (e.g., Eisenhart & DeHaan, 2005; Miksa, 1987). For example, marketing researchers often draw on sociologists' and geographers' concepts and data collection techniques to identify the needs and shopping patterns of different populations, and psychologists can learn a great deal about human thought processes by using the positron emission tomography (PET) and magnetic resonance imaging (MRI) technologies of neurophysiologists. Hence, researchers need to have easy access to existing knowledge and research tools in a wide variety of disciplines.

How to Access Information Quickly and Efficiently

Skilled researchers have several general library resources at their disposal to locate the information they need; key among these resources are library catalogs, indexes and abstracts, and reference librarians. Furthermore, many researchers find that just browsing among the library shelves is often time well spent.

Library Catalogs

Book collections still comprise much of the core of information and ideas housed in a library today. The easiest way to find specific books is through the library catalog. Although you may occasionally find a small public library that still uses a physical card catalog, college libraries rely exclusively on electronic catalogs that list their holdings. You sit at a computer terminal and type in one or two keywords, or perhaps you type in the title or author of a specific book. With the flick of a finger, information about one or more books is instantaneously displayed on the computer monitor.

Indexes and Abstracts

During one of your next trips to the library, take some time to visit the reference section—the "heart" of the library for the researcher. Typically, this section of the library contains large volumes that can help you identify and locate needed information. Whether you are looking for general information or specific research articles in history, nursing, education, engineering, or agriculture, indexes can help you locate relevant titles, authors, and abstracts for any conceivable topic.

Most libraries have both paper and electronic versions of indexes and abstracts. Especially if you want to explore many years' worth of research about a complex topic, a manual search through any one of the paper indexes may take considerable time and effort. This is where electronic databases become indispensable tools for the researcher. A college library typically provides access to a wide variety of *online databases*—not only indexes and abstracts, but also encyclopedias, dictionaries, and online journals—that enable you to locate sources of information that

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are available either in the campus library or in other libraries and institutions around the world. In the rare instance when a college library does not provide access to online databases, it is likely to have a number of in-house electronic indexes, typically in the form of compact disks (CDs) that each contain vast amounts of information—perhaps abstracts for tens of thousands of journal articles related to a particular discipline or perhaps the contents of an entire encyclopedia.

Indexes and abstracts are especially useful when you are conducting a literature review for your research project. Accordingly, we will look at such resources in more detail in Chapter 4, "Review of the Related Literature."

The Reference Librarian

When you visit the reference section of your library, you will almost certainly see one or more librarians sitting at the reference desk. These individuals are there for one reason only: to help you and others find needed information. They can show you reference materials you never dreamed existed. They can show you how to use the computer catalog, online databases, paper and CD-based indexes, or any of the library's other resources.

Some new researchers are reluctant to approach a reference librarian for fear of looking foolish or stupid. Yet the reality is that library resources are changing so quickly that most of us cannot possibly keep up with them. Whatever you do, don't be afraid to ask librarians for assistance. Even as seasoned researchers, we sometimes seek the advice of these individuals; by doing so, we can often save ourselves a great deal of time and aggravation.

Browsing the Library Shelves

An important research skill is browsing the library, either physically by walking among the stacks or electronically by "browsing" the entries in the library's computer catalog. In many cases, when one goes to a library shelf to locate a book or journal, the information most useful is found not in the material that was originally targeted, but rather in a book nearby on the shelf. Skilled researchers not only look for the book they have originally designated but also scan nearby shelves and call numbers for related materials.

Books are coded and arranged on the library shelves in accordance with one of two principal systems for the classification of all knowledge: the Dewey decimal classification system and the Library of Congress system.

- *The Dewey decimal classification system.* Books are cataloged and shelved according to 10 basic areas of human knowledge and subsequent subareas, each divided decimally. The Dewey decimal system is the principal classification system in most public libraries and many other libraries and is probably the most generally accepted system throughout the world.
- *The Library of Congress (LC) classification system.* Books are assigned to particular areas of human knowledge that are given special alphabetical categories. This system is widely used in college and university libraries.

For students who wish to browse or locate books in a particular category of knowledge, a guide to each system of classification may be helpful. Table 2.1 shows an equivalency chart of the two systems. Read down the "Subject" column to locate the area of knowledge in which the book may be located. The "DC" column of numbers to the left gives the Dewey decimal classification. The "LC" column of letters to the right indicates the corresponding Library of Congress classification symbols.

The best way to master the library as a research tool is to use it! Go in, explore, take stock of its resources, try electronic searching; browse in the reference room; go into the stacks and browse some more. You may be surprised at what a magnificent research tool the library really is.

To learn about library resources available to skilled researchers, go to the Activities and Applications section in Chapter 2 of MyEducational ResearchLab, located at www.myeducationlab.com. Complete Activity 2: Library Resources and Their Uses.

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TABLE 2.1 A conversion chart: Dewey decimal classification system versus the Library of Congress classification system

DC	*Subject*	*LC*	*DC*	*Subject*	*LC*
630	Agriculture	S	400	Language	P
570	Anthropology	GN	340	Law	K
913	Archaeology	CC	020	Library Science	Z
700	Art	N	800	Literature	P
220	Bible	BS	810	Literature, American	PS
010–020	Bibliography	Z	820	Literature, English	PR
920.92	Biography	CT	840–860	Literature, Romance	PQ
560	Biology	QH	658	Management	HD
580	Botany	QK	510	Mathematics	QA
650	Business	HF	610	Medicine	R
540	Chemistry	QD	355–358	Military Science	U
155.4	Child Development	BF	780	Music	M
260–270	Church History	BR	560	Natural Science	QH
330	Economics	HB–HJ	359	Naval Science	V
370	Education	L	610	Nursing	RT
378	Education, Higher	LD	750	Painting	ND
030	Encyclopedias	AE	615	Pharmacy	RS
400	English	PE	100	Philosophy	B
600	Engineering	T	770	Photography	TR
700	Fine Arts	N	530	Physics	QC
440	French Language	PC	320	Political Science	J
000	General	A	150	Psychology	BF
910	Geography	G	200	Religions	B
550	Geology	QE	500	Science	Q
430	German Language	PF	730	Sculpture	NB
740	Graphic Arts	NC	300	Social Science	H
480	Greek Language	PA	301–309	Sociology	HM–HX
930–960	History (except American)	D	460	Spanish Language	PC
970–980	History, American (General)	E	790	Sports	GV
970–980	History, U.S. (Local)	F	310	Statistics	HA
640	Home Economics	TX	230	Theology, Doctrinal	BT
070	Journalism	PN	250	Theology, Practical	BV
			590	Zoology	QL

Note: This arrangement of the dual classification systems was conceived by Roger Miller, former director of the Murray Resources Learning Center, Messiah College, Grantham, PA.

The Computer and Its Software as a Tool of Research

USING TECHNOLOGY

As a research tool, the personal computer is now commonplace. Over the past four decades, computer software packages have become increasingly user-friendly, such that novice researchers can learn to use them quickly and easily. But like any tool, no matter how powerful, computers have their limitations. They are not human brains. Yes, a computer can certainly calculate, compare, search, retrieve, sort, and organize data more efficiently and more accurately than you can. Compared to the intelligence and perceptiveness of the human brain, however, computers are relatively limited machines. In their present stage of development, they depend largely on a person to give them directions about what to do.

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A computer is not a miracle worker. It cannot do your thinking for you. It can, however, be a fast and faithful assistant. When told exactly what to do, it is one of the researcher's best friends.

Throughout this book, you will find many "Using Technology" sections that describe specific ways in which, as a researcher, you can use computers to make your job easier. Table 2.2 provides suggestions for how you might use a computer to assist you in the research process. At this point, we describe one use of the computer that a researcher is likely to use *throughout* a research project: taking advantage of the Internet.

TABLE 2.2

The computer as a research assistant

Part of the Study	*Team of Research Assistants*
Planning the study	• Brainstorming assistance—software used to help generate and organize ideas for the research focus, to illustrate how different concepts could be related, and to consider how the process will be conducted. • Outlining assistance—software used to help structure the different aspects of the study and coordinate work efforts. • Project management assistance—software used to highlight and coordinate all the different efforts that need to occur in a timely fashion. • Budget assistance—spreadsheet software to help in outlining, estimating, and monitoring the potential costs involved in the research effort.
Literature review	• Background literature identification assistance—CDs and online databases that identify and describe related published research that should be considered during the formative stages of the research endeavor. • Telecommunication assistance—computer technology used to communicate with other researchers and groups of researchers through e-mail, electronic bulletin boards, list servers, and the World Wide Web. • Writing assistance—software used to facilitate the writing, editing, formatting, and printing of the literature review.
Study implementation and data gathering	• Materials production assistance—software used for the development and use of instructional materials, graphics, simulations, and so on to be used in experimental interventions. • Experimental control assistance—software used to control the effects of specific variables and restrict the occurrence of other potentially confounding variables. • Survey distribution assistance—database use coupled with word processing to identify and send specific communications to a targeted population. • Data collection assistance—software used to take fieldnotes or to monitor specific types of responses made by the participants in a research study.
Analysis and interpretation	• Organizational assistance—software used to assemble, categorize, code, integrate, and search potentially huge data sets (e.g., survey open-ended responses, qualitative interview data). • Conceptual assistance—software used to write and store ongoing reflections about data or to construct theories that integrate research findings. • Statistical assistance—statistical and spreadsheet software packages used to categorize and analyze various types of data sets. • Graphic production assistance—software used to depict data in graphic form to facilitate interpretation.

(*continued*)

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Reporting	• Communication assistance—telecommunication software used to distribute and discuss research findings and initial interpretations with colleagues and to receive their comments and feedback. • Writing and editing assistance—word processing software used to write and edit successive drafts of the final report. • Publishing assistance—desktop publishing software used to produce professional-looking documents that can be distributed at conferences and elsewhere to get additional comments and feedback. • Distribution assistance—the Internet and other more specific networks used to electronically distribute a report of one's findings and to generate discussion for follow-up studies by others in the field.

Taking Advantage of the Internet

The Internet provides many resources that were simply not available to researchers 30 years ago. These resources include the World Wide Web, electronic mail, and news.

World Wide Web

Currently the most popular feature of the Internet is the **World Wide Web (WWW).** Specific locations on the Web—**websites**—are the fastest growing part of the Internet, and for many people, these sites are the main reason for using the Internet. Each site includes one or more **Web pages** that you can read in much the same way you would read the pages of a book. Many pages have graphics in addition to text, and some also have audio recordings, video clips, or both.

If you looked for any of the online journals mentioned in Chapter 1, then you were visiting the websites for those journals. The online databases we described in the preceding section on the library are also located on the Web. Every site on the Web has a particular address, or **URL** (short for "Uniform Resource Locator"). Following are examples:

University of New Hampshire
www.unh.edu

Brown University Library
http://library.brown.edu

Association for Psychological Science
www.psychologicalscience.org

National Aeronautics and Space Administration (NASA)
www.nasa.gov

As these examples illustrate, many URLs include the letters www, standing for "World Wide Web." Typically a URL actually begins with the letter-symbol combination http://, standing for "Hypertext Transfer Protocol," a set of rules and procedures by which information is transmitted from one Web page to another. We have omitted this letter-symbol combination from the URLs in the preceding list because your computer is apt to insert it automatically when you type in the URL to which you want to go.

If you want to access and use the WWW on your personal computer, you must have software known as a **Web browser** (e.g., Netscape, Internet Explorer, Firefox, or Safari). This software allows users to go to various websites and move easily among connected sites. If you know the URL for the website you want to visit, you simply type it in the specified box in the browser. If you do not know the URL you need—or perhaps don't even know what sites might help you in finding the information you need—you can usually find the relevant URLs by using a *search*

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engine such as Google or Yahoo! (we'll explain how to use these search engines in Chapter 4). Once you have electronically reached a site you want, you can often move to related sites by moving the cursor on the screen to a particular word or icon and then clicking the mouse; the software immediately transports you to another page via a **Web link.** Whenever you find pages that are especially helpful, the software allows you to print them out.

Another useful feature of Web browsers is that they allow you to save useful websites in an "address book" of sorts. Some browser software programs call this feature *bookmarks*, whereas others call it *favorites*. Whenever you reach a Web page you think might be helpful on future occasions, you can tell the software to "Add Bookmark" or "Add Page to Favorites." At some later date, you can then scroll down your list of saved addresses until you find the one you want, and the software immediately takes you there.

Electronic Mail

Electronic mail service, more commonly known as **e-mail**, allows people to communicate quickly with one another. As is true when using the national postal service (sometimes called *snail mail* by people too impatient to use it in this lightning-fast electronic age), the person who is sending the mail must know the address of the person who will be receiving it. A single message can be sent directly to one or many individuals at a single time. Unlike mail delivered by the postal service, a message sent through e-mail is generally delivered in a matter of seconds, no matter where in the world the receiver is. In most cases, people who use either university-based or commercial online services can send an unlimited number of e-mail messages.

Although most e-mail messages contain short statements and questions, it is also possible to send or receive a lengthy, detailed message (e.g., a full manuscript of a research report), perhaps by adding it as an **attachment** to an e-mail message (depending on the software, an attachment may instead be called an *enclosure*).

E-mail technology can greatly facilitate communication and collaboration among people who have similar interests, in some cases without ever meeting face-to-face. For example, we have found e-mail to be an excellent way to collaborate in writing journal articles. One author will write a first draft of an article, send it as an attachment to a coauthor, who will revise and add to it, send it on to a third author or back to the first author for inspection and further editing, and so on.

News

The news feature of the Internet is like a huge bulletin board on which people post messages and comments; others then react and add their own comments. Of particular value to the researcher are **list servers**, which provide a mechanism for electronic discussion groups. A list server is a mailing list, and any e-mail message sent to it is distributed to everyone who has subscribed to the list.

Thousands of list servers on a wide variety of topics are available for subscription, often without charge. Through them, people can easily communicate with one another about topics of common interest. For example, if you like music, you can subscribe to list servers that focus on any number of special musical interests. As e-mail messages are received by this list server, you will automatically receive a copy.

Accessing the Internet

The Internet can be accessed in several ways. For people at colleges and universities, access is generally quite easy through their institution's computer services. Likewise, many national, regional, and local commercial services (e.g., America Online, AT&T, Comcast) provide access to the Internet for a monthly fee, which is often less than the cost of cable television.

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Learning More About the Internet

Using the Internet becomes a more user-friendly process all the time; even the most computer-anxious of researchers should have little or no trouble picking up the basics. If for some reason you've had little opportunity to use it, you might ask a computer-literate friend to introduce you to basic procedures. You can find classes on using the Internet at almost any university or community college (check the "Continuing Education" or "Outreach" class schedule). You can also find a free tutorial on Internet basics at this address on the World Wide Web:

www.learnthenet.com

This address is active as the ninth edition of this book goes to press. If it is no longer operational when you read the book, you will discover firsthand one of the many ways in which the World Wide Web continues to change and evolve over time.

PRACTICAL APPLICATION Using the Internet to Facilitate Communication

USING TECHNOLOGY

Read the following scenarios. In each case, think about how the researcher might use the Internet to solve his or her problem.

1. Arwin is a professor at a small college. Although his research is prominent in his field, few people on campus share his enthusiasm for his specialty—forensic pathology. Although Arwin avidly reads relevant academic journals, he looks forward to the annual meetings of his national organization, where he can exchange ideas with others who have similar interests. He wishes that such exchanges could occur more frequently.
2. Deirdre has a once-in-a-lifetime opportunity to spend 6 months in Australia collecting data about the various marine plants of the Great Barrier Reef. Although she is excited about the opportunity, she realizes that the work of her campus research group will suffer. Because of the distance, it will be difficult to provide feedback on the group's ongoing papers and projects. Deirdre and her colleagues can use the postal service to transport the work between them, but this will definitely slow the progress of their work.
3. Recently, Alexis read about a new corrective eye procedure being investigated at a major medical research institution. The work appears potentially relevant to her own research, but she has questions about the procedures and long-term results. Hoping to get some quick answers, she writes a letter to the authors of the article, in care of their research institution, and waits for their reply.

How can the Internet help each of these researchers? For Arwin, being on one or more list servers might enable him to keep up with current developments in his field and communicate regularly with others in the field. During her time in Australia, Deirdre can stay in regular communication with her colleagues at home via e-mail, and she can easily send papers back and forth as attachments. To gain information about the corrective procedure in which she's interested, Alexis might visit the website of the hospital conducting the research, where she may find additional information about the procedure or the e-mail addresses of the individuals conducting the research.

PRACTICAL APPLICATION Using E-mail

USING TECHNOLOGY

If for some reason you have not yet discovered the joys of electronic mail, there's no time like the present to do so. Not only will e-mail help you communicate with fellow researchers around the world, but it will also help you stay in touch with family and friends. Within the past few years, we have seen our own e-mail messages (both sent and received) increase dramatically in number. We now use it even to reconnect with old friends from high school, schedule appointments, and pass along jokes received from other e-mailing acquaintances.

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GUIDELINES Getting Started on E-mail

The best way to appreciate the advantages of e-mail is to try it. Here are some basic steps for getting started with e-mail.

1. *Get an e-mail account on a computer system.* If you are currently affiliated with a college or university, you can almost certainly get an account at your institution. When you get such an account, you will also get an e-mail address, perhaps one that looks something like this:

jormrod@alumni.brown.edu

The letters (and in some cases numbers as well) that appear before the "at" sign (@) make up your user ID. Following the @ is information about the **server** (the specific computer and/or institution that handles the e-mail account) and the nature of that server's "host." In the address just presented, *jormrod* is the user ID, *alumni.brown* indicates where the server is located (Brown University) and a category of addresses within that server (alumni), and *edu* refers to the nature of the host (in this case, an educational institution).

An alternative is to get an account with a local or national Internet service provider, such as America Online or Comcast. In such a situation, your e-mail address might look something like this:

jormrod@comcast.net

2. *Find out how to access the system and obtain the needed software to do so.* Ask the institution or company with whom you have obtained an account to provide instructions and software for sending and receiving e-mail. The agency should do so willingly, typically at little or no charge.

3. *Find the e-mail addresses of people you wish to contact.* In this day and age, almost all of your friends and acquaintances probably have e-mail addresses. You can also frequently find e-mail addresses in college directories and on business cards, product advertisements, and websites. When you have accumulated more than a few addresses, you may wish to use the *address book* feature of most e-mail software packages, which allows you to store the addresses directly on your computer and access them easily whenever you need them. Most commercial Internet service providers also include a personal address book within each user's account.

4. *Connect to the computer system that services your e-mail account and send a short message to a friend.* If a response does not return in a few days, try sending the message again. People don't always check their electronic mailboxes every day.

The great majority of our readers are no doubt already quite experienced in using e-mail. Yet it is important for you to reflect on how you might use it specifically as a tool that can assist you in your research—for instance, as a means of facilitating communication and collaboration with people who have conducted studies similar to yours or who possess information and insights that may be critical to your own project.

Measurement as a Tool of Research

Most researchers strive for objectivity: They believe that their observations should be influenced as little as possible—ideally not at all—by their own perceptions, impressions, and biases. (As we will note in Chapter 7, some qualitative researchers are an exception to this rule.) And one way of remaining objective is to identify a systematic way of measuring a phenomenon being studied.

But what is measurement? Most of us think of measurement in terms of such objects as rulers, scales, gauges, and thermometers. In research, **measurement** takes on a somewhat different meaning:

> Measurement is limiting the data of any phenomenon—substantial or insubstantial—so that those data may be interpreted and, ultimately, compared to a particular qualitative or quantitative standard.

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Let's look more closely at this definition. The first five words are *measurement is limiting the data*. When we measure something, we set a limit that constrains the data in some way. We erect a barrier beyond which those data cannot go. What is a foot, a mile, a pound? Each is a unit of measure governed by a numerical constraint: 12 inches constrain a foot; 5,280 feet, a mile; and 16 ounces, a pound.

Now, let's look at the next six words: *of any phenomenon—substantial or insubstantial*. This phrase is all-inclusive. Nothing exists that the researcher cannot measure. In some cases, observable objects are measured. These are **substantial** measurements; that is, the things being measured have physical substance, an obvious basis in the physical world. An engineer measures the span of a bridge; a chemist measures the mass of a compound both before and after transforming it in some way. A Greek scholar, Eratosthenes, attempted to measure the circumference of the earth by comparing two shadows of a gnomon (the rod of a sundial) in different cities. All of these are attempts to measure substantial phenomena.

We may also measure those things—if "things" they be—that are **insubstantial**, that exist only as concepts, ideas, opinions, feelings, or other intangible entities. For example, we might attempt to measure the economic "health" of business, the degree to which students have "learned," or the extent to which people "value" physical exercise. We seek to measure these intangibles, not with tape measures or scales, but with the Dow-Jones index, achievement tests, questionnaires, or interviews.[1]

For certain researchers, such as those in the social sciences, humanities, and education, measuring intangibles is a primary stock-in-trade. The following example illustrates one way this might be accomplished.

Measuring insubstantial phenomena: An example. A group of nine people, shown in Figure 2.1, work together in the human resources department of a large corporation. They are to attend a recognition dinner at an exclusive hotel.

They arrive in four cars. They enter the hotel in the following order: Terri, Sara, Greg, Tim, Gretchen, Matt, Peter, Jeff, and Joe. They greet one another and have time for a brief conversation before dinner. They position themselves in the conversation groups shown in Figure 2.2.

To the perceptive observer, the interpersonal dynamics within the group will soon become apparent. Who greets whom with enthusiasm or with indifference? Who joins in conversation with whom? Who seems to be a relative outsider? If there were "personal magnetic fields"

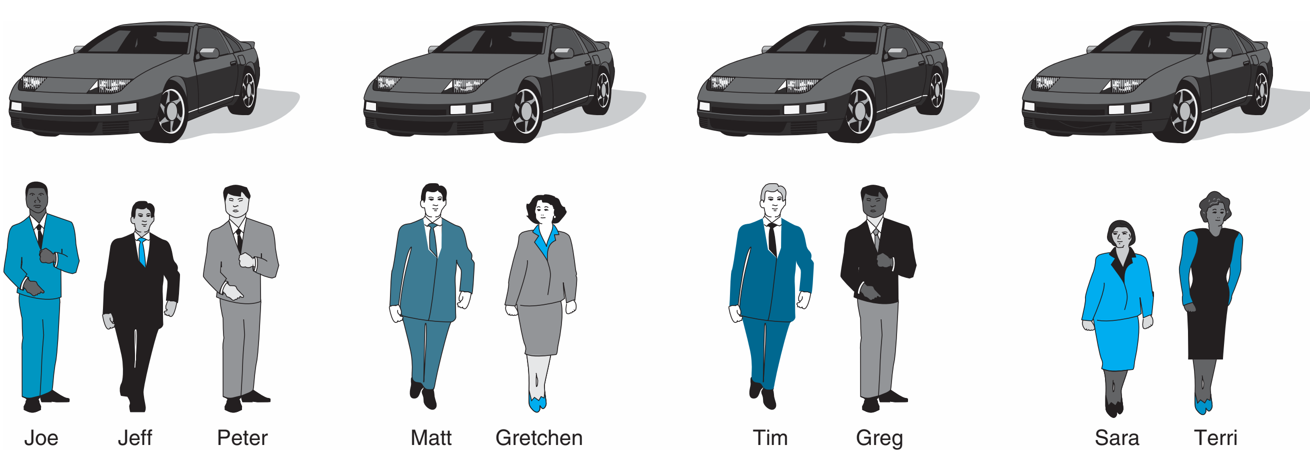

FIGURE 2.1
Recognition dinner participants

[1] You may sometimes see the substantial–insubstantial distinction referred to as *manifest variables* (which can be directly observed and measured) versus *latent variables* (which lie below the surface and can be measured only indirectly through their effects on another, observable entity; e.g., see Bartholomew, 2004).

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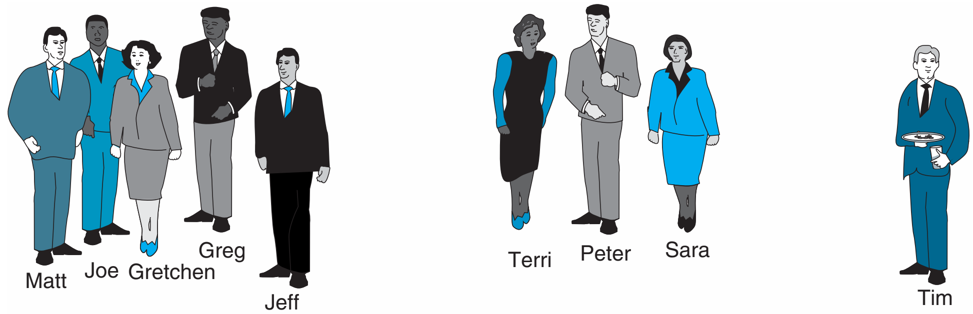
FIGURE 2.2
Conversation groups



among the guests, we might, with proper instrumentation, easily detect the presence of personal attraction, indifference, or rejection among various individuals within the group. But no such objective sensors of interpersonal relationships exist. *To merely observe the behavior of individuals in a particular situation is not to measure it.*

One possible approach to measuring the interpersonal dynamics of the group is to give each person in the group a slip of paper on which to record three choices: (a) one or more individuals in the group whom the person likes most, (b) one or more individuals whom the person likes least, and (c) one or more individuals for whom the person has no strong feeling one way or another. When using this method, we should poll each person in the group individually and guarantee that every response will be kept confidential.

We can then draw a chart, or **sociogram**, of these interpersonal reactions, perhaps in the manner depicted in Figure 2.3. We might also assign "weights" that place the data into three numerical categories: +1 for a positive choice, 0 for indifference, and –1 for a negative reaction. Categorizing the data in this way, we can then construct a sociometric matrix. To create a matrix, we arrange the names of each person twice: vertically down the left side of a grid and horizontally across the top of the grid. The result is shown in Table 2.3. The dashes in the grid reflect the fact that the people can choose other individuals but cannot choose *themselves.*

Certain relationships begin to emerge. As we represent group dynamics in multiple forms, certain clusters of facts suggest the following conclusions:

- Jeff is the informal or popular leader (sometimes called the "star") of the group. He received five choices and only one rejection (see the "Jeff" column in Table 2.3). The sociogram confirms Jeff's popularity with his colleagues.
- Probably some factions and possible tension are present in this group. Notice that Peter, Sara, and Terri form a subclique, or "island," that is separated from the larger clique that Jeff leads. The apparent liaison between these two groups is Joe, who has mutual choices with both Jeff and Peter.
- Friendship pairs may lend cohesion to the group. Notice the mutual choices: Matt and Gretchen, Peter and Joe, Jeff and Joe, Sara and Terri, Gretchen and Jeff. The sociogram reveals these alliances quite clearly.
- Tim apparently is the isolate of the group. He received no choices; he is neither liked nor disliked. In such a position, he is probably the least influential member of the group.

We have presented this body of sociometric data in its various forms to show how intangible data can be measured. Many other approaches can be devised to measure similar phenomena. In fact, there are other methods of drawing sociograms aside from that just illustrated. For example, Chatterjee and Srivastava (1982) have proposed a method useful for large populations, one that may be especially helpful in studying social forces within extended groups.

Interpretation of the Data

The ultimate criterion of any type of measurement is contained in the next seven words of our definition of measurement: *so that those data may be interpreted*. We have demonstrated what it means to interpret data by analyzing the interpersonal dynamics within a group of nine individuals,

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FIGURE 2.3

Sociogram of interpersonal dynamics

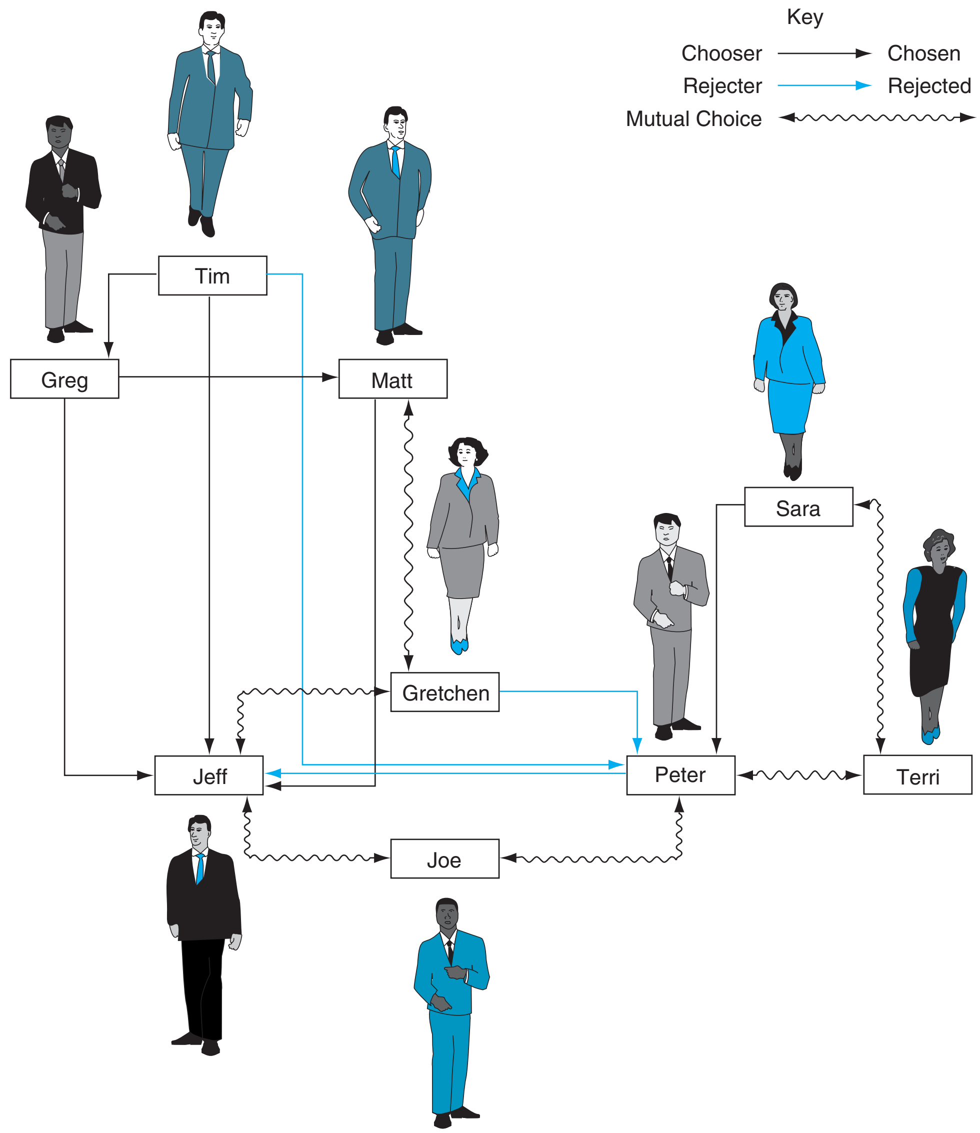

TABLE 2.3 Data from Figure 2.3 presented as a sociometric matrix

How Each Person Was Rated by the Others

How Each Person Rated the Others	Gretchen	Joe	Greg	Sara	Peter	Jeff	Tim	Matt	Terri
Gretchen	—	0	0	0	−1	+1	0	+1	0
Joe	0	—	0	0	+1	+1	0	0	0
Greg	0	0	—	0	0	+1	0	+1	0
Sara	0	0	0	—	+1	0	0	0	+1
Peter	0	+1	0	0	—	−1	0	0	+1
Jeff	+1	+1	0	0	0	—	0	0	0
Tim	0	0	+1	0	−1	+1	—	0	0
Matt	+1	0	0	0	0	+1	0	—	0
Terri	0	0	0	+1	+1	0	0	0	—
Totals	2	2	1	1	1	4	0	2	2

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presumably amicably assembled for a dinner occasion. There we looked below the surface to discover hidden social forces at play in the individuals' behaviors with one another.

When researchers gain sudden insights about the data with which they have been working, they may experience a sense of excitement. The data have been *interpreted*: They have been transformed into new discoveries, revelations, and enlightenments.

Now, we finish our definition: *and, ultimately, compared to a particular qualitative or quantitative standard*. A researcher must have a goalpost, a true north, a point of orientation. In research, we call these standards *norms*, *averages*, *conformity to expected statistical distributions*, *goodness of fit*, *accuracy of description*, and the like.

Measurement is ultimately a comparison: a thing or concept measured against a point of limitation. We compare the length of an object with the scale of a ruler or a measuring tape. We "measure" an ideology against the meaning of it as articulated or suggested by the originator of the ideology. The essence of a religious belief resides in its sacred writings, in the precepts of its great teachers, and in its creed. The meaning of freedom is articulated in many political documents—for instance, in the Declaration of Independence and the Constitution of the United States. The essence of a philosophy arises from the writings and teachings of its founder: Platonism from Plato, Marxism from Karl Marx, and romanticism perhaps from Jean Jacques Rousseau. Against these original sources, it is possible to measure the thoughts and ideas of others and to approximate their similarity or deviance from them.

Data examined statistically are constantly being interpreted in comparison with statistical norms: the normal curve, a point of central tendency, the degree of dispersion, and other accepted statistical standards. Data analyzed qualitatively are compared across data sources, across methods, and across time.

We see, therefore, that our definition of measurement implies much more than a surface reading might suggest. Measurement is indeed a tool by which data may be inspected, analyzed, and interpreted so that the researcher may probe the meaning that lies below the surface.

Four Scales of Measurement

We might think of any form of measurement as falling into one of four categories, or **scales:** (1) nominal, (2) ordinal, (3) interval, and (4) ratio (Stevens, 1946). The scale of measurement will ultimately dictate the statistical procedures (if any) that can be used in processing the data. To appreciate this fact, we consider each scale of measurement and its characteristics.

Nominal Scale of Measurement

The word *nominal* comes from the Latin *nomen*, meaning "name." Hence, we can "measure" data to some degree by assigning names to them. Remember the earlier discussion of measurement, where we suggested that its basic meaning was to restrict, to limit. That's what a **nominal scale** does—and just about all that it does. Assign a specific name to anything, and you have restricted that thing to the meaning of its name. For example, we can measure a group of children by dividing it into two groups: girls and boys. Each subgroup is thereby measured—restricted—by virtue of gender to a particular category.

Things can be measured nominally in an infinite number of ways. We can further measure girls and boys according to the home site of each child. Imagine that the town in which they live is divided into two sections by Main Street, which runs from east to west. Those children who live north of Main Street are "the Northerners"; those who live south of it are "the Southerners." In one period of U.S. history, we measured the population of the entire nation in just such a manner.

Nominal measurement is quite simplistic, but it does divide data into discrete categories that can be compared with one another. Let's take an example. Imagine that we have six people: Zahra, Paul, Kathy, Binh, Ginger, and Nicky. They can be divided into six units of one each. They can also form two groups: Zahra, Kathy, and Ginger (the girls) in one and Paul, Binh, and Nicky (the boys) in the other. Let's think of them as a class that meets in Room 12 at Thompson's

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Corner School. By assigning a room number, we have provided the class with a name even though that "name" may be a number. That number, however, has no quantitative meaning: Room 12 is not necessarily bigger or better than Room 11, nor is it inferior to Room 13.

Only a few statistical procedures are appropriate for analyzing nominal data. We can use the *mode* as an indicator of the most frequently occurring category within our data set; for instance, we might determine that there are more boys than girls in Room 12 at Thompson's Corner School. We can find the *percentage* of people in various subgroups within the total group; for instance, we could calculate the percentage of boys in each classroom. We can use a *chi-square test* to compare the relative frequencies of people in various categories; for instance, we might discover that more boys than girls live north of Main Street but that more girls than boys live south of Main Street. (We will discuss these statistics, as well as the statistics listed in the following discussions of the other three scales, in Chapter 11.)

Ordinal Scale of Measurement

With an **ordinal scale** of measurement, we can think in terms of the symbols > (greater than) and < (less than). We can compare various pieces of data in terms of one being greater or higher than another. In essence, this scale allows us to *rank-order* our data (hence its name *ordinal*).

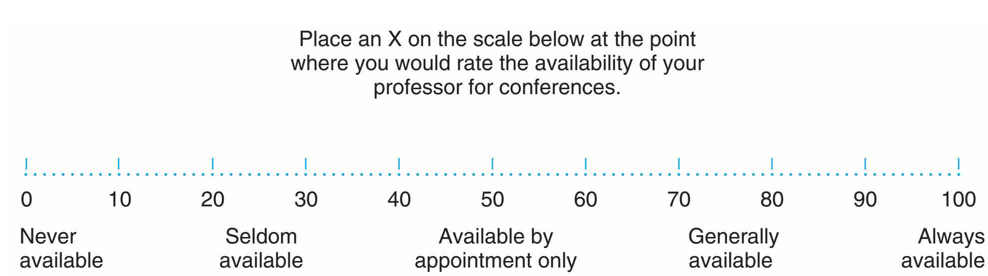
We can roughly measure level of education on an ordinal scale by classifying people as being unschooled or as having an elementary, high school, college, or graduate education. Likewise, we can measure members of the workforce by grades of proficiency: unskilled, semiskilled, or skilled.

An ordinal scale expands the range of statistical techniques we can apply to our data. In addition to the statistics we can use with nominal data, we can also determine the *median*, or halfway point, in a set of data. We can use a *percentile rank* to identify the relative position of any item or individual in a group. We can determine the extent of the relationship between two characteristics by means of Spearman's *rank order correlation*.

Interval Scale of Measurement

An **interval scale** of measurement is characterized by two features: (1) it has equal units of measurement, and (2) its zero point has been established arbitrarily. The Fahrenheit (F) and Celsius (C) scales for measuring temperature are examples of interval scales: The intervals between any two successive numbers of degrees reflect equal changes in temperature, but the zero point is not equivalent to a total absence of heat. For instance, when Gabriel Fahrenheit was developing his Fahrenheit scale, he first took as his zero point the coldest temperature he observed in Iceland. Later, he made it the lowest temperature obtainable with a mixture of salt and ice. This was purely an arbitrary decision. It placed the freezing point of water at 32° and the boiling point at 212° above zero.

The rating scales employed by many survey groups, businesses, and professional organizations are often assumed to be on interval scales. For instance, many universities ask students to use rating scales to evaluate the teaching effectiveness of various professors. Following is an example of an item from one university's teaching evaluation form:



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Notice that the scale has 11 equidistant points ranging from 0 to 100. The equidistance creates what is presumed to be an interval scale for the measure. At five points along the scale are descriptive labels that can help students determine how they should rate their professor's availability. We might place descriptors at more places along the scale (perhaps at 10-point distances), thus potentially making the scale more sensitive or more accurate. For indicating the availability of a professor, such fineness of discrimination may not be either possible or desirable, but one may conceive of situations in which such a degree of discrimination may be necessary and appropriate.

Interval scales of measurement allow statistical analyses that are not possible with nominal or ordinal data. Because an interval scale reflects equal distances among adjacent points, any statistics that are calculated using addition or subtraction—for instance, *means*, *standard deviations*, and *Pearson product moment correlations*—can now be used.

Ratio Scale of Measurement

Two measurement instruments may help you understand the difference between the interval and ratio scales: a thermometer and a yardstick. If we have a thermometer that measures temperature on either the Fahrenheit or Celsius scale, we cannot say that 80°F is twice as warm as 40°F. Why? Because these scales do not originate from a point of absolute zero; a substance may have some degree of heat even though its measured temperature falls *below* zero. With a yardstick, however, the beginning of linear measurement is absolutely the beginning. If we measure a desk from the left edge to the right edge, that's it. There is no more desk in either direction beyond those limits. A measurement of "zero" means there's no desk there at all, and a "minus" distance isn't even possible.

More generally, a **ratio scale** has two characteristics: (1) equal measurement units (similar to an interval scale) and (2) *an absolute zero point*, such that 0 on the scale reflects a total absence of the quantity being measured.

Let's consider once again our "availability" scale for measuring professor effectiveness. This scale could never be considered a ratio scale. Why? Because there is only one condition in which the professor would be absolutely unavailable: if the professor were dead!

What distinguishes the ratio scale from the other three scales is that *the ratio scale can express values in terms of multiples and fractional parts*, and the ratios are *true* ratios. A yardstick can do that: A yard is a *multiple* (by 36) of a 1-inch distance; an inch is one twelfth (a *fractional part*) of a foot. The ratios are 36:1 and 1:12, respectively.

Ratio scales outside the physical sciences are relatively rare. And whenever we cannot measure a phenomenon in terms of a ratio scale, we must refrain from making comparisons such as "this thing is three times as great as that" or "we have only half as much of one thing as another." Only ratio scales allow us to make comparisons that involve multiplication or division.

We can summarize our description of the four scales this way:
If you can say that

- One object is different from another, you have a *nominal scale*;
- One object is bigger or better or more of anything than another, you have an *ordinal scale*;
- One object is so many units (degrees, inches) more than another, you have an *interval scale*;
- One object is so many times as big or bright or tall or heavy as another, you have a *ratio scale*. (Senders, 1958, p. 51)

To identify uses of the four scales of measurement, go to the Activities and Applications section in Chapter 2 of MyEducational ResearchLab, located at www.myeducationlab.com. Complete Activity 3: Four Scales of Measurement

Table 2.4 provides a quick reference for the various types of scales, their distinguishing characteristics, and the statistical analysis possibilities for each scale. When we consider the statistical interpretation of data in later chapters (especially in Chapter 11), you may want to refer to this table to determine whether the type of data measurement you have employed will support the statistical operation you are contemplating.

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TABLE 2.4 A summary of measurement scales, their characteristics, and their statistical implications

	Measurement Scale	*Characteristics of the Scale*	*Statistical Possibilities of the Scale*
Non-interval scales	Nominal scale	A scale that "measures" in terms of names or designations of discrete units or categories	Enables one to determine the mode, the percentage values, or the chi-square
	Ordinal scale	A scale that "measures" in terms of such values as "more" or "less," "larger" or "smaller," but without specifying the size of the intervals	Enables one also to determine the median, percentile rank, and rank correlation
Interval scales	Interval scale	A scale that measures in terms of equal intervals or degrees of difference but whose zero point, or point of beginning, is arbitrarily established	Enables one also to determine the mean, standard deviation, and product moment correlation; allows one to conduct most inferential statistical analyses
	Ratio scale	A scale that measures in terms of equal intervals and an absolute zero point of origin	Enables one also to determine the geometric mean and the percentage variation; allows one to conduct virtually any inferential statistical analysis

Validity and Reliability of Measurement

Validity and *reliability* are two words that you will encounter repeatedly in research methodology, and these two terms are often used in connection with measurement. The validity and reliability of your measurement instruments influence the extent to which you can learn something about the phenomenon you are studying, the probability that you will obtain statistical significance in your data analysis, and the extent to which you can draw meaningful conclusions from your data. We introduce these two concepts briefly here and examine them in greater depth in Chapter 5.

Validity

The **validity** of a measurement instrument is the extent to which the instrument measures what it is intended to measure. Certainly no one would question the notion that a yardstick is a valid means of measuring length. Nor would most people doubt that a thermometer measures temperature; for instance, in a mercury thermometer, the level to which the mercury rises is a function of how much it expands, which is a function of the degree to which it is hot or cold.

But to what extent does a standardized intelligence test actually measure a person's intelligence? How accurately do people's annual incomes reflect their social class? And how well does a sociogram capture the interpersonal dynamics in a group of nine people? Especially when we are measuring *insubstantial* phenomena—phenomena without a direct basis in the physical world—our measurement instruments may be somewhat suspect in terms of validity.

Let's return to the rating-scale item we presented earlier to assess a professor's availability for students (see p. 26) and consider its validity as such a measure. Notice how fuzzy some of the labels are. The professor is "always available." What does *always* mean? Twenty-four hours a day? Could you call the professor at 3 A.M. any day of the week, or only whenever the professor is on campus? If the latter is the case, could you call your professor out of a faculty meeting or out of a conference with the president of the college? We might have similar problems in interpreting "generally available," "seldom available," and "never available." What seems at first glance to be a scale that anyone could understand does, on careful inspection, have limitations *as a measuring instrument* for research purposes.

A paper-and-pencil test may be intended to measure a certain characteristic, and it may be *called* a measure of that characteristic, but these facts don't necessarily mean that the test actually measures what its creators say it does. For example, consider a paper-and-pencil test of personality traits in which, with a series of check marks, a person indicates his or her most representative

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characteristics or behaviors in given situations. The person's responses on the test are presumed to reveal relatively stable personality traits. The question that validity asks is: Does such a test, in fact, measure the person's personality traits, or does it measure something else altogether? The answer depends, at least in part, on the extent to which the person is, or *can* be, truthful in responding. If the person responds in terms of characteristics and behaviors that he or she believes to be socially desirable, the test results may reveal not the person's actual personality, but rather an idealized portrait of how he or she would like to be seen by others.

Reliability

Imagine that you are concerned about your growing waistline and decide to go on a diet. Every day you put a tape measure around your waist and pull the two ends together snugly to get a measurement. But just how tight is "snug"? Quite possibly, the level of snugness might be different from one day to the next. In fact, you might even measure your waist with different degrees of snugness from one *minute* to the next. To the extent that you are not measuring your waist in a consistent fashion—even though you always use the same tape measure—you have a problem with reliability.

More generally, **reliability** is the consistency with which a measuring instrument yields a certain result when the entity being measured hasn't changed. As we have just seen in our waist-measuring situation, instruments that measure physical phenomena aren't necessarily completely reliable. As another example, think of a balance scale that a storekeeper might use. When weighing out a pound of rice, the storekeeper won't always measure *exactly* the same amount of rice each time.

Instruments designed to measure psychological characteristics (insubstantial phenomena) tend to be even less reliable than those designed to measure physical (substantial) phenomena. For example, a student using the preceding rating-scale item for measuring professor availability might easily rate the professor as "70" one day and "90" the next, not because the professor's availability has changed overnight but because the student's interpretations of the phrases "generally available" and "always available" *have* changed. Similarly, if we asked the nine people portrayed in Figure 2.1 (Gretchen, Joe, Greg, etc.) to indicate the people they liked best and least among their colleagues, they wouldn't necessarily always give us the same answers they gave us previously, even if the interpersonal dynamics within the group have remained constant.

We can measure something accurately only when we can also measure it consistently. Yet measuring something consistently doesn't necessarily mean measuring it accurately. In other words, *reliability is a necessary but insufficient condition for validity.* For example, we could use a tape measure to measure a person's head circumference and claim that the result is a good reflection of intelligence. In this situation, we might have reasonable reliability (we are apt to get similar measures of an individual's head circumference on different occasions) but absolutely no validity (head size is *not* a good indication of intelligence level).

Both validity and reliability, then, reflect the degree to which we may have *error* in our measurements. In many instances—and especially when we are measuring insubstantial phenomena—a measurement instrument may allow us to measure a characteristic only indirectly and so may be subject to a variety of biasing factors (e.g., people's responses on a rating scale are apt to be influenced by their interpretations, prejudices, memory lapses, etc.). In such cases, we have error due to the imperfect *validity* of the measurement instrument. Yet typically—even when we are measuring substantial phenomena—we may get slightly different measures from one time to the next simply because our measurement tool is imprecise (e.g., the waist or head size we measure may depend on how snugly we pull the tape measure). In such cases, we have error due to the imperfect *reliability* of the measure. Generally speaking, validity errors reflect biases in the instrument itself and are relatively constant sources of error. In contrast, reliability errors reflect *use* of the instrument and are apt to vary unpredictably from one occasion to the next.

Validity and reliability take different forms, depending on the nature of the research problem, the general methodology the researcher uses to address the problem, and the nature of the data that are collected. Accordingly, we will look at the various forms of validity and reliability in Chapter 5, "Planning Your Research Project."

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Statistics as a Tool of Research

All tools are more suitable for some purposes than for others. Consider a screwdriver as an example. A screwdriver was designed for just a single purpose: to insert and remove screws. We've had friends, however, who have used screwdrivers for a wide variety of other tasks: to pry off lids, punch holes, scratch away unwanted paint, and so on. Certainly these friends often accomplished their objectives by using—or rather, misusing—a screwdriver in such ways, but other tools would have been more suitable. So, too, with statistics. They can be a powerful tool when used correctly—in particular, when they are used for the specific kinds of data and research questions for which they were designed—but they are less effective and can often be misleading when they are applied in other contexts.

All data, as they come to us from the real world, are unorganized, separate bits of information. They have no focus; they need to be managed in some way. Statistics provide a means to get order out of chaos.

Statistics are typically more useful in some academic disciplines than others. For instance, researchers use them quite often in such fields as psychology, medicine, and education; they use them less frequently in such fields as history, musicology, and literature. But whenever we use statistics, we must remember that the statistical values we obtain are never the end of a research endeavor nor the final answer to a research problem. The final question in research is, *What do the data indicate?* not What is their numerical configuration (where they cluster, how broadly they spread, or how closely they are related)? Statistics give us *information* about the data, but a conscientious researcher is not satisfied until the *meaning* of this information is revealed.

The Lure of Statistics

Statistics can be like the voice of a bevy of Sirens to the novice researcher. For those who have forgotten their Homer, the *Odyssey* describes the perilous straits between Scylla and Charybdis. On these treacherous rocks sat an assembly of Sirens—svelte maidens who, with enticing songs, lured sailors in their direction and, by so doing, caused ships to drift and founder on the jagged shores.

For many beginning researchers, statistics hold a similar appeal. Subjecting data to elegant statistical routines may lure novice researchers into thinking they have made a substantial discovery, when in fact they have only calculated a few numbers that can help them interpret the data. Behind every statistic lies a sizable body of data; the statistic may summarize these data in a particular way, but it cannot capture all the nuances of the data. The entire body of data collected, not any single statistic calculated, is what ultimately must be used to resolve the research problem. There is no substitute for the task the researcher ultimately faces: to discover the meaning of the data and its relevance to the research problem. Any statistical process you may employ is merely ancillary to this central quest.

Furthermore, even the most sophisticated statistical procedures can never make amends for a poorly conceived research study. An editorial in the journal *Research in Nursing and Health* once made this point quite poignantly:

> The use of elegant statistics can never compensate for inelegant conceptual bases. The new evaluative procedures are exciting because they enable examination of data in ways previously not possible. The bottom line remains the same, however. One cannot draw large savings out of an account into which little has been deposited. Neither can one draw useful meanings from studies into which less-than-important notions have been entered ("Use of Elegant Statistics," 1987, p. iii).

Primary Functions of Statistics

Statistics have two principal functions: to help the researcher (1) describe the data and (2) draw inferences from the data. **Descriptive statistics** summarize the general nature of the data obtained—for instance, how certain measured characteristics appear to be "on average," how

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much variability exists among different pieces of data, how closely two or more characteristics are interrelated, and so on. In contrast, **inferential statistics** help the researcher make decisions about the data; for instance, they help one decide whether the differences observed between two groups in an experiment are large enough to be attributed to the experimental intervention rather than to a once-in-a-blue-moon fluke.

Both of these functions of statistics ultimately involve summarizing the data in some way. In the process of summarizing, statistical analyses often create entities that have no counterpart in reality. For instance, we usually accept the arithmetic mean, commonly called the *average*, without question or reservation. But take a simple example: Four students have part-time jobs on campus. One student works 24 hours a week in the library, the second works 22 hours a week in the campus bookstore, the third works 12 hours a week in the parking lot, and the fourth works 16 hours a week in the cafeteria. Data presented in this form are unorganized and random.

How might we summarize the random work hours of the four students? One approach is to calculate the arithmetic mean. By doing so, we find that the students work, "on average," 18.5 hours a week. Although we have learned something about these four students and their working hours, to some extent we have learned a myth: No student has worked exactly 18.5 hours a week. That figure represents absolutely no fact in the real world.

Apparently, we have solved one problem only to create another. We have created a dilemma. If statistics offer us only an unreality, then why use them? Why create myth out of hard, demonstrable data? The answer lies in the nature of the human mind. Human beings can handle only so much information at a time. (If you have studied cognitive psychology, you may recognize that we are talking about the limited capacity of *working memory*.) Statistics help condense an overwhelming body of data into an amount of information that the mind can more readily comprehend and deal with. In the process, they can help the researcher "see" patterns and relationships in the data that might otherwise go unnoticed. More generally, statistics *help the human mind comprehend disparate data as an organized whole*. And as we shall see now, the human mind is another indispensable tool in the researcher's toolkit.

The Human Mind as a Tool of Research

Statistics can tell us where the center of a body of data lies, how broadly the data are spread, how much two or more variables are interrelated—more generally, how the data stack up. But statistics cannot interpret those data and arrive at a logical conclusion as to their meaning. Only the mind of the researcher can do that.

The human mind is undoubtedly the most important tool on the researcher's workbench. Its functioning dwarfs all other gadgetry. Nothing equals its powers of comprehension, integrative reasoning, and insight.

Over the past several millennia, human beings have developed several general strategies through which they can more effectively reason about and better understand worldly phenomena. Key among these strategies are critical thinking, deductive logic, inductive reasoning, the scientific method, theory building, and collaboration with others.

Critical Thinking

Before beginning a research project, effective researchers typically look at research studies and theoretical perspectives related to their topic of interest. But they don't just accept research findings and theories at face value; instead, they scrutinize them for faulty assumptions, questionable logic, weaknesses in methodology, inappropriate statistical analyses, and unwarranted conclusions. In other words, good researchers engage in critical thinking.

In general, **critical thinking** involves evaluating information or arguments in terms of their accuracy and worth (Beyer, 1985). Critical thinking may take a variety of forms, depending on

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the context. For instance, it may involve any one or more of the following (adapted from Halpern, 1998, 2008):

- *Verbal reasoning:* Understanding and evaluating the persuasive techniques found in oral and written language.
- *Argument analysis:* Discriminating between reasons that do and do not support a particular conclusion.
- *Decision making:* Identifying and evaluating several alternatives and selecting the alternative most likely to lead to a successful outcome.
- *Critical analysis of prior research:* Evaluating the value of data and research results in terms of the methods used to obtain them and their potential relevance to particular conclusions. Such critical analysis involves considering questions such as these:
  - Was an appropriate method used to measure a particular outcome?
  - Are the data and results derived from a relatively large number of people, objects, or events?
  - Have other possible explanations or conclusions been eliminated?
  - Can the results obtained in one situation be reasonably generalized to other situations?

Critical thinking sometimes takes different forms in different content areas. In history, it might involve scrutinizing various historical documents and looking for clues as to whether things *definitely* happened a particular way or only *maybe* happened that way. In psychology, it might involve critically evaluating the way in which a particular psychological characteristic (e.g., intelligence, personality) is being measured. In anthropology, it might involve observing people's behaviors over an extended period of time and speculating about what those behaviors indicate about the society being studied.

Deductive Logic

Deductive logic begins with one or more *premises*. These premises are statements or assumptions that the researcher initially takes to be true. Reasoning then proceeds logically from these premises toward conclusions that, if the premises are indeed true, must *also* be true. For example,

If all tulips are plants, (premise 1)

And if all plants produce energy through photosynthesis, (premise 2)

Then all tulips must produce energy through photosynthesis (conclusion).

To the extent that the premises are false, the conclusions may also be false. For example,

If all tulips are platypuses, (premise 1)

And if all platypuses produce energy through spontaneous combustion, (premise 2)

Then all tulips must produce energy through spontaneous combustion (conclusion).

The if-this-then-that logic is the same in both examples. We reach an erroneous conclusion in the second example (we conclude that tulips are likely to burst into flame at unpredictable times) only because both of our premises are also erroneous.

Let's look back more than 500 years to Christopher Columbus's first voyage to the New World. At the time, people held many beliefs about the world that, to them, were irrefutable facts: Humans are mortal; God is good; the earth is flat. The terror that gripped Columbus's sailors as they crossed the Atlantic was a fear supported by deductive logic. If the earth is flat (premise), its flat surface should have boundaries. The boundaries of a flat surface should be the edges of that surface. A ship that continues to travel across a flat surface must eventually come to the edge of it and fall off.

The logic was sound; the reasoning, accurate; the conclusion, valid. Where the whole proposition went wrong was that the major premise was incorrect. The reasoning began with a preconceived idea—the earth is flat—that *seemed* to be true but in fact was not.

Deductive logic is extremely valuable for generating research hypotheses and testing theories. As an example, when developing her dissertation proposal, doctoral student Dinah Jackson was

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interested in the effects of *self-questioning:* asking oneself questions about the topic one is studying. She knew from well-established theories about human learning that forming mental associations among two or more pieces of information results in more effective learning than does trying to learn each piece of information separately from the others. She also found a body of research literature indicating that the kinds of questions people ask themselves (mentally) and try to answer as they learn (e.g., as they sit in class or read a textbook) affect what they learn and how effectively they remember it. (For instance, a student who is trying to answer the question, "What do I need to remember for the test?" might learn very differently from the student who is considering the question, "How might I apply this information to my own life?") Jackson's reasoning was as follows:

> If learning information in an associative, integrative fashion is more effective than learning information piecemeal, (premise 1)
>
> If the kinds of questions learners ask themselves during a learning activity influence how they learn, (premise 2)
>
> If training in self-questioning techniques influences the kinds of questions that students ask themselves, (premise 3)
>
> And if learning is reflected in the kinds of notes that learners take during class, (premise 4)
>
> Then teaching students to ask themselves integrative questions as they study class material should lead to class notes that are more integrative in nature (conclusion).

Such reasoning led Jackson to form and test the following hypothesis:

> Students who have formal training in integrative self-questioning will take more integrative notes than students who have not had any formal training (Jackson, 1996, p. 12).

Happily, Jackson's dissertation research supported her hypothesis.

Inductive Reasoning

Inductive reasoning begins not with a preestablished truth or assumption but instead with an observation. For instance, as a baby in a high chair many years ago, you may have observed that if you held a cracker in front of you and then let go of it, it fell to the floor. Hmmm, you may have thought, what happens if I do that again? So you took another cracker from the tray on your high chair, held it in front of you, and released it. It, too, fell to the floor. You followed the same procedure with several more crackers, and the result was always the same: The cracker traveled in a downward direction. Eventually you may have performed the same actions on other things—blocks, rattles, peas, milk, and so on—and invariably observed the same result. You probably eventually drew the conclusion that all things fall when dropped—your first inkling about a force called *gravity*. (You may also have concluded that dropping things from your high chair greatly annoyed your parents, but that is another matter.)

In **inductive reasoning**, people use specific instances or occurrences to draw conclusions about entire classes of objects or events. In other words, they observe a sample and then draw conclusions about the population from which the sample has been taken. For instance, an anthropologist may draw conclusions about a certain culture after studying a particular community within that culture. A professor of special education may use a few case studies in which a particular instructional approach is effective with students who have autism to recommend that teachers use the instructional approach with other students who have autism. A sociologist may conduct two surveys, one in 2010 and a second in 2020, asking 1,000 people to describe their beliefs about AIDS and then drawing conclusions about how society's attitudes toward AIDS have changed over that time.

Figure 2.4 graphically depicts the nature of inductive reasoning. Let's look at an example of how this representation applies to an actual research project. Neurologists Silverman, Masland, Saunders, and Schwab (1970) sought the answer to a problem in medicine: How long can a person have a "flat EEG" (i.e., an absence of measurable electrical activity in the brain, typically indicative of cerebral death) and still recover? Silverman and his colleagues observed 2,650 actual

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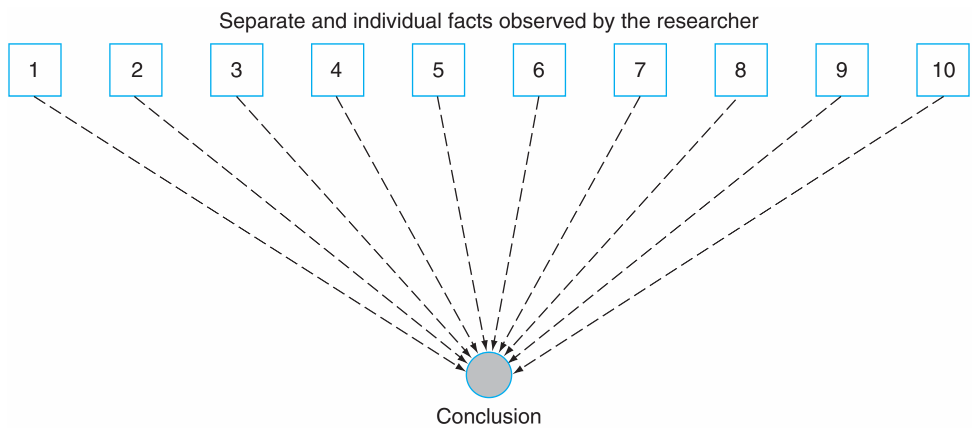
FIGURE 2.4

The inductive process



To practice noting the difference between deductive reasoning and inductive reasoning, go to the Activities and Applications section in Chapter 2 of MyEducationalResearchLab, located at www.myeducationlab.com. Complete Activity 4: Deductive and Inductive Reasoning.

cases. They noted that, in all cases in which the flat EEG persisted for 24 hours or more, not a single recovery occurred. All of the data pointed to the same conclusion: *It is unlikely that a recovery might take place for those who exhibit flat EEGs of 24 hours or more in duration*. We cannot, of course, rule out the unexplored cases, but *from the data observed*, the conclusion reached was that recovery seems impossible. The EEG line from *each* case led to that *one* conclusion.

The Scientific Method

During the Renaissance, people found that when data are assembled and studied objectively and systematically, the data may yield previously undiscovered insights. Thus was the scientific method born; the words literally mean "the method that searches after knowledge" (*scientia* is Latin for "knowledge" and derives from *scire,* "to know"). The scientific method gained momentum during the 16th century with such men as Paracelsus, Copernicus, Vesalius, and Galileo.

Traditionally, the **scientific method** is a means whereby insight into the unknown is sought by (1) identifying a problem that defines the goal of one's quest; (2) positing a hypothesis that, if confirmed, resolves the problem; (3) gathering data relevant to the hypothesis; and (4) analyzing and interpreting the data to see whether they support the hypothesis and resolve the question that initiated the research.

To develop hypothesis(es) from a research article, go to the Building Research Skills section in Chapter 2 of MyEducationalResearchLab, located at www.myeducationlab.com.

Figure 1.1 in Chapter 1, which depicts research as a cyclical process, is a good illustration of the scientific method in action. We should keep in mind, however, that not all research methodologies follow the steps we have just listed in exactly that sequence. For instance, as you will discover when you read Chapter 7, such approaches as ethnographic research and grounded theory research involve collecting data and *then* developing one or more hypotheses about them.

As you may already have realized, application of the scientific method typically involves both deductive logic and inductive reasoning. Researchers may develop a hypothesis either from a theory (deductive logic) or from observations of specific events (inductive reasoning). Then, using deductive logic, they make predictions about the patterns they are likely to see in the data *if* the hypothesis is true. And often, using inductive reasoning, they generalize from data taken from a sample to describe the characteristics of a larger population.

Theory Building

Cognitive psychologists are increasingly realizing that the human mind is a very *constructive* mind. People don't just take in and remember the innumerable pieces of information they acquire in a piecemeal fashion. Instead, they pull together what they learn about the world to form well organized and integrated understandings about a wide variety of phenomena. Human

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beings, then, seem to have a natural tendency to develop *theories* about the world around them (e.g., see Bransford, Brown, & Cocking, 2000; J. E. Ormrod, 2008).

People's everyday, informal theories about the world aren't always accurate. For example, imagine that as an airplane travels forward through the air, it drops a large metal ball. What kind of path does the ball take as it falls downward? The answer, of course, is that it will fall downward at an increasingly fast rate (thanks to gravity) but will also continue to travel forward (thanks to inertia). Thus, its path will have the shape of a parabolic arc. Yet many college students erroneously believe that the ball (a) will fall straight down, (b) will take a straight diagonal path downward, or (c) will actually move *backward* from the airplane as it falls down (McCloskey, 1983).

An important role of the researcher is to build theories based on *facts* rather than on naive beliefs and subjective impressions about the world. This theory-building process involves thinking *actively* and *intentionally* about the phenomenon at hand. Beginning with the facts known about a particular phenomenon, the researcher brainstorms ideas about possible and reasonable explanations.[2] Such explanations are apt to involve an interrelated set of concepts and propositions that form the foundation for a new theory about the phenomenon being studied. This theory yields hypotheses that the researcher can test systematically using deductive reasoning and the scientific method. As new data come in that either support or don't support particular hypotheses, the researcher may continue to revise the theory, reworking parts that research findings repeatedly fail to support, filling in gaps with additional concepts or propositions, extending the theory to apply to other situations, relating the theory to other theories with which it is compatible, and so on (Steiner, 1988; K. R. Thompson, 2006).

Theory building tends to be a relatively slow process, with any particular theory continuing to evolve over a period of years, decades, or centuries. Often, many researchers contribute to the theory-building effort, testing hypotheses that the theory suggests, suggesting additional concepts and propositions to include, and so on. This last point brings us to yet another effective strategy of the human mind: collaborating with others.

Collaboration With Others

As the old saying goes, two heads are better than one. Typically, three or more are better still. Any single researcher is apt to have certain perspectives, assumptions, and theoretical biases—not to mention holes in his or her knowledge about the subject matter—that will limit how he or she approaches a research project. By bringing one or more professional colleagues onto the scene—ideally, colleagues who have perspectives, backgrounds, and areas of expertise somewhat different from the researcher's own—the researcher brings just that many more cognitive resources to bear on how to tackle the research problem and how to find meaning in the data obtained (e.g., see Nichols, 1998).

Sometimes these colleagues enter the picture as equal partners. On other occasions, they may simply offer suggestions and advice. For example, when a graduate student conducts research for a master's thesis or doctoral dissertation, the student is, of course, the key player in the endeavor. Yet the student typically has considerable guidance from an advisor and, especially in the case of a doctoral dissertation, from a faculty committee. The prudent student selects an advisor and committee members who have the expertise to help shape the research project into a form that will truly address the research question and, perhaps more importantly, will make a genuine contribution to the student's topic of study.

All of the processes just described—critical thinking, deductive logic, inductive reasoning, the scientific method, theory building, and collaboration with others—help the researcher take advantage of the human mind as a tool of research. We look at one final tool—language—in the next section.

[2] This process is sometimes known as *abduction* or *retroduction*.

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Language as a Tool of Research

One of humankind's greatest achievements is language. Not only does it allow us to communicate with one another, but it also enables us to think more effectively. People can often think more clearly and efficiently about a topic when they can represent their thoughts in their heads with specific words and phrases.

Imagine, for a moment, that you are driving along a country road. In a field to your left, you see something with the following characteristics:

- Black and white in color, in a splotchy pattern
- Covered with a short, bristly substance
- Appended at one end by an object similar in appearance to a paintbrush
- Appended at the other end by a lumpy thing with four pointy objects sticking upward (two soft and floppy, two hard and curved around)
- Held up from the ground by four spindly sticks, two at each end

Unless you were born yesterday, you would almost certainly identify the object as a *cow*.

Words—even those as simple as *cow*—and the concepts that the words represent enhance our thinking in several ways (J. E. Ormrod, 2008):

1. *They reduce the world's complexity.* Classifying similar objects and events into categories and labeling those categories in terms of specific words make our experiences easier to understand. For instance, it is much easier to think to yourself, "I see a herd of cows," than to think, "There is a brown object, covered with bristly stuff, appended by a paintbrush and a lumpy thing, and held up by four sticks. Ah, yes, and I also see a black-and-white spotted object, covered with bristly stuff, appended by a paintbrush and a lumpy thing, and held up by four sticks. And over there is a brown-and-white object. . . ."
2. *They allow abstraction of the environment.* An object that has bristly stuff, a paintbrush at one end, a lumpy thing at the other, and several spindly sticks at the bottom is a concrete entity. The concept *cow*, however, is more abstract: It connotes such characteristics as *female*, *supplier of milk*, and, to the farmer or rancher, *economic asset*. Concepts and the labels associated with them allow us to think about our experiences without necessarily having to consider all of their concrete characteristics.
3. *They enhance the power of thought.* When you are thinking about an object covered with bristly stuff, appended by a paintbrush and a lumpy thing, held up by four sticks, and so on, you can think of little else (as we mentioned earlier, human beings can think about only a very limited amount of information at any one time). In contrast, when you simply think *cow*, you can easily think about other ideas at the same time and perhaps form connections and interrelationships among them in ways you hadn't previously considered.
4. *They facilitate generalization and inference drawing in new situations.* When we learn a new concept, we associate certain characteristics with it. Then, when we encounter a new instance of the concept, we can draw on our knowledge of associated characteristics to make assumptions and inferences about the new instance. For instance, if you see a herd of cattle as you drive through the countryside, you can infer that you are passing through either dairy or beef country, depending on whether you see large udders hanging down between some of the spindly sticks.

Just as *cow* helps us categorize certain experiences into a single idea, so, too, does the terminology of your discipline help you interpret and understand your observations. The words *tempo*, *timbre*, and *perfect pitch* are useful to the musicologist. Such terms as *central business district*, *folded mountain*, and *distance to k* have special meaning for the geographer. The terms *lesson plan*, *portfolio*, and *charter school* communicate a great deal to the educator. Learning the specialized terminology of your field is indispensable to conducting a research study, grounding it in prior theory and research, and communicating your results to others.

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The Value of Knowing Two or More Languages

It should go without saying that not all significant research is reported in English. Accordingly, many doctoral programs require that students demonstrate a reading competency in one or two foreign languages in addition to proficiency in English. The choice of these languages is usually linked to the area of proposed research.

The language requirement is a reasonable one. Human enlightenment has spread across the world at an astounding rate because of research and new discoveries. The former Soviet Union, for example, made gigantic strides in science, especially in physics and space science. Japan has pushed back the frontiers of knowledge in electronics and robotics. Two of the most influential theorists in child development today—Jean Piaget and Lev Vygotsky—wrote in French and Russian, respectively. Many new discoveries are reported in the native language of the researcher. A researcher doing a doctoral dissertation that demands knowledge of research in other languages must be able to access that research by way of reading competency in the languages in which the research is reported.

The Importance of Writing

To be generally accessible to the larger scientific community and ultimately to society as a whole, all research must eventually be presented as a written document, either on paper or in electronic form. To produce such a document, the researcher must possess the ability to use language with a degree of skill and accuracy that will clearly delineate all aspects of the research process. The written document is often referred to as the *research report*. The basic requirement for writing such a report is the ability to use language in a clear, coherent manner. We present some suggestions for writing effectively in the "Practical Application" section that immediately follows this section.

Although the conventional wisdom is that clear thinking *precedes* clear writing, we have learned through both our own work and that of others that writing can be a productive form of thinking in and of itself. When you write your ideas down on paper, you do several things:

- You must identify the specific ideas you do and do not know about your topic.
- You must clarify and organize your thoughts sufficiently to communicate them to your readers.
- You may detect gaps and logical flaws in your thinking.

Perhaps it is not surprising, then, that writing about a topic actually enhances the writer's understanding of the topic (Kellogg, 1994; Shanahan, 2004).

If you wait until all of your thoughts are clear before you start writing, you may never begin. Therefore, we recommend that you start writing your research proposal or report as soon as possible. Begin with a title and a purpose statement for your study. Commit your title to paper; keep it in plain sight as you focus your ideas. Although you may very well change the title later as your research proceeds, creating a working title in the early stages can provide both focus and direction. When you can draft a clear and concise statement that begins, "The purpose of this study is . . .," you are well on your way to planning a focused research study.

PRACTICAL APPLICATION Communicating Effectively Through Writing

In our own experience, most students have a great deal to learn about what good writing entails. Yet we also know that with effort, practice, expert guidance, and regular feedback, students *can* learn to write more effectively. Chapters 6 and 12 will present specific strategies for writing research proposals and research reports. Here we offer more general strategies for writing in a way that clearly communicates your ideas and reasoning to others. We also offer suggestions for using word processing software.

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GUIDELINES Writing to Communicate

The following guidelines are based on techniques often seen in effective writing. Furthermore, such techniques have consistently been shown to facilitate readers' comprehension of what others have written (e.g., J. E. Ormrod, 2008).

1. *Say exactly what you mean.* Precision is of utmost importance, not only in research proposals and reports, but in writing in general. Choose your words and phrases carefully so that you communicate your *exact* meaning, not some vague approximation. Many books and other resources offer suggestions for writing clear, concise, and effective sentences and in combining those sentences into unified and coherent paragraphs (e.g., see the sources in the "For Further Reading" list at the end of the chapter).

2. *Continually keep in mind your primary objective in writing your paper, and focus your discussion accordingly.* All too often, novice researchers try to include everything they've learned, both from their literature review and from their data analysis, in their writing. But ultimately, everything you say should relate either directly or indirectly to your research problem. If you can't think of how something relates, leave it out! You'll undoubtedly have enough things to write about as it is.

3. *Provide an overview of what you will be talking about.* Your readers can more effectively read your work when they know what to expect as they read. Providing an overview of the topics to be discussed and their order, and possibly also showing how the various topics interrelate, is sometimes called an **advance organizer.** As a simple example, recall Dinah Jackson, the doctoral student who studied the effects of self-questioning on the quality of classroom note taking. She began the "Review of the Literature" in her dissertation as follows:

> The first part of this review will examine the theories, frameworks, and experimental research behind the research on adjunct questioning. Part two will investigate the transition of adjunct questioning to self-generated questioning. Specific models of self-generated questioning will be explored, starting with the historical research on question position (and progressing) to the more contemporary research on individual differences in self-questioning. Part three will explore some basic research on note taking, and tie note taking theory with the research on self-generated questioning. (Jackson, 1996, p. 17)

4. *Organize your ideas into general and more specific categories, and use headings and subheadings to guide your readers through your discussion of these categories.* Take a moment to flip through the pages of this book. Notice how often we use headings to let you know what we'll be talking about in the paragraphs to come. In our own experience, students often organize their thoughts (their literature reviews, for example) without communicating their organizational scheme to their readers. Using headings is one simple way to make that scheme crystal clear.

5. *Provide transitional phrases, sentences, or paragraphs that help your readers follow your train of thought.* If one idea, paragraph, or section leads logically to the next, say so! Furthermore, give readers some sort of signal when you change the course of your discussion. For instance, in her doctoral dissertation examining the various learning processes that students might use when listening to a lecture, Nancy Thrailkill finished a discussion of the effects of visual imagery (mental "pictures" of objects or events) and was making the transition to a more theoretical discussion of imagery. She made the transition easy to follow with this sentence:

> Although researchers have conducted numerous studies on the use and value of imagery in learning, they seem to have a difficult time agreeing on why and how it works. (Thrailkill, 1996, p. 10)

The first clause in this transitional sentence recaps the discussion that immediately preceded it, whereas the second clause introduces the new (albeit related) topic.

6. *Use concrete examples to make abstract ideas more understandable.* There's a fine line between being abstract and being vague. Even as scholars who have worked in our respective academic

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disciplines for many years, we still find that we understand something better when the writer gives us a concrete example to illustrate an abstract idea. Let's look once again at Jackson's dissertation on self-questioning and class note taking. Jackson makes the point that how a researcher evaluates, or *codes*, the content of participants' class notes will affect what the researcher discovers about those notes; more specifically, she argues that a superficial coding scheme (e.g., counting the number of main ideas included in notes) fails to capture the true quality of the notes. She clarifies her point with a concrete example:

> For example, while listening to the same lecture, Student A may record only an outline of the lecture, whereas Student B may record an outline, examples, definitions, and mnemonics. If a researcher only considered the number of main ideas that students included in their notes, then both sets of notes might be considered equivalent, despite the fact that the two sets differ considerably in the type of material recorded. (Jackson, 1996, p. 9)

7. *Use appropriate punctuation.* Appropriate punctuation is not merely a bothersome formality. On the contrary, it can help you communicate your meanings. A colon will announce that what follows it explains the general statement that immediately precedes it. Similarly, the semicolon, the dash, quotation marks, parentheses, and italics are all tools for clarifying your thoughts. Also learn to use the comma correctly. Many style manuals, such as those in the "For Further Reading" list at the end of this chapter, have sections dealing with correct punctuation usage.

8. *Use figures and tables to help you more effectively present or organize your ideas and findings.* Although the bulk of your research proposal or report will almost certainly be prose, in some cases it might be helpful to present some information in figure or table form. Consider the sociogram and sociometric data presented earlier in Figure 2.3 and Table 2.3, respectively. We're sure you will agree that we couldn't possibly have presented the same information as effectively by describing it through words alone.

9. *At the conclusion of a chapter or major section, summarize what you've said.* Chances are, you will be presenting a great deal of information in any research proposal or report that you write. Summarizing what you've said helps your readers identify the things that are, in your mind, the most important things for them to remember. For example, in a dissertation that examined children's beliefs about the mental processes involved in reading, Debby Zambo summarized a lengthy discussion about the children's understanding of what it means to pay attention:

> In sum, the students understand attention to be a mental process. They know their attention is inconsistent and affected by emotions and interest. They also realize that the right level of material, amount of information, and length of time helps their attention. The stillness of reading is difficult for some of the students but calming for others, and they appear to know this, and to know when reading will be difficult and when it will be calming. This idea is contrary to what has been written in the literature about struggling readers. (Zambo, 2003, p. 68)

10. *Anticipate that you will almost certainly have to write multiple drafts.* All too often, we have had students submit research proposals, theses, or dissertations with the assumption that they have completed what they set out to do. Such students have invariably been disappointed (sometimes even outraged) when we've asked them to revise their work, usually several times over. The necessity to write multiple drafts applies not only to novice researchers but to experienced scholars as well. For instance, we would hate to count the number of times this book has undergone revision—certainly far more often than the label "ninth edition" indicates! Multiple revisions enable you to reflect on and critically evaluate your own writing, revise and clarify awkward passages, get feedback from peers and advisors who can point out where the manuscript lacks clarity, and spend more time ensuring that the final draft is as clear and precise as possible.

Fortunately, computer technology makes the revision process infinitely easier than it was in the days of manual typewriters. In the next section, we often some guidance for the novice word processor.

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GUIDELINES Using a Word Processor

USING TECHNOLOGY

One of the most common uses of the computer today is word processing. A **word processor** is a computer program for writing text. By supporting the entering, formatting, editing, saving, and printing of text, a word processor can greatly enhance a researcher's personal productivity. Powerful word processing programs are now available that allow users to accomplish tasks that previously only professional typesetters could complete.

Most word processing programs include the following features:

- *Editing features.* Common editing features allow you to enter information quickly, change wording, and delete unwanted letters, words, and paragraphs. As you examine what you have written, it is easy to move sections of text from one location to another. Editing features give the researcher more freedom to write, critically examine what has been written, and make modifications as necessary.

- *Formatting features.* Common formatting features provide control over how the words appear on the page. If special emphasis is needed, a word can be highlighted by changing the type size or by underlining, *italicizing*, or using **boldface**. Text can be arranged in columns with various types of margins and alignments. Tables can be set up easily with borders and shading to highlight information. Many word processing programs also let the writer insert graphics quickly and easily into a body of text.

- *Special editing features.* Several special features have proved invaluable to writers using word processors. These include an *outliner* to facilitate the initial planning and organization of the major sections of a writing project; a *spell checker* to call attention to and make suggestions for suspiciously spelled words; a *thesaurus* to help the writer identify alternative words and phrases; a *grammar checker* to detect potential problems in how words have been put together; and a *track changes* feature that enables collaborating researchers to identify changes that the others make to a paper they are coauthoring.

- *Search and replace features.* These features enable you to scan an entire document very quickly for certain contents—perhaps a particular word, phrase, date, or punctuation mark—and, if so desired, replace it with something else. For example, imagine that you want to replace the term *autism* with the broader term *autism spectrum disorder*. A *search-and-replace* command enables you to make the switch for the entire document automatically or, if you prefer, to look at your uses of *autism* on a case–by–case basis. Or imagine, instead, that you learn that you have misunderstood when semicolons are appropriately used. You can search a document for all of its semicolons and, as necessary, change them to more appropriate forms of punctuation.

You will find that word processing software is an invaluable tool throughout the research process; in fact, we ourselves don't know how we lived without it for as long as we did. For example, as the *study is being planned*, word processing software can be used for brainstorming and organizing ideas. As *literature is being reviewed*, the software provides an efficient means of keeping track of bibliographic information, along with the ideas, theories, and research results found in various books, journal articles, and other resources. As the *study is being implemented*, the software can be used to generate various types of data collection instruments and to transcribe people's responses to such instruments as interviews and questionnaires. As the *data are being analyzed*, tables and graphics can be developed to help categorize and summarize patterns in the data. Finally, as the *final report is being completed*, it can be written in the proper form for review and potential publication.

We offer three general recommendations for using a word processor effectively:

1. *Save your document frequently.* This seems like such an obvious point that we almost left it on the editing room floor, but then we remembered all the personal horror stories we have heard (and in some cases experienced ourselves) about losing data, research materials, and other valuable

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information. Every computer user eventually encounters some type of glitch that causes problems in the retrieval of information. Whether the electricity goes out before you can save a file, a misguided keystroke leads to a system error, or your personal computer inexplicably crashes, data sometimes get lost. It is imperative that you get in the habit of saving your work. Save multiple copies so that if something goes awry in one place, you will always have a backup in a safe location. Here are a few things to think about:

- Save at least two copies of important files, and save them in different places—perhaps one file at home and another at the office, at a friend's house, or in a safe deposit box.
- Save your work-in-progress frequently, perhaps every 10 minutes or so.
- Save various versions of your work with titles that help identify each version—for instance, by including the date on which you completed each file.
- If something horrible does happen, some software programs (e.g., Norton Utilities) may be able to fix the damage and retrieve some or possibly all of the lost material.

2. *Use such features as the spell checker and grammar checker to look for errors, but don't rely on them exclusively.* As we noted earlier in the chapter, although computers are marvelous machines, their "thinking" capabilities have not yet begun to approach those of the human mind. For instance, although a computer can detect spelling errors, it does so by comparing each word against a "dictionary" of correctly spelled words. Not every word in the English language will be included in the dictionary; for instance, proper nouns (e.g., such surnames as Leedy and Ormrod) will *not* be. Furthermore, it may assume that *abut* is spelled correctly when the word you really had in mind was *about*, and it may very well not know that *there* should actually be *their*.

3. *Print out a paper copy for final editing and proofreading.* One of us once had a student who turned in a dissertation draft that was so full of spelling and grammatical errors, it was a very poor reflection on the student indeed—and this from a student who was, ironically, teaching a college-level English composition course at the time. A critical and chastising e-mail message to the student made her irate; she had checked her document quite thoroughly before submitting it, she replied, and was convinced that it was virtually error-free. When her paper draft was returned to her almost bloodshot with spelling and grammatical corrections, she was quite contrite. "I don't know how I missed them all!" she said. When asked if she had ever edited a printed copy of the draft, she replied that she had not, figuring that she could read her work just as easily on the computer monitor and thereby save a tree or two. But in our own experience, it's *always* a good idea to read a printed version of what you have written. For some reason, on a paper copy we can often catch errors that we have overlooked when they stared us in the face on the computer screen.

PRACTICAL APPLICATION Identifying Important Tools in Your Discipline

In this chapter we have discussed several key tools used by researchers as they go about their work. These tools can be effective and helpful only to the extent that they are used—and used correctly.

Some of the tools may be somewhat new to you. How will you learn when, how, and why you should use them? One effective means of learning about research tools is to work closely with an expert researcher in your field. Watch and observe this person in action as he or she uses one or more of these research tools.

Take the time to find a person who has completed a few research projects—perhaps someone who teaches a research methods class, someone who has published in several journals, someone who has received several research grants, or even someone who has recently finished a dissertation. Ask this individual the questions listed in the following checklist and, if possible, observe the person as he or she goes about research work. If you cannot locate anyone locally, it may be possible to contact one or more persons through e-mail (see the discussion of e-mail earlier in this chapter).

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Practical Research: Planning and Design, Ninth Edition, by Paul D. Leedy and Jeanne Ellis Ormrod. Published by Merrill.

✔ CHECKLIST
Interviewing an Expert Researcher

_____ 1. How do you start a research project?

____

____

_____ 2. What specific tools do you use (e.g., library resources, computer software, forms of measurement, statistics)?

____

____

_____ 3. How did you gain your expertise with the various tools you use?

____

____

_____ 4. What are some important experiences you suggest for a novice researcher?

____

____

_____ 5. If I wanted to learn how to become a competent researcher, what specific tools would you suggest I work with?

____

____

Reflections on Significant Research

The time: February 13, 1929. The place: St. Mary's Hospital, London. The occasion: the reading of a paper before the Medical Research Club. The speaker: a member of the hospital staff in the Department of Microbiology. Such was the setting for the presentation of one of the most significant research reports of the early 20th century. The report was about a discovery that has transformed the practice of medicine. Dr. Alexander Fleming presented to his colleagues his research on penicillin. The group was apathetic. No one showed any enthusiasm for Fleming's paper. Great research has frequently been presented to those who are imaginatively both blind and deaf.

Fleming, however, knew the value of what he had done. The first public announcement of the discovery of penicillin appeared in the *British Journal of Experimental Pathology* in 1929. It is a readable report—one that André Maurois (1959) called "a triumph of clarity, sobriety, and precision." Get it; read it. You will be reliving one of the great moments in 20th-century medical research.

Soon after Fleming's paper, two other names became associated with the development of penicillin: Ernst B. Chain and Howard W. Florey (Chain et al., 1940; also see Abraham et al., 1941). Together, they developed a pure strain of penicillin. Florey was particularly instrumental in initiating its mass production and its use as an antibiotic for wounded soldiers in World War II (Coghill, 1944; also see Coghill & Koch, 1945). Reading these reports takes you back to the days when the medical urgency of dying people called for a massive research effort to make a newly discovered antibiotic available for immediate use.

October 25, 1945: The Nobel Prize in medicine was awarded to Fleming, Chain, and Florey.

If you wish to know more about the discovery of penicillin, read André Maurois's *The Life of Sir Alexander Fleming* (1959), the definitive biography done at the behest of Fleming's widow. The document will give you an insight into the way great research comes into being.

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The procedures of great research are identical to those every student follows in doing a dissertation, a thesis, or a research report. All research begins with a problem, an observation, a question. Curiosity is the germinal seed. Hypotheses are formulated. Data are gathered. Conclusions are reached. What *you* are doing in research methodology is the same as what has been done by those who have pushed back the barriers of ignorance and made discoveries that have greatly benefited humankind.

For Further Reading

The Library as a Research Tool

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The Computer and Internet as Research Tools

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Effective Writing and Word Processing

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Chicago manual of style (15th ed.) (2003). Chicago: University of Chicago Press.

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Williams, J. M. (2006). *Style: Ten lessons in clarity and grace* (9th ed.). Reading, MA: Addison-Wesley Longman.

Now go to MyEducationalResearchLab at www.myeducationlab.com to take a quiz to evaluate your mastery of chapter concepts. Review, Practice, and Enrichment exercises are also available to help you master the chapter. Feedback for these exercises is provided so that you can see why your answers are correct or incorrect.

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3

The Problem: The Heart of the Research Process

The problem or question is the axis around which the whole research effort revolves. The statement of the problem must first be expressed with the utmost precision; it should then be divided into more manageable subproblems. Such an approach clarifies the goals and directions of the entire research effort.

To identify and define important terms included in this chapter, go to the Activities and Applications section in Chapter 3 of MyEducationalResearchLab, located at www.myeducationlab.com. Complete Activity 1: Defining Key Terms.

The heart of every research project is the problem. It is paramount to the success of the research effort. To see the problem with unwavering clarity and to state it in precise and unmistakable terms is the first requirement in the research process.

Finding Research Projects

Problems in need of research are everywhere. To get an idea of typical research projects for doctoral dissertations, go to the reference room at your university library, open any volume of *Dissertation Abstracts International*—most university libraries also have these abstracts in an online database—and look at the dissertation abstracts in your academic discipline. To get an online sample of recent published research studies in your area of interest, go to Google Scholar at www.scholar.google.com; type a topic in the search box and then click on some of the titles that pique your curiosity.

Some research projects are intended to enhance basic knowledge about the physical, biological, psychological, or social world or to shed light on historical, cultural, or aesthetic phenomena. For example, a psychologist might study the nature of people's cognitive processes, and an ornithologist might study the mating habits of a particular species of birds. Such projects, which can advance human beings' theoretical conceptualizations about a particular topic, are known as **basic research**.

Other research projects are intended to address issues that have immediate relevance to current practices, procedures, and policies. For example, a nursing educator might compare the effectiveness of different strategies for training future nurses, and an agronomist might study the effects of various fertilizers on the growth of sunflowers. Such projects, which can inform human decision making about practical problems, are known as **applied research**. Occasionally applied research involves addressing questions in one's immediate work environment, with the goal of solving an ongoing problem in that environment; such research is known as *action research* (e.g., Cochran-Smith & Lytle, 1993; Mills, 2007).

Keep in mind, however, that the line between basic research and applied research is, at best, a blurry one. Answering questions about basic theoretical issues can often inform current practice in the everyday world; for example, by studying the mating habits of a particular species of birds, an ornithologist might lead the way in saving that species from extinction. Similarly, answering questions about practical problems may enhance theoretical understandings of particular phenomena; for example, the nursing educator who finds that one approach to training

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nurses is more effective than another may enhance psychologists' understanding of how, in general, people learn new skills.

Regardless of whether you conduct basic or applied research, a research project is likely to take a significant amount of your time and energy, so whatever problem you study should be *worth* that time and energy. As you begin the process of identifying a suitable research problem to tackle, keep two criteria in mind. First, your problem should address an important question, such that the answer can actually "make a difference" in some way. And second, it should advance the frontiers of knowledge, perhaps by leading to new ways of thinking, suggesting possible applications, or paving the way for further research in the field. To accomplish both of these ends, your research project must involve not only the collection of data but also the *interpretation* of those data.

Some problems are not suitable for research because they lack the "interpretation of data" requirement; they do not elicit a mental struggle on the part of the researcher to force the data to reveal their meaning. Following are four situations to avoid when considering a problem for research purposes:

1. *Research projects should not be a ruse for achieving self-enlightenment.* All of us have large holes in our education, and filling them is perhaps the greatest joy of learning. But self-enlightenment is not the purpose of research. Gathering information to know more about a certain area of knowledge is entirely different from looking at a body of data to discern how it contributes to the solution of the problem.

A student once submitted the following as the statement of a research problem:

> The problem of this research is to learn more about the way in which the Panama Canal was built.

For this student, the information-finding effort would provide the satisfaction of having gained more knowledge about a particular topic, but it would *not* have led to *new* knowledge.

2. *A problem whose sole purpose is to compare two sets of data is not a suitable research problem.* Take this proposed problem for research:

> This research project will compare the increase in the number of women employed over 100 years—from 1870 to 1970—with the employment of men over the same time span.

A simple table completes the project (*Historical Statistics, 1975*).

	1870	***1970***
Women employed	13,970,000	72,744,000
Men employed	12,506,000	85,903,000

The "research" project involves nothing more than a quick trip to the library to reveal what is already known.

3. *Calculating a correlation coefficient between two sets of data to show a relationship between them is not acceptable as a problem for research.* Why? Because the basic requirement for research is ignored: a human mind struggling with data. What we see here is a proposal to perform a statistical operation that a computer can do infinitely faster and more accurately than a person can. A correlation coefficient is nothing more than a statistic that expresses how closely two characteristics or other variables are associated with each other. It tells us nothing about *why* the association exists.

Some novice researchers think that their work is done when they collect data and, by using a simple statistical procedure, find that two variables are closely related. In fact, their work is *not* done at this point; it has only begun. For example, many researchers have found a correlation between the IQ scores of children and those of their parents. In and of itself, this fact has very little usefulness. It does, however, suggest a problem for research: What is the *cause* of the relationship between children's and parents' intelligence test scores? Is it genetic? Is it environmental? Is it a combination of both genetics and environment?

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4. *Problems that result in a yes or no answer are not suitable problems for research.* Why? For the same reason that merely finding a correlation coefficient is unsatisfactory. Both situations simply skim the surface of the phenomenon under investigation, without exploring the mechanisms underlying it.

"Is homework beneficial to children?" That is no problem for research, certainly not in the form in which it is stated. The researchable issue is not whether homework is beneficial, but wherein the benefit of homework, if there is one, lies. Which components of homework are beneficial? Which ones are counterproductive? If we knew the answers to these questions, then teachers could structure homework assignments with more purpose and greater intelligence—and thereby promote the learning of children—more effectively than they do now.

There is so much to learn and so many important questions being generated each day that we should look for significant problems and not dwell on those that will make little, if any, contribution. Peter Medawar (1979), a Nobel laureate who investigated causes of the human body's rejection of organs and tissues transplanted from other human beings, gave wise advice to the young scientist when asked about conducting research:

> It can be said with complete confidence that any scientist of any age who wants to make important discoveries must study important problems. Dull or piffling problems yield dull or piffling answers. It is not enough that a problem should be "interesting"—almost any problem is interesting if it is studied in sufficient depth. (p. 13)

Good research, then, begins with identifying a good question to ask—ideally a question that no one has ever thought to ask before. In our minds, researchers who contribute the most to our understanding of the physical, biological, psychological, and social worlds are those who pose questions that lead us into entirely new lines of inquiry. To illustrate, let's return to that correlation between the IQ scores of children and those of their parents. For many years, psychologists bickered about the relative influences of heredity and environment on intelligence and other human characteristics. They now know not only that heredity and environment *both* influence virtually every aspect of human functioning but also that they *influence each other's influences* (for a good, down-to-earth discussion of this point, see Lippa, 2002). Rather than ask the question "How much do heredity and environment each influence human behavior?" a more fruitful question—one that's fairly new on the scene—is "How do heredity and environment interact in their influences on behavior?"

PRACTICAL APPLICATION Identifying and Describing the Research Problem

How can the beginning researcher formulate an important and useful research problem? Here we offer guidelines both for identifying a particular problem and for describing it in precise terms.

GUIDELINES Finding a Legitimate Problem

As a general rule, appropriate research projects don't fall out of trees and hit you on the head. You must be sufficiently knowledgeable about your topic of interest to know what projects might make important contributions to the field. Following are several strategies that are often helpful for novice and expert researchers alike.

1. *Look around you.* In many disciplines, questions that need answers—phenomena that need explanation—are everywhere. For example, let's look back to the early 17th century, when Galileo was trying to make sense of a variety of earthly and celestial phenomena. For example, why did large bodies of water (but not small ones) rise and fall in the form of tides twice a day? Why did sunspots consistently move across the sun's surface from right to left, gradually disappear, and then, about 2 weeks later, reappear on the right edge? Furthermore, why did sunspots usually move in an upward or downward path as they traversed the sun's surface, while only

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occasionally moving in a direct, horizontal fashion? Galileo correctly deduced that the various "paths" of sunspots could be explained by the facts that both the earth and sun were spinning on tilted axes and that (contrary to popular opinion at the time) the earth revolved around the sun rather than vice versa. Galileo was less successful in explaining tides, attributing them to the natural "sloshing" that would take place as the earth moved through space rather than to the moon's gravitational pull (Sobel, 2000).

We do not mean to suggest that novice researchers should take on such monumental questions as the nature of the solar system or oceanic tides. But smaller problems suitable for research exist everywhere. Perhaps you might see them in your professional practice or in everyday events. Continually ask yourself questions about what you see and hear: Why does such-and-such happen? What makes such-and-such tick? and so on.

2. *Read the literature.* One essential strategy is to find out what things are already known about your topic of interest; little can be gained by reinventing the wheel. In addition to telling you what is already known, the existing literature is likely to tell you what is *not* known in the area—in other words, what still needs to be done. For instance, your research project might

- Address the suggestions for future research that another researcher has identified
- Replicate a research project in a different setting or with a different population
- Consider how various subpopulations might behave differently in the same situation
- Apply an existing perspective or theory to a new situation
- Explore unexpected or contradictory findings in previous studies
- Challenge research findings that seem to contradict what you know or believe to be true (Neuman, 1994)

Reading the literature has other advantages as well. It gives you a theoretical base on which to generate hypotheses and build a rationale for your study. It provides potential research methodologies and methods of measurement. And it can help you interpret your results and relate them to what is already known in the field. (We address strategies for finding and reviewing related literature in Chapter 4.)

3. *Attend professional conferences.* Many researchers have great success finding new research projects at national or regional conferences in their discipline. By scanning the conference program and attending sessions of interest, they can learn "what's hot and what's not" in their field. Furthermore, conferences are a place where novice researchers can make contacts with experts in their field—where they can ask questions, share ideas, and exchange e-mail addresses with more experienced and knowledgeable individuals.

Some beginning researchers, including many students, are reluctant to approach well-known scholars at conferences, for fear that these scholars don't have the time or patience to talk with novices. Quite the opposite is true: Most experienced researchers are happy to talk with people who are just starting out. In fact, they may feel flattered that you are familiar with their work and that you would like to extend or apply it in some way.

4. *Seek the advice of experts.* Another simple yet highly effective strategy for identifying a research problem is simply to ask an expert: What needs to be done? What burning questions are still out there? What previous research findings seemingly don't make sense? Your professors will almost certainly be able to answer each of these questions, as will other scholars you may meet at conferences or elsewhere.

5. *Choose a topic that intrigues and motivates you.* As you read the professional literature, attend conferences, and talk with experts, you will uncover a number of potential research problems. At this point, you need to pick just *one* of them, and your selection should be based on what you personally want to learn more about. Remember, the project you're about to undertake will take you many months, quite possibly a couple of years or even longer. So it should be something that you believe is worth your time and effort—even better, one you are truly passionate about. Peter Leavenworth, at the time a doctoral student in history, explained the importance of choosing an interesting dissertation topic this way: "You're going to be married to it, so you might as well enjoy it."

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6. *Choose a topic that others will find interesting and worthy of attention.* Ideally, your work should not end with a thesis, dissertation, or other unpublished research report. If your research adds an important piece to what human beings know and understand about the world, then you will, we hope, want to share your findings with a larger audience. In other words, you will want to describe what you have done at a regional or national conference, publish an article in a professional journal, or both (we'll talk more about doing such things in Chapter 12). Conference coordinators and journal editors are often quite selective about the papers they accept for presentation or publication, and they are most likely to choose those papers that will have broad appeal.

Future employers, too, may make judgments about you, at least in part, based on the topic you have chosen for a thesis or dissertation. Your résumé or curriculum vitae will be more apt to attract their attention if, in your research, you are pursuing an issue of broad scientific or social concern or, more generally, a hot topic in your field.

GUIDELINES Stating the Research Problem

As noted earlier, the heart of any research project is the problem. At every step in the process, successful researchers ask themselves: What am I doing? For what purpose am I doing it? Such questions can help focus your efforts toward achieving your ultimate purpose for gathering data: to resolve the problem.

Researchers get off to a strong start when they begin with an unmistakably clear statement of the problem. After identifying a research problem, therefore, you must articulate it in such a way that *it is carefully phrased and represents the single goal of the total research effort.* Following are some general guidelines to help you do just that:

1. *State the problem clearly and completely.* Your problem should be so clearly stated that anyone who reads English can read and understand it. If the problem is not stated with such clarity, then you are merely deceiving yourself that you know what the problem is. Such self-deception will cause you difficulty later on.

You can state your problem clearly only when you also state it completely. At a minimum, you should describe it in one or more *grammatically complete sentences*. As examples of what *not* to do, following are some meaningless half-statements—verbal fragments that only hint at the problem. Ask yourself whether you understand exactly what each student researcher plans to do.

From a student in sociology:

Welfare on children's attitudes.

From a student in music:

Palestrina and the motet.

From a student in economics:

Busing of schoolchildren.

From a student in social work:

Retirement plans of adults.

Unfortunately, all four statements lack clarity. It is imperative to think in terms of specific, researchable goals expressed in complete sentences. We take the preceding fragments and develop each of them into one or more complete sentences that describe a researchable problem.

Welfare on children's attitudes becomes:

What effect does welfare assistance to parents have on the attitudes of their children toward work?

Palestrina and the motet becomes:

This study will analyze the motets of Giovanni Pierluigi da Palestrina (1525?–1594) written between 1575 and 1580 to discover their distinctive contrapuntal

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> characteristics and will contrast them with the motets of his contemporary William Byrd (1542?–1623) written between 1592 and 1597. During the periods studied, each composer was between 50 and 55 years of age.

Busing of schoolchildren becomes:

> What factors must be evaluated and what are the relative weights of those several factors in constructing a formula for estimating the cost of busing children in a midwestern metropolitan school system?

Retirement plans for adults becomes:

> How do retirement plans for adults compare with the actual realization, in retirement, of those plans in terms of self-satisfaction and self-adjustment? What does an analysis of the difference between anticipation and realization reveal for a more intelligent approach to planning?

Notice that, in the full statement of each of these problems, the areas studied are carefully limited so that the study is of manageable size. The author of the Palestrina–Byrd study carefully limited the motets that would be studied to those written when each composer was between 50 and 55 years of age. A glance at the listing of Palestrina's works in *Grove's Dictionary of Music and Musicians* demonstrates how impractical it would be for a student to undertake a study of all the Palestrina motets. He wrote 392 of them!

2. *Think through the feasibility of the project that the problem implies.* Students sometimes rush into a problem without thinking through its implications. It's great to have ideas. It's much better to have practical ideas. Before your enthusiasm overtakes you, consider the following research proposal submitted by John:

> This study proposes to study the science programs in the secondary schools in the United States for the purpose of . . .

Let's think about that. The United States has more than 24,000 public and private secondary schools. These schools, north to south, extend from Alaska to the tip of Florida; east to west, from Maine to Hawaii. Certain practical questions immediately surface. How does John intend to contact each of these schools? By personal visit? Being very optimistic, he might be able to visit two schools per day—one in the morning and one in the afternoon. That would amount to more than 12,000 visitation days. The number of school days in the average school year is 180, so it would take more than 66 years for John to gather the data. Furthermore, the financial outlay for the project would be exorbitant; if we conservatively estimated $125 for daily meals, lodging, and travel, John would be spending $1.5 million just to collect the data!

"But," John explains, "I plan to gather the data by mail with a questionnaire." Fine! Each letter to the 24,000 schools, with an enclosed questionnaire and a return postage-paid envelope, would probably cost at least a dollar just for the postage. Thus, the total postage cost for letters to all the schools would be at least $24,000. And we mustn't overlook the fact that John would need a second and perhaps a third mailing. A 50% return on the first mailing would be considered a good return. But, for the nonreturnees, a follow-up mailing would be needed, at a cost of another $12,000. That would bring the mailing bill to approximately $36,000. And we haven't even figured in the cost of envelopes, stationery, photocopying, and data analysis. All in all, we are talking about a project that would cost well over $40,000.

Obviously, John did not intend to send surveys to every school in the United States, yet that is what he wrote that he would do.

3. *Say precisely what you mean.* When you state your research problem, you should say exactly what you mean. You cannot assume that others will be able to read your mind. People will always take your words at their face value: You mean what you say. That's it.

Your failure to be careful with your words can have grave results for your status as a scholar and a researcher. In the academic community, a basic rule prevails: *Absolute honesty and integrity are assumed in every statement a scholar makes.*

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Look again at John's problem statement. We could assume that John means to fulfill precisely what he has stated (although we would doubt it, given the time and expense involved). Had he intended to survey only *some* schools, then he should have said so plainly:

> This study proposes to survey the science programs *in selected secondary schools throughout the United States*.

Or, perhaps he could have limited his study to a specific geographical area or to schools serving certain kinds of students. Such an approach would give the problem constraints that the original statement lacked and would communicate to others what John intended to do—what he realistically *could* commit to doing. Furthermore, it would have preserved his reputation as a researcher of integrity and precision.

Ultimately, an imprecisely stated research problem can lead others to have reservations about the quality of the overall research project. If a researcher cannot be meticulous and precise in stating the nature of the problem, others might question whether such a researcher is likely to be any more meticulous and precise in gathering and interpreting the data. Such uncertainty and misgivings are very serious indeed, for they reflect on the basic integrity of the whole research effort.

We have discussed some common difficulties in the statement of the problem, including statements that are unclear or incomplete and statements that suggest impractical or impossible projects. Here's another difficulty: Occasionally, a researcher *talks about the problem* but never actually *states what the problem is*. Under the excuse that the problem needs an introduction or needs to be seen against a background, the researcher launches into a generalized discussion, continually obscuring the problem, never clearly articulating it. Take, for example, the following paragraph that appeared under the heading "Statement of the Problem":

> The upsurge of interest in reading and learning disabilities found among both children and adults has focused the attention of educators, psychologists, and linguists on the language syndrome. In order to understand how language is learned, it is necessary to understand what language is. Language acquisition is a normal developmental aspect of every individual, but it has not been studied in sufficient depth. To provide us with the necessary background information to understand the anomaly of language deficiency implies a knowledge of the developmental process of language as these relate to the individual from infancy to maturity. Grammar, also an aspect of language learning, is acquired through pragmatic language usage. Phonology, syntax, and semantics are all intimately involved in the study of any language disability.

Can you find a statement of problem here? Several problems are suggested, but none is articulated with sufficient clarity that we might put a finger on it and say, "There, that is the problem."

Earlier in this chapter, we invited you to go to *Dissertation Abstracts International* to see how the world of research and the real world of everyday living are intertwined. Now return to those abstracts and notice with what directness the problems are set forth. The problem should be stated in the very first words of an abstract: "The purpose of this study is to. . ." No mistaking it, no background buildup necessary—just a straightforward plunge into the business at hand. All research problems should be stated with the same clarity.

4. *State the problem in a way that reflects an open mind about its solution.* In our own research methods classes, we have occasionally seen research proposals in which the authors state that they intend to *prove* that such-and-such a fact is true. For example, a student once proposed the following research project:

> In this study, I will prove that obese adults experience greater psychological distress than adults with a healthy body mass index.

This is not a research question; it is a presumed—and quite presumptuous!—*answer* to a research question. If this student already knew the answer to her question, why was she proposing to

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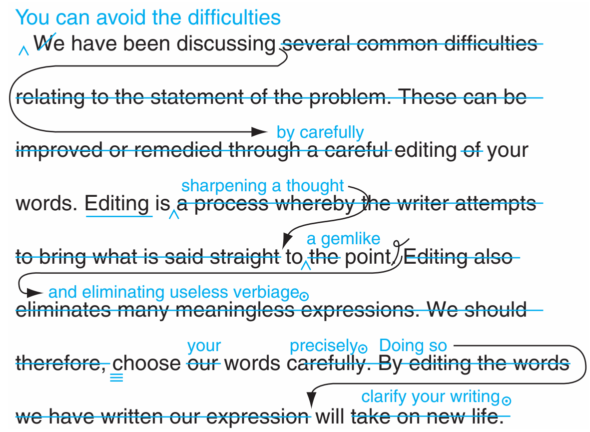
FIGURE 3.1

Editing to clarify your writing: An example



study it? Furthermore, as we noted in Chapter 1, it is quite difficult to prove something definitively, beyond the shadow of a doubt. We can certainly obtain data consistent with what we believe to be true, but in the world of research we can rarely say with one hundred percent certainty that it is true.

Good researchers try to keep open minds about what they might find. Perhaps they will find the result they hope to find, perhaps not. Any hypothesis should be stated as exactly that—a *hypothesis*—rather than as a foregone conclusion. As we will see shortly, hypotheses certainly do have their place in a research proposal. However, they should not be part of the problem statement.

Let's rewrite the preceding research problem, this time omitting any expectation of results that the research effort might yield:

> In this study, I will investigate the possible relationship between body mass index and psychological stress, as well as more specific psychological factors (e.g., depression, anxiety) that might underlie such a relationship.

Such a statement clearly communicates that the researcher is open-minded about what she may or may not find.

5. *Edit your work.* You can avoid the difficulties we have been discussing by carefully editing your words. *Editing* is sharpening a thought to a gemlike point and eliminating useless verbiage. Choose your words precisely. Doing so will clarify your writing.

The sentences in the preceding paragraph began as a mishmash of foggy thought and jumbled verbiage. The original version of the paragraph contained 71 words. These were edited down to 37 words. This is a reduction of about 50% and a great improvement in readability. Figure 3.1 shows the original version and the way it was edited. The three lines under the *c* in *choose* means that the first letter should be capitalized. When we discuss editing in more detail in Chapter 6, we'll present some of the common editing marks and what they mean.

Notice the directness of the edited copy. We eliminated unnecessarily wordy phrases—"relating to the statement of the problem," "a process whereby the writer attempts to bring what is said straight to the point"—replacing the verbosity with seven words: "sharpening a thought to a gemlike point."

Editing almost invariably improves your thinking and your prose. Many students think that any words that approximate a thought are adequate to convey it to others. This is not so. Approximation is never precision.

The thought's the thing. It is clearest when it is clothed in simple words, concrete nouns, and active, expressive verbs. Every student would do well to study how the great writers and poets set their thoughts into words. These masters have much to say by way of illustration to those who have trouble putting their own thoughts on paper.

The following checklist can help you formulate a research problem that is clear, precise, and accurate.

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✔ **CHECKLIST**

Evaluating the Research Problem

____ 1. Write a clear statement of a problem for research.

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____ 2. Review your written statement and ask yourself the following questions:

- Is the problem stated in a complete, grammatical sentence?
- Is it clear how the area of study will be limited or focused?
- Is it clear that you have an open mind about results that the research effort might yield?

____ 3. On the basis of your answers to the questions in item 2, edit your written statement.

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____ 4. Look at your edited statement and reflect on the following questions:

- Does the answer to this problem have the potential for providing important and useful answers and information?
- Will the result be more than a simple exercise in gathering information, answering a yes/no question, or making a simple comparison?
- Is the problem focused enough to be accomplished with a reasonable expenditure of time, money, and effort?

____ 5. Looking at the statement once more, consider this: Is the problem really what you want to investigate?

____ 6. Show other research students your work. Ask them to consider the questions listed in items 2 and 4 and then to give you their comments. With your compiled feedback, edit and rewrite your problem statement once again:

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Dividing the Research Problem Into Subproblems

Most research problems are too large or too complex to be solved without subdividing them. The strategy, therefore, is to divide and conquer. Almost every problem can be broken down into smaller units. From a research standpoint, these units are easier to address and resolve.

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The subparts of the main problem are called **subproblems**, discussed briefly in the first chapter. By viewing the main problem through its subproblems, the researcher frequently gets a better idea of how to approach the entire research endeavor. So always think of a problem in terms of its component parts.

Subproblems Versus Pseudo-Subproblems

The researcher must distinguish subproblems that are an integral part of the main problem from things that look like problems but are nothing more than procedural issues. The latter, which we might call *pseudo-subproblems*, involve decisions the researcher must make before he or she can resolve the research problem and its subproblems. Consider the following as examples:

- What is the best way to choose a sample?
- How large should a representative sample of a population be?
- What instruments or methods should be used to gather the data?
- What statistical procedures should be used to analyze the data?

Deal with pseudo-subproblems forthrightly by making a firm decision about them and then get on with the solution of the research problem. To deal with pseudo-subproblems, you must decide whether (a) a little common sense and some creative thinking might help in solving your "problem" or (b) you simply lack the knowledge to address the difficulty. In the latter case, you have three options:

1. Turn to the index of this text to see whether the pseudo-subproblem is discussed.
2. Carefully peruse the "For Further Reading" sections at the end of each chapter in this book to see whether they contain any references that might help you. Don't overlook general research methods books, such as *Educational Research* (Gay, Mills, & Airasian, 2009), *Research Methods for Social Work* (Rubin & Babbie, 2007), and *Research Methods in Psychology* (Shaughnessy, Zechmeister, & Zechmeister, 2008). Consult these or similar works.
3. Go to a library, preferably a college or university library, and search for books under the subject heading "Research Methodology." Consult the indexes of these books, as you did with this text. Also check the leading periodical indexes under the heading "Research Methodology" to determine whether you can locate any articles related to your procedural issue. If your library does not have certain periodicals, you can typically obtain any article you need through interlibrary loan.

Characteristics of Subproblems

Following are four key characteristics of subproblems:

1. *Each subproblem should be a completely researchable unit.* A subproblem should constitute a logical subarea of the larger research undertaking. Each subproblem might be researched as a separate subproject within the larger research goal. The solutions to the subproblems, taken together, combine to resolve the main problem.

It is essential that each subproblem be stated clearly and succinctly. Often, a subproblem is stated in the form of a question. A question tends to focus the researcher's attention more directly on the research target of the subproblem than does a declarative statement. As we've seen, a questioning, open-minded attitude is the mark of a true researcher.

2. *Each subproblem must be clearly tied to the interpretation of the data.* At some point in the statement of the subproblem—as within the main problem—it must be clearly evident that data will be interpreted as well as collected. This fact may be expressed as a part of each subproblem statement, or it may be reflected in a separate but related subproblem.

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3. *The subproblems must add up to the totality of the problem.* After you have stated the subproblems, check them against the statement of the main problem to see that (a) nothing in excess of the coverage of the main problem is included and that (b) all significant areas of the main problem are covered by the subproblems.

4. *Subproblems should be small in number.* If the main problem is carefully stated and properly limited to a feasible research effort, the researcher will find that it usually contains two to six subproblems. Sometimes, the inexperienced researcher will come up with as many as 10, 15, or 20 subproblems. When this happens, a careful review of the problem and its attendant subproblems is in order. If you find yourself in this situation, you should study the individual subproblems to see whether (a) some are actually procedural issues (pseudo-subproblems), (b) some might reasonably be combined into larger subproblems, or (c) the main problem is more complex than you originally believed. If the last of these is true, you may want to reconsider whether the solution to the overall research problem is actually achievable given the time and resources you have.

Identifying Subproblems

Novice researchers frequently have difficulty identifying the subproblems within the main problem. You should begin with the problem itself. If the problem is correctly written, you will be able to detect subproblem areas that can be isolated for further study. The old axiom that the sum of the parts equals the whole applies here. All of the subproblems must add up to the total problem.

You can use either paper and pencil or "brainstorming" software to help you identify your subproblems. We briefly describe each of these strategies.

Taking a Paper-and-Pencil Approach

Using this approach, you write the problem on a piece of paper and then box off the subproblem areas. More specifically, you might follow these steps:

1. Copy the problem onto a clean sheet of paper, leaving considerable space between the lines.
2. Read the problem critically to discover the areas that should receive in-depth treatment before the problem can be resolved.
3. Make sure every subproblem contains a word that indicates the necessity to interpret the data within that particular subproblem (e.g., *analyze*, *discover*, *compare*). Underline this word.
4. Arrange the entire problem, which will now have the subproblems boxed off, into a graphic that shows the research structure of the problem. You now have a structure of the whole research design.

This procedure for finding subproblems should work for any problem in any academic discipline. We use a problem in musicology to illustrate the technique. More specifically, we take the problem of the motets of Palestrina. As presented earlier in the chapter, this problem is as follows:

> This study will analyze the motets of Giovanni Pierluigi da Palestrina (1525?–1594) written between 1575 and 1580 to discover their distinctive contrapuntal characteristics and will contrast them with the motets of his contemporary William Byrd (1542?–1623) written between 1592 and 1597. During the periods studied, each composer was between 50 and 55 years of age.

Let's first delete the factual matter, such as life-span dates and the fact that the two men were contemporaries. These facts merely help in giving a rationale for certain elements within the problem. Modified to reflect its essential parts, the motet problem becomes the following:

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> The purpose of this study will be *to analyze* the motets of Palestrina written between 1575 and 1580 to discover their distinctive contrapuntal characteristics, *to analyze* the same characteristics in the motets of William Byrd written between 1592 and 1597, and to determine what *a comparison of these two analyses* may reveal.

Notice that we have broken up the "will contrast them with" phrase in the original statement into two distinct tasks, *analyzing* Byrd's motets in the same manner that Palestrina's motets have been analyzed, and *comparing* the two analyses. The three italicized phrases in the revised problem statement reflect three subproblems, each of which involves interpretation of data that is necessary for resolving the main research problem.

Let's now arrange the problem so that we may see precisely what the design will be. Figure 3.2 is a graphic depiction of the problem. We have divided the problem into three subproblems. The first and second of these have the same general structural configuration: The analytical aspect of the subproblem is stated in the upper box and the purpose of the analysis is stated in the lower box. Addressing the third subproblem involves comparing the analyses conducted for the two preceding subproblems to determine what similarities and differences may exist. The last of the three subproblems—the comparison step—resolves the original main problem: characterizing Palestrina's motets.

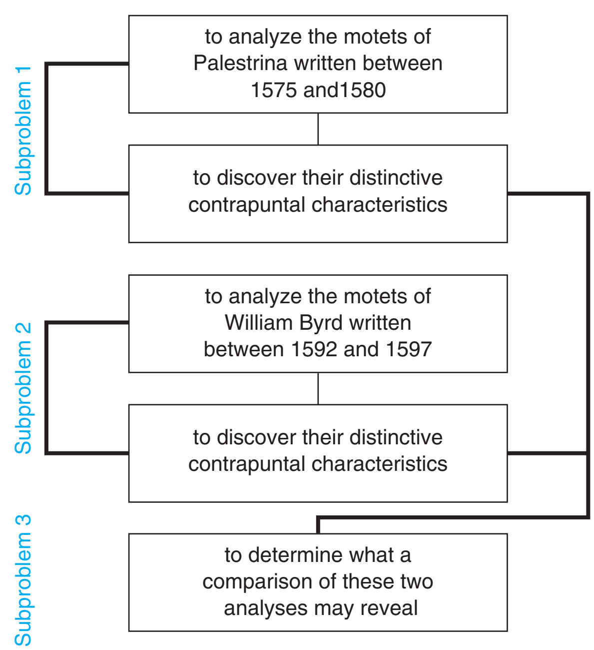
USING TECHNOLOGY

Using Brainstorming Software

Some computer software facilitates the process of breaking problems into subproblems. Computer programs such as Inspiration, BrainStorm, and MindJet allow you to brainstorm research ideas and construct graphic networks of interrelated concepts, terms, and principles. For example, in Inspiration, you put the main problem, idea, or concept inside a box or oval in the middle of your computer screen. As you brainstorm other, related ideas, you put those on the screen as well, and you draw (and perhaps label) arrows to represent how various ideas are interconnected. You can break each concept or problem into subparts, and break down each subpart even further. The process is fast and flexible, and you can save and print your final diagram (Figure 4.1, presented in Chapter 4, is an example). Some brainstorming software, such as Inspiration, also allows you to convert your diagram into an outline that lists major topics and various levels of subtopics.

FIGURE 3.2

A structural representation of the Palestrina–Byrd problem



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Every Problem Needs Further Delineation

Up to this point, we have been discussing only the problem and its subparts. The statement of the problem establishes the goal for the research effort. The subproblems suggest ways of approaching that goal in a manageable, systematic way. But a goal alone is not enough. To comprehend fully the meaning of the problem, we need other information as well. Both the researcher and those reading the research proposal should ultimately have a clear understanding of every detail of the process.

In every research endeavor, the researcher should eliminate any possibility of misunderstanding by

- *Stating the hypotheses and/or research questions:* Describing the specific hypotheses being tested or questions being asked.
- *Delimiting the research:* Fully disclosing what the researcher intends to do and, conversely, does not intend to do.
- *Defining the terms:* Giving the meanings of all terms in the statements of the problem and subproblems that have any possibility of being misunderstood.
- *Stating the assumptions:* Presenting a clear statement of all assumptions on which the research will rest.

Taken as a whole, these elements comprise *the setting of the problem*. We look at each of them in more detail in the following sections. We also include a section titled "Importance of the Study," as this topic is frequently discussed in dissertations and other research reports.

Stating the Hypotheses and/or Research Questions

For practice in identifying hypotheses, go to the Building Research Skills section in Chapter 3 of MyEducationalResearchLab, located at www.myeducationlab.com. Complete Activity 1: Identifying Hypotheses.

We previously discussed hypotheses in Chapter 1. There we pointed out that hypotheses are intelligent, tentative guesses about how the research problem may be resolved. *Research questions* are somewhat different in that, in and of themselves, they don't offer any speculative answers related to the research problem. Hypotheses are essential to experimental research (see Chapter 10), whereas research questions are more common in many forms of qualitative research (see Chapter 7). Both hypotheses and research questions provide guidance for the kinds of data the researcher should collect and suggest how the researcher should analyze and interpret those data. It is not unusual for a researcher to form hypotheses *and* ask questions related to a research problem.

Research hypotheses and questions may originate in the subproblems. Often a one-to-one correspondence exists between the subproblems and their corresponding hypotheses or questions, giving us as many hypotheses or questions as we have subproblems.

In essence, a hypothesis or research question is to a researcher what a point of triangulation is to a surveyor: It provides a position from which the researcher may initiate an exploration of the problem or subproblem and also acts as a checkpoint against which to test the findings that the data reveal. After collecting and analyzing data, the researcher must ultimately ask: How do the data answer my research questions? What do they say about my research hypotheses?

Certainly, the data from a research study can (and should) answer each research question, and they may support or not support each research hypothesis. But notice how we just said that the data may *support* or *not support* each research hypothesis; we intentionally did *not* say that the data would prove or disprove a hypothesis. As we've previously pointed out, hypotheses are nothing more than *tentative propositions set forth to assist in guiding the investigation of a problem or to provide possible explanations for the observations made*.

A researcher who deliberately sets out to prove a hypothesis does not have the objective, impartial open-mindedness so important for good research. The researcher might bias the procedure by looking only for those data that would support the hypothesis. Difficult as it may be at times, we must let the chips fall where they may. Hypotheses have nothing to do with proof.

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Rather, their acceptance or rejection depends on what the data—and the data alone—ultimately reveal. If you discover that your data do not support your research hypothesis, do not let such an outcome disturb you. It merely means that your educated guess about the outcome of the investigation was incorrect.

Distinguishing Null Hypotheses from Research Hypotheses

Because we can never really prove a hypothesis, we often set out to *dis*prove an opposite hypothesis. For instance, let's say that a team of social workers believes that one type of after-school program for teenagers (we'll call it Program A) is more effective than another program (we'll call it Program B) in terms of reducing high school dropout rates. The team's research hypothesis is:

> Teenagers enrolled in Program A will graduate from high school at a higher rate than teenagers enrolled in Program B.

Because the social workers cannot actually prove their hypothesis, they instead try to discredit an opposite hypothesis:

> There will be no difference in the high school graduation rates of teenagers enrolled in Program A and those enrolled in Program B.

If, in their research, the social workers find that there *is* a substantial difference in graduation rates between the two programs—and in particular, if the graduation rate is higher for youth in Program A—they can reject the "no differences" hypothesis and thus have, by default, supported their research hypothesis.

When we hypothesize that there will be *no* differences between groups, *no* consistent relationships between variables, or, more generally, *no* patterns in the data, we are forming a **null hypothesis**. Null hypotheses are used primarily during statistical analyses; we support a research hypothesis by showing, statistically, that its opposite—the null hypothesis—probably is *not* true. Accordingly, we will look at null hypotheses again in our discussion of statistics in Chapter 11.

For practice in writing research and null hypotheses, go to the Activities and Applications section in Chapter 3 of MyEducationalResearchLab, located at www.myeducationlab.com. Complete Activity 2: Writing Research Hypotheses.

Delimiting the Research

We need to know precisely what the researcher intends to do. We also need to know precisely what the researcher does *not* intend to do.

What the researcher intends to do is stated in the problem. What the researcher is not going to do is stated in the *delimitations*. The limits of the problem should be as carefully bounded for a research effort as a parcel of land is for a real estate transfer.

Research problems typically emerge from larger contexts and larger problem areas. The researcher can easily be beguiled by discovering interesting information that lies beyond the precincts of the problem under investigation. For instance, in the Palestrina–Byrd problem, it is possible that, because the two men were contemporaries, Byrd may have met Palestrina or at least come in contact with some of his motets. Such contact may have been a determinative influence on Byrd's compositions. But we are not concerned with *influences* on the motets of the two composers. We are interested only in the *characteristics* of the motets, including their musical style, musical individualism, and contrapuntal likenesses and differences. Study the contrapuntal characteristics—that is what a researcher of this problem will do. What the researcher will *not* do is become involved in any data extraneous to this goal—no matter how enticing or interesting such an exploratory safari may be.

Only a researcher who thinks carefully about the problem and its focal center can distinguish between what is relevant and what is not relevant to the problem. All irrelevancies to the problem must be firmly ruled out in the statement of delimitations. Figure 3.3 may make the matter of delimitations more understandable.

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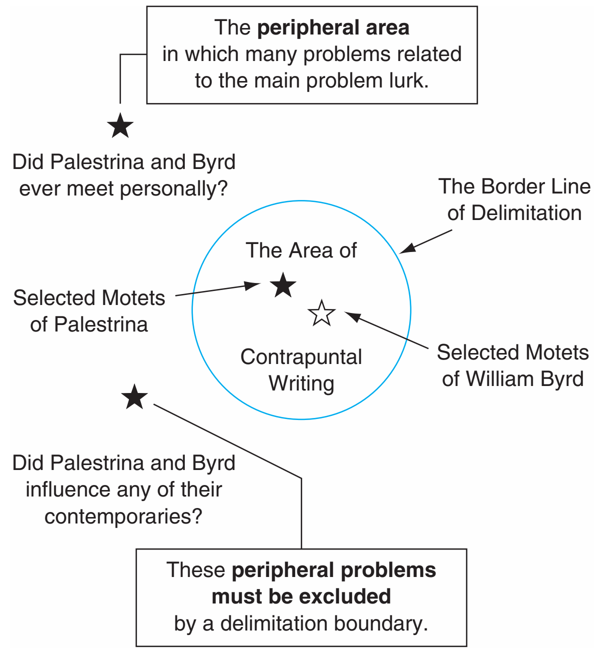
FIGURE 3.3
Delimitation of a problem



Defining the Terms

What precisely do the terms in the problem and the subproblems mean? For example, if we say that the purpose of the research is to analyze the harmonic characteristics of motets, what are we talking about? What are *harmonic characteristics*? Without knowing explicitly what a term means, we cannot evaluate the research or determine whether the researcher has carried out what was proposed in the problem statement.

Sometimes, novice researchers rely on dictionary definitions, which are rarely either adequate or helpful. Instead, each term should be defined *as it will be used in the researcher's project*. In defining a term, the researcher makes the term mean whatever he or she wishes it to mean within the context of the problem and its subproblems. We must know how the researcher defines the term. We won't necessarily agree with such a definition, but as long as we know what the researcher means when using the term, we are able to understand the research and appraise it appropriately.

A formal definition contains three parts: (a) the *term* to be defined; (b) the *genera*, or the general class to which the concept being defined belongs; and (c) the *differentia*, the specific characteristics or traits that distinguish the concept being defined from all other members of the general classification. For example, *harmonic characteristics* (the term to be defined) might be defined as *the manner* (the genera) in which tonal values are combined *to produce individualized polyphonic patterns associated with the works of a particular composer* (the differentia: telling what particular "manner" we mean).

The researcher must be careful to avoid *circular definitions*, in which the terms to be defined are used in the definitions themselves. For instance, if we were to define *harmonic characteristics* in a circular manner, we might describe them as "those characteristics that derive from the harmonic patterns found in the works of a particular composer." Here the words *characteristics* and *harmonic* are used to define harmonic characteristics, giving others little if any guidance in understanding what the researcher means by the term.

Especially when talking about *insubstantial* (rather than substantial) phenomena—phenomena that have no obvious basis in the physical world—it is often helpful to include an **operational definition**. That is, the researcher defines a characteristic or variable in terms of how it will be measured in the research study. For instance, a researcher might, for purposes of his or her study,

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define *intelligence* as a score on a certain intelligence test or define *popularity* as the number of peers who specifically identify an individual as being a desirable social partner.

Stating the Assumptions

We briefly discussed assumptions in Chapter 1. Assumptions are so basic that, without them, the research problem itself could not exist. For example, suppose we are attempting to determine, by means of a pretest and a posttest, whether one method of classroom instruction is superior to another. A basic assumption in such a situation is that the pretest and posttest measure knowledge of the subject matter in question.[1] We must assume, too, that the teacher(s) in the study can teach effectively and that the students are capable of learning the subject matter. Without these assumptions, our research project would be meaningless.

In research, we try to leave nothing to chance in order to prevent any misunderstandings. All assumptions that have a material bearing on the problem should be openly and unreservedly set forth. If others know the assumptions a researcher makes, they are better prepared to evaluate the conclusions that result from such assumptions.

To discover your own assumptions, ask yourself, What am I taking for granted with respect to the problem? Ideally, your answer should bring your assumptions into clear view.

Importance of the Study

In dissertations or research reports, researchers frequently set forth their reasons for undertaking the study. In a research proposal, such a discussion may be especially important. Some studies seem to go far beyond any relationship to the practical world. Of such research efforts one inwardly, if not audibly, asks, "Of what *use* is it? What *practical value* does the study have?"

In the 1970s, contemplating the exploration of the moon, the average citizen frequently asked, "What good is it? What's the use of it all? How will spending all of this money on space flights benefit anyone?" Perhaps those engaged in space research did not set forth clearly and succinctly enough the reasons the missions were undertaken. Only now are we beginning to appreciate the practical value of those early missions.

Ordering the Topics in a Research Proposal

You may often find a one-to-one correspondence between the discussions in this text and the sequence of topics that typically appear in a research proposal or research report. In any document, the first order of business is to present the problem and its setting. Generally, the document opens with a statement of the problem for research. This is followed by subproblems, hypotheses, and questions presented in a logical order.

Once the problem and its component parts have been articulated, the remaining items comprising the setting of the problem are presented, typically including a statement of delimitations, definitions of terms, and assumptions. A discussion of the importance of the study may have its own section or, alternatively, may be integrated into early paragraphs that introduce the research problem.

In a proposal or research report, such items often comprise the first chapter or section. The document then generally continues with a discussion of investigations that others have done, usually titled "Review of the Related Literature" or something of that nature. We discuss this topic in the next chapter.

[1] Alternatively, we might make no such assumption; instead, we might set out to determine the *validity* of the tests as measures in this situation. We introduced the concept of validity in Chapter 2 and will address it more fully in Chapter 5.

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A Sample Research Proposal

On the following pages, we present an excerpt from a research proposal submitted to the faculty of the School of Education of the American University in Washington, DC. The proposal is not meant to be slavishly emulated. We present it here because its organization closely reflects some of the recommendations we've made in this chapter. Note, however, that, in the interest of space, we've shortened it considerably from the original.

The proposed research concerns a practical problem: developing a means of using an existing measurement instrument, the Strong Vocational Interest Blank (SVIB), to identify potential cartographers for the federal government. The SVIB assesses a person's interests in a wide variety of activities; the profile of interests that it generates is then compared with the interests of people in various occupations to identify occupations in which the person might find satisfaction and success. At the time the study was conducted, interest scales for 54 different occupational groups had been developed for the SVIB, but none had been developed for cartographers. The SVIB was published in two versions, the SVIB for Men and the SVIB for Women; to limit the scope of the project, the researcher focused only on the SVIB for Men.

The excerpt itself is presented on the left-hand side of the page, as are several editorial changes. On the right is a running commentary that points out the proposal's strengths and identifies suggestions that might make the proposal even more effective.

As you read the excerpt, notice the care with which the details of the proposed research are spelled out. The greater the anticipated investment of time, money, and effort, the fuller and more specific a research proposal should be.

Dissertation ANALYSIS 1

THE PROBLEM AND ITS SETTING

The Statement of the Problem

This research^er proposes to identify and evaluate the existing discrete interests among Federally employed male cartographers and to develop a scale for the revised Strong Vocational Interest Blank to aid recruitment of cartographers into Federal employment.

The Subproblems

1. The first subproblem. The first subproblem is to determine whether male cartographers employed by the Federal Government have a discrete pattern of interests different from those of men in general as measured by the Strong Vocational Interest Blank for Men.

2. The second subproblem. The second subproblem is to construct a scoring key for the Strong Vocational Interest Blank to differentiate ^the interests of^ cartographers from ^those of^ men in general and ^also from the interests of^ other occupational groups.

3. The third subproblem. The third subproblem is to analyze and interpret the treated data so as to evaluate the discovered interests in terms of their discreteness in recruiting cartographers.

The Hypotheses

The first hypothesis is that male cartographers employed by the Federal Government have a discrete pattern of interests different from those of men in general.

The second hypothesis is that the Strong Vocational Interest Blank can identify the existing discrete interests of cartographers differentially from ^those of^ men in general and ^those of^ other occupational groups.

Comments

The headings clearly indicate the organization and outline of the proposal.

Research *doesn't "propose," hence our editorial change to* researcher. *The word* existing *is unnecessary; if interests are "discrete," they do "exist."*

The numbering here is superfluous. The indented subheading makes it apparent that this is the first subproblem. No need, therefore, to number it 1.

Here the researcher is not saying what he means. He wants to differentiate the interests of cartographers from those of other professionals. The edited additions bring the thought into correct perspective.

Notice that the three subproblems add up to the totality of the problem.

Notice the position of the hypothesis section. It immediately follows the subproblems. It facilitates seeing the one-to-one correspondence between the subproblem and the hypothesis pertaining to that subproblem.

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The third hypothesis is that the development of an interest scale can aid the recruitment of cartographers into Federal employment.

The third hypothesis goes beyond the limits of the problem. The researcher does not intend to investigate the actual recruitment of cartographers so will not be able to either support or refute the hypothesis.

The Delimitations

The study will not attempt to predict success of cartographers.

The study will not determine or evaluate the preparation and training of cartographers.

The study will be limited to male cartographers who have attained, within the U.S. Civil Service classification system, full performance ratings of GS-09 or higher in Occupation Series 1370.

The study will not evaluate ^ any cartographers who may also be uniformed military personnel.

Again, the researcher is not saying what he means precisely. Our editing clarifies his meaning.

The Definitions of Terms

<u>Cartographer.</u> A cartographer[1] is a professional employee[2] who engages in the production of maps,[3] including construction of projections, design, drafting (or scribing), and preparation through the negative stage for the reproduction of maps, charts, and related graphic materials.

<u>Discrete interests</u>. Discrete interests are those empirically derived qualities or traits common to an occupational population that serve to make them distinct from the general population or universe.

Notice that the word to be defined is given in the indented subheading. Then follows a complete definition comprising the three parts discussed in this chapter: (1) the term to be defined, (2) the genera, and (3) the differentia.

Abbreviations

SVIB is the abbreviation used for the <u>Strong Vocational Interest Blank.</u>

USATOPOCOM is an acronym for the U.S. Army Topographic Command.

CIMR is an abbreviation used for the Center for Interest Measurement Research.

SD is the abbreviation used for standard deviation.

An abbreviations section is not discussed in the text, but it is perfectly appropriate. Whatever makes reading easier and aids in giving the problem an appropriate setting is worth including in this part of the proposal.

Assumptions

<u>The first assumption.</u> The first assumption is that the need for cartographers in Federal service will continue.

<u>The second assumption.</u> The second assumption is that the revised <u>Strong Vocational Interest Blank</u> will continue in use as a vocational guidance tool.

<u>The third assumption.</u> The third assumption is that the recent revolutionary advances in the cartographic state of the art will not alter the interests of persons in the employment of the Federal Government as cartographers.

Notice that the assumptions are set up with appropriate paragraph subheadings. The earlier discussion of hypotheses might have been set up in a similar manner, perhaps using the subheadings "The first hypothesis," "The second hypothesis," and so on.

<u>The fourth assumption.</u> The fourth assumption is that the criterion group consisting of the population of cartographers employed by the USATOPOCOM at Washington, D.C.; Providence, Rhode Island; Louisville, Kentucky; Kansas City, Missouri; and San Antonio, Texas, is representative of the universe of Federally employed cartographers.

Clarity is most important in the writing and structuring of a proposal. Here the author's assumptions are spelled out clearly and succinctly.

The Importance of the Study

Cartographers and the nature of their work are little known in American society. The total annual production of graduates, at the bachelor's level, with competence in the broader field of survey engineering within which cartography is subsumed, is currently less than one percent of the annual requirement. The addition of a cartographer scale to the occupations routinely reported for the <u>Strong Vocational Interest Blank</u> would potentially bring to the attention of everyone involved with the existing vocational guidance system the opportunities within the field of map-making and serve to attract serious and capable students into the appropriate preparatory college programs.

This section gives the reader a practical rationale for undertaking the study.

NOTE: Excerpt is from a research proposal submitted by Arthur L. Benton to the American University, Washington, DC, in partial fulfillment of the requirement for the degree of Doctor of Philosophy.

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PRACTICAL APPLICATION Writing the First Sections of a Proposal

In a checklist earlier in this chapter, you stated your main problem for research. In doing so, you took the first step in creating a research proposal. Now you can add the subproblems and identify the setting of the problem by doing the following exercise. As you complete the exercise, you may occasionally find it helpful to refer back to the sample proposal just presented and to our comments beside it.

1. *State the subproblems.* On a blank sheet of paper, write the research problem statement you developed earlier. Allow considerable space between the lines. Now inspect your problem carefully and do the following:
   a. Within the problem, box off those areas that must receive in-depth treatment if the problem is to be fully explored. Number the boxed-in areas consecutively.
   b. Underline the words that indicate your intention to interpret the data (e.g., *analyze, compare*).
   c. Below the problem, which has been thus treated, write the several subproblems of your study in complete sentences. Make sure each subproblem includes a word that reflects data interpretation.

For practice in developing a hypothesis, go to the Building Research Skills section in Chapter 3 of MyEducationalResearchLab, located at www.myeducationlab.com. Complete Activity 2: Developing a Hypothesis.

2. *Write your hypotheses/questions.* Read again what we have said about hypotheses and research questions in this chapter. Study the way the author of the sample proposal presented his hypotheses, and notice how they are precisely parallel to the subproblems. Then write your own hypothesis/question related to each of your subproblems.

3. *Write the delimitations.* Review the earlier section "Delimiting the Research." Look at the discussion of delimitations in the sample proposal. Now write down the specific things that your own research project will *not* address.

4. *Write the definitions of terms.* Before writing your definitions, reread the section "Defining the Terms" earlier in the chapter. After writing your definitions, it may be helpful to box in the specific parts of each definition, labeling each box as "term," "genera," or "differentia." (Delete these labels in the final draft of your proposal.)

5. *Write the assumptions.* Reread the section "Stating the Assumptions," and study the section of the sample proposal dealing with assumptions. Now write a list of the specific assumptions you will be making as you design and carry out your research project.

6. *Describe the importance of the study*. Look once again at the section in the sample proposal that describes the importance of the study. Then, in a short paragraph or two, explain why your study is important. Eventually you may want to move this discussion to an earlier point in your proposal where you introduce your topic and provide an overall context for it (more on this point in Chapter 6). For now, however, keeping it in a separate section with its own label can help you remember that *talking* about your study's importance is important in its own right.

7. *Type your proposal.* Look at how the sample proposal appears, and type your own proposal using a similar style and format.

Now that you have written the first sections of a proposal, evaluate what you have done using the following checklist.

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✔ **CHECKLIST**

Evaluating Your Proposed Research Project

_____ 1. Have you read enough literature relevant to your topic to know that your research project is worth your time and effort?

- Will the project advance the frontiers of knowledge in an important way?

- Have you asked an expert in your field to advise you on the value of your research effort?

_____ 2. Have you looked at your research problem from all angles to minimize unwanted surprises?

- What is good about your potential project?

- What are the potential pitfalls of attempting this research effort?

_____ 3. What research procedure will you follow?

- Do you have a plan to review the literature?

- Do you have a plan for data collection?

- Do you have a plan for data analysis?

- Do you have a plan to interpret the data you collect?

_____ 4. What research tools are available for you to use? Make a list and check their availability. Determine how you will use them.

_____ 5. Ask two or three peers to read your proposal. Do they understand what you are proposing to do? What questions do they have? What concerns do they express?

- I have discussed this plan with _______________, _______________, and _______________.

- They have the following questions and concerns:

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PRACTICAL APPLICATION Reappraising a Proposed Research Problem

In this chapter, we have given you numerous suggestions for identifying an appropriate problem or question for your research. Because the problem is the center and driving force of any research project, we have devoted considerable space to its discussion. We cannot overemphasize that if the problem is not correctly selected and stated, you may put considerable time, energy, and resources into an endeavor that is much less than what it could be.

GUIDELINES Fine-Tuning Your Research Problem

Earlier in the chapter, we presented guidelines for identifying and stating an appropriate research problem. Here we offer a few general suggestions for fine-tuning the problem you've identified:

1. *Conduct a thorough literature review.* Make sure you know enough about your topic that you can ask important questions and then make solid decisions about how you might answer them through your research effort. You may find that you need to revise your research plan significantly once you have delved deep into the literature related to your topic. (We address strategies for conducting a literature review in the next chapter.)

2. *Try to see the problem from all sides.* What is good about this potential project? What is not? Try to take a critical view of what you are proposing to do. Such a perspective will help minimize unwanted surprises.

3. *Think through the process.* Once you have brought your research problem into clear focus, imagine walking through the whole research procedure, from literature review through data collection, data analysis, and interpretation. You can gain valuable insights as you mentally walk through the project. Pay close attention to specific bottlenecks and pitfalls that might cause problems later on.

4. *Use all available tools and resources at your disposal.* Remember that research is always a learning experience. Allow time for learning about new tools or for learning how to use old tools in new ways.

5. *Discuss your research problem with others.* Frequently, beginning researchers need to clarify their problem statement. One good way to do this is to present it to others in as clear a fashion as possible. If they do not understand, further explanation and clarity are needed. One can learn a great deal from trying to explain something to someone else.

For practice in reviewing research proposals, go to the Activities and Applications section in Chapter 3 of MyEducationalResearchLab, located at www.myeducationlab.com. Complete Activity 3: Reviewing Research Proposal A and Activity 4: Reviewing Research Proposal B.

6. *Hold up your proposed project for others to examine and critique.* Describe your proposed research study to other people. Do not hide it because you are afraid someone else may not like the idea or may want to steal it from you. Rarely will either of these events happen.

Continually ask for feedback from others. Ask other people questions about your research problem, and ask them to ask *you* questions about it. Don't be overly discouraged by a few individuals who may get some sense of satisfaction from impeding the progress of others. Many great discoveries have been made by people who were repeatedly told that they couldn't do what they set out to do.

7. *Remember that your project will take time—lots of time.* All too often, we have had students tell us that they anticipate completing a major research project, such as a thesis or dissertation, in a semester or less. In the vast majority of cases, such a belief is unrealistic. Consider all the steps involved in research: formulating a research problem, conducting the necessary literature search, collecting and interpreting the data, describing what you have done in writing, and improving on your research report through multiple drafts. If you think that you can accomplish all of these things within 2 or 3 months, you're almost certainly setting yourself up for failure

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and great disappointment. We would much rather you think of any research project—and especially your first project—as something that is a valuable learning experience in its own right. As such, it is worth however much of your time and effort it takes to do the job well.

For Further Reading

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McBurney, D. H. (1995). The problem method of teaching research methods. *Teaching of Psychology*, *22*(1), 36–38.

McMillan, J. H., & Schumacher, S. (2006). *Research in education: Evidence-based inquiry* (6th ed.). Upper Saddle River, NJ: Prentice Hall. [See Chapter 3.]

Medawar, P. B. (1979). *Advice to a young scientist.* New York: Harper & Row.

Neuman, W. L. (2006). *Social research methods: Quantitative and qualitative approaches* (6th ed.). Boston: Allyn & Bacon.

Schram, T. H. (2006). *Conceptualizing and proposing qualitative research* (2nd ed.). Upper Saddle River, NJ: Merrill/Prentice Hall. [See Chapter 5.]

Now go to MyEducationalResearchLab at www.myeducationlab.com to take a quiz to evaluate your mastery of chapter concepts. Review, Practice, and Enrichment exercises are also available to help you master the chapter. Feedback for these exercises is provided so that you can see why your answers are correct or incorrect.

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