1 The Nature and Tools of Research

In virtually every subject area, our knowledge is incomplete and problems are waiting to be solved. We can address our incomplete knowledge and unsolved problems by asking relevant questions and then seeking answers through systematic research. We have many tools at our disposal to help us do these things—not only physical tools but also mental and social tools.

In everyday speech, the word *research* has numerous meanings, making it a decidedly confusing term for university 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 to describe a variety of activities. In some situations the word connotes finding a piece of information or taking notes and then writing a so-called "research 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 locate a few tidbits of information. Such activities have often been called research but are more accurately called other names: information gathering, library skills, self-enlightenment, documentation, or summarization.

Yet when used more appropriately, for many people the word *research* suggests a mystical 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 general public is often unaware of what researchers do on a day-to-day basis and how their work contributes to people's overall quality of life and well-being.

In fact, research is often a practical enterprise that—given appropriate tools—*any* rational, conscientious individual can conduct. In this chapter we lay out the nature of true research and describe the general tools that make it possible.

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 three statements that describe what research is not. Accompanying each statement is an example that illustrates a common misconception about research.

1. *Research is not merely gathering information.* 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 find a few facts. This might be *information discovery,* or it might be learning *reference skills.* But it certainly is not, as the teacher labeled it, research.

2. *Research is not merely rummaging around for hard-to-locate information.* The house across the street is for sale. You consider buying it and call your realtor to find out much money someone else might pay you for your current home. "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 own 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.*

3. *Research is not merely transporting facts from one location to another.* A college student reads several articles about the mysterious Dark Lady in William Shakespeare's sonnets and then writes a "research paper" describing various scholars' suggestions of who the lady might have been. Although the student does, indeed, go through certain activities associated with formal research—collecting information, organizing it in a certain way for presentation to others, supporting statements with documentation, referencing statements properly, and so on—these activities 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 I have gathered seem to indicate such-and-such 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. Such activity might more realistically be called *fact transcription, fact documentation, fact organization,* or *fact summarization.* Going a little further, 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.

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, in general, research has eight distinct characteristics:

1. Research originates with a question or problem.
2. Research requires clear articulation of a goal.
3. Research usually divides the principal problem into more manageable subproblems.
4. Research is guided by the specific research problem, question, or hypothesis.
5. Research requires a specific plan for proceeding.
6. Research rests on 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.

Let's look at each of these characteristics more closely.

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 a spark that ignites a chain reaction leading to the research process. An inquisitive mind is the beginning impetus for 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.

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 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, can 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 drive from your hometown to a town 50 miles away. Your principal goal is to get from one location to the other as 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 route appears to be the most direct one?
	2. Is the most direct one also the quickest one? If not, what route might take the least amount of time?
	3. Which is more important to me: minimizing my travel time or minimizing my energy consumption?
	4. At what critical junctions in my chosen route must I turn right or left?

What seems like a single question can be divided into several 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 a researcher doesn't take the time or trouble to isolate the lesser problems within the major problem, the overall research project can become cumbersome and difficult to manage.

Identifying and clearly articulating the problem and its subproblems are the essential starting points for formal research. Accordingly, we discuss these processes in depth in Chapter 2.

4. *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, as a result, may also help to resolve the principal research problem.

Hypotheses are certainly not unique to research. They are constant, recurring features of everyday life and 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 recent weather event interrupted your 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 get a flashlight from your car, find a new bulb, and put the new bulb in the lamp. 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 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—your electric bill payments are up to date.)
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 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 will increase the odds that viewers 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.

Let's return to a point we made a few paragraphs back, 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 9). 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 6). 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.

5. *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 emerge. 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—*Planning and Design*—are especially 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 and subproblems. Depending on the research question, different designs and methods are more or less appropriate.

In addition to identifying the specific goal of your research, then, 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 you have them? 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]

Ultimately the research methodology directs the whole research 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

[1]As should be apparent in the questions we pose in this paragraph, 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 has its origins in Latin) refers to two or more pieces of information. A single piece of information is known as a *datum*, or sometimes as a *data point*.

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 analyze the acquired data in order to extract meaning from them

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

6. *Research rests on certain critical assumptions.* 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 research, assumptions are equivalent to axioms in geometry—self-evident truths that any reasonable person might accept. Careful researchers—certainly those conducting research in an academic environment—set forth a statement of their assumptions as the bedrock upon which their study rests.

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 might reasonably learn to distinguish between them.

Assumptions are often 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, however, careful researchers state their assumptions, so that other people inspecting the research project can 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 hypotheses, identified a suitable design and methodology, and identified the assumptions that underlie 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.[2]

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, for example, the many 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 a very different conclusion. Which one is right? Perhaps

[2] Some people in academia use the term *research* more broadly to include deriving new equations or abstract principles from existing equations and/or principles through a sequence of mathematically logical and valid steps. Such an activity can be quite intellectually challenging, of course, and is often at the heart of doctoral dissertations and scholarly journal articles in mathematics, physics, and related disciplines. In this book, however, we use the term *research* more narrowly to refer to *empirical* research—research that involves the collection and analysis of new data.

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.

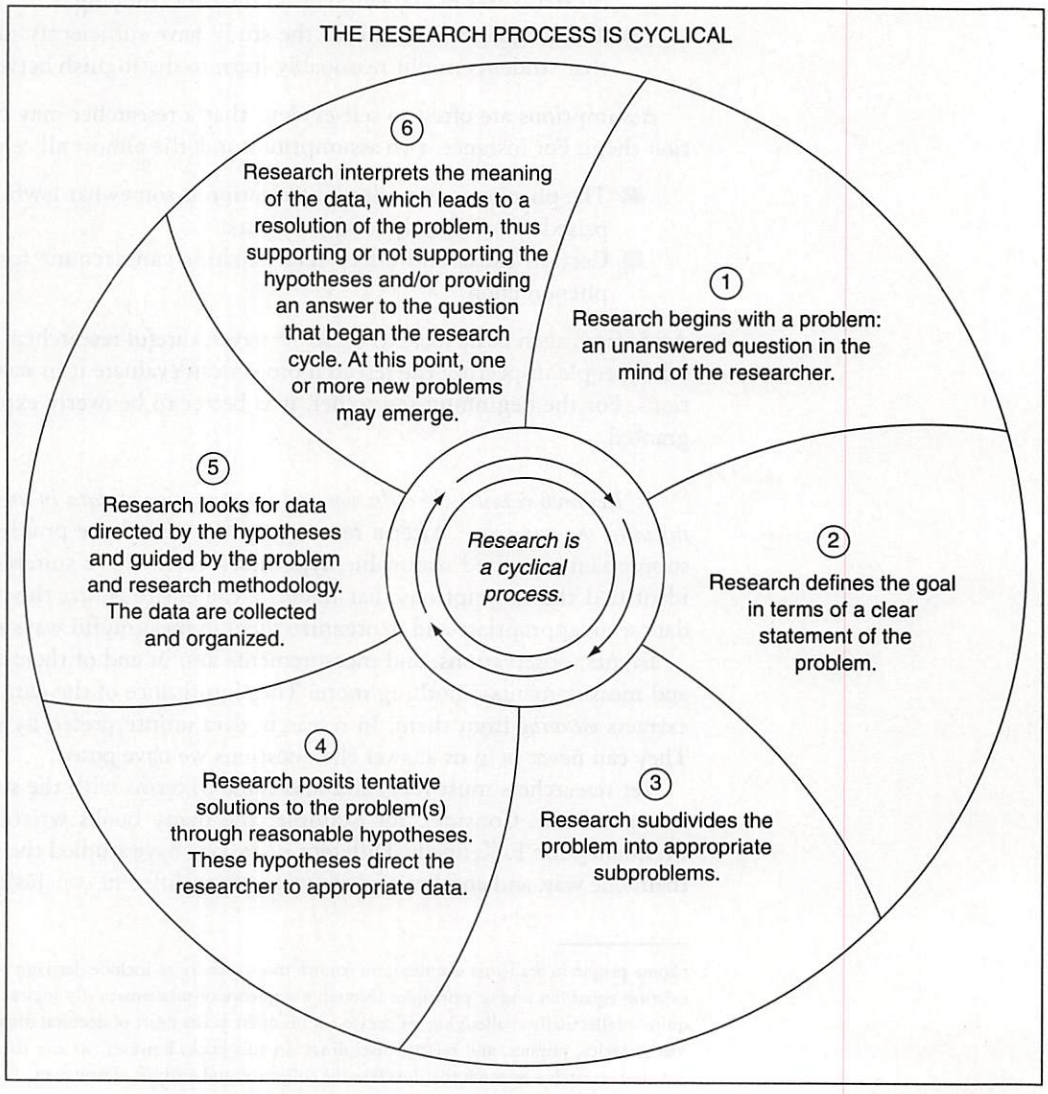
Once we believed that clocks measured time and that yardsticks measured space. In one sense, they still do. We further assumed that time and space were two different entities. Then along came Einstein's theory of relativity, and time and space became locked into one concept: the time–space continuum. 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.

Data demand interpretation. But no rule, formula, or algorithm can lead the researcher unerringly to a correct interpretation. Interpretation is inevitably a somewhat subjective process that depends on the researcher's hypotheses, assumptions, and logical reasoning processes. In subsequent chapters we present a number of potentially useful methods for 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.* Any research project begins simply and then follows a predictable, systematic sequences of steps, as shown in Figure 1.1:

FIGURE 1.1
The research cycle



1. A questioning mind observes a particular situation and asks, Why? What caused that? How come? (This is the internal, mental origin of research.)
2. One or more of these questions become formally stated as a problem. (This is the overt, observable beginning of research.)
3. The problem is divided into several simpler, more specific subproblems.
4. Preliminary information is gathered that appears to bear on the problem. This information may include informal observations of events in one's environment; typically it also includes previous research findings related to the topic at hand. The preliminary information may point to a tentative solution to the problem. A guess is made; a hypothesis or guiding question is formed.
5. A method of collecting data more systematically is identified and carried out in order to address the problem.
6. The body of data is processed and interpreted. A discovery is made, a conclusion reached. The tentative hypothesis is either supported or not supported by the data; the question is either answered (partially or completely) or not answered.

Such is the general format of all research. Different academic disciplines merely use different routes to arrive at the same destination.

Yet only rarely is a research project a one-shot effort that completely resolves a problem. For instance, even with the best of data, hypotheses in a research project are rarely proved or disproved—and thus research questions are rarely answered—beyond a shadow of a doubt. Instead, hypotheses 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 other hypotheses as being more likely explanations of the phenomenon in question. In either case, one or more additional, follow-up studies are called for.

Ultimately, then, most research studies don't bring total closure to a research problem. There is no obvious end point—no point at which a researcher can say "*Voila!* I've completely answered the question about which I'm concerned." Instead, research typically involves a cycle, or more accurately, a *helix* (spiral) in which one study spawns additional, follow-up studies. In exploring a topic, one comes across additional problems that need resolving, and so the process must begin anew. Research begets more research.

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 presented early in the chapter. Every researcher soon learns that genuine research is likely to yield as many problems as it resolves. Such is the nature of the acquisition of knowledge.

Tools of Research

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. Researchers, likewise, have their own set of tools to carry out their plans.

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

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 at some point 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.

Six general tools of research are these:

1. The library and its resources
2. Computer technology
3. Measurement
4. Statistics
5. Language
6. The human mind

In the following sections, we look more closely at each of these general tools.

The Library and Its Resources

Historically, many literate human societies used libraries to assemble and store their collective knowledge. For example, in the seventh century B.C., the ancient Assyrians' Library of Nineveh contained 20,000 to 30,000 tablets, and in the second century A.D., the Romans' Library of Celsus in Ephesus housed more than 12,000 parchment and papyrus scrolls.

Until the past few decades libraries were primarily repositories of concrete, physical representations of knowledge—clay tablets, scrolls, manuscripts, books, journals, and so on. For the most part, any society's collective knowledge expanded rather slowly and could seemingly be contained within masonry walls. But by the latter half of the 20th century, people's knowledge about their physical and social worlds began to increase many times over, and at the present time it continues to increase at an astounding rate. In response, libraries have evolved in important ways. First, they have made use of many emerging technologies (e.g., microforms, compact disks, online databases) to store information in more compact forms. Second, they have provided increasingly fast and efficient means of locating and accessing information on virtually any topic. And third, many of them have made catalogs of their holdings available on the Internet (e.g., see www.library.unh.edu or library.brown.edu). The libraries of today—especially university libraries—extend far beyond their local, physical boundaries.

We explore efficient use of a library and its resources in depth in Chapter 3. For now, we simply want to stress that the library is—and must be—one of the most valuable tools in any researcher's toolbox.

Computer Technology

As a research tool, the personal computer is now commonplace. Personal computers have become increasingly compact and portable—first in the form of laptops and more recently in the form of iPads and other tablet computers. And 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. Yes, computers can certainly calculate, compare, search, retrieve, sort, and organize data more efficiently and more accurately than you can. But in their present stage of development, they depend largely on people to give them directions about what to do.

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 1.1 provides suggestions for how you might use a computer to assist you in the research process.