Variables and Hypotheses

5

How many variables can you identify?

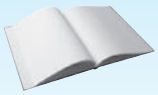
OBJECTIVES **Studying this chapter should enable you to:**

- Explain what is meant by the term "variable" and name five variables that might be investigated by educational researchers.
- Explain how a variable differs from a constant.
- Distinguish between a quantitative and a categorical variable.
- Explain how independent and dependent variables are related.
- Give an example of a moderator variable.
- Explain what a hypothesis is and formulate two hypotheses that might be investigated in education.
- Name two advantages and two disadvantages of stating research questions as hypotheses.
- Distinguish between directional and nondirectional hypotheses and give an example of each.

INTERACTIVE AND APPLIED LEARNING After, or while, reading this chapter:

Go to the Online Learning Center at www.mhhe.com/fraenkel8e to:

- Learn More About Hypotheses: To State or Not to State



Go to your online Student Mastery Activities book to do the following activities:

- Activity 5.1: Directional vs. Nondirectional Hypotheses
- Activity 5.2: Testing Hypotheses
- Activity 5.3: Categorical vs. Quantitative Variables
- Activity 5.4: Independent and Dependent Variables
- Activity 5.5: Formulating a Hypothesis
- Activity 5.6: Moderator Variables

Marge Jenkins and Jenna Rodriguez are having coffee following a meeting of their graduate seminar in educational research. Both are puzzled by some of the ideas that came up in today's meeting of the class.

"I'm not sure I agree with Ms. Naser" (their instructor), says Jenna. "She said that there are a lot of advantages to predicting how you think a study will come out."

"Yeah, I know," replies Marge. "But formulating a hypothesis seems like a good idea to me."

"Well, perhaps, but there are some disadvantages, too."

"Really? I can't think of any."

"Well, what about . . . ?"

Actually, both Jenna and Marge are correct. There are both advantages and disadvantages to stating a hypothesis in addition to one's research question. We'll discuss examples of both in this chapter.

The Importance of Studying Relationships

We mentioned in Chapter 2 that an important characteristic of many research questions is that they suggest a relationship of some sort to be investigated. Not all research questions, however, suggest relationships. Sometimes researchers are interested only in obtaining descriptive information to find out how people think or feel or to describe how they behave in a particular situation. Other times the intent is to describe a particular program or activity. Such questions also are worthy of investigation. As a result, researchers may ask questions like the following:

- How do the parents of the sophomore class feel about the counseling program?
- What changes would the staff like to see instituted in the curriculum?
- Has the number of students enrolling in college preparatory as compared to noncollege preparatory courses changed over the last four years?
- How does the new reading program differ from the one used in this district in the past?
- What does an inquiry-oriented social studies teacher do?

Notice that no relationship is suggested in these questions. The researcher simply wants to identify characteristics, behaviors, feelings, or thoughts. It is often necessary to obtain such information as a first step in designing other research or making educational decisions of some sort.

The problem with purely descriptive research questions is that answers to them do not help us understand why people feel or think or behave a certain way, why programs possess certain characteristics, why a particular strategy is to be used at a certain time, and so forth. We may learn what happened, or where or when (and even how) something happened, but not why it happened. As a result, our understanding of a situation, group, or phenomenon is limited. For this reason, scientists highly value research questions that suggest relationships to be investigated, because the answers to them help explain the nature of the world in which we live. We learn to understand the world by learning to

explain how parts of it are related. We begin to detect *patterns* or connections between the parts.

We believe that understanding is generally enhanced by the demonstration of relationships or connections. It is for this reason that we favor the formation of a hypothesis that predicts the existence of a relationship. There may be times, however, when a researcher wants to hypothesize that a relationship does *not* exist. Why so? The only persuasive argument we know of is that of contradicting an existing widespread (but perhaps erroneous) belief. For example, if it can be shown that a great many people believe, in the absence of adequate evidence, that young boys are less sympathetic than young girls, a study in which a researcher finds no difference between boys and girls (i.e., *no* relationship between gender and sympathy) might be of value (such a study may have been done, although we are not aware of one). Unfortunately, most (but by no means all) of the methodological mistakes made in research (such as using inadequate instruments or too small a sample of participants) increase the chance of finding no relationship between variables. (We shall discuss several such mistakes in later chapters.)

Variables

WHAT IS A VARIABLE?

At this point, it is important to introduce the idea of variables, since a relationship is a statement about variables. What is a variable? A **variable** is a concept—a noun that stands for variation within a class of objects, such as *chair, gender, eye color, achievement, motivation,* or *running speed.* Even *spunk, style,* and *lust for life* are variables. Notice that the individual members in the class of objects, however, must differ—or vary—to qualify the class as a variable. If all members of a class are identical, we do not have a variable. Such characteristics are called **constants**, since the individual members of the class are not allowed to vary, but rather are held constant. In any study, some characteristics will be variables, while others will be constants.

An example may make this distinction clearer. Suppose a researcher is interested in studying the effects of reinforcement on student achievement. The researcher systematically divides a large group of students, all of whom are ninth-graders, into three smaller subgroups. She then trains the teachers of these subgroups to reinforce their students in different ways (one gives verbal praise, the second gives monetary rewards, the third gives extra points) for various tasks the students perform. In this study, *reinforcement* would be a variable (it contains three variations), while the grade level of the students would be a constant.

Notice that it is easier to see what some of these concepts stand for than others. The concept of *chair,* for example, stands for the many different objects that we sit on that possess legs, a seat, and a back. Furthermore, different observers would probably agree as to how particular chairs differ. It is not so easy, however, to see what a concept like *motivation* stands for, or to agree on what it means. The researchers must be specific here—they must define *motivation* as clearly as possible. They must do this so that it can be measured or manipulated. We cannot meaningfully measure or manipulate a variable if we cannot define it. As we mentioned above, much educational research involves looking for a relationship among variables. But what variables?

There are many variables "out there" in the world that can be investigated. Obviously, we can't investigate them all, so we must choose. Researchers choose certain variables to investigate because they suspect that these variables are somehow related and believe that discovering the nature of this relationship, if possible, can help us make more sense out of the world in which we live.

QUANTITATIVE VERSUS CATEGORICAL VARIABLES

Variables can be classified in several ways. One way is to distinguish between quantitative and categorical variables. **Quantitative variables** exist in some degree (rather than all or none) along a continuum from less to more, and we can assign numbers to different individuals or objects to indicate how much of the variable they possess. Two obvious examples are height (John is 6 feet tall and Sally is 5 feet 4 inches) and weight (Mr. Adams weighs only 150 pounds and his wife 140 pounds, but their son tips the scales at an even 200 pounds). We can also assign numbers to various individuals to indicate how much "interest" they have in a subject, with a 5 indicating very much interest, a 4 much interest, a 3 some interest, a 2 little interest, a 1 very little interest, down to a 0 indicating no interest. If we can assign numbers in this way, we have the variable *interest.*

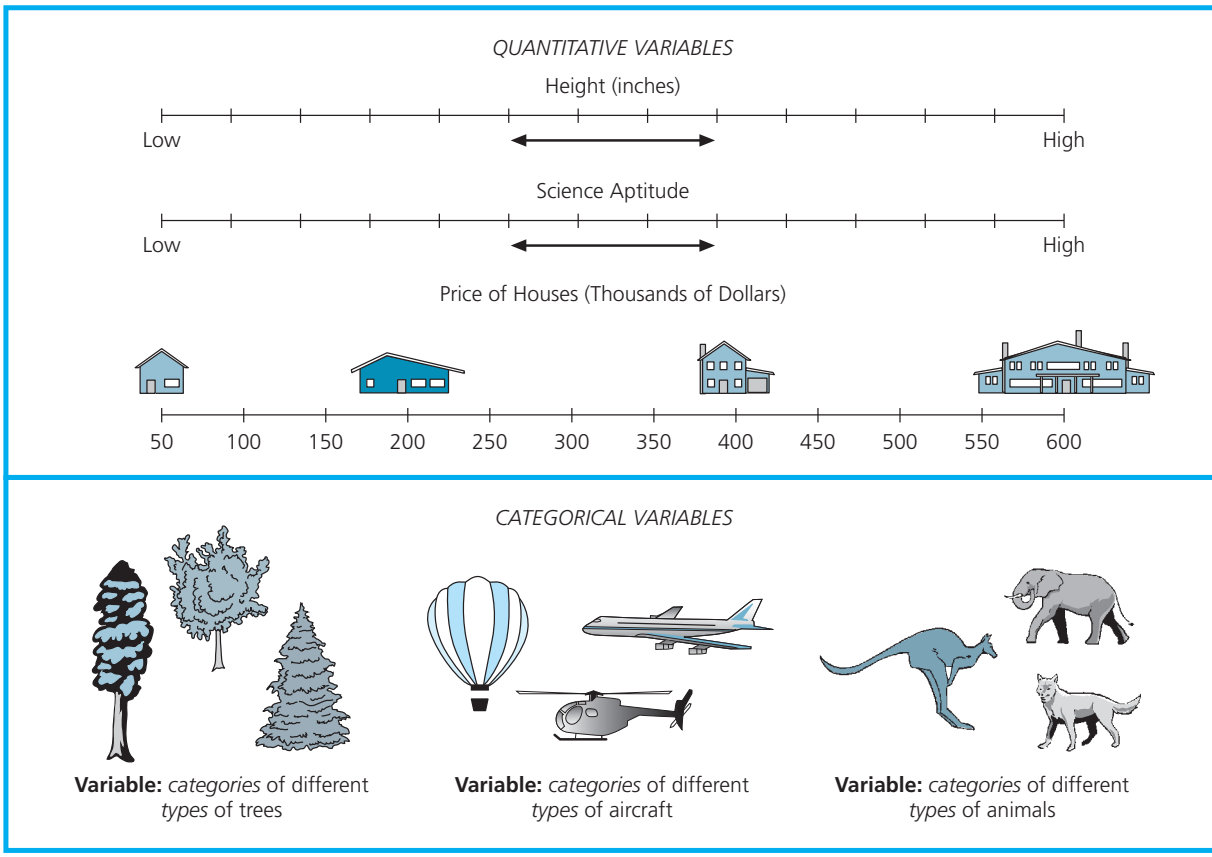


Figure 5.1 *Quantitative Variables Compared with Categorical Variables*

Quantitative variables can often (but not always) be subdivided into smaller and smaller units. Length, for example, can be measured in miles, yards, feet, inches, or in whatever subdivision of an inch is needed. By way of contrast, **categorical variables** do not vary in degree, amount, or quantity but are qualitatively different. Examples include eye color, gender, religious preference, occupation, position on a baseball team, and most kinds of research "treatments" or "methods." For example, suppose a researcher wishes to compare certain attitudes in two different groups of voters, one in which each individual is registered as a member of one political party and the other in which individuals are members of another party. The variable involved would be *political party.* This is a categorical variable—a person is either in one or the other category, not somewhere in between being a registered member of one party and being a registered member of another party. All members within each category of this variable are considered the same as far as party membership is concerned (see Figure 5.1).

Can *teaching method* be considered a variable? Yes, it can. Suppose a researcher is interested in studying teachers who use different methods in teaching. The researcher locates one teacher who lectures exclusively, another who buttresses her lectures with slides, films, and computer images, and a third who uses the case-study method and lectures not at all. Does the teaching method "vary"? It does. You may need to practice thinking of differences in methods or in groups of people (teachers compared to administrators, for example) as variables, but mastering this idea is extremely useful in learning about research.

MORE ABOUT RESEARCH

Some Important Relationships That Have Been Clarified by Educational Research

1. "The more time beginning readers spend on phonics, the better readers they become." (Despite a great deal of research on the topic, this statement can neither be clearly supported nor refuted. It is clear that phonic instruction is an important ingredient; what is not clear is how much time should be devoted to it.)*
2. "The use of manipulatives in elementary grades results in better math performance." (The evidence is quite supportive of this method of teaching mathematics.)†
3. "Behavior modification is an effective way to teach simple skills to very slow learners." (There is a great deal of evidence to support this statement.)‡
4. "The more teachers know about specific subject matter, the better they teach it." (The evidence is inconclusive despite the seemingly obvious fact that teachers must know more than their students.)§
5. "Among children who become deaf before language has developed, those with hearing parents become better readers than those with deaf parents." (The findings of many studies *refute* this statement.)‖

*R. Calfee and P. Drum (1986). Research on teaching reading. In M. C. Wittrock (Ed.), *Handbook of research on teaching,* 3rd ed. New York: Macmillan, pp. 804–849.

†M. N. Suydam (1986). Research report: Manipulative materials and achievement. *Arithmetic Teacher, 10* (February): 32.

‡S. L. Deno (1982). Behavioral treatment methods. In H. E. Mitzel (Ed.), *Encyclopedia of educational research,* 5th ed. New York: Macmillan, pp. 199–202.

§L. Shulman (1986). Paradigms and research programs in the study of teaching. In M. C. Wittrock (Ed.), *Handbook of research on teaching,* 3rd ed. New York: Macmillan, pp. 3–36.

‖C. M. Kampfe and A. G. Turecheck (1987). Reading achievement of prelingually deaf students and its relationship to parental method of communication: A review of the literature. *American Annals of the Deaf, 10* (March): 11–15.

Now, here are several variables. Which ones are quantitative variables and which ones are categorical variables?

1. Make of automobile
2. Learning ability
3. Ethnicity
4. Cohesiveness
5. Heartbeat rate
6. Gender*

Researchers in education often study the relationship between (or among) either (1) two (or more) quantitative variables; (2) one categorical and one quantitative variable; or (3) two or more categorical variables. Here are some examples of each:

1. *Two quantitative variables*
   - Age and amount of interest in school
   - Reading achievement and mathematics achievement
   - Classroom humanism and student motivation
   - Amount of time watching television and aggressiveness of behavior
2. *One categorical and one quantitative variable*
   - Method used to teach reading and reading achievement
   - Counseling approach and level of anxiety
   - Nationality and liking for school
   - Student gender and amount of praise given by teachers
3. *Two categorical variables*
   - Ethnicity and father's occupation
   - Gender of teacher and subject taught
   - Administrative style and college major
   - Religious affiliation and political party membership

*1, 3, and 6 represent categorical variables; 2, 4, and 5 represent quantitative variables.

Sometimes researchers have a choice of whether to treat a variable as quantitative or categorical. It is not uncommon, for example, to find studies in which a variable such as *anxiety* is studied by comparing a group of "high-anxiety" students to a group of "low-anxiety" students. This treats anxiety as though it were a categorical variable. While there is nothing really wrong with doing this, there are three reasons why it is preferable in such situations to treat the variable as quantitative.

1. Conceptually, we consider variables such as anxiety in people to be a matter of degree, not a matter of either-or.

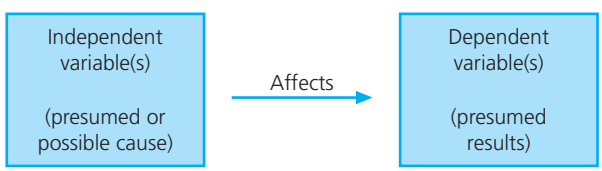
2. Collapsing the variable into two (or even several) categories eliminates the possibility of using more detailed information about the variable, since differences among individuals within a category are ignored.
3. The dividing line between groups (for example, between individuals of high, middle, and low anxiety) is almost always arbitrary (that is, lacking in any defensible rationale).

INDEPENDENT VERSUS DEPENDENT VARIABLES

A common and useful way to think about variables is to classify them as *independent* or *dependent*. **Independent variables** are those that the researcher chooses to study in order to assess their possible effect(s) on one or more other variables. An independent variable is presumed to affect (at least partly cause) or somehow influence at least one other variable. The variable that the independent variable is presumed to affect is called a **dependent variable**. In commonsense terms, the dependent variable "depends on" what the independent variable does to it, how it affects it. For example, a researcher studying the relationship between *childhood success in mathematics* and *adult career choice* is likely to refer to the former as the independent variable and subsequent career choice as the dependent variable.

It is possible to investigate more than one independent (and also more than one dependent) variable in a study. For simplicity's sake, however, we present examples in which only one independent and one dependent variable are involved.

The relationship between independent and dependent variables can be portrayed graphically as follows:



At this point, let's check your understanding. Suppose a researcher plans to investigate the following question: "Will students who are taught by a team of three teachers learn more science than students taught by one individual teacher?" What are the independent and dependent variables in this question? *

Notice that there are two conditions (sometimes called *levels*) in the independent variable—"three teachers" and "one teacher." Also notice that the dependent variable is not "science learning" but "*amount* of science learning." Can you see why?

At this point, things begin to get a bit complicated. Independent variables may be either *manipulated* or *selected*. A **manipulated variable** is one that the researcher *creates*. Such variables are typically found in experimental studies (see Chapter 13). Suppose, for example, that a researcher decides to investigate the effect of different amounts of reinforcement on reading achievement and systematically assigns students to three different groups. One group is praised continuously every day during their reading session; the second group is told simply to "keep up the good work"; the third group is told nothing at all. The researcher, in effect, manipulates the conditions in this experiment, thereby creating the variable *amount of reinforcement*. Whenever a researcher sets up experimental conditions, one or more variables are created. Such variables are called manipulated variables, **experimental variables**, or **treatment variables**.

Sometimes researchers *select* an independent variable that already exists. In this case, the researcher must locate and select examples of it, rather than creating it. In our earlier example of reading methods, the researcher would have to locate and select existing examples of each reading method, rather than arranging for them to happen. Selected independent variables are not limited to studies that compare different treatments; they are found in both causal-comparative and correlational studies (see Chapters 15 and 16). They can be either categorical or quantitative. The key idea here, however, is that the independent variable (either created or selected) is thought to affect the dependent variable. Here are a few examples of some possible relationships between a selected independent variable and a dependent variable:

Independent Variable	Dependent Variable
Gender (categorical)	Musical aptitude (quantitative)
Mathematical ability (quantitative)	Career choice (categorical)
Gang membership (categorical)	Subsequent marital status (categorical)
Test anxiety (quantitative)	Test performance (quantitative)

Notice that none of the independent variables in the above pairs could be directly manipulated by the researcher. Notice also that, in some instances, the

*The independent (categorical) variable is the *number of teachers,* and the dependent (quantitative) variable is the *amount of science learning*.

independent/ dependent relationship might be reversed, depending on which one the researcher thought might be the cause of the other. For example, he or she might think that test performance causes anxiety, not the reverse.

Generally speaking, most studies in education that have one quantitative and one categorical variable are studies comparing different methods or treatments. As we indicated above, the independent variable in such studies (the different methods or treatments) represents a categorical variable. Often the other (dependent) variable is quantitative and is referred to as an **outcome variable**.* The reason is rather clear-cut. The investigator, after all, is interested in the effect(s) of the differences in method on one or more outcomes (student achievement, their motivation, interest, and so on).

Again, let's check your understanding. Suppose a researcher plans to investigate the following question: "Will students like history more if taught by the inquiry method than if taught by the case-study method?" What is the outcome variable in this question?†

MODERATOR VARIABLES

A **moderator variable** is a special type of independent variable. It is a secondary independent variable that has been selected for study in order to determine if it affects or *modifies* the basic relationship between the primary independent variable and the dependent variable. Thus, if an experimenter thinks that the relationship between variables X and Y might be altered in some way by a third variable Z, then Z could be included in the study as a moderator variable.

Consider an example. Suppose a researcher is interested in comparing the effectiveness of a discussion- oriented approach to a more visually oriented approach for teaching a unit in a U.S. History class. Suppose further that the researcher suspects that the discussion approach may be superior for the girls in the class (who appear to be more verbal and to learn better through conversing with others) and that the visual approach may be more effective for boys (who seem to perk up every time a video is shown). When the students are tested together at the end of the unit, the overall results of the two approaches may show no difference, but when the results of the girls are separated from those of the boys, the two approaches

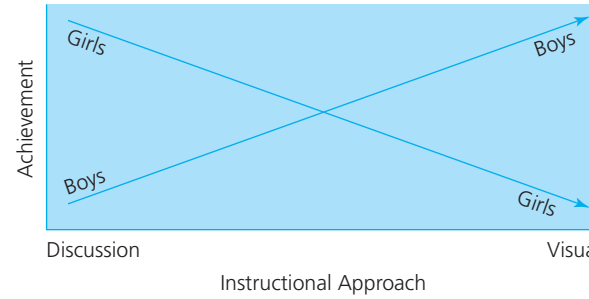


Figure 5.2 *Relationship Between Instructional Approach (Independent Variable) and Achievement (Dependent Variable), as Moderated by Gender of Students*

may reveal different results for each subgroup. If so, then the gender variable *moderates* the relationship between the *instructional approach* (the independent variable) and *effectiveness* (the dependent variable). The influence of this moderator variable can be seen in Figure 5.2.

Here are two examples of research questions that contain moderator variables.

Research Question 1: "Does anxiety affect test performance and, if so, does it depend on test-taking experience?"

- Independent variable: *anxiety level*
- Moderator variable: *test-taking experience*
- Dependent variable: *test performance*

Research Question 2: "Do high school students taught primarily by the inquiry method perform better on tests of critical thinking than high school students taught primarily by the demonstration method and, if so, does it vary with grade level?"

- Independent variable: *instructional method*
- Moderator variable: *grade level*
- Dependent variable: *performance on critical thinking tests*

As you can see, the inclusion of a moderator variable (or even two or three) in a study can provide considerably more information than just studying a single independent variable alone. We recommend their inclusion whenever appropriate.

MEDIATOR VARIABLES

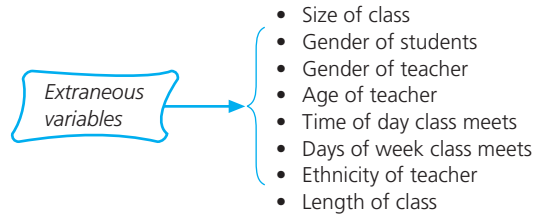
While a moderator variable can modify or influence the strength of a relationship between two other variables, a **mediator variable** is one that attempts to explain the relationship between the two other variables. Let us reexamine the relationship in Hypothesis 1 above between anxiety level (AL) and test performance (TP) on a

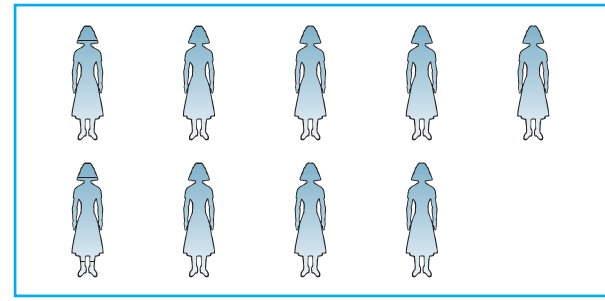
*It is also possible for an outcome variable to be categorical. For example, the variable *college completion* could be divided into the categories of *dropouts* and *college graduates.*

†*Liking for history* is the outcome variable.

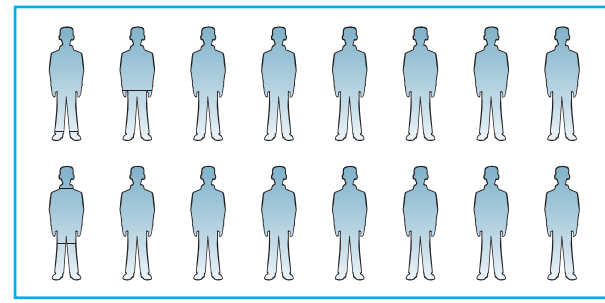
Figure 5.3 *Examples of Extraneous Variables*

The principal of a high school compares the final examination scores of two history classes taught by teachers who use different methods, not realizing that they are also different in many other ways because of *extraneous variables.* The classes differ in:





Ms. Brown's (age 31) history class meets from 9:00 to 9:50 A.M., Tuesdays and Thursdays. The class contains 9 students, all girls.



Mr. Thompson's (age 54) history class meets from 2:00 to 3:00 P.M. Mondays and Wednesdays. The class contains 16 students, all boys.

high-stakes test like the SAT exam. The moderator variable in this case is test-taking experience (TTE) because the relationship between AL and TP is stronger for students with prior experience taking the SAT. A possible mediator variable in this case could be socioeconomic status (SES) because it could explain why there is a relationship between AL and TP.

EXTRANEOUS VARIABLES

A basic problem in research is that there are many possible independent variables that could have an effect on the dependent variables. Once researchers have decided which variables to study, they must be concerned about the influence or effect of other variables that exist. Such variables are usually called *extraneous variables.* The task is to control these extraneous variables somehow to eliminate or minimize their effect.

Extraneous variables are independent variables that have not been controlled. Look again at the research question about team teaching on page 80. What are some other variables that could have an effect on the learning of students in a classroom situation?

There are many possible extraneous variables. The personality of the teachers involved, the experience level of the students, the time of day the classes are taught, the nature of the subject taught, the textbooks used, the type of learning activities the teachers employ, and the teaching methods—all are possible extraneous variables that could affect learning in this study. Figure 5.3 illustrates the importance of identifying extraneous variables.

One way to control extraneous variables is to hold them constant. For example, if a researcher includes only boys as the subjects of a study, she is controlling the variable of *gender.* We would say that the gender of the subjects does not vary; it is a constant in this study.

Researchers must continually think about how they might control the possible effect(s) of extraneous variables. We will discuss how to do this in some detail in Chapter 9, but for now you need to make sure you understand the difference between independent and dependent variables and to be aware of extraneous variables. Try your hand at the following question: "Will female students who are taught history by a teacher of the same gender like the subject more than female students taught by a teacher of a different gender?" What are the variables?*

Hypotheses

WHAT IS A HYPOTHESIS?

A **hypothesis** is, simply put, a prediction of the possible outcomes of a study. For example, here is a research question followed by its restatement in the form of a possible hypothesis:

Question: Will students who are taught history by a teacher of the same gender like the subject more than students taught by a teacher of a different gender?

Hypothesis: Students taught history by a teacher of the same gender will like the subject more than students taught history by a teacher of a different gender.

Here are two more examples of research questions followed by the restatement of each as a possible hypothesis:

Question: Is rapport with clients of counselors using client-centered therapy different from that of counselors using behavior-modification therapy?

Hypothesis: Counselors who use a client-centered therapy approach will have a greater rapport with their clients than counselors who use a behavior-modification approach.

Question: How do teachers feel about special classes for the educationally handicapped?

Hypothesis: Teachers in XYZ School District believe that students attending special classes for the educationally handicapped will be stigmatized.

or

Teachers in XYZ School District believe that special classes for the educationally handicapped will help such students improve their academic skills.

Many different hypotheses can come from a single research problem, as illustrated in Figure 5.4.

ADVANTAGES OF STATING HYPOTHESES IN ADDITION TO RESEARCH QUESTIONS

Stating hypotheses has both advantages and disadvantages. What are some of the advantages? First, a hypothesis forces us to think more deeply and specifically about the possible outcomes of a study. Elaborating on a question by formulating a hypothesis can lead to a more sophisticated understanding of what the question implies and exactly what variables are involved. Often, as in the case of the third example above, when more than one hypothesis seems to suggest itself, we are forced to think more carefully about what we really want to investigate.

A second advantage of restating questions as hypotheses involves a philosophy of science. The rationale underlying this philosophy is as follows: If one is attempting to build a body of knowledge in addition to answering a specific question, then stating hypotheses is a good strategy because it enables one to make specific predictions based on prior evidence or theoretical argument. If these predictions are borne out by subsequent research, the entire procedure gains both in persuasiveness and efficiency. A classic example is Albert Einstein's theory of relativity. Many hypotheses were formulated as a result of Einstein's theory, which were later verified through research. As more and more of these predictions were shown to be fact, not only did they become useful in their own right, they also provided increasing support for the original ideas in Einstein's theory, which generated the hypotheses in the first place.

Lastly, stating a hypothesis helps us see if we are, or are not, investigating a relationship. If not, we may be prompted to formulate one.

*The dependent variable is *liking for history,* the independent variable is the *gender of the teacher.* Possible extraneous variables include the *personality* and *ability of the teacher(s)* involved; the *personality* and *ability level of the students;* the *materials used,* such as textbooks; the *style of teaching; ethnicity* and/or *age of the teacher and students;* and others. The researcher would want to control as many of these variables as possible.

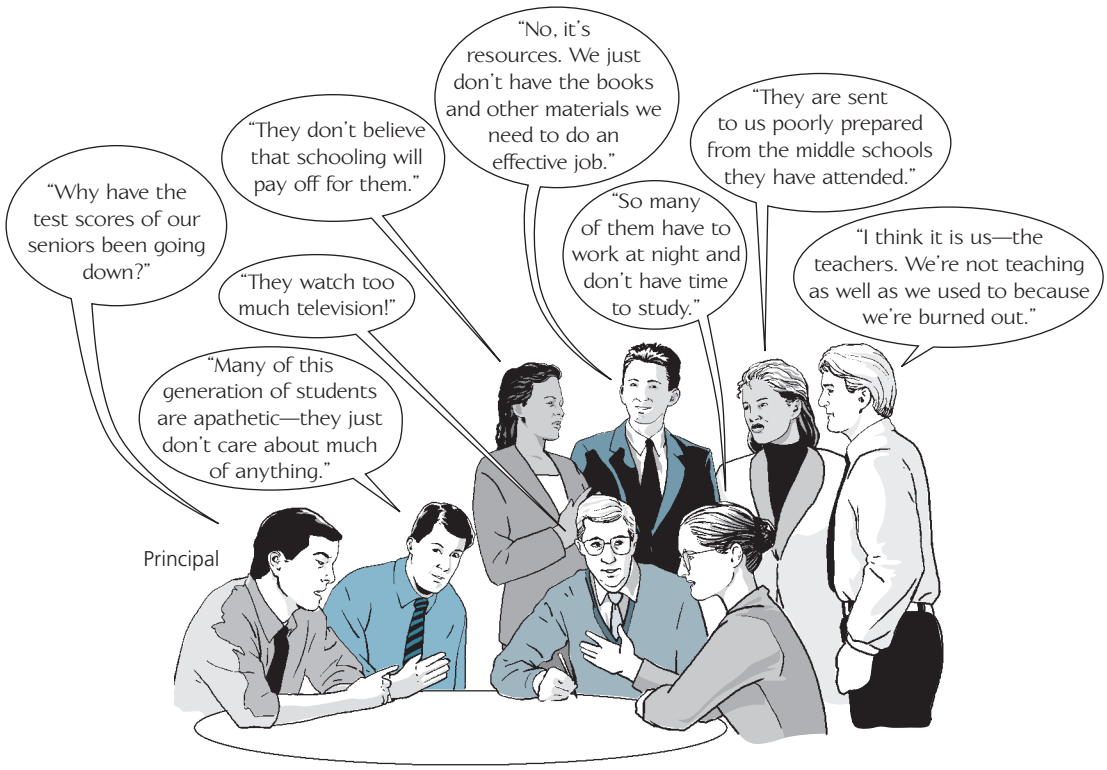


Figure 5.4 *A Single Research Problem Can Suggest Several Hypotheses*

DISADVANTAGES OF STATING HYPOTHESES

Essentially, the disadvantages of stating hypotheses are threefold. First, stating a hypothesis may lead to a **bias**, either conscious or unconscious, on the part of the researcher. Once investigators state a hypothesis, they may be tempted to arrange the procedures or manipulate the data in such a way as to bring about a desired outcome.

This is probably more the exception than the rule. Researchers are assumed to be intellectually honest—although there are some famous exceptions. All studies should be subject to peer review; in the past, a review of suspect research has, on occasion, revealed such inadequacies of method that the reported results were cast into doubt. Furthermore, any particular study can be replicated to verify the findings of the study. Unfortunately, few educational research studies are repeated, so this "protection" is somewhat of an illusion. A dishonest investigator stands a fair chance of getting away with falsifying results. Why would a person deliberately distort his or her findings? Probably because professional recognition and financial reward accrue to those who publish important results.

Even for the great majority of researchers who are honest, however, commitment to a hypothesis may lead to distortions that are unintentional and unconscious. But it is probably unlikely that any researcher in the field of education is ever totally disinterested in the outcomes of a study; therefore, his or her attitudes and/or knowledge may favor a particular result. For this reason, we think it is desirable for researchers to make known their predilections regarding a hypothesis so that they are clear to others interested in their research. This also allows investigators to take steps to guard (as much as possible) against their personal biases.

The second disadvantage of stating hypotheses at the outset is that it may sometimes be unnecessary, or even inappropriate, in research projects of certain types, such as descriptive surveys and ethnographic studies. In many such studies, it would be unduly presumptuous, as well as futile, to predict what the findings of the inquiry will be.

The third disadvantage of stating hypotheses is that focusing attention on a hypothesis may prevent researchers from noticing other phenomena that might be important to study. For example, deciding to study the effect of a "humanistic" classroom on student motivation might lead a researcher to overlook its effect on such characteristics as sex-typing or decision making, which would be quite noticeable to another researcher who was not focusing solely on motivation. This seems to be a good argument against all research being directed toward hypothesis testing.

Consider the example of a research question presented earlier in this chapter: "How do teachers feel about special classes for the educationally handicapped?" We offered two (of many possible) hypotheses that might arise out of this question: (1) "Teachers believe that students attending special classes for the educationally handicapped will be stigmatized" and (2) "Teachers believe that special classes for the educationally handicapped will help such students improve their academic skills." Both of these hypotheses implicitly suggest a comparison between special classes for the educationally handicapped and some other kind of arrangement. Thus, the relationship to be investigated is between teacher beliefs and type of class. Notice that it is important to compare what teachers think about special classes with their beliefs about other kinds of arrangements. If researchers looked only at teacher opinions about special classes without also identifying their views about other kinds of arrangements, they would not know if their beliefs about special classes were in any way unique or different.

IMPORTANT HYPOTHESES

As we think about possible hypotheses suggested by a research question, we begin to see that some of them are more important than others. What do we mean by *important?* Simply that some may lead to more useful knowledge. Compare, for example, the following pairs of hypotheses. Which hypothesis in each pair would you say is more important?

Pair 1

a. Second-graders like school less than they like watching television.
b. Second-graders like school less than first-graders but more than third-graders.

Pair 2

a. Most students with academic disabilities prefer being in regular classes rather than in special classes.
b. Students with academic disabilities will have more negative attitudes about themselves if they are placed in special classes than if they are placed in regular classes.

Pair 3

a. Counselors who use client-centered therapy procedures get different reactions from counselees than do counselors who use traditional therapy procedures.
b. Counselees who receive client-centered therapy express more satisfaction with the counseling process than do counselees who receive traditional therapy.

In each of the three pairs, we think that the second hypothesis is more important than the first, since in each case (in our judgment) not only is the relationship to be investigated clearer and more specific but also investigation of the hypothesis seems more likely to lead to a greater amount of knowledge. It also seems to us that the information to be obtained will be of more use to people interested in the research question.

DIRECTIONAL VERSUS NONDIRECTIONAL HYPOTHESES

Let us make a distinction between directional and nondirectional hypotheses. A **directional hypothesis** indicates the specific direction (such as higher, lower, more, or less) that a researcher expects to emerge in a relationship. The particular direction expected is based on what the researcher has found in the literature, in theory, or from personal experience. The second hypothesis in each of the three pairs above is a directional hypothesis.

Sometimes it is difficult to make specific predictions. If a researcher suspects that a relationship exists but has no basis for predicting the direction of the relationship, she cannot make a directional hypothesis. A **nondirectional hypothesis** does not make a specific prediction about what direction the outcome of a study will take. In nondirectional form, the second hypotheses of the three pairs above would be stated as follows:

1. First-, second-, and third-graders will feel differently toward school.
2. There will be a difference between the scores on an attitude measure of students with academic disabilities placed in special classes and such students placed in regular classes.

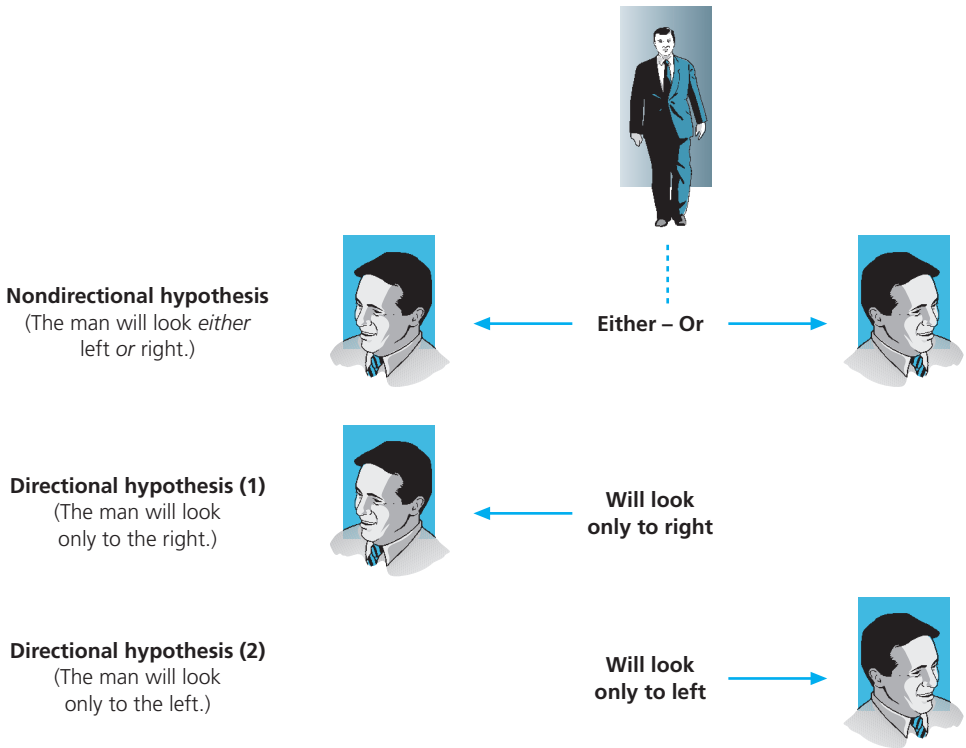


Figure 5.5 *Directional Versus Nondirectional Hypotheses*

3. There will be a difference in expression of satisfaction with the counseling process between counselees who receive client-centered therapy and counselees who receive traditional therapy.

Figure 5.5 illustrates the difference between a directional and a nondirectional hypothesis. If the person pictured is approaching a street corner, three possibilities exist when he reaches the corner:

- He will continue to look straight ahead.
- He will look to his right.
- He will look to his left.

A nondirectional hypothesis would predict that he will look one way *or* the other. A directional hypothesis would predict that he will look in a particular direction (for example, to his right). Since a directional hypothesis is riskier (because it is less likely to occur), it is more convincing when confirmed.*

Both directional and nondirectional hypotheses appear in the literature of research, and you should learn to recognize each.

*If he looks straight ahead, neither a directional nor a nondirectional hypothesis is confirmed.

HYPOTHESES AND QUALITATIVE RESEARCH

What is notable about the formation of hypotheses in qualitative research is that they are typically *not* stated at the beginning of a study, but rather they *emerge* as a study progresses. Rather than testing hypotheses as in quantitative studies, qualitative researchers are more likely to generate new hypotheses as a result of what they find as they go about their work—as they observe patterns and relationships in the natural setting rather than hypothesizing what such patterns and relationships might be beforehand. Many qualitative researchers *do* state some of their ideas before they begin a study, but these are usually called **propositions** rather than hypotheses.[1] Propositions differ from hypotheses in that they are not intended to be tested against the data (as in quantitative research) but rather are viewed as flexible tools intended to help guide researchers in their collection and analysis of qualitative data. The reluctance of qualitative researchers to formulate hypotheses at the beginning of a study is based on their conviction that participants and situations often differ widely and must first be understood before any hypotheses can be suggested.

Go back to the **INTERACTIVE AND APPLIED LEARNING** feature at the beginning of the chapter for a listing of interactive and applied activities. Go to the **Online Learning Center** at **www.mhhe.com/fraenkel8e** to take quizzes, practice with key terms, and review chapter content.

Main Points

THE IMPORTANCE OF STUDYING RELATIONSHIPS

- Identifying relationships among variables enhances understanding.
- Understanding relationships helps us to explain the nature of our world.

VARIABLES

- A variable is any characteristic or quality that varies among the members of a particular group.
- A constant is any characteristic or quality that is the same for all members of a particular group.
- A quantitative variable varies in amount or degree, but not in kind.
- A categorical variable varies only in kind, not in degree or amount.
- Several kinds of variables are studied in educational research, the most common being independent and dependent variables.
- An independent variable is presumed to affect or influence other variables.
- Independent variables are sometimes called *experimental variables* or *manipulated variables*.
- A dependent (or outcome) variable is presumed to be affected by one or more independent variables.
- Independent variables may be either manipulated or selected. A manipulated variable is created by the researcher. A selected variable is one that already exists that the researcher locates and then chooses to study.
- A moderator variable is a secondary independent variable that the researcher selects to study because he or she thinks it may affect the basic relationship between the primary independent variable and the dependent variable.
- An extraneous variable is an independent variable that may have unintended effects on a dependent variable in a particular study.
- A *proposition* is a tentative, flexible statement used sometimes by qualitative researchers to help guide their data collection and analysis.

HYPOTHESES

- The term *hypothesis,* as used in research, refers to a prediction of results usually made before a study commences.
- Stating a research question as a hypothesis has both advantages and disadvantages.
- An important hypothesis is one that is likely to lead, if it is supported, to a greater amount of important knowledge than a nonimportant hypothesis.
- A directional hypothesis is a prediction about the specific nature of a relationship—for example, method A is more effective than method B.
- A nondirectional hypothesis is a prediction that a relationship exists without specifying its exact nature—for example, there will be a difference between method A and method B (without saying which will be more effective).

Key Terms

bias 84
categorical variable 78
constant 77
dependent variable 80
directional hypothesis 85
experimental variable 80
extraneous variable 82
hypothesis 83
independent variable 80
manipulated variable 80
mediator variable 81
moderator variable 81
nondirectional hypothesis 85
outcome variable 81
propositions 86
quantitative variable 77
treatment variable 80
variable 77

For Discussion

1. Here are several research questions. Which ones suggest relationships?
   a. How many students are enrolled in the sophomore class this year?
   b. As the reading level of a text passage increases, does the number of errors students make in pronouncing words in the passage increase?
   c. Do individuals who see themselves as socially "attractive" expect their romantic partners also to be (as judged by others) socially attractive?
   d. What does the faculty dislike about the new English curriculum?
   e. Who is the brightest student in the senior class?
   f. Will students who score above the 90th percentile on a standardized reading test also score above the 90th percentile on a standardized writing test?
   g. Which political party contains the most Protestants—Democratic or Republican?
2. How would you rank the questions in item 1 in terms of significance? Why?
3. What might cause a researcher to state a directional hypothesis rather than a nondirectional hypothesis? What about the reverse?
4. Are there any variables that researchers should *not* study? Explain.
5. It is often argued that we cannot meaningfully measure a variable if we cannot define it. Is this true? always? Discuss.
6. "Commitment to a hypothesis may lead to distortions that are unintentional and unconscious." Would you agree? If so, can you give an example of such a hypothesis?
7. Can you think of a possible study for which it would be presumptuous to predict the outcome?

Note

1. J. A. Maxwell (2005). *Qualitative research design: An interactive approach,* 2nd ed. Thousand Oaks, CA: Sage, p. 69.

Research Exercise 5: Variables, Hypotheses, and Propositions

If you are planning a quantitative study, try to formulate a testable hypothesis that is related to the research question you developed in Research Exercise 2. Using Problem Sheet 5, state the hypothesis in a sentence or two and check to see if it suggests a relationship between at least two variables. If it does not, revise it so that it does. Now indicate which is the independent and which is the dependent variable. Next, list as many extraneous variables as you can think of that might affect the results of your study. On the other hand, if you are planning a qualitative or mixed-methods study, state your proposition(s).

Problem Sheet 5

Variables, Hypotheses, and Propositions

My research question is: _____

1. For a *quantitative* study, my hypothesis is:

   _____

   _____

   _____

2. This hypothesis suggests a relationship between at least two variables:

   a. _____

   b. _____

   c. _____

3. More specifically, the variables in my study are:

   a. Dependent _____ *(Is it categorical or quantitative?—circle one.)*

   b. Independent _____ *(Is it categorical or quantitative?—circle one.)*

4. Possible extraneous variables that might affect my results include:

   a. _____

   b. _____

   c. _____

5. I am planning a *qualitative or mixed-methods study*. The proposition(s) is/are:

   _____

   _____

   _____

An electronic version of this Problem Sheet that you can fill in and print, save, or e-mail is available on the Online Learning Center at www.mhhe.com/fraenkel8e.