Chapter 2

Problems and Hypotheses

Many people think that science is basically a fact-gathering activity. It is not. As Cohen says:

There is . . . no genuine progress in scientific insight through the Baconian method of accumulating empirical facts without hypotheses or anticipation of nature. Without some guiding idea we do not know what facts to gather . . . . we cannot determine what is relevant and what is irrelevant.

The scientifically uninformed person often has the idea that the scientist is a highly objective individual who gathers data without preconceived ideas. Poincaré long ago pointed out how wrong this idea is. He said:

It is often said that experiments should be made without preconceived ideas. That is impossible. Not only would it make every experiment fruitless, but even if we wished to do so, it could not be done.

PROBLEMS

It is not always possible for a researcher to formulate his problem simply, clearly, and completely. He may often have only a rather general, diffuse, even confused notion of the problem. This is in the nature of the complexity of scientific research. It may even take an investigator years of exploration, thought, and research before he can clearly say what questions he has been seeking answers to. Nevertheless, adequate statement of the research problem is one of the most important parts of research. That it may be difficult or
impossible to state a research problem satisfactorily at a given time should not allow us to lose sight of the ultimate desirability and necessity of doing so.

Bearing this difficulty in mind, a fundamental principle can be stated: If one wants to solve a problem, one must generally know what the problem is. It can be said that a large part of the solution lies in knowing what it is one is trying to do. Another part lies in knowing what a problem is and especially what a scientific problem is.

What is a good problem statement? Although research problems differ greatly and there is no one "right" way to state a problem, certain characteristics of problems and problem statements can be learned and used to good advantage. To start, let us take two or three examples of published research problems and study their characteristics. First, take the problem of the study by Hurlock mentioned in Chapter 1: What are the effects on pupil performance of different types of incentives? Note that the problem is stated in question form. The simplest way is here the best way. Also note that the problem states a relation between variables, in this case between the variables incentives and pupil performance (achievement). ("Variable" will be formally defined in Chapter 3. For now, a variable is the name of a phenomenon, or a construct, that takes a set of different numerical values.)

A problem, then, is an interrogative sentence or statement that asks: What relation exists between two or more variables? The answer is what is being sought in the research. A problem in most cases will have two or more variables. In the Hurlock example, the problem statement relates incentive to pupil performance. Another problem, studied in an ingenious experiment by Glucksberg and King, is associated with an adage: We remember what we want to remember, and with Freud's concept of repressed memory items associated with unpleasant events more readily forgotten than neutral items.

One variable is items associated with unpleasantness, and the other variable is remembering (or forgetting). Still another problem, by Jones and Cook, is quite different: Do attitudes toward blacks influence judgments of the effectiveness of alternative racial social policies?

Criteria of Problems and Problem Statements

There are three criteria of good problems and problem statements. One, the problem should express a relation between two or more variables. It asks, in effect, questions like: Is A related to B? How are A and B related to C? How is A related to B under conditions C and D?

The exceptions to this dictum occur mostly in taxonomic or methodological research. (See Appendix A and footnote 6.)

Two, the problem should be stated clearly and unambiguously in question form. Instead of saying, for instance, "The problem is . . . . . . ." or "The purpose of this study is . . . . . . .," ask a question. Questions have the virtue of positing problems directly. The purpose of a study is not necessarily the same as the problem of a study. The purpose of the Hurlock study, for instance, was to throw light on the use of incentives in school situations. The problem was the question about the relation between incentives and performance. Again, the simplest way is the best way: ask a question.

A problem statement should be such as to imply possibilities of empirical testing. A problem that does not contain implications for testing its stated relation or relations is not a scientific problem. This means not only that an actual relation is stated, but also that the variables of the relation can somehow be measured. Many interesting and important questions are not scientific questions simply because they are not amenable to testing. Certain philosophic and theological questions, while perhaps important to the individuals who consider them, cannot be tested empirically and are thus of no interest to the scientist as a scientist. The epistemological question, "How do we know?", is such a question. Education has many interesting but nonscientific questions, such as, "Does democratic education improve the learning of youngsters?" "Are group processes good for children?" These questions can be called metaphysical in the sense that they are, at least as stated, beyond empirical testing possibilities. The key difficulties are that some of them are not relations, and most of their constructs are very difficult or impossible to define that they can be measured.

HYPOTHESES

A hypothesis is a conjectural statement of the relation between two or more variables. Hypotheses are always in declarative sentence form, and they relate, either generally or specifically, variables to variables. There are two criteria for "good" hypotheses and hypothesis statements. They are the same as two of those for problems and problem statements. One, hypotheses are statements about the relations between variables. Two, hypotheses carry clear implications for testing the stated relations. These criteria mean, then, that hypothesis statements contain two or more variables that are measurable or potentially measurable and that they specify how the variables are related.

Let us take three hypotheses from the literature and apply the criteria to them. The first hypothesis seems to defy common sense: Overlearning leads to performance decrement (or, as the authors say: Practice makes imperfect). Here a relation is stated between one variable, overlearning, and another variable, performance decrement. Since the two variables are readily defined and measured, implications for testing the hypothesis, too, are readily conceived. The criteria are satisfied. A second hypothesis is stated in the form of the so-called null form: Practice in a mental function has no effect on the future learning of that function. The relation is stated clearly: one variable, practice, in a mental function statement.

1 Webb, working from a different point of view, has proposed the following criteria of research problems: knowledge of (the researcher); dissatisfaction (seeker, going against the tide, etc.); a generality (wideness of applicability); Webb's article is doubly valuable because he effectively dispenses of irrelevant criteria, such as conformity, credibility ("payola"), conformity ("Everybody's doing it"). W. Webb, "The Choice of Problem," American Psychologist, 16 (1961), 223-227.


THE IMPORTANCE OF PROBLEMS AND HYPOTHESES

There is little doubt that hypotheses are important and indispensable tools of scientific research. There are three main reasons for this belief. One, they are, so to speak, the working instruments of theory. Hypotheses can be deduced from theory and from other hypotheses. If, for instance, we are working on a theory of aggression, we are presumably looking for causes and effects of aggressive behavior. We might have observed cases of aggressive behavior occurring after frustrating circumstances. The theory, then, might include the proposition: Frustration produces aggression. From this broad hypothesis we may deduce more specific hypotheses, such as: To prevent children from reaching desired goals (frustration) will result in their fighting each other (aggression); if children are deprived of parental love (frustration), they will react in part with aggressive behavior. The second reason is that hypotheses can be tested and shown to be probably true or probably false. Isolated facts are not tested, as we said before; only relations are tested. Once hypotheses are relational propositions, this is probably the main reason they are used in scientific inquiry. They are, in essence, predictions of the form that if A, then B.


Problems and hypotheses, then, have important virtues. One, they direct investigation. The relations expressed in the hypotheses tell the investigator, in effect, what to do. Two, problems and hypotheses, because they are ordinarily generalized relational statements, enable the researcher to deduce specific empirical manifestations implied by the problems and hypotheses. We may say, following Allport and Ross: If it is indeed true that people of extrinsic religious orientation (they use religion) are prejudiced, whereas people of intrinsic religious orientation (they live religion) are not, then it follows that churchgoers should be more prejudiced than nonchurchgoers. They should perhaps also have a "jungerian" philosophy: general suspicion and distrust of the world.

There are important differences between problems and hypotheses. Hypotheses, if properly stated, can be tested. While a given hypothesis may be too broad to be tested directly, if it is a "good" hypothesis, then other testable hypotheses can be deduced from it. Facts or variables are not tested as such. The relations stated by the hypotheses are tested. And a problem cannot be scientifically solved unless it is reduced to hypothesis form, because a problem is a question, usually of a broad nature, and is not directly testable. One does not test the questions: Does efficiency enhance organizational effectiveness and profitability? 12 Does differential experience modify the brain? 16 One tests one or more hypotheses implied by these questions. For example, to study the latter problem, one may hypothesize that animals with different levels of experience will have different thicknesses of the brain cortex.
Problems and hypotheses advance scientific knowledge by helping the investigator confirm or disconfirm theory. Suppose a psychological investigator gives a number of subjects three or four tests, among which is a test of anxiety and an arithmetic test. Routinely computing the intercorrelations between the three or four tests, he finds that the correlation between anxiety and arithmetic is negative. He concludes, therefore, that the greater the anxiety the lower the arithmetic score. But it is quite conceivable that the relation is fortuitous or even spurious. If, however, he had hypothesized the relation on the basis of theory, the investigator could have greater confidence in the results. Investigators who do not hypothesize relations in advance, in short, do not give the facts a chance to prove or disprove anything.17

This use of the hypothesis is similar to playing a game of chance. The rules of the game are set up in advance, and bets are made in advance. One cannot change the rules after an outcome, nor can one change one’s bets after making them. That would not be “fair.” One cannot throw the dice first and then bet. Similarly, if one gathers data first and then selects a datum and comes to a conclusion on the basis of the datum, one has violated the rules of the scientific game. The game is not “fair” because the investigator can easily capitalize on, say, two significant relations out of five tested. What happens to the other three? They are usually forgotten. But in a fair game every throw of the dice is counted, in the sense that one either wins or does not win on the basis of the outcome of each throw.

Hypotheses direct inquiry. As Darwin pointed out long ago, observations have to be for or against some view if they are to be of any use. Hypotheses incorporate aspects of the theory under test in testable or near-testable form. Earlier, an example of reinforcement theory was given in which testable hypotheses were deduced from the general problem. The importance of recognizing this function of hypotheses may be shown by going through the back door and using a theory that is very difficult, or perhaps impossible, to test. Freud’s theory of anxiety includes the construct of repression. Now, by repression Freud meant the forcing of unacceptable ideas deep into the unconscious. In order to test the Freudian theory of anxiety it is necessary to deduce relations suggested by the theory. These deductions will, of course, have to include the repression notion, which includes the construct of the unconscious. Hypotheses can be formulated using these constructs; in order to test the theory, they have to be so formulated. But testing them is another, more difficult matter because of the extreme difficulty of so defining terms such as “repression” and “unconscious” that they can be measured. To the present, no one has succeeded in defining these two constructs without seriously departing from the original Freudian meaning and usage. Hypotheses, then, are important bridges between theory and empirical inquiry.

PROBLEMS, VALUES, AND DEFINITIONS

To clarify further the nature of problems and hypotheses, two or three common errors will now be discussed. First, scientific problems are not moral and ethical questions. Are punitive disciplinary measures bad for children? Should an organization’s leadership be democratic? What is the best way to teach college students? To ask these questions is to ask value and judgmental questions that science cannot answer. Many so-called hypotheses are not hypotheses at all. For instance, The small-group method of teaching is better than the lecture method. This is a value statement; it is an article of faith and not a hypothesis. If it were possible to state a relation between the variables, and if it were possible to define the variables so as to permit testing the relation, then we might have a hypothesis. But there is no way to test value questions scientifically.

A quick and relatively easy way to detect value questions and statements is to look for words such as “should,” “ought,” “better than” (instead of “greater than”), and similar words that indicate cultural or personal judgments or preferences. Value statements, however, are tricky. While a “should” statement is obviously a value statement, certain other kinds of statements are not so obvious. Take the statement: Authoritarian methods of teaching lead to poor learning. Here there is a relation. But the statement fails as a scientific hypothesis because it uses two value expressions or words, “authoritarian methods of teaching” and “poor learning,” neither of which can be defined for measurement purposes without deleting the words “authoritarian” and “poor.”

Other kinds of statements that are not hypotheses are position ones are frequently formulated, especially in education. Consider, for instance: The core curriculum is an enriching experience. Another type, too frequent, is the vague generalization: Reading skills can be identified in the second grade; the goal of the unique individual is self-realization; Prejudice is related to certain personality traits.

Another common defect of problem statements often occurs in doctoral theses: the listing of methodological points or “problems” as subproblems. These methodological points have two characteristics that make them easy to detect: (1) they are not substantive problems that spring from the basic problem; and (2) they relate to techniques or methods of sampling, measuring, or analyzing. They are usually not in question form, but rather contain the words “test,” “determine,” “measure,” and the like. “To determine the reliability of the instruments used in this research.” “To test the significance of the differences between the means.” “To assign pupils at random to the experimental groups” are examples of this mistaken notion of problems and subproblems.

GENERATIVITY AND SPECIFICITY OF PROBLEMS AND HYPOTHESES

One difficulty that the research worker usually encounters and that almost all students working on a thesis find bothersome is the generality and specificity of problems and hypotheses. If the problem is too general, it is usually to vague to be tested. Thus, it is scientifically useless, though it may be interesting to read. Problems and hypotheses that are too general or too vague are common. For example: Creativity is a function of the self-actualization of the individual; Democratic education enhances social learning and citizenship; Authoritarianism in the college classroom inhibits the creative imagination of students. These are interesting problems. But, in their present form, they are worse than uselessly scientific, because they cannot be tested and because they give one the spurious assurance that they are hypotheses that can “some day” be tested.

Terms such as “creativity,” “self-actualization,” “democracy,” “authoritarianism,” and so forth are value-free terms that are commonly used in education. They are, in reality, value-laden. To say that democracy is a good thing is to prejudge the matter; to say that it is not is to prejudge it in the opposite way. The same is true of the other terms.

17An almost classic case of the use of the word “authoritarian” is the statement sometimes heard among educators: The lecture method is authoritarian. This seems to mean that the speaker does not like the lecture method and he is telling us that it is bad. Similarly, one of the most effective ways to criticize a teacher is to say that he is authoritarian.
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isn't, and the like have, at the present time at least, no adequate empirical referents. Now, it is quite true that we can define "creativity," say, in a limited way by specifying one or two creativity tests. This may be a legitimate procedure. Still, in so doing, we run the risk of getting far away from the original term and its meaning. This is particularly true when we speak of artistic creativity. We are often willing to accept the risk in order to be able to investigate important problems, of course. Yet terms like "democracy" are almost hopeless to define. Even when we do define it, we often find we have destroyed the original meaning of the term.00

The other extreme is too great specificity. Every student has heard that it is necessary to narrow problems down to workable size. This is true. But, unfortunately, we can also narrow the problem out of existence. In general, the more specific the problem or hypothesis the clearer are its testing implications. But triviality may be the price we pay. While researchers cannot handle problems that are too broad because they tend to be too vague for adequate research operations, in their zeal to cut the problems down to workable size or to find a workable problem, they may cut the life out of it. They may make it trivial or inconsequential. A thesis, for instance, on the simple relation between the speed of reading and size of type, while important and maybe even interesting, is too thin for doctoral study. Too great specificity is perhaps a worse danger than too great generality. At any rate, some kind of compromise must be made between generality and specificity. The ability effectively to make such compromises is a function partly of experience and partly of critical study of research problems.

THE MULTIVARIATE NATURE OF BEHAVIORAL RESEARCH AND PROBLEMS

Until now the discussion of problems and hypotheses has been pretty much limited to two variables, x and y. We must hasten to correct any impression that such problems and hypotheses are the norm in behavioral research. Researchers in psychology, sociology, education, and other behavioral sciences have become keenly aware of the multivariate nature of behavioral research. Instead of saying: If p, then q, it is often more appropriate to say: If p1, p2, ... pn, then q; or: If p1, then q, under conditions x, z, and r. An example may clarify the point. Instead of simply stating the hypothesis: If frustration, then aggression, it is more realistic to recognize the multivariate nature of the determinants and influences of aggression by saying, for example: If high intelligence, middle class, male, and frustrated, then aggression. Or: If frustration, then aggression, under the conditions of high intelligence, middle class, and male. Instead of one x, we now have a set of x's. Although one phenomenon may be the most important in determining or influencing another phenomenon, it is unlikely that most of the phenomena of interest to behavioral scientists are determined simply. It is much more likely that they are determined multiply. It is much more likely that aggression is the result of several influences working in complex ways. Moreover, aggression itself has multiple aspects. After all, there are different kinds of aggression.

Problems and hypotheses thus have to reflect the multivariate complexity of psycho-

logical, sociological, and educational reality. Although we will talk of one x and one y, especially in the early part of the book, it must be understood that contemporary behavioral research, which used to be almost exclusively univariate in its approach, is rapidly becoming multivariate. (For now, "univariate" means one x and one y. "Multivariate," strictly speaking, applies to y. If there is more than one x or more than one y, the word "multivariate" is used, at least in this book.) We will soon encounter multivariate conceptions and problems. And later parts of the book will be especially concerned with a multivariate approach and emphasis.

CONCLUDING REMARKS—THE SPECIAL POWER OF HYPOTHESES

One will sometimes hear that hypotheses are unnecessary in research, that they unnecessarily restrict the investigative imagination, that the job of science and scientific investigation is to find out things and not to belabor the obvious, that hypotheses are obsolete, and the like. Such statements are quite misleading. They misconstrue the purpose of hypotheses.

It can almost be said that the hypothesis is one of the most powerful tools yet invented to achieve dependable knowledge. We observe a phenomenon. We speculate on possible causes. Naturally, our culture has answers to account for most phenomena, many correct, many incorrect, many a mixture of fact and superstition, many pure superstition. It is the business of scientists to doubt most explanations of phenomena. Such doubts are systematic. Scientists insist upon subjecting explanations of phenomena to controlled empirical test. In order to do this, they formulate the explanations in the form of theories and hypotheses. In fact, the explanations are hypotheses. Scientists simply discipline the business by writing systematic and testable hypotheses. If an explanation cannot be formulated in the form of a testable hypothesis, then it can be considered to be a metaphysical explanation and thus not amenable to scientific investigation. As such, it is dismissed by scientists as being of no interest.

The power of hypotheses goes further than this, however. A hypothesis is a prediction. It says that if x occurs, y will also occur. That is, y is predicted from x. If, then, x is made to occur (vary), and it is observed that y also occurs (varies concomitantly), then the hypothesis is confirmed. This is more powerful evidence than simply observing, without prediction, the covarying of x and y. It is more powerful in the bet-having-game sense discussed earlier. The scientist makes a bet that x leads to y. If, in an experiment, x does lead to y, then he has won the bet. He cannot just enter the game at any point and pick a perhaps fortuitous common occurrence of x and y. Games are not played this way (at least in our culture). He must play according to the rules, and the rules in science are made to minimize error and fallibility. Hypotheses are part of the rules of the game.

Even when hypotheses are not confirmed, they have power. Even when y does not covary with x, knowledge is advanced. Negative findings are sometimes as important as positive ones, since they cut down the total universe of ignorance and sometimes point up fruitful further hypotheses and lines of investigation. But the scientist cannot tell positive from negative evidence unless he uses hypotheses. It is possible to conduct research without using hypotheses, of course, particularly in exploratory investigations. But it is hard to conceive modern science in all its rigorous and disciplined fertility without the guiding power of hypotheses.

Study Suggestions

1. Use the following variable names to write research problems and hypotheses: frustration, academic achievement, intelligence, verbal ability, race, social class (socioeconomic status), etc.
reinforcement, teaching methods, occupational choice, conservatism, education, income, authority, need for achievement, group cohesiveness, obedience, social prestige, permissiveness.

2. Eight problems from the research literature are given below. Study them carefully, choose two or three, and construct hypotheses based on them:

(a) If people are given more time than necessary to do a task, will they continue to take more time than necessary on subsequent similar tasks?

(b) Does organizational climate affect administrative performance?

(c) Is comprehension of text facilitated by constructing meaningful elaborations of the text?

(d) Do colleges discriminate against women applicants?

(e) How does equalization of extrinsic environmental factors and conditions affect the mental performance of school children?

(f) Are "natural" categories of color and form developed around basic prototypes (basic colors, basic forms) more readily learned than less prototypical categories?

(g) What is the influence of massive rewards on the reading achievements of potential school dropouts?

(h) Does extrinsic reward undermine intrinsic motivation?

3. Eight hypotheses are given below. Discuss possibilities of testing them. Then read two or three of the studies to see how the authors tested them.

(a) The greater the cohesiveness of a group, the greater its influence on its members.

(b) The greater the state control of the economic system, the lower the level of democracy of the political system.

(c) Revolutionary leaders who are successful before and after the success of the revolutionary movement exhibit a low level of conceptual complexity before the revolution and a high level of complexity after its success.

(d) Role conflict is a function of incompatible expectations placed on or held by the individuals.

(e) Prejudiced (anti-Semitic) subjects, when frustrated, will displace aggression on to individuals not necessarily related to the source of the frustration.

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(f) Teachers who are perceived by students as dissimilar (to the students) in traits relevant to teaching are more attractive to students than teachers perceived as similar.

(g) The more continuous and unlagging the provisions of lessons, the greater the task involvement of pupils.

(h) Vivid information is better remembered than pallid information and is more likely to influence subsequent inference.

4. Multivariate (for now, more than two variables) problems and hypotheses have become common in behavioral research. To give the student a preliminary feeling for such problems, we here append several of them. Try to imagine how you would do research to study them:

(a) What are the relative contributions to the verbal achievement of white and black elementary school pupils of home background, school facilities, and pupil attitudes?

(b) How do self-esteem, educational attainment, and family background influence occupational attainment?

(c) How does communication, urbanization, education, and agriculture influence the political development of nations?

(d) How do ethnic group membership and home learning environment relate to mental ability?

(e) How does air pollution and socioeconomic status effect pulmonary mortality?

(f) Do primary candidates' campaign expenditures, regional exposure, and past performance influence voting outcomes in primary elections?

(g) How do sex-role stereotyping, sexual conservatism, adversarial sexual beliefs, and acceptance of interpersonal violence affect attitudes toward rape and sexual violence?

(h) How is rank in the U.S. Civil Service related to social class, race, and sex?

(i) How do home conditions, classroom processes, and peer group environment influence science and mathematics achievement and attitudes?

(j) Does stimulus exposure have two effects, one cognitive and one affective, which in turn affect liking, familiarity, and recognition confidence and accuracy.

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