

Chapter 2 Psychometrics: Measurement

When measuring distance, a ruler in feet or meters can be used; to measure weight, a scale is used. After a unit of instruction, teachers, trainers, and professors usually administer an examination to ascertain what and how much an individual and/or the group learned. These research applications don't typically require theory driven instrumentation, but do follow a standard measurement procedure and rely on variables. For example, in the classroom what is learned may be called a dependent variable, because it is measured; the curriculum (i.e., what is taught) an independent variable, because it is intended to impact the learning; and the instructor a moderating variable, since the instructor can impact (positively or negatively) learning as well as the curriculum. The assessment of instructional effects is rarely theory driven.

For more complex research purposes, e.g., measuring intelligence, a theory-based instrument (i.e., data collection tool) is required. Theories are built, based on logical analysis and empirical research. Once the theory has been fully developed and described, it must be tested to determine whether or not it explains or predicts behavior or other phenomena as intended. An instrument based upon a theory, would be constructed possessing measurement items which, when grouped as theorized, comprehensively describe the theory. Data are next collected using the data collection tool (i.e., measure, instrument, index, scale, test, etc.) measure; these data are then statistically treated so that the theory may be tested, further refined, revised, etc. Theory driven research employs variables which can be measured.

Program evaluation may or may not be theory driven. In either case, an understanding of the process of constructing a theory and the role of variables in measurement is critical. Because variables are essential to the design of an evaluation research study, regardless of its complexity or theoretical basis. We will first examine some basic measurement concepts and then the types and roles variables play in any type of research. We will also examine the formulation of program evaluation research questions and hypothesis.

I. Measurement Basics: Concepts + Constructs = Theory

A. Concepts and Constructs

1. Concepts
 - a. Concepts are words with an implied or understood meaning or symbols which are commonly accepted as labeling a specific event, situation, behavior, attitude, value, etc. Examples include: walking, eating, reading, telephone, paying taxes, Christmas, being ill, \$, etc.
 - b. A concept can be measured, either directly or indirectly. Measures of concepts tend to be simple, such as distance, weight, or height. A concept is the building block of a construct.
2. Constructs
 - a. Concepts are combined into constructs. Constructs are not directly measurable or observable. Constructs range from the simple to complex and vary in levels of abstraction. Constructs are the building blocks of theory.

- b. Researchers use the terms construct and variable interchangeably; however there is a difference. Constructs are not observable and can not be measured directly; variables are observable and can be directly measured. Variables are discussed in detail below.
- c. How concepts relate to one another within the context of a construct is described by propositions (specific relationships between and among constructs) which will be either true or false. For example:
 - (1) McGregor (1960) posited that managers are either Theory X or Theory Y. These are examples of two constructs.
 - (a) A Theory X manager is described as one who believes workers are only money motivated, must be closely supervised, don't want to work, and that a manager must be autocratic. This brief summary of the Theory X construct (management orientation) is composed of four concepts.
 - (b) A Theory Y manager is one who believes workers want to work, require more than money to be motivated, don't generally need close supervision, and want to participate in decision-making. This characterization of the Theory Y construct is composed of four concepts.
 - (c) Reddin (1967) added the effectiveness dimension (which propositioned that a manager can be equally effective (concept) in applying Theory X or Theory Y depending on the circumstances (concept) and worker characteristics (concept). For example high knowledge workers (scientists, teachers, nurses, doctors, lab technicians, etc.) respond better to Theory Y approaches, but depending on behavior (not showing up at work, being rude, etc.) may need to be confronted in a Theory X style so that the behavior is corrected.
 - (2) Maslow's Needs Hierarchy (1970) is composed of five constructs; physiological needs, security needs, social needs, esteem needs, and self-actualization needs. In turn each of the five constructs is composed of concepts. For example the physiological needs construct is comprised of the need for water, food, shelter, clothing, transportation, etc. Once physiological needs are met, a person has a need to secure the means of meeting his or her physiological needs. Once physiological and security needs are met, social needs are manifest and so on.

B. Theory

1. Kerlinger (1986, p. 9) defines theory as "...a set of interrelated constructs ([or] concepts), definitions, and propositions that present a systematic view of phenomena [e.g., consumer, employee, manager, leader, administrator, or student behavior] by specifying relations among variables with the purpose of explaining and predicting the phenomena."

- a. A theory must specify the relationships between and among its component constructs; the expression of these relationships are called propositions. Propositions are either true or false.
 - b. All theories must be testable. In order for a theory to be “tested” its constructs must be operationally defined and their interrelationships specified.
 - (1) Operational definitions specify the construct’s characteristics and how those characteristics are to be observed.
 - (2) Operational definitions and propositions are the basis for constructing measures. Measures (i.e., scales or indexes) are used to measure the theory as it is found in a contrived or natural state.
 - c. We try to disprove theories, as it’s impossible to prove them because all potential influencing factors or variables can not be taken into account. If, after a substantial number of soundly designed tests, the theory is not disproven, it is generally accepted as being valid. For example, scientists and health organizations argued that smoking causes various forms of cancer and that nicotine is addictive or decades. Others very strongly denied these assertions. We now know through scientific research and a preponderance of the evidence that smoking does cause specific types of cancer and that nicotine is highly addictive.
2. A way to explain how constructs are related and/or to explain behavior is to construct a theoretical model. Models are used to explain, understand, predict, or control a phenomenon. Modeling requires empirical testing using Path Analysis, LISREL and other advanced statistical testing procedures, to determine the degree to which the collected data fit the model as posited. Models might include theories of consumer purchasing, why adults go to college, how organizations behave, etc.
 - a. Cross (1981, p. 124) proposed the Chain of Response (COR) Model to explain how and why adults return to formal schooling after years of absence.
 - (1) The COR Model is a composed of seven constructs and a description of their inter-relationships. Cross argues that adults who have a positive evaluation of their ability to be successful in the real or virtual classroom (Point A) and who have had positive educational or training experiences (Point B) are ready to negotiate Points D and C. An adult considering returning to higher education is assumed to have important goals and a reasonable expectation that participating in formal study will contribute to meeting those goals (Point C). Further he or she must be in life circumstances (Point D) which permit enrollment in formal study in order to achieve those goals. Once Points A-D have been negotiated, the adult must identify and overcome barriers to enrollment and capitalize upon opportunities (Point E); relevant information (Point F) is critical at this juncture. Once Points A-F have been successfully negotiated, he or she is able to participate.

- (2) The arrows in Figure 2.1 specify which construct influences which other construct at specific points in the model. Points A and B interact, as do Points C and D, as well as Points E and F. Participation experience feeds back into the interaction between Points A and B. Points A, C, and E influence directly Point G, and in turn, influence each other.
- b. Presented in Appendix 4.7 is an instrument, The Academic Credit Participation Index, which tested Cross' theory whose data were factor analyzed. The factor analysis confirmed the COR model.
3. Another way for a theory to be constructed is for it to emerge from the data.
 - a. Here, (a) data are gathered; (b) a researcher looks for uniformities (also called patterns or regularities) in the data; and (c) once found, a theory is then constructed, based on those uniformities to bring order to the data, i.e., explain the phenomenon under investigation.
 - b. This approach does not rely on constructs, but is grounded in empirical data gathered before model construction. This application is widely used in qualitative research.
4. In the social and behavioral sciences, we usually specify how constructs are related, based on research, as in Figure 2.1 to form a theory, which is then tested or the theory emerges from the qualitative data collected, which is then examined for interpretative validity and trustworthiness. However, other professions refer to theory differently. For example, attorneys and law enforcement personnel develop what is called a theory of the crime. By this they mean why and how the crime was committed. They then collect evidence to prove or disprove their theory in order to convict the guilty party or parties.

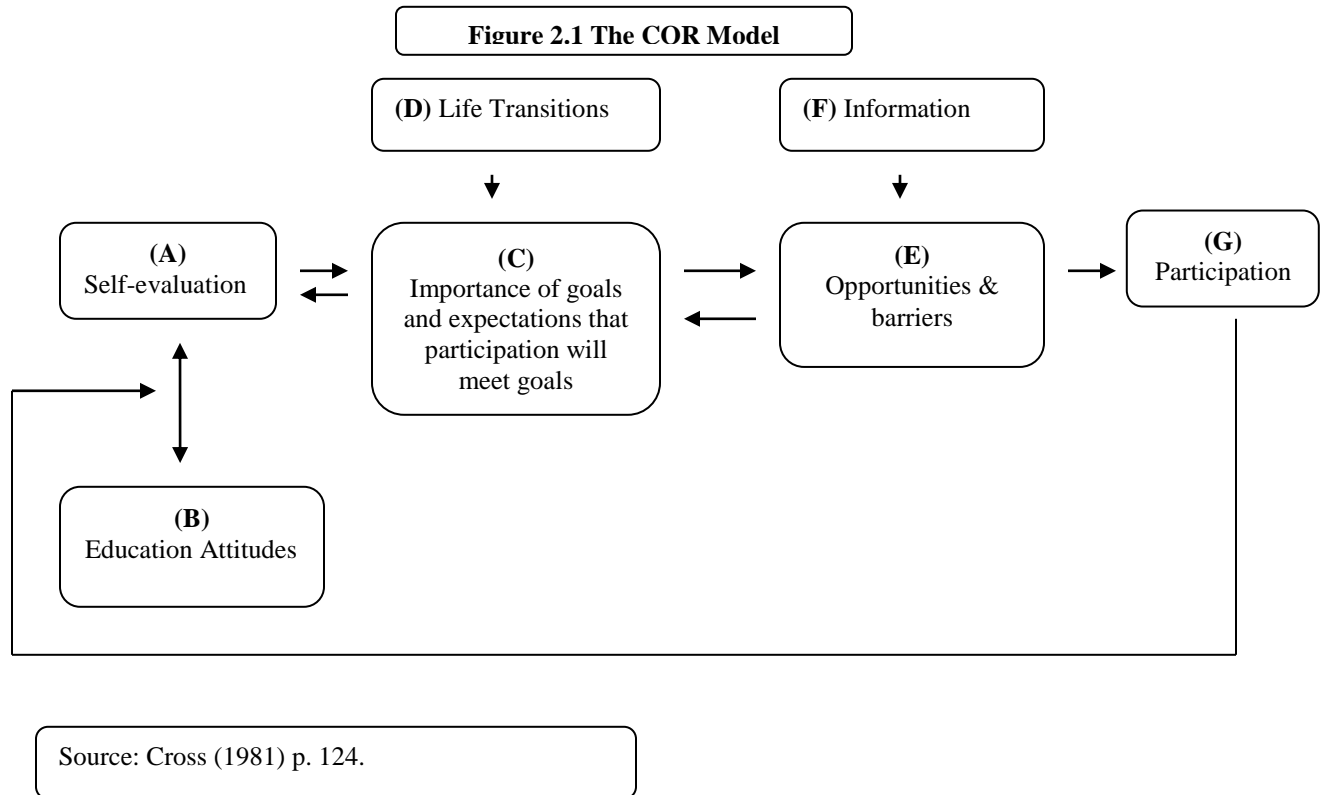
II. Measurement Basics: Variables

A. Introduction

1. Variables play a central role in research.
2. Constructs are never directly observable; it is necessary to identify indicators, observables, etc. for the construct.
 - a. The term "variable" and "construct" are often used interchangeably; or the term, "variable" is used to specify a single indicator or observable, which is part of a construct's operational definition.
 - (1) Part II (The Academic Credit Participation Index) of the survey instrument in Appendix 4.1 assesses each point of the COR model found in Figure 2.1. There are six subtests, one for each COR model construct. For example, subtest A is composed of 10 observables or variables; subtest C is composed of 9 observables or variables.
 - (2) In this example each variable is actually a concept. Thus, construct A (self-evaluation) is composed of 10 concepts. Construct D (life transitions) is defined by 11 concepts. Combined, these concepts comprise each construct's operational definition. The items presented

in each subtest of the Academic Credit Participation Index were drawn directly from the operational definition of each construct.

- (3) The reader is cautioned in that he or she will not always find a one-to-one correlation between a concept and a variable in research instruments, articles, or reports.



b. Operational Definitions

- (1) The definition of variables at either the concept or construct level must be based on related research, rational analysis, and professional expertise.
- (2) Operational definitions explicitly specify variable attributes or characteristics which function as indicators.
 - (a) Indicators serve as guides for constructing items to be used on a survey, test, scale, index, etc.
 - (b) The specification should be so clear that a knowledgeable colleague would know what you intend to measure.
 - (c) These indicators or observables must be measurable, because, it is based upon these measurements that inferences or judgments about the construct or theory and its viability (i.e., to explain, understand, predict, or control, behavior or other phenomena) are made.
- (3) General Types of Variables
 - (a) A dichotomous variable has two values where one value possesses an attribute or characteristic and the other does not. Examples

include gender (male or female), liberal or conservative, student or non-student, employed or unemployed, etc. Dichotomous variables are often coded as 0 or 1.

- (b) Categorical or discrete variables are similar to dichotomous except that more than two values are possible but each category must be mutually exclusive. Examples are not working, working part-time, working full-time; freshman, sophomore, junior, senior; Catholic, Protestant, Jewish, Islamic, Taoist, Animist; A, B, C, D, F; and Canadian, American, Mexican, Chinese, Irish, Egyptian, Vietnamese.
- (c) Continuous variables are those which can assume any value within a specified range or extend into infinity. Examples are income, exam scores, age, height, weight, shoe size, temperature, etc.

B. Independent and Dependent Variables

1. There are several generic research variable classification schemas or taxonomies just as there are literally trillions of potential research projects (Cooper & Schindler, 2003; Kerlinger, 1986; Salkind, 1997; Wiersma, 1995). Each taxonomy system classifies variables somewhat differently but the information is essentially the same. For ease of understanding, we'll adapt the Cooper and Schindler (2003) schema:
 - a. The independent variable is manipulated so that its effect or impact on the dependent variable may be measured.
 - b. There are moderating and extraneous variables which may exert influence on how the independent variable affects the dependent variable.
 - c. Intervening (or moderating) variables help explain the relationship between the independent and dependent variables, by "hiding" other moderating variables. For example, educational attainment, may hid the effect of income on the dependent variable, "health status." We know that higher levels of education are positively associated with higher income. Generally, those with higher incomes have better health; they can access health services more easily and frequently than those with less money.
2. The Independent Variable

The independent variable (IV) is manipulated to examine its impact on a dependent variable. It is also called a treatment, factor, stimulus, antecedent, or predictor variable. An independent variable must be fully (i.e., operationally) defined so that it is fully understood by the researcher and other knowledgeable readers; this is necessary for research replication.

 - a. Quantitative or Qualitative
 - (1) Quantitative independent variables differ in amount, e.g., number of hours spent studying per week or number of call backs to close a sale.
 - (2) Qualitative independent variables differ in category, e.g., male or female, education level, ethnicity, geography, etc.

- b. Active or Assigned
 - (1) An independent variable is active if the researcher can control which value of the IV is exerted on the dependent variable. For example, a training group was formed and trainees were sorted into three sub-groups based on intensity of training (low, medium, or high) and later a test was given. The independent variable is considered "active" because the researcher sorted trainees into the three sub-groups also called levels. The dependent variable would be the amount of learning which is measured by the test.
 - (2) An independent variable is said to be assigned if the subject possesses values of the variable, e.g., gender (male or female), intelligence (low, medium or high), learning style, other physical characteristics, prior experience, prior performance, etc.
 - (a) Most demographic, occupational, and academic characteristics are assigned independent variables if the effect of the characteristic on the dependent variable is of interest. These preexisting assigned variables (e.g., characteristics) have been called organismic variables.
 - (b) Demographic variables such as age, gender, race, ethnicity, and educational level are often treated (assigned) as independent variables in survey research, as are occupational and academic characteristics.
- 3. The Dependent Variable
 - a. The dependent variable (DV) is the variable that is measured to ascertain the effect of the independent variable(s) on it.
 - b. The DV is what is measured. Other names include: outcome, results, consequence, or criterion variable. Remember that a dependent variable must be fully (i.e., operationally) defined so that it can be measured.
- 4. Independent and Dependent Variable Examples
 - a. Customer Service Training Program
 - (1) Situation. Your Company has employed a large group of entry level customer service representatives. Your company has a three week customer service representative (CSR) training program for new hires; two weeks are classroom training and three weeks are practical (e.g., on-the-job-training). The trainees must pass a customer service proficiency test before entering the practical portion of the CSR training program.
 - (2) Independent Variable. Suppose we were attempting to answer the question, "Is the classroom component of the CSR training program effective in preparing CSR trainees for their practical training as measured by an examination? In this instance, the class room training program is your independent variable.

- (3) Dependent Variable. When evaluating the effectiveness of an educational or business training program, participants are typically administered an examination over the materials and skills which they were expected to learn. From the examination, a test score is used to reflect the degree of examinee mastery of the knowledge and skills which were to be learned. In this instance, CSR trainee performance (i.e., knowledge) as measured by the examination is your dependent variable. Dependent variables are measured and are affected by the independent variable(s).
- b. English Language Training
- (1) Situation. Your insurance company is planning to open an office in Beijing, China. Since the home office and virtually all of the back-office operations are in the US, Beijing employees (sales agents, support personnel, supervisors, and executives) must be bi-lingual. A conversational English language proficiency test is given to applicants. Those passing the conversational English test are eligible for employment, after more training. After hiring, some employees attend a two week intensive insurance English course; those passing the course go onto work. Some employees complete the same insurance English course by attending sessions three nights each week over a four week period and completing assignments out-side-of-class. Those failing either course either attend remedial sessions or are let-go.
- (2) Independent Variable. We are interested in answering the question, “Is the evening insurance English class as effective as the two week class?” As in the CSR example, the independent variable is the insurance English course. The added dimension is the evening class sessions.
- (3) Dependent Variable. The dependent variable is insurance English proficiency (i.e., achievement as measured by test resulting in a test score, which is interpreted). Please remember that how the dependent variable is to be measured is often not specified in either evaluation research questions or hypotheses, but should be.
- c. Employee Turn-over
- (1) Situation. A school district in the mid-west with 5,800 teachers, administrators, and support personnel is experiencing an annual 20% turn-over rate, when surrounding districts report a 9% average. Each employee group has very different job responsibilities, but has the same job benefits and holidays during the school year. The school board has hired a consulting company to assess reasons for such high turn-over rates. The consulting company decides to develop a survey instrument to assess employee satisfaction with wages, hours, working conditions, and benefits. The employee turn-over research indicates that the vast majority of employees leave due to dissatisfaction with hours and working conditions. Personal reasons play a small role. A

portion of the survey instrument asks respondents whether or not they are thinking about leaving. Respondents contemplating leaving are asked about the importance of several reasons (which have already been given by those who have already exited the school district).

- (2) Independent Variable. One question we want to answer is, “Do the reasons for considering leaving differ by employee group?” In this research question, we have three assigned independent variables: teachers, administrators, and support personnel. We have three IV’s because we want to know how each group differs (if at all) regarding reasons for considering exit. It is very common practice in survey research to sort or group responses by demographic or occupational characteristics.
- (3) Dependent Variable. One question we want to answer is, “Do the reasons for considering leaving differ by employee group?” Depending on how the survey instrument is constructed and scored, we could compute a “considering exit score.” Those individuals scoring highest are presumed to have the greatest likelihood of leaving. “The importance of reasons for leaving,” expressed as a score, is the dependent variable because we want to know which employee group has members who are most likely to leave.

d. Productivity Problem

- (1) Situation. Your company relies on several organizational-wide and job classification productivity indicators. The vice-president for operations has noticed that most of these indicators have been trending downward over the past three months; she is concerned. A comprehensive employee morale survey is conducted; one of the findings is that workers, particularly administrative support employees, have too many personal demands on their time and that frequently these demands carry over to the workplace. The vice-president researched the business literature looking for possible solutions, finding two: telecommuting and compressed work week. She developed a proposal for the CEO to test the effect of both strategies on productivity improvement.
- (2) Independent Variable. Here, the VP wants to answer three questions, “Will telecommuting improve administrative support employee productivity?”; “Will a compressed work week improve administrative support employee productivity?” and “Which improves productivity more, telecommuting or compressed work week?” For these three research questions, we have two independent variables: telecommuting and compressed work week.
- (3) Dependent Variable: For these three research questions, we have one dependent variable: productivity. Productivity must be carefully defined in terms of what benefits the employees and firm most.

5. Independent and Dependent Variables: The Relationship
 - a. Researchers attempt to measure the effect of an independent variable on a dependent variable. Both are known by many other names.
 - b. Alternative Names include (IV, DV) cause, effect; stimulus, response; predictor, criterion; antecedent, consequent; or treatment, effect.
 - c. What every researcher or consumer of research must remember is that there are always alternative explanations for how a dependent variable behaves, other than the effect of its independent variable upon it. That is why explicit operational definitions of each independent and dependent variable are essential and that research must be replicated to demonstrate consistency of findings.
 - d. Other variables (moderator or extraneous) may affect the IV-DV relationship. Depending on the strength and direction of the relationship with the IV or DV or both, these variables may inflate (bias), deflate (suppress) or render the IV-DV relationship spurious (i.e., account for all the observed IV-DV relationship). These three categories of “noise” variables introduce variability in the dependent variable which is unrelated to the independent variable.

C. Research Variables: Moderating, Extraneous, and Intervening Variables

1. Moderating and extraneous variables are sometimes called the “3rd variable.” These 3rd variables can be related to either the IV, DV or both.
 - a. Moderating variables are usually related to the independent variable (but can be related to the dependent variable) and have a direct effect on the dependent variable. In effect, a moderating variable changes the relationship between the IV and DV, unless its effects are controlled (i.e., removed from the relationship) or mitigated (i.e., lessened).
 - b. Some authors suggest that a moderating variable is a “second independent variable.” Sometimes moderating variables are self-evident; sometimes their presence is inferred based on the researcher’s expertise, knowledge of the topic, and/or literature associated with the study.
 - c. Control and Confounding Moderating Variables
 - (1) A “control” moderating variable affects the IV-DV relationship, but is related to the dependent variable. Intelligence plays a role in achievement testing, common in both education and training; more intelligent people tend to score higher on achievement tests than the less intelligent, regardless of the content. Intelligence in this example is related to the dependent variable which is content mastery or knowledge.
 - (2) An uncontrolled or insufficiently controlled moderating variable is a “confounding variable” which may be related to both the independent and dependent variable.
 - (a) It changes the IV-DV relationship as it could amplify the effect of the DV on the IV and/or mask (or minimize) an effect of the DV on the IV.

- (b) The confounding variable isn't part of the hypothesized relationship between the IV and DV; but is related to one or both. Interpretation is complicated as it's difficult to separate the individual and/or interactive effects of IV and confounding variable on the DV.
 - (c) For example, "What is the primary cause of heart disease?" A research team proposes to answer this question.
 - [1] The research team identifies patients with heart disease; they learn that these patients ate a diet high in cholesterol and smoked over 1 pack a day. Using multiple regression, they were able to separate the individual effects of each of the 2 independent variables as well as their interactive (combined) effect.
 - [2] They presented their findings to peers who were critical. The peers pointed out that the researchers failed to examine age which is positively related to heart disease, lack of exercise, and heavy alcohol consumption. Did the patients develop heart disease because of the 2 IV's and/or because they were old or for another reason?
 - [3] In this case age, lack of exercise, and heavy alcohol consumption are confounding variables as they complicate or confound the team's understanding of the IV-DV relationship because of their unrecognized and uncontrolled effect on the dependent variable.
 - (d) Some authors use the terms, "moderating" and "confounding" variables interchangeably. Additionally, some use the terms "confounding" and "intervening or mediating" interchangeably. Remember that moderating and confounding variables affect the IV-DV relationship. Intervening or mediating variables don't. To avoid confusion, be familiar with the terminology used in your discipline's professional and empirical literature.
2. Controlling Moderating and Extraneous Variable Effects
- a. When a researcher attempts to control (i.e., eliminate or reduce) the effects of moderating and extraneous variables, he or she is attempting to remove the effects of any of those variables upon the dependent variable, leaving only the effect of the independent variable.
 - b. Identify probable moderating variables. When planning to study an IV-DV relationship, identify all other variables that may probably influence the DV aside from the IV. An almost endless list of moderating variables can be generated for any research question or hypothesis. Additionally, one researcher may specify a variable as a moderator, while another would not. Have a reason for your moderating variable identification based on logical analysis, prior research, professional expertise, and the agreement of 2 or 3 knowledgeable colleagues.

- c. Specific Control Strategies
- (1) Revise the research question or hypothesis. Whether a variable is an IV or MV depends on the research question or hypothesis. Carefully craft your research question or hypothesis so that it is explicitly clear what the independent variable is. You may find adding the moderating variable to the research question (acts a filter to more clearly identify the sample or population, you study) to be most helpful. See the examples below.
 - (2) Use randomization in sampling. Use a randomly selected sampling strategy and a research design which employs random assignment to a control or use a comparison group, if possible.
 - (a) Subjects are randomly selected into the researcher's sample. Random selection of subjects ensures that the research sample is likely to be representative of the population. Representativeness allows for generalization and an assertion that any operating moderating, extraneous, or intervening variables are no more present in the sample than within the population from which the sample was drawn.
 - (b) After subjects are randomly selected, they may be randomly assigned to a treatment or control group. The argument is made that moderating, extraneous, or intervening variables are equally representative in the treatment and control groups, essentially, "cancelling out their effects."
 - (c) There is always some sampling error which is estimated. A decision is made based upon prior research and professional expertise as to whether or not the sampling error is of sufficient size to exert more than a minor deleterious effect, if any.
 - (3) Use instrumentation of known appropriate reliability and validity, if possible. If an instrument's reliability and validity are unknown, conduct a field-trial of the instrument and establish at a minimum its internal consistency reliability and content validity over the knowledge and/or skills to be learned or a theory.
 - (4) Make judicious use delimitations and/or limitations.
 - (a) Sample delimitation is the most common. Here, the researcher simply states that he or she will not study or include in the study certain variables. Limitations maybe imposed upon a research study over which the researcher has no control. Examples are:
[1] You want to conduct an employee satisfaction survey and include all 9,000 employees in your company at a cost of \$10.00 each. Your boss says no, due to cost, and tells you to draw a sample of 900 employees. This is a limitation, as you had the narrowing of your study imposed on you.

- [2] You want to draw a profile of potential customers who are likely to purchase your new series of pork products. Since there are religious and philosophical groups who don't consume pork, you might identify those and delimit (i.e., exclude) them from your study when assessing pleasing taste and texture characteristics. This is a delimitation, as you selected this constraint.
- [3] Your company wants to sell high-end cars. When organizing focus groups to identify desirable amenities, color, etc., you exclude households making less than \$75,000 per year. Households making less than that are unlikely to be able to purchase your product. This is a delimitation as you made the choice.
- (5) Carefully and clearly specify evaluation study assumptions
- (a) Another strategy is specification of key assumptions. It is important that all delimitations, limitations, and assumptions are clearly stated.
- (b) Two examples are:
- [1] When conducting surveys or opinion polls, one frequently hears the refrain, "How do you know they are telling you the truth?" The fact is a surveyor rarely does. So we assume that survey subjects will tell the truth. Matter solved.
- [2] Trend studies are conducted over a fairly long period of time. There is evidence that people are less gloomy during the summer than winter. Thus, we might expect that more negative responses will be provided during the winter than the summer. One way to "control" for this possible effect is to assume that subject's responses are independent of season of year.
- (6) Employ statistical controls. There are statistical strategies or techniques which are used to control the effects of operating moderating, extraneous, or intervening variables.
- (a) These statistical procedures include:
- [1] Analysis of Covariance (ANCOVA)
- [2] Partial and Semi-Partial Correlations
- [3] Multiple Regression
- [4] Factorial Analysis
- [5] Path Analysis
- (b) While discussions of any one of these are beyond the scope of the present work, a brief comment on ANCOVA will illustrate. ANCOVA is used in research designs where a pretest and posttest are given or where only a posttest is administered. ANCOVA statistically equates the experimental and control groups on the dependent variable, so that any differences between groups as a

result of the manipulation of the independent variable will be more easily detected.

- d. Some research questions do not permit use of a probability sampling strategy (i.e., random selection or assignment); so, other strategies must be implemented. Random assignment is not possible with comparison groups, used in pre-experimental or quasi-experimental designs; so, the use of statistical control is essential. Sometimes controlling moderating variables just isn't possible; so, say so and why you believe this and move on. The reader should be advised to interpret the results cautiously.
3. Extraneous Variables (EV)
 - a. An extraneous variable is usually unrelated to the study design, but may be present. There are literally 1000's of these and their effect on the IV-DV relationship is usually either non-existent or minimal. Some authors use the terms, "moderating" and "extraneous" variables interchangeably.
 - b. An extraneous variable is related to either the independent or dependent variable, but is not intended as part of the research study. The control strategies for extraneous variables are the same as moderating variables.
 - (1) Extraneous variables have been called threatening, confounding, or control variables. Regardless of the term, if the variable "behaves" as described in the definition, it's an extraneous variable.
 - (2) What makes a variable moderating or extraneous depends significantly on the circumstances of the study and the DV-IV relationship. If we are able to identify one variable more likely than the others to have an effect on the DV, then we would classify that as a moderating variable.
 4. Intervening (or Mediating) Variables
 - (a) An intervening variable is usually caused by the relationship between the independent variable and the dependent variable. Intervening variables are helpful in explaining the relationship between the IV and DV. Think of the relationship this way: IV ----Intervening Variable ----DV.
 - (b) Intervening variables are also called mediating variables. Unlike a confounding variable, intervening variables don't affect the IV-DV relationship; intervening variables exist because of the relationship.
 - (1) Take for example globalization and the declining US middle class. Globalization (IV) has shifted high paying unionized manufacturing jobs (intervening variable) to lower wage countries resulting in fewer middle class families (DV). Globalization causes fewer middle class families because of manufacturing job-shifting. To increase the number of middle class families, local and central governments might invest in high technology job training as these jobs tend to be highly paid.
 - (2) More years of formal education (IV) is usually associated with higher income. Major or job choice is an intervening variable as an accountant with a bachelor's degree will typically make more money

than a teacher with a bachelor's degree. With this knowledge, we are better able to understand the relationship between formal education and income.

- (3) Job training is associated with increased job readiness. While a job training program (IV) may be given credit for producing high scores on an job readiness (DV) scale, it might be that the training program was poorly designed and taught, but participants were very highly motivated (intervening variable) as they had been unemployed for a long time. Their motivation to achieve overcame the effects of poor instructional design and teaching. This information is critical to improving the job training program.
 - (4) Crime rates and ice cream consumption are positively related. Does eating ice cream causes rising crime rates? One would need to examine the effects temperature as it mediates crime rates (which go up on hot days) as does ice cream consumption. So, eating ice cream doesn't cause crime rate increases; warm temperatures contribute as more people are out and about.
- (c) In designing evaluation research, we try to uncover and measure the effect of intervening or mediating variables to more accurately understand the relationship between an independent and dependent variable. To do this, the researcher must possess significant expertise; variable operational definitions must be thorough, explicit, and complete; instruments must be highly reliable and valid; and data must be properly analyzed.

D. Moderating, Extraneous, and Intervening Examples

1. Customer Service Training Program

- a. Situation. Your Company has employed a large group of entry level customer service representatives. Your company has a three week customer service representative (CSR) training program for new hires; two weeks are classroom training and three weeks are practical (e.g., on-the-job-training). The trainees must pass a customer service proficiency test before entering the practical portion of the CSR training program.
- b. Variables. If we conceptualize, that the independent variable is the class room training program; the dependent variable is CSR trainee performance (i.e., knowledge) as measured by the examination. Moderating variables could include: substantial relevant prior knowledge, trainer quality, or a poorly constructed test.
 - (1) CSR trainees' with significant relevant experience may be able to "pass" the test without paying very much attention during the class. Hence, the training program can be presumed to have had minimal, if any, effect on their current stock of knowledge.
 - (2) High quality, experienced trainers are known to be effective instructors in promoting student learning. It is likely that if the CSR trainees are under the tutelage of an inexperienced or poorly prepared trainer, their performance on the exit measure will be less than if they were taught by an experienced, properly prepared instructor.

- (c) Even if the CSR trainees were fully involved in the course and under the instruction of a highly qualified, effective trainer, the test could be so poorly constructed that it prevented proficient students from passing.
 - c. Comment. In the present instance, prior experience might have little impact on the dependent variable; but already proficient trainees passing the test could actually conceal design defects in the training program, which could adversely affect less experienced trainees later on. An inexperienced, poorly prepared instructor would directly, adversely affect the dependent variable; thereby discrediting what might be an otherwise excellent training curricula. Finally, even an excellent training curricula and effective instructor can be defeated by a poorly constructed examination. A majority of trainees failing an exit test reflects poorly on what might actually be an effective curriculum and trainer.
 - d. Control Strategies. A key control strategy is to add moderating variables to the research question or hypothesis. Using this strategy, the research question could be recast as “Is the classroom component of the CSR training program effective in preparing inexperienced CSR trainees for their practical training, as measured by an examination? To control for the effects of an inexperienced and/or poorly prepared trainer, only a highly experienced trainer with a substantial, successful track record would teach the class. To avoid or control for the effects of a poorly constructed test, one would use an examination with established internal consistency, reliability, and content validity.
2. English Language Training
- a. Situation. Your insurance company is planning to open an office in Beijing, China. Since the home office and virtually all of the back-office operations are in the US, Beijing employees (sales agents, support personnel, supervisors, and executives) must be bi-lingual. A conversational English language proficiency test is given to applicants. Those passing the conversational English test are eligible for employment, after more training. After hiring, some employees attend a two week intensive insurance English course; those passing the course go onto work. Some employees complete the same insurance English course by attending sessions three nights each week over a four week period and completing assignments out-side-of-class. Those failing either course either attend remedial sessions or are let-go.
 - b. Variables: The independent variable is the insurance English course. The dependent variable is insurance English proficiency (i.e., achievement as measured by test score). As in the CSR Training Program example, moderating variables could include: substantial relevant prior knowledge, trainer quality, test construction quality, but also we could add instructional methods, course scheduling, and test item format (e.g., knowledge recall and/or application)

- c. Comment. We will focus only on the three added moderating variables. The methods used to present information and “practice” its application will affect trainee performance. Lecture is an efficient method for transmitting information, but not for learning to apply it. The application of cases is an effective method for students or trainees to learn application but not the underlying knowledge. Thus, if the primary instructional methodology is lecture and the examination asks application questions, student performance is diminished. Of course, there are other instructional methods that could be used. Some people learn more efficiently in an intensive format (two week course schedule) and some in a less intense format, a three night four week schedule).
 - d. Control Strategies. Control strategies for the three added MV’s could include using a combination of lecture, discussion, and cases but incorporate that mix into the research question. Thus, the research question becomes, “Is the evening insurance English class as effective as the two week course which each using a common instructional approach with an appropriately aligned examination?” We can use a statistical control strategy (Analysis of Covariance) to ensure that each comparison group is “equivalent” at the outset of the two course sessions.
 - (1) We could operationally define the “common instructional approach” to include a mix of lecture, discussion, and case analysis.
 - (2) The operational definition of “appropriately aligned examination” would specify that item formats used on the test assess both knowledge and application in proportion to the extent each is stressed in the course.
3. Employee Turn-over
- a. Situation. A school district in the mid-west with 5,800 teachers, administrators, and support personnel is experiencing turn-over rates of 20% each year within each group when surrounding districts report an average 9% turn-over. Each group has very different job responsibilities, but have the same job benefits and holidays during the school year. Recall the research question, “Do the reasons for considering leaving differ by employee group?”
 - b. Variables. There are three IV’s because we want to know how each group differs (if at all) regarding reasons for considering exit. “The importance of reasons for leaving” expressed as a score, is the dependent variable. The higher the score, the greater is the likelihood of leaving. Moderating variables could include unspoken personal reasons, reasons related to wages, hours, working conditions, and benefits not previously expressed, or limited reading and writing skills.
 - c. Comment. In survey research, it is essential that the instrument and its items be well written, clear, and complete. One needs to anticipate all reasonably probable responses and include those as response options. A limitation of survey research is that respondents are usually unable to ask

clarifying questions regarding instrument items; so, directions must be very explicit and complete.

- d. Control Strategies. The survey instrument and its items should be well constructed. The consulting company should include commonly reported personal reasons for leaving as well as those supplied by the school district. A team of human resources personnel with substantial exit interview experience should be assembled to add unexpressed exiting reasons related to wages, hours, working conditions, and benefits which have not been given before by district employees who left. The survey instrument should not contain many open-ended items which require respondents to construct an answer and should be on a 6th or 7th grade reading level.

4. Productivity Problem

- a. Situation. Your company relies on several organizational-wide and job classification productivity indicators. The vice-president for operations has noticed that most of these indicators have been trending downward over the past three months; the VP wants to evaluate the effect of two job design innovations, telecommuting and compressed work week, on administrative support employee productivity. The VP wants to answer three questions, “Will telecommuting improve administrative support employee productivity?” “Will a compressed work week improve administrative support employee productivity?” and “Which improves productivity more, telecommuting or compressed work week?” For these three research questions, we have one dependent variable: productivity.
- b. Variables. The independent variables are telecommuting and compressed work week. The dependent variable is productivity. There could be one or two separate research projects conducted. Moderating variables for the telemarketing investigation could include: number of pre-school children at home, presence of a chronically ill spouse or parent, employee self-discipline, employee need for social interaction, familiarity with technology, etc. Moderating variables for the compressed work week could be employee age, health status, or nature of the work to be completed, or demands on non-work time.
- c. Comment. If the VP wanted a direct comparison between telecommuting and compressed work week, then there would be one study. However, that would not be recommended. What would be most revealing is to compare each independent variable against the current working conditions. Thus, there would be two studies, which upon analysis would yield productivity information. If the compressed work week was actually more effective in raising productivity than telecommuting, then the data should bear that out.
- d. Control Strategies. The most efficient control strategy would be to randomly select employees to participate in each trial. Next employees would be randomly assigned to both the telecommuting group, the compressed work week group, and two comparison groups. Randomization is the most consistently powerful control strategy; it distributes the effects of moderating variables across both the treatment

and control groups. If randomization was not possible a combination of the previously discussed control strategies could be applied.

III. Program Evaluation Questions and Hypotheses

A. Framing Effective Program Evaluation Research Questions

1. The purpose of the program evaluation question is to focus the study so that all activities undertaken on behalf of the study will produce information that leads to an answer of the program evaluation research question(s). Elements of a research question include the (1) identification of who is to be studied, (2) the relevant time frame, (3) the independent variable (e.g., a training program), (4) the dependent variable (e.g., what is being learned), (5) the measuring tool (e.g., test, performance assessment, attitude inventory, etc.) and (6) any potentially influencing moderating variables.
2. To write PEQ's, focus on key program performance dimensions.
 - a. The program's goals (distal outcomes) and objectives (proximal outcomes) are usually the key performance dimensions.
 - (1) A program's distal outcomes may or may not be measurable within the "lifespan" of the project. If distal outcomes are measurable, then they are most suitable for summative (i.e., impact or efficiency) evaluation.
 - (2) A program's proximal outcomes are almost always measurable during the "life" of the project. If distal outcomes are not measurable, then proximal outcomes usually substitute. Proximal outcomes are most suitable for formative evaluation (i.e., needs assessment, cross-sectional or longitudinal implementation evaluation).
 - (3) Write the PEQ's so that they are answerable by program data. This requires that the evaluator and evaluation team be thoroughly knowledgeable about the program's theory.
 - (4) A PEQ is matched with one or more program performance dimensions.
 - (a) If there are three program goals (distal outcomes) each with four objectives (proximal outcomes), then there are three PEQ's, with four program performance indicators. A performance indicator is evidence that the performance dimension has been accomplished.
 - (b) If a determination is made that the program's distal outcomes are not measurable, the programs proximal outcomes will substitute. Let's suppose there are 6 proximal outcomes each with 7 action steps. In this example, we might have 6 PEQ's (proximal outcomes) where each has 7 performance indicators (action steps).
 - (c) There is no "hard and fast rule" for selecting key program performance dimensions; however, they are typically drawn from the program's distal and proximal outcomes. Also, there is no standard rule for what constitutes a performance indicator. What is most important is that there is a logical relationship between the PEQ and performance indicators. There must be evidence available to answer the PEQ and agreement, among the evaluator, evaluation team, stakeholder, and sponsor that a logical

relationship between the PEQ and its indicators exist with retrievable evidence.

- (5) The program evaluator and evaluation team should articulate however many PEQ's that seem reasonable, and which are agreed to by relevant stakeholders and the evaluation sponsor.
 - b. As precise PEQ's facilitate program evaluation design and results utilization, they must be framed in unambiguous and non-controversial language.
 - c. Formulating PEQ's is a joint responsibility between significant stakeholders, the evaluator, evaluation team, and evaluation sponsor. Approval of PEQ's is often reserved for the evaluation sponsor. PEQ's must be important to stakeholders and the evaluation sponsor.
 - d. PEQ's should iteratively be revised by the evaluator until relevant parties reach agreement. The evaluator should remember that he or she is an expert in evaluation, and stakeholders are experts in the program. Thus, PEQ development is a continuous negotiation process.

3. PEQ's must be relevant, reasonable, and answerable within the context of the program theory, program data, program evaluation resources, and time frame. PEQ's which don't meet all three standards should be revised until they do and agreement on the part of all relevant parties is reached. For example if a PEQ is not answerable (program data is not available), then the PEQ is either discarded or revised, or plans are made to collect the necessary data even if those data are not readily generated by the program.
 - a. If a logical relationship exists between the PEQ and the program theory, then the PEQ is likely relevant.
 - b. If a suitable relationship exists between the PEQ and program evaluation resources and controlling timeframe, then the PEQ is likely reasonable.
 - c. If the program generates data which may be used to answer the PEQ, then the PEQ is answerable.
 - (1) Answerability also requires that there be performance criteria or standards against which actual program performance is compared; these comparative criteria are usually drawn from program goals (distal outcomes) and objectives (proximal outcomes).
 - (a) Suppose a program intended to deliver 1,500 service units (likely a proximal outcome) and delivered 200, leaving a performance gap of 1,300 service units.
 - (b) Suppose a program intended to prevent 100 premature deaths due to drug use among a particular demographic in XWZ community during 2011. At the end of the year, drug related mortality was determined to be 97 as compared to 216 in 2010, a 119 person reduction year-over-year. The program exceeded its key performance dimension of preventing 100 premature deaths.
 - (c) We need to be able to compare actual performance against a performance criterion or standard to answer the question, "Did the program prevent 100 premature deaths?"

- (2) Comparative performance criteria must be explicitly stated in non-controversial language and be defensible (i.e., have a solid supportive literature base).
 - (3) If comparison performance criteria (standards) are not drawn from the program's goals and objectives, then they are usually arrived at through professional consensus, and must be consistent with the prevailing relevant professional and empirical literature. If there are "Industry" comparative standards that are widely accepted and used, then consideration should be given to incorporating the standards into the evaluation design.
 - (4) Actual program performance indicators must be compared against acceptable or expected performance criteria (standards) in order to determine program performance sufficiency and/or acceptability.
4. If more than one, PEQ's should build on each other.
 - a. Answers to PEQ's from a needs analysis should inform program theory assessment which next informs program process assessment, which informs impact assessment and eventually an efficiency analysis.
 - b. We can think of these types of evaluations, when sequenced, as building blocks in building a chain of evidence to support decision-making. To the extent possible, an evaluator and evaluation team should have copies of all relevant prior program evaluations to frame current evaluation questions.
 - c. Not all programs undergo a needs assessment, program theory assessment, program process assessment (implementation evaluation), impact assessment (implementation or summative evaluation), and an efficiency assessment (ROI or cost-benefit analysis). It is rare for an evaluator who is conducting an efficiency assessment to have all four of the other program evaluation reports available to him or her.
 - d. The evaluator's responsibility is to lead in the preparation of the most relevant PEQ's for the program evaluation he or she is responsible for.
 5. Once a list of PEQ's has been developed, the questions may need to be prioritized based on agreed relevant criteria. Prioritization of PEQ's is complete when the evaluator, evaluation team, stakeholders, and evaluation sponsor have reached agreement. In cases of conflict, the evaluation sponsor decides. Each PEQ on the list must be relevant, reasonable, and answerable.
 6. There are two types of program evaluation research questions.
 - a. A descriptive research question is intended to generate data which describe a variable or variables as to existence, form, distribution, effect, etc. with respect to a specific circumstance or case. This type of research has been called descriptive. Examples are:
 - (1) What is the income distribution among citizens within each province of Canada?

- (2) What is the relative importance of specific job benefits to information technology specialists considering recruitment into the Florida civil service?
- (3) What is the effect of merit pay on public school teacher morale?
- (4) Will the relaxation of The XYZ Company dress code affect employee job performance?
- (5) What taste characteristics do consumers find desirable in tomato soup?
- (6) How many learning disabled adults attend the local community college and what is their number sorted by learning disability?

b. A relational research question identifies both the independent and dependent variables to be considered for study; a relationship is posited. Moderating variables are often added so that they can be controlled, and to improve the specificity of the research question. Examples include:

- (1) What will be the effect of the introduction of an on-line MBA in management on the We Want You to Learn University profit?
- (2) Will the XYZ Company experience a decrease in employee morale due to its resistance to unionization?
- (3) Will the average three year career of public school teachers be shortened once teacher salary is tied to student standardized test performance?
- (4) Will direct instruction in reading improve third grade reading achievement?
- (5) Does the 4th grade DARE drug education program reduce drug experimentation among 7th graders?

To answer a relational program evaluation research question, it may be necessary to formulate several very specific sub-questions or fashion a relational hypotheses which can be statistically tested.

7. Moderating Variables

a. A moderating variable is anything that can affect the dependent variable other than the independent variable.

- (1) For example, let's suppose we have completed the design of a customer service training course for a local employer's new call center hires. The course is eight weeks long. The elements of the research question would be:

Who is to be studied: New hires

Timeframe: March to April

Independent Variable: CSR Training Program

Dependent Variable: CSR knowledge And Service Skills

Measuring Tool: CSR Knowledge and Skill Inventory (CSR-KSI)

Potential Moderating Variables: Prior Experience, Motivation to Learn, Personality

- (2) Thus, the evaluation question might be: "How effective is the CSR Training Program in providing knowledge and service skills to new hires (who are highly motivated, demonstrate a people oriented

personality, but lack relevant prior experience) to serve company customers as measured by CSR Knowledge and Skill Inventory for training completed between March and April 2011?”

- b. With a moderating variable, you want to reduce its impact or eliminate its potential impact on the dependent or independent variable. To do this, (1) first identify the moderating variable and define it; (2) describe the moderating variables potential impact on the dependent variable; and (3) explain how you will attempt to reduce or eliminate its effect. See examples in Table 2.1.
 - (1) We want as clean a measure of the independent variable’s influence on the dependent variable as possible.
 - (2) In this example, we incorporated the three moderating variables into the research question so that they are part of what we study. Most of the time, we probably can't do this, so our next best strategy is to just identify any likely moderating variables, given our training situation and explain what affect it or they might have, and any control strategies we put into place. In the table below are presented some common moderating variables, potential influence (positive & negative), and a control strategy. Remember, we are using the CSR-KSI to measure the effect of the training program (independent variable) on participant (study subjects, a.k.a. CSR new hires) knowledge and skills (dependent variable).
 - (3) While we may not be able to control any moderating variable's influence, we can identify potential effect so that training program results can be placed into a more complete interpretive context.

B. Framing an Evaluation Hypothesis

- 1 A hypothesis may be either descriptive or posit a relationship between variables, often an independent and dependent variable. A hypothesis is formulated with respect to a specific circumstance or case. A descriptive or relational hypothesis can be statistically tested and be found to be either true or false.
2. Descriptive hypotheses confirm or describe the existence, size, form, distribution, or attribute of a variable. A descriptive hypothesis is typically composed of one variable, one case or specific circumstance, and is either true or false. No relationship between variables is posited. Examples are:
 - a. Well educated persons (c) are not productive (v) as manual laborers.
 - b. Considering educational attainment, professors (c) are under-paid (v).
 - c. American companies (c) are experiencing a down business cycle (v).
 - d. The stock market (c) is undervalued (v).
 - e. Truant school children (c) commit 50% of petty crimes (v) during school hours.

3. The relational hypothesis posits a relationship between two variables, such as an independent and dependent variable, within the context of a specified circumstance or case.
 - a. If a relational hypothesis does not specify a causal relationship, it is said to be a correlational hypothesis. Correlational hypotheses are advanced when a researcher knows two or more variables are related in some way, but he or she lacks the evidence to assert a causal relationship. Correlational hypotheses are more tentative than causal hypotheses. Examples include:
 - (1) Proper back safety training decreases work-related back injury rates at The XWZ Company.
 - (2) Merit pay will improve employee productivity at The XWZ Company.
 - (3) A four day work week will result in improved Chuck's Company employee morale.
 - (4) Older people are more religious than younger people.
 - (5) Older workers are more reliable than workers under 25 years.
 - b. If a causal relationship between variables is expected, a researcher states a causal or explanatory hypothesis, and the nature of the relationship, i.e., the effect of the independent variable on the dependent variable. Remember, here the researcher is asserting that the independent variable caused the effect observed in the dependent variable. Such an assertion must be based upon high quality, substantial prior evidence. For example:
 - (1) Higher levels of formal education lead to higher standards of living.
 - (2) Participatory management improves employee morale.
 - (3) A four day work week will result in improved per hour employee productivity.
 - (4) More frequent use of direct instruction will lead to higher 3rd grade reading achievement.

Table 2.1

Controlling Moderating Variables

Moderating Variable	Potential Influence	Control Strategy
Prior Experience	CSR's with prior experience may artificially inflate CSR-KSI score	Hire CSR trainees without prior experience
Motivation to Learn	A lack of desire to learn may artificially deflate CSR-KSI score	Hire CSR trainees with a demonstrated willingness to learn
Personality	People oriented CSR's tend to be extroverted which will reduce service and training fatigue which have affect on learning. Introverted CSR's may tire of the training and role-playing such training involves leading to the opposite effect.	Hire CSR trainees with demonstrated extroversion
Training Program Design	Interactive training programs are more effective with adult extroverted personalities. Introverted CSR's may tire of all the activity with their learning being adversely affected.	Design training program to be highly interactive and experiential
Training Leader	Enthusiastic instructors are associated with higher levels of learning and participant engagement. Boring training leaders always make learning less fun and so less learning occurs	Training leader is a former highly effective, enthusiastic CSR who models expected behaviors and attitudes
Training Environment	A comfortable learning environment enables learning. An uncomfortable environment focuses trainees on their discomfort and not their learning.	The corporate training room is comfortable, well lit, suitably warm/cool, has convenient restrooms, etc.
Unfavorable News	A round of company layoffs has been announced, during the training. This potential effect is self-explanatory.	There's really nothing the training leader can do about this news. We are not always able to control the potential influence of moderating variables.

Review Questions

Directions. Read each item carefully; either fill-in-the-blank or circle letter associated with the term that best answers the item.

1. A variable that is acted upon is called the _____ variable.
 - a. Independent variable
 - b. Dependent variable
 - c. Moderator variable
 - d. Mediating variable
2. Variables which can't be manipulated and whose presence is inferred by the effects of another variable are called:
 - a. Independent variable
 - b. Dependent variable
 - c. Extraneous variable
 - d. Intervening variable
3. A variable that is related to the dependent or independent variable that is not part of the study is called:
 - a. Independent variable
 - b. Dependent variable
 - c. Extraneous variable
 - d. Mediating variable
4. When a researcher excludes market segments that are unlikely to purchase a product from marketing research study to control for certain variables, he or she is using what type of control strategy?
 - a. Delimitation
 - b. Assumption
 - c. Limitation
 - d. Selective
5. In surveys, researchers believe that respondents answer questions truthfully. This type of control is called:
 - a. Delimitation
 - b. Assumption
 - c. Limitation
 - d. Selective
6. Multiple regression is what type of control?
 - a. Selective
 - b. Assumption
 - c. Limitation
 - d. Statistical
7. When we want quantify the amount of an attribute or phenomena, we
 - a. Classify
 - b. Measure
 - c. Scale
 - d. Hypothesize
8. Characteristics of a “good” measure (i.e., test, scale, index, etc.) include all of the following except:
 - a. Short
 - b. Valid
 - c. Reliable
 - d. Practical
9. Which one of the following has been labeled, as “the building blocks of theory”?
 - a. Concepts
 - b. Constructs
 - c. Propositions
 - d. Hypothesis

10. A multidimensional measure has specific characteristics. Which one of the following is not a characteristic?
- a. Based on two or more constructs
 - b. Scores quantify attribute amount
 - c. Presents one score
 - d. May test propositions
11. Which one of the following speculates upon the relationships, if any, among constructs?
- a. Concepts
 - b. Propositions
 - c. Hypotheses
 - d. Theories
12. For measuring research variables, which one the following statements is not accurate?
- a. The independent variable is manipulated so that its effect or impact on the dependent variable may be measured.
 - b. Moderator variables exert an influence on the dependent variable.
 - c. A research question identifies the independent and dependent variables.
 - d. A hypothesis identifies the independent and dependent variables.
13. An independent variable which has two levels is said to be a(n) _____ variable.
- a. Assigned
 - b. Active
 - c. Quantitative
 - d. Qualitative
14. Concerning operational definitions which one of the following is not accurate?
- a. It is critical that each independent and dependent variable be operationally defined with such explicit clarity that what is to be measured is almost self-evident.
 - b. Operational definitions specify variable attributes and indicators, as well as how they are to be measured.
 - c. The definition of variables must be based on related research, rational analysis, and professional expertise.
 - d. Defining moderator, extraneous, or intervening variables is difficult; so refrain from attempting to identify and define.
15. Control strategies for moderating and extraneous variables include each of the following except:
- a. Physical control
 - b. Selective control
 - c. Passive control
 - d. Statistical control
16. The process for collecting and analyzing data is _____.
- a. Measurement
 - b. Assessment
 - c. Evaluation
 - d. Not listed

Application Exercise: Variable Identification

Directions. Identify the independent, dependent, moderator, extraneous, and intervening or mediating variables based on the information provided in each mini-case.

17. The management of a financial services company, “We are Rich and You are Not”, has set a performance standard for loan application processors. You have been asked to assist the local branch manager to determine whether or not her unit meets the mandated standard of an average of 13 applications processed over a 4 hour period per processor. She has 34 loan application processors. The mean number of applications processed is 11.9 with a standard deviation of 1.2. You are going to test the claim that the average number of applications processed meets the mandated standard.
18. The credit card company you work for as a manager in Tampa has just launched a third shift to meet service needs for its Asian customers. You have spent the last three weeks training your 300 bilingual staff in the company’s service policies and procedures. The Company requires that a performance standard of 135 points be earned before trainees are allowed to service “live” customers. As time is of the essence, you have randomly selected nine trainees and tested them. You are asserting that the nine trainees’ scores are drawn from a population (the 300) with a mean greater than 135 points.
19. Your home healthcare organization is considering adopting a new home health service protocol (treatment program) which is designed to improve the functional ability of home-bound elderly patients to prevent placement into a nursing home. You have decided to test the effectiveness of the new protocol, as your company might buy it to replace your current protocol.

Accordingly, you have randomly selected and assigned 13 patients to a treatment (i.e., the new protocol or Group One) and 13 more to a control group (i.e., the company’s current treatment protocol). Further, you have randomly selected and assigned home health care services providers, who have been trained in one of the service protocols, to each group. At the end of your trial, a test was administered by independent raters to assess the functional ability (i.e., the ability to take care of one-self, with minimal help). The scores range from zero to 30 (highest); the higher the score, the better a patient’s functional ability.
20. The foundation which funds your community service organization has asked it to demonstrate that its six week, residential program actually increases a client’s level of civic responsibility. Research has shown that youth with high levels of civic responsibility are less likely to violate the law and get into trouble. A civic responsibility index was given to clients at program entry and program exit. Scores ranged from zero to 20 (highest); the higher the score, the greater the level of civic responsibility. Eight clients were tested.
21. The manager of the company’s motor pool has asked you to help her determine the relationship between vehicle weight and miles per gallon (mpg) for the company’s fleet. She has given you the following information about vehicle weights, in 100’s of pounds, and mpg for city and highway driving. She next asked you to predict the mpg based on the vehicle weight for two purchases at 4,200 and 3,700 pounds.

22. Your company produces four types of microwave oatmeal products: Apple, Peach, Cherry, and Prune. The vice-president for sales has received marketing data that suggests the purchasing decision is not based on fruit taste preference. You have been asked to verify these data. Test the claim that product purchase is unrelated to taste preference. You have randomly identified 88 customers and learned which oatmeal product they last purchased.
23. A product manager within your organization has recommended that your company's historically most successful product needs new packaging to boost sales. You randomly selected 305 shoppers at the local mall and asked them to evaluate current product packaging. One demographic variable you assessed was gender.

Answers: 1. b, 2. d, 3. c, 4. a, 5. b, 6. d, 7. c, 8. a, 9. b, 10. c, 11. b, 12. b, 13. b, 14. d, 15. c; 16. b

Application Exercise: Variable Identification

For each case, there are potentially dozens of moderating, extraneous, and confounding variables. The key to proper identification is the degree to which each fits its definition.

16. **Financial Services Company**

Independent: performance standard

Dependent: performance standard met or not

Moderating: reasonableness of the performance standard, application complexity

Extraneous: fatigue, management style, stress, etc.

Intervening or Mediating: Identifying and explaining these requires substantial subject matter and situational expertise.

17. **Credit Card Company**

Independent: training program

Dependent: achievement as measured by the number of points earned on a test

Moderating: quality of the trainer, quality of the training program, length, curricula, test

Extraneous: prior foreign language skill, trainee motivation, test quality, etc.

Intervening or Mediating: Identifying and explaining these requires substantial subject matter and situational expertise.

18. **New Home Health Services Protocol**

Independent: New treatment protocol

Dependent: elderly patient functionality as measured by ADL scale

Moderating: protocol complexity, provider skill with the new protocol, quality of training and trainer, provider commitment to new or old protocol

Extraneous: patient acceptance of change, interpersonal relationship between service providers and patients, quality of training, etc.

Intervening or Mediating: Identifying and explaining these requires substantial subject matter and situational expertise.

19. **Civic Responsibility**

Independent: six week residential program

Dependent: civic responsibility index

Moderating: relationships between counselors and clients, program quality, success expectations, program culture, skill of counselors, etc.

Extraneous: motivation of clients to show less likelihood to re-offend, attitudes towards authority, time between index administrations, quality of the civic responsibility index, etc.

Intervening or Mediating: Identifying and explaining these requires substantial subject matter and situational expertise.

20. **Motor Pool**

Independent: vehicle weight

Dependent: miles per gallon

Moderating: tire pressure

Extraneous: mechanical condition of the car, driver characteristics, speed limit, weather conditions, etc.

Intervening or Mediating: Identifying and explaining these requires substantial subject matter and situational expertise.

21. **Oatmeal Preference**

Independent: taste preference

Dependent: purchases made

Moderating: customer's mood, preferences tend to change over time, changes in taste buds, etc.

Extraneous: competitor's price for similar product, brand loyalty, social desirability, etc.

Intervening or Mediating: Identifying and explaining these requires substantial subject matter and situational expertise.

22. **New Packaging**

Independent: Gender

Dependent: packaging preference change needed (yes or no)

Moderating: thinking patterns, decision-making processes, other differences which drive gender preferences, etc.

Extraneous: favorite colors, cellophane preference, shape preferences, etc.

Intervening or Mediating: Identifying and explaining these requires substantial subject matter and situational expertise.

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