

# **VARIABLES—TYPES OF VARIABLES AND CONTROLLING VARIABLES**

## **Constructs**

A construct is an abstraction that cannot be observed directly; it is a concept invented to explain behavior. Examples of educational constructs are intelligence, personality, teacher effectiveness, creativity, ability, achievement, and motivation. To be measurable, constructs must be operationally defined—that is, defined in terms of processes or operations that can be observed and measured. To measure a construct, it is necessary to identify the scores or values it can assume. When constructs are operationally defined, they become variables.

## **Variables**

A variable is a characteristic or attribute of an individual or an organization that

- Researchers can measure or observe and
- Varies among individuals or organizations Studied.

They are the ideas that researchers seek to collect information on to address the purpose of their study. A variable is a placeholder that can assume any one of a range of values. The variable must be able to take on at least two values or scores. We deal with variables in all our research studies. Gender, ethnicity, socioeconomic status (SES), test scores, age, and teacher experience are all variables; people differ on these characteristics. There are many different approaches to measuring a variable and many instruments for doing so (in educational research, an instrument is a tool used to collect data).

A variable is a concept or abstract idea that can be described in measurable terms. In research, this term refers to the measurable characteristics, qualities, traits, or attributes of a particular individual, object, or situation being studied.

## **Types of Variables**

Variables themselves differ in many ways. For example, variables can be represented by different kinds of measurements, they can be identified as categorical or quantitative, or they can be classified as dependent or independent. The following sections discuss these distinctions.

Variables are things that we measure, control, or manipulate in research. They differ in many respects, most notably in the role they are given in our research and in the type of measures that can be applied to them.

## **Measurement Scales and Variables**

Researchers use four types of measurement scales: nominal, ordinal, interval, and ratio scales. A measurement scale is a system for organizing data so that it may be inspected, analyzed, and

interpreted. In other words, the scale is the instrument used to provide the range of values or scores for each variable.

### **Nominal Variables**

A nominal variable is also called a categorical variable because the values include two or more named categories. Nominal variables include sex (e.g., female, male), employment status (e.g., full time, part time, unemployed), marital status (e.g., married, divorced, single), and type of school (e.g., public, private, charter). For identification purposes, nominal variables are often represented by numbers. For example, the category “male” may be represented by the number 1 and “female” by the number 2. It is critically important to understand that such numbering of nominal variables does not indicate that one category is higher or better than another. That is, representing male with a 1 and female with a 2 does not indicate that males are lower or worse than females or that male are at a higher rank than females. The numbers are only labels for the groups.

### **Ordinal Variables**

An ordinal variable not only classifies persons or objects, it also ranks them. In other words, ordinal variables have, as their values, rankings in order from highest to lowest or from most to least. For example, if 50 students were placed into five reading groups, with each group representing a different reading ability, a student in Reading Group 1 would be in the highest achieving group and a student in Reading Group 5 would be in the lowest reading group. Rankings make it possible to make comparisons, such as to say that one student is achieving at a higher level than another student. Class rank is another example of an ordinal variable.

### **Interval Variables**

An interval variable has all the characteristics of nominal and ordinal variables, but its values also represent equal intervals. Scores on most tests used in educational research, such as achievement, aptitude, motivation, and attitude tests, are treated as interval variables. When variables have equal intervals, it is assumed that the difference between a score of 30 and a score of 40 is essentially the same as the difference between a score of 50 and a score of 60, and the difference between 81 and 82 is about the same as the difference between 82 and 83. Interval scales, however, do not have a true zero point. Without a true zero point, we can say that a test score of 90 is 45 points higher than a score of 45, but we cannot say that a person scoring 90 knows twice as much as a person scoring 45. Variables that have or are treated as having equal intervals are subject to an array of statistical data analysis methods.

### **Ratio Variables**

A ratio variable has all the properties of the previous three types of variables and, in addition, its measurement scale has a true zero point. Height, weight, time, distance, and speed are examples of ratio scales. The concept of “no weight,” for example, is a meaningful one. Because of the true zero point, we can say not only that the difference between a height of 3 ft 2 in. and a height

of 4 ft 2 in. is the same as the difference between 5 ft 4 in. and 6 ft 4 in. but also that a person 6 ft 4 in. is twice as tall as one 3 ft 2 in. As another example, the total number of correct items on a test can be measured on a ratio scale (i.e., a student can get zero items correct; a student with 20 items correct has twice as many correct answers as a student with 10 items correct).

### **Quantitative and Qualitative Variables**

Quantitative variables exist on a continuum that ranges from low to high, or less to more. Ordinal, interval, and ratio variables are all quantitative variables because they describe performance in quantitative terms. Examples are test scores, heights, speed, age, and class size. Nominal or categorical variables do not provide quantitative information about how people or objects differ. They provide information about qualitative differences only. Nominal variables permit persons or things that represent different qualities (e.g., eye color, religion, gender, political party) but not different quantities.

### **Dependent and Independent Variables**

The dependent variable in an experimental study is the variable hypothesized to depend on or to be caused by another variable, the independent variable.

Independent variables are antecedent to dependent variables and are known or are hypothesized to influence the dependent variable, which is the outcome. In experimental studies, the treatment is the independent variable and the outcome is the dependent variable. In an experiment in which freshmen are randomly assigned to a “hands-on” unit on weather forecasting or to a textbook-centered unit and are then given a common exam at the end of the study, the method of instruction (hands-on versus textbook) antecedes the exam scores and is the independent variable in this study. The exam scores follow and are the dependent variable. The experimenter is hypothesizing that the exam scores will partially depend on how the students were taught weather forecasting. In this case, freshman status is a constant.

In non experimental studies, it is often more difficult to label variables as independent or dependent. We call the variable that inevitably precedes another one in time the independent variable. In a study of the relationship between teacher experience and students’ achievement scores, teacher experience would be considered the independent variable. Not only does it precede student achievement but also it would be illogical to say that student achievement influenced teacher experience.

In some other cases, it is not possible to tell which variable is antecedent and which follows. In a study of the relationship between self-confidence and popularity in high school students, either variable could be considered independent or dependent. It is possible for a variable to be an independent variable in one study and a dependent variable in another. Whether a variable is independent or dependent depends on the purpose of the study. If you investigate the effect of

motivation on achievement, then motivation is the independent variable. However, if you wish to determine the effect of testing procedures, classroom grouping arrangements, or grading procedures on students' motivation, then motivation becomes the dependent variable. Intelligence is generally treated as an independent variable because educators are interested in its effect on learning, the dependent variable. However, in studies investigating the effect of preschool experience on the intellectual development of children, intelligence is the dependent variable.

The independent variable in a research study is sometimes called the experimental variable, the manipulated variable, the cause, or the treatment variable, but regardless of the label, the independent variable is always the hypothesized cause of the dependent variable (also called the criterion variable, the effect, the outcome, or the post-test). Independent variables are primarily used in experimental research studies (and grouping variables are used in similar ways in causal-comparative studies). It is important to remember that the independent variable must have at least two levels of treatments. Thus, neither positive nor negative reinforcement is a variable by itself. The independent variable is type of reinforcement; positive reinforcement and negative reinforcement are the two levels of the variable.

## Dependent Vs Independent Variables

Independent Variable	Dependent Variable
<ul style="list-style-type: none"> <li>❑ The variable that is <b>manipulated</b> either by the researcher or by nature or circumstance</li> <li>❑ Independent variables are also called “stimulus” “input” or “predictor” variables</li> <li>❑ Analogous to the “cause” in a cause-effect relationship.</li> </ul>	<ul style="list-style-type: none"> <li>❑ A variable that is <b>observed or measured</b>, and that is influenced or changed by the independent variable.</li> <li>❑ Dependent variables are also known as “response” or “output” or “criterion” variables.</li> <li>❑ Analogous to the “effect” in a cause-effect relationship.</li> </ul>

### Dichotomous and Continuous Variable

Variables can be categorical, or they can be continuous. When researchers classify subjects by sorting them into mutually exclusive groups, the attribute on which they base the classification is termed a categorical variable. Home language, county of residence, father's principal occupation, and school in which enrolled are examples of categorical variables. The simplest type of categorical variable has only two mutually exclusive classes and is called a **dichotomous variable**. Male–female, citizen–alien, and pass–fail are dichotomous variables. Some categorical variables have more than two classes; examples are educational level, religious affiliation, and state of birth.

When an attribute has an infinite number of values within a range, it is a **continuous variable**. As a child grows from 40 to 41 inches, he or she passes through an infinite number of heights. Height, weight, age, and achievement test scores are examples of continuous variables.

### **Extraneous variable**

Independent variables that are not related to the purpose of the study, but may affect the dependent variable are termed as extraneous variables. Suppose the researcher wants to test the hypothesis that there is a relationship between children's gains in social studies achievement and their self-concepts. In this case self-concept is an independent variable and social studies achievement is a dependent variable. Intelligence may as well affect the social studies achievement, but since it is not related to the purpose of the study undertaken by the researcher, it will be termed as an extraneous variable. Whatever effect is noticed on dependent variable as a result of extraneous variable(s) is technically described as an 'experimental error'. A study must always be so designed that the effect upon the dependent variable is attributed entirely to the independent variable(s), and not to some extraneous variable or variables.

**E.g.** Effectiveness of different methods of teaching Social Science.

Here variables such as teacher's competence, Teacher's enthusiasm, age, socio economic status also contribute substantially to the teaching learning process. It cannot be controlled by the researcher. The conclusions lack credibility because of extraneous variables.

### **Intervening variables**

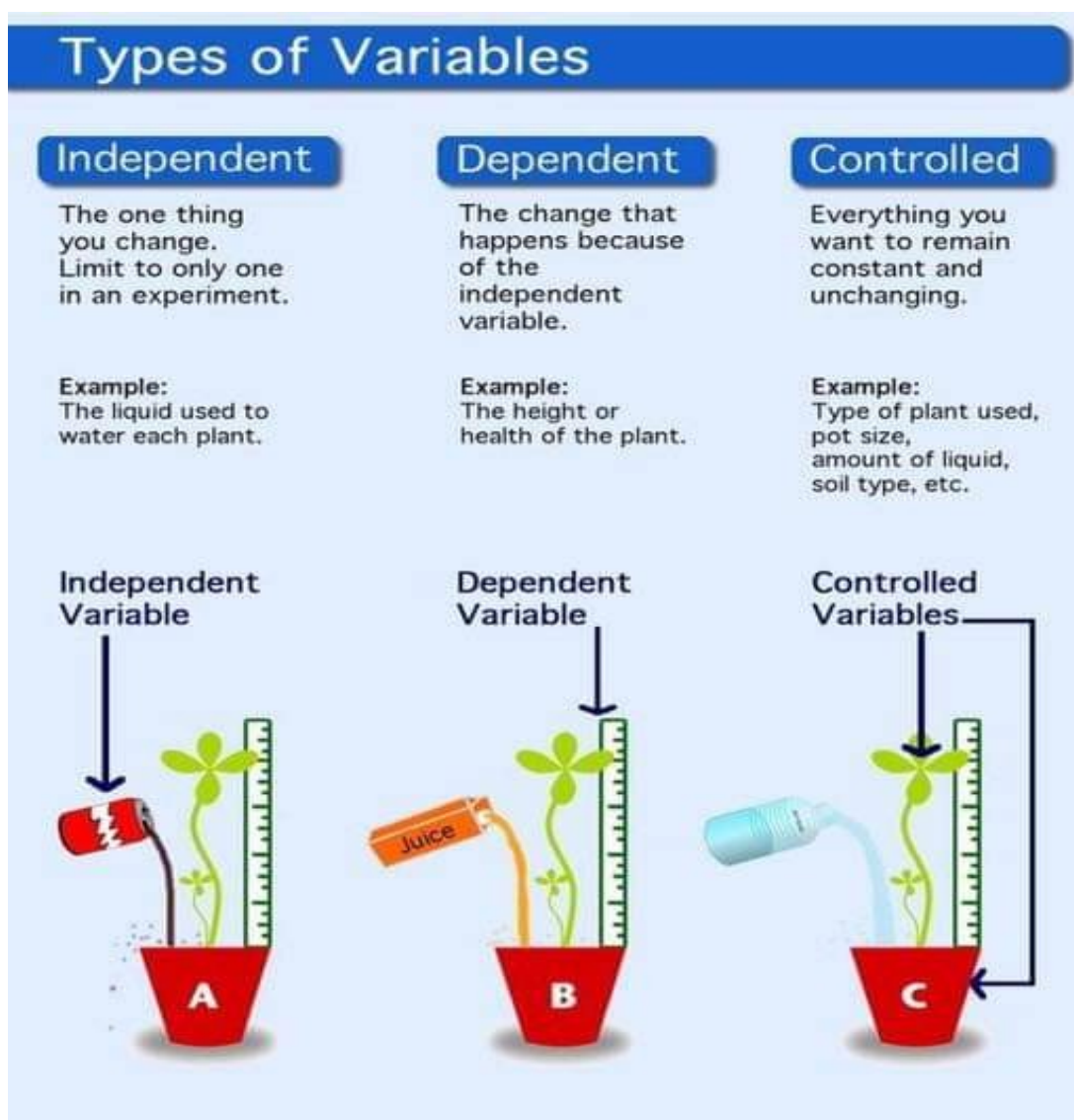
They intervene between cause and effect. It is difficult to observe, as they are related with individuals feelings such as boredom, fatigue excitement At times some of these variables cannot be controlled or measured but have an important effect upon the result of the study as it intervenes between cause and effect. Though difficult, it has to be controlled through appropriate design. Eg. "Effect of immediate reinforcement on learning the parts of speech". Factors other than reinforcement such as anxiety, fatigue, and motivation may be intervening variables. They are difficult to define in operational, observable terms however they cannot be ignored and must be controlled using appropriate research design.

### **Moderator**

A third variable that when introduced into an analysis alters or has a contingent effect on the relationship between an independent and a dependent variable. A moderator variable is an independent variable that is not of primary interest that has levels, which when combined with the levels of the independent variable of interest produces different effects.

### Constants

The opposite of variable is **constant**. A constant is a fixed value within a study. If all subjects in a study are eighth-graders, then grade level is a constant. In a study comparing the attitudes toward school of high school girls who plan professional careers with those who do not plan professional careers, high school girls constitute a constant; whether they plan professional careers is the independent variable, and their attitudes constitute the dependent variable.



## **Suggested Reading**

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