

Variables in Educational Research

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ABSTRACT

A variable is a concept, construct, condition, or attribute that can have several values. For example, people's IQ is measured on a scale from low to high. Gender is another variable that can have two values, such as 'Male' or 'Female'. Kerlinger (1986), UNESCO (2005), and Kumar (2001) et al. classify the variable in various ways. However, most of them concentrate on independent, dependent, extraneous, confounding, intervening, and moderator variables. The majority of educational research studies are completely dependent on these variables. So, in any research study, these variables are referred to be key variables. These important variables are explored using four primary study designs: descriptive, causal comparative, correlational, and experimental/quasi-experimental. (Korb, 2012). Variables other than the essential variables are not investigated in any research study. But these are used to carry out the research study.

Keywords: *Variable, Independent, Dependent, Extraneous, Confounding, Intervening, Moderator Variable*

All educational research depends upon variables. It is essential from the start to the finish of a research study. That is, variables are required to write an introduction, an operational definition, search for research articles for a literature review, prepare research methods, research tools that measure variables during data collection, statistical analysis based on variables, and, finally, write a discussion and conclusion to a research study. Once a research topic has been determined, the researcher should determine the essential variables of the chosen research study. It's crucial to know how to investigate the important variables after they have been identified. Which is the foundation of all research design. So, before starting any educational research work, it is critical to understand what defines a variable. How many types of variables are used in educational research? How will they be studied? And how will they be measured? Etc.

❖ What is variable?

Before discussing variables in educational studies. Two terms, 'concepts' and 'construct', must be discussed because they are inseparably linked to variables.

Concepts are generalized ideas and associated features, or commonly accepted abstractions, formed about the objects, people, or events around us based on our observations, experiences, and reflective thinking. For example, different type of animals, birds, trees, clouds, school systems, teaching learning methods, honesty, truthfulness, teaching

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competency etc. And **construct** is the combination of the related concepts. For example, 'intelligence'. It is a combination of various related concepts or factors such as verbal ability, numerical ability, perceptual ability, memorizing ability, inductive and deductive reasoning ability, spatial ability, word fluency ability, and problem-solving ability, as discussed by the famous psychologist Thurston in his group theory of intelligence.

- According to Swain (2007) “A variable is a concept or construct which varies and is assigned numerals or values. The numerals or values which are assigned are based on properties of the variable”
- According to Kerlinger (1986, p.29) “A variable is a symbol to which numerals are assigned”.
- According to Johnson & Christensen (2008) “A variable is a condition or characteristic that can take on different values or categories”

So, based on the definitions above, a variable is a concept, construct, condition, or attribute that can have many values. That is, variable refers to the quantifiable form of a concept, construct, condition, or characteristic. For example, people's IQ varies from low to high, and gender is another variable that has two values: 'Male' or 'Female'.

DIFFERENT VARIABLES USE IN EDUCATIONAL RESEARCH

- **Independent Variable:**

It is the condition, characteristic, component, or procedure that the experimenter or researcher measures and manipulates in order to investigate its link to an observed phenomenon or another variable.

Let's say the researcher wishes to investigate "The Effects of Various Teaching Methods on Mathematical Learning Achievements." In this case, the **independent variable** is **various methods of teaching**.

The independent variable causes a change in another variable, and it is always interested in observing only its effect on another variable. According to Johnson & Christensen (2008) “An independent variable is a variable that is presumed to cause a change in another variable.”

- **Dependent variable:**

The dependent variable is any factor, condition, trait, or scenario that is observed and quantified to determine the effect of the independent variable. This variable is sometimes referred to as the outcome variable or the response variable. Science's value is determined by the value of the independent variable. So, it is referred to as dependent. The dependent variable in the example "The Effects of Various Teaching Methods on Mathematical Learning Achievements." is a measure of mathematical learning achievement. According to Johnson & Christensen (2008) “A dependent variable is the variable that is presumed to be influenced by one or more independent variable”

- **Extraneous, Control and confounding variables:**

Every experimental research study aims to determine the link between two specified variables (independent and dependent). However, most experiments incorporate multiple variables at the same time and in the same scenario. As a result, it is often difficult to determine this relationship precisely since other variables may influence the relationship or

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the outcome of the experiment. **Extraneous variables** are those that influence dependent variables while independent variables are being studied.

So, any researcher should attempt to control or neutralize these variables. If it is not possible to control or neutralize certain variables, they should be considered when interpreting results. Extraneous variables that are controlled or neutralized in a study are referred to as **control variables**.

Confounding variables are extraneous variables that are not under the researcher's control and systematically vary with the independent variables while simultaneously influencing the dependent variables, making it impossible to draw clear and meaningful conclusions. Extraneous variables are not confounding variables if they have the same effects on all participants in the research or are constant across all participants. Confounding only occurs when they systematically influence one group but not the other. (Johnson and Christensen, 2008).

For example, suppose a researcher wishes to investigate the effect of a new teaching method (an independent variable) on a child's mathematics achievement scores (a dependent variable). The researcher will most likely conclude that the new teaching style has a beneficial effect on the children's mathematics achievement scores. However, it is unclear whether students with the new teaching method have higher marks because of the new teaching method or because they are older (age) or have more prior knowledge of the given topic, among other factors. Then age, previous knowledge etc. will be the **extraneous variables**. The variable 'age' will be easier to regulate than the students' previous knowledge. So, if the extraneous variable 'age' is controlled or neutralized throughout the experiment, it will be considered the **control variable**. However, if the extraneous variable "the students' previous knowledge" is not controlled or neutralized, the researcher will be unable to conclude the conclusion with any degree of confidence, and the reviewer may claim that the result was caused by this additional variable. So this additional variable is referred to as a **confounding variable**.

Type of Extraneous variables:

According to McLeod (2008),

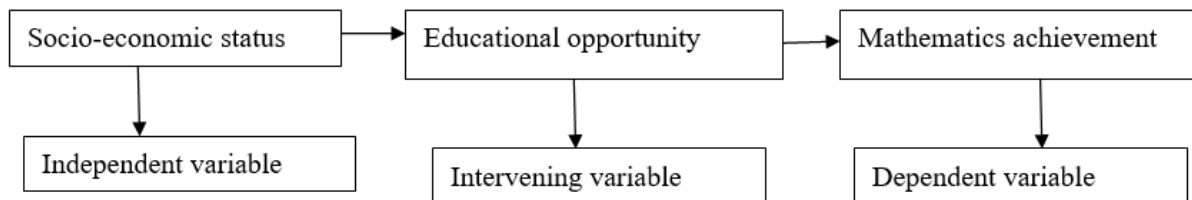
There are four types of extraneous variables,

- i) **Situational variables:** These are components of the environment that may influence the participant's behaviour. For example, noise, temperature, illumination, and so forth.
- ii) **Participant / Person variables:** This relates to how each person differs from the other. Examples include mood, intelligence, anxiety, nerves, and focus.
- iii) **Experimenter / Investigator Effect:** The experimenter inadvertently / unintentionally influences the study's outcomes by instructing participants on how to act. For example, the personal attributes (e.g. age, gender, accent, manner etc.) of the experimenter can affect the behaviour of the participants.
- iv) **Demand characteristics:** These are all contextual clues that convey / teach the participant how to act during the research study. These clues include environmental aspects, researcher characteristics, nonverbal interactions, and interpretations of what is going on in the current situation.

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- **Intervening variable:**

Intervening variables are abstract or hypothetical factors that cannot be directly seen but are used to explain the causal relationships or links between independent and dependent variables. For example: In the relationship between socioeconomic status and children's mathematical achievement. It is observed that children with a higher socioeconomic background perform better in mathematics. Simply having a high socioeconomic class does not imply great mathematical achievement. Other abstract / hypothetical variables are required to understand this relationship. That is, children with a higher socioeconomic position have more educational opportunities than others, resulting in higher mathematics achievement. So, educational opportunity serves as an intervening variable.



- **Moderator Variable:**

Assume a researcher analyzes a collection of research data and discovers that there is little or no difference in the mathematics achievement scores of students taught using the lecture method vs students taught using a new teaching method. However, upon additional examination, the researcher may discover that the new teaching method is more effective for male students and lecture method for female students. In this case, Sex/Gender type is a moderator variable. That is, the relationship between teaching method and mathematical achievement scores varies according to the students' sex or gender.

So, a moderator variable is a special kind of independent variable in a research study to see if it impacts, changes, or moderates the relationship between the primary independent variable and the dependent variable. Personality type (introvert vs. extrovert), gender (male vs. female), sex (boy vs. girl), and location (rural vs. urban) are common moderator variables. According to Johnson & Christensen (2008) “A moderator variable is a variable that change (i.e., moderates) the relationship between other variables.”

- **Dummy variable:**

When a qualitative variable, such as gender (Male-M and Female-F), is converted into a quantitative variable, such as Male-1 and Femal-0, it is referred to as a dummy variable in educational research.

- **Latent Variable:**

A latent variable is a hypothetical or abstract concept that cannot be directly observed or measured. However, it is inferred from other variables that are both observable and measurable. For examples, health of a person, socio-economic status of a person etc. Health of a person is not measured through a single measurement. But it is measured by a skilled or medical person through different physical qualities of this person. Examples include blood pressure, cholesterol levels, weight, blood sugar, temperature, and a variety of other observable and measurable measurements.

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- **Experimental Variable:**

In experimental research, the researcher conducts an experiment to investigate, discover, or observe the influence of a variable or treatment known as the experimental variable. In the research, "The Effect of New Teaching Method Over the Lecture or Traditional Teaching Method on Mathematics Learning Achievement". The new teaching method might be used as the experimental variable.

- **Controlled Variable:**

It's also employed in experimental studies. The relative term 'effectiveness' of an experimental variable is assessed by comparing it to another variable in the research study. Then this second variable is referred to as the controlled variable. In the preceding example, the lecture or traditional teaching method may be the controlled variable. Because the effectiveness of the new teaching method (experimental variable) is compared to lecture or traditional teaching methods in terms of mathematics learning achievement.

- **Criterion variable:**

Criterion variable is a variable in any experimental study on which the influence of the experimental variable is happened. That is, on which the effectiveness of an experimental variable is determined. In the example above, the criterion variable is 'mathematics learning achievement'. Because the researcher will construct two equivalent groups to test the effectiveness of the experimental variables, one group will be taught a new teaching method, while the other will be given lecture or the traditional way. Then, two groups' mathematical learning achievement will be assessed. By which. The effectiveness will be established.

CLASSIFICATION OF VARIABLES

There are different views on classification of variables in educational research. Some are discussed below.

- According to Kerlinger (1986),
Variables can be classed in numerous ways. However, three types of variables are given significant emphasis in his book. They are
 1. Independent and dependent variables
 2. Active and attribute variables
 3. Continuous and categorical variables

These are emphasized below

1. **Independent and dependent variables:** In any experiment, the variable that the researcher manipulates is known as the independent variable. For instance, if the researcher want to investigate how various teaching strategies affect students' academic progress. Then, the independent variable is the mode of instruction. However, experimental manipulation is not possible in non-experimental research. The variable that "logically" influences the dependent variable in this scenario is the independent variable. For instance, smoking is the independent variable in the research on smoking and lung cancer, which has already been conducted on a large number of participants. Referenced in Kerlinger (1986). Conversely, the independent variable is predicted from, and the dependent variable is the variable that was predicted to. Stated differently, the dependent variable refers to the expected outcome of the independent variable. "Achievement" or "learning" is the most frequently used dependent variable in educational research; in the aforementioned cases, the dependent variables are lung cancer and learning achievement. Other

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independent factors that are examined in connection to the dependent variable of achievement include social class, teaching strategies, personality types, motivational styles (reward and punishment), attitudes toward education, and classroom environment, among others. However, one should be aware that a variable may be both a dependent and an independent variable in different studies, or even both, within the same study. (Kerlinger, 1986). For example, 'anxiety' can be examined as an independent variable that influences the dependent variable achievement. However, whether it is investigated as the effectiveness of different styles of instruction or teacher supporting behaviour in reducing anxiety. The dependent variable will be 'anxiety'.

2. **Active and Attribute variables:** Based on the distinction between measured and experimental variables, a categorization of variables is developed that will be helpful in the study of research design. Active variables are those that have been manipulated, while attribute variables are those that have been measured. Active variables are any variables that can be manipulated. As an illustration, consider teaching strategies, anxiety, and reinforcement. Attribute variables are the measured variables that are not manipulated. For instance, all factors that are specific to humans, such as sex, IQ, aptitude, socioeconomic standing, conservation, etc. Here, people arrive for investigations already equipped with these factors (aspects). Certain variables are always attributes by definition, but attributes can also be active variables. Consider "Anxiety."
 3. **Continuous and Categorical variables:** **Continuous** variables can take an ordered set of values within a specified range. In theory, any given range can include an endless number of values. That is, any individual may have a score of 4.72, 4.5, etc. Rather than just 4 or 5. **Categorical variables** are subject to nominal measurement. In nominal measurement, the set of items being measured is divided into two or more subsets. Individuals are classified based on whether they exhibit the characteristics that characterize any subset. Here, categorization refers to assigning an object to a subset based on whether or not the object possesses the characteristic that defines the subset. In categorical variables, all participants in a subset are treated as identical, with the same name (nominal) and numeral. There is no rank order or greater-than-and-less-than among the categories, and all of the participants in each have the same value. For instance, sex. In this case, '1' is allocated to one sex ('Male') and '0' to the other ('Female'). There are two kinds of categorical variables. **Dichotomous categorical** variables have only two subsets. For example, sex (male and female). **Polytomies** include more than two subgroups. Examples include religious preference, nationality, occupational choice, and so forth. Categorical variables are sometimes used to describe qualitative variables.
- According to UNESCO (2005),
Variables are categorized into four primary kinds by UNESCO (2005). These variables include ratio, interval, nominal, and ordinal variables.
 1. **Nominal variables:** All variables that are measured using the nominal scale. This sort of variable allows statements that are just about equality or difference. Examples include hair color, religion, country of birth, gender, and sex.
 2. **Ordinal variables:** All variables measured using the ordinal scale. This type of variable allows for comments regarding the rank ordering of members of a group. Examples include physical attractiveness, happiness, agility, and so on.

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3. **Interval variables:** All variables that are measured using the interval scale. This sort of variable allows for reports regarding 'rank ordering' as well as 'size of the interval' along the scale, which is used to measure individuals and compare distances at different locations along the scale. For example, achievement and IQ scores.
4. **Ratio variables:** All variables that are measured using the ratio scale. This sort of variable allows assertions that are valid for the other three types of variables, as well as having an absolute zero point. For example, consider an individual's physical height and weight.

- According to Kumar (2001),
Kumar (2001) grouped variables in three ways:

1. Base on causal relationship
2. Base on study design
3. Base on the unit of measurement

1. **Base on the causal relationship:** Variables are categorized into four kinds based on their causal relationships.
 - i) **Change variables,** These are responsible for making a change in a phenomenon, scenario, or circumstance.
 - ii) **Outcome variables,** these are the effects, impacts or consequences of a change variable.
 - iii) Variables which affect or influence the link between cause-and-effect variables.
 - iv) **Connecting or linking variables,** these are necessary to complete the relationship between cause-and-effect variables.

In research terminology, the four variables listed above (change variables, outcome variables, unmeasured variables affecting the cause-and-effect relationship, and variables that link a cause-and-effect relationship) are referred to as independent variables, dependent variables, extraneous variables, and intervening variables, respectively.

2. **Base on study design:** Base on study design, the variables are classified in two ways,
 - i) **Active variables:** The variables that can be manipulated, changed or controlled.
 - ii) **Attribute variables:** The variables that cannot be manipulated, changed or controlled, but these variables reflect the characteristics of the study population. For example, age, gender, education, income etc.
3. **Base on the unit of measurement:** Base on the unit of measurement, there are two ways to categorise variables.
 - i) Whether the unit of measurement is **categorical** (as in nominal and ordinal scales) or **continuous** in nature (as in interval and ratio scales)
 - ii) Whether it is **qualitative** (as in nominal and ordinal scales) or **quantitative** in nature (as in interval and ratio scales).

Categorical variables are classified in three types

- a) **Constant variable:** It has only one category. For example, tree, water etc.
- b) **Dichotomous variable:** It has only two categories, For example male/female, yes/no, good/bad, head/tail, up/down and rich/poor.

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c) **Polytomous variable:** It can be divided into more than two categories. For example, Religion (Christian, Muslim, Hindu), Attitudes (Strongly favourable, favourable, uncertain, unfavourable, strongly unfavourable).

- According to Johnson & Christensen (2008),
The variables are classified into two types
- 1. Level of measurement: It is divided into two types
 - i) Categorical variables
 - ii) Quantitative variables
- 2. Role taken by the variable: It is divided into five types.
 - i) Independent variable
 - ii) Dependent variable
 - iii) Mediating or intervening variable
 - iv) Moderator variable
 - v) Extraneous variable

HOW WILL THE VARIABLES BE STUDIED?

Korb (2012) identifies four primary research designs for studying variables in educational research. They are

- i) Descriptive
 - ii) Causal Comparative
 - iii) Co relational
 - iv) Experimental and Quasi-Experimental
- i) **Descriptive design** is used to describe the current state of the variables. For example, “The Current Status of Vocational Education in West Bengal”
 - ii) **The causal comparative design** is used to investigate the effect of one variable that cannot be changed on other variables. For example, “The effect of Gender on Examination Malpractice”. Here the investigator cannot manipulate a person’s gender, instead to compare male and female on their examination malpractice behaviour. Causal comparative studies are sometimes referred to as ex post factor studies.
 - iii) **Co relational design** describes the relationship between variables. Here, the variables should have continuous values, and both variables should be researched in the same group of participants. For example, “The Relationship between Academic Achievement and Motivation in Students”. Here both variables are continuous and both variables are studied in same group of individuals (students).
 - iv) **Experimental and quasi-experimental methods** are used to investigate the effect of a variable that the researcher should manipulate on other variables. For example, “Effect of a New Teaching Method on Student’s Mathematics Learning Achievement”. Here, the researcher manipulates the teaching method to observe the impact on students' mathematical achievement.

❖ How will the variables be measured?

No single level or method is used to measure the variables in any kind of educational research. This measurement is heavily influenced by how the variables are framed and the kind of indicators employed. The same variable can be measured in several ways (Sarantakos, 2005). According to John and Mnyawi (2014), the measurement of any variable can be done at four stages.

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- i) Nominal level
- ii) Ordinal level
- iii) Interval level
- iv) Ratio level

- i) The nominal level** is the simplest and lowest level of measurement. The nominal scale is used for measuring a variable. At the nominal level, only individual replies are categorized. They do not indicate an order among the responses. For example, if the researcher wants to classify participants based on their favorite color, there is no reason why red should be preferred over blue, green, or any other colour. Gender, favorite color, religion, and other categorical factors are measured on a nominal scale.
- ii) The ordinal level** of measuring is stronger than the nominal level of measurement. When measuring a variable, an ordinal scale is utilized. Individual responses are ordered from least to most. For example, assume a researcher wants to assess consumer satisfaction with their governance system. So, they are asked to specify their feelings as 'very dissatisfied', 'somewhat dissatisfied', 'somewhat satisfied', or 'very satisfied'. Here, the replies are sorted from least to most happy.
- iii) The interval level** of measurement is stronger than preceding levels of measurement and retains all of their qualities. The interval scale is used to measure any variable. This level of measurement has a start and end point that are separated by an equal number of intervals. These intervals have the same meaning throughout this measurement. For example, imagine four children's mathematics achievement test scores are 30, 40, 50, and 60. The scores between 30 and 40, as well as 50 and 60, show the same difference. Because each 10-point variation has the same physical significance. This level of measurement is primarily employed in educational research.
- iv) The ratio level** of measurement is the most powerful of all levels of measurement. It includes all of the attributes of the preceding measurement levels, as well as the absolute zero point of origin. The ratio scale is used to measure any variable. The same difference and/or ratio at two points on the scale conveys the same concept. For example, height, weight, and income. This degree of measurement is mostly utilized in scientific research.

CONCLUSION

According to the preceding discussion, variables are fundamental to every educational research. Different educators and experts categorize the variables in different ways. However, they place a greater emphasis on independent, dependent, extraneous, confounding, intervening, and moderator variables, all of which are essential in educational research. On these essential variables, the majority of the research study is completely dependable. So, it is argued that they are the key variables in every educational research. Aside from these basic variables, there are numerous other variables employed in educational research. These include dummy variables, categorical variables, dichotomous variables, and polychotomous variables. The primary purpose of every educational research study is to investigate the essential variables. These essential variables are investigated using four primary study designs. These include descriptive, causal comparative, co-relational, and experimental/quasi-experimental designs. (Korb, 2012). Independent and dependent variables are explored using casual-comparative, experimental, and quasi-experimental research designs, whereas descriptive research designs just reflect the current status of any

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variables. This design does not rely on presumed cause and effect. So, it has no independent or dependent variables. Furthermore, co-relational research design alone looks at the link between the variables. Therefore, no variable is changed. As a result, it is impossible to identify the cause and effect. Therefore, there are neither independent nor dependent variables in a co-relational research design. Korb (2012). Variables other than the essential variables are not investigated in any research study. But these are used to carry out the research study.

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Conflict of Interest

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