

Guide to elaborate the operationalization of variables

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— *Abstract* —

The main objective of this scientific article is to produce a guide to develop the operationalization of variables and is aimed at teachers, researchers, undergraduate and graduate students involved with scientific research from the quantitative route. It is intended to show a tool that allows students and researchers to know the fundamental criteria and the steps to follow to develop a table of operationalization of variables, both from the theoretical part and from the practice. This guide is developed in six fundamental parts: The variables, the conceptual definition of the variables, the operational definition, dimensions, indicators, and the measurement scale. Each section collects the theorization of more than twenty authors of books aligned to the topic and the experience gathered by the author in the practice of university and research teaching.

Keywords:

Variables; dimensions; indicators; measurement scales; operational definition.

This review article presents a guide to elaborate the operationalization of variables and is aimed at researchers and undergraduate and graduate students who are in the stage of carrying out their research thesis from the quantitative approach, route, or paradigm. It is relevant to mention that an epistemic discussion is not carried out on the position or denomination that quantitative research should carry. Each researcher, according to the preferred author, can use the denomination that he or she sees fit. It is not the only way to operationalize the variables, nor is it presented as a unique model to follow due to the diversity of the methodological fields and perspectives of the authors; rather, it is constituted as a guide that describes a didactic and systematic procedure for the operationalization of variables.

This process has three fundamental elements that define the research: The variables, the population, and the context. It is precisely about the variables that main care must be taken due to their methodological and constructive representation and importance in the study. According to Arias (2020), "the variable is that phrase or word found in the title or research topic, it is also found in the general objective, general problem, and general hypothesis" (p. 33). For Hernández-Sampieri and Mendoza (2018), the variables must be measured, observed, and inferred according to a theoretical analysis; that is to say, through the variables data are obtained from the reality investigated; in this regard, Tamayo (2003) mentions that the variables are observable characteristics of an evaluated reality, which, from the quantitative approach, assumes values or units of measurement, this is done through the operationalization or operational definition of variables.

The importance of variables and their operationalization is understood once a research work is written. This article provides a tool with theoretical and practical support that can serve as a guide so that the undergraduate and graduate students do not have problems when operationalizing their variables; from the formulation of variables, dimensions, indicators, to the measurement scale, for which a guide will be developed to elaborate the operationalization of variables.

An analysis and description of the theoretical and practical foundations are also presented following the formulation of the objective of this article, having primary sources such as books that address scientific research topics, research methodology, and scientific research writing guides with a period comprised of thirty years until 2020, which contain theory aligned to the field of study.

THE VARIABLE AND ITS DEVELOPMENT

Variables must be known in two ways: The conceptual definition and the operational definition; concerning the first, variables must be defined as if

it were a word or phrase within a glossary; for the second, how the variable is going to be measured is specified, this is called: Operationalization of variables.

The operationalization of variables consists of a set of techniques and methods that allow measuring the variable in research, it is a process of separation and analysis of the variable in its components that allow to measure it (Morán and Alvarado, 2010). It is made up of the activities carried out by the researcher to collect population data (Hernández-Sampieri and Mendoza, 2018). The operationalization of a variable consists of a process of assigning categories or identifying data in its study characteristics (Cea, 2012). According to Cazau (2006), the operationalization of variables is divided into two: Simple and complex; when it comes to the simple one, the variable is only measured with indicators, that is, no dimensions are presented; A practical example of a simple variable is marital status, it is only measured by indicators: Married, single, widowed, divorced; there is no need for dimensions. When it comes to the complex form, it involves measuring variables with dimensions, indicators, and even sub-indicators. For practical purposes, this guide aligns itself to complex variables. The operationalization of variables is a table made up of three or more rows and six columns, in which the following are presented in an orderly manner: The variables, conceptual definition of the variables, the operational definition, the dimensions, the indicators, and the measurement scale. Here is an example.

Table 1
Variables operationalization

Variables	Conceptual Definition	Operational Definition	Dimensions	Indicators	Measuring scale
Variables 1					
Variables 2					

Source: Operationalization of variables based on APA 7th edition standards

Variables

The variable is a characteristic, magnitude, or quantity that undergoes changes and that is the object of analysis for research (Arias, 2012). For Aceituno, Silva, and Cruz (2020) the variable groups the attribute and the concept, which means that the variable is made up of a measurement property and logical and theoretical construction of the phenomenon under study.

For Bernal (2010) and Cabezas, Andrade, and Torres (2018), there are these types of variables that are, according to their purpose: Independent, dependent and intervening; In the case of the independent variable, only if it is ex post facto studies should it be operationalized and measured; If it is an experimental study, it is operationalized but not measured, the action carried out, in this case, is to control or manipulate its changes intentionally; Regarding the intervening variable, in many cases, they are not measured or operationalized, however, they are phenomena that may or may not be present during the study, such as sociodemographic data or some alteration in the environment. According to its complexity: Simple and complex; according to their nature: quantitative and qualitative.

The operationalization of variables can have quantitative variables and qualitative variables; simple and complex variables; but they cannot have only independent or dependent variables, there must be at least one independent variable and at least one dependent variable because one depends on the other, otherwise it would not have that name. As already mentioned, the independent variable is not measured, but it is necessary to show it in the operationalization of variables to observe how it will develop during the study. To measure the variables, at least two dimensions must be formed for each variable and two indicators for each dimension; in case only one dimension is chosen, this dimension would become the variable.

The number of variables presented in the operationalization table will depend on the problem that they have established for their study; It can be one, two, or three variables and it must be explicitly stated as it was written in the general research problem: That is if the problem is: What is the relationship between emotional control and students' academic performance? The variables must be the following:

- a) Variable 1: Emotional control
- b) Variable 2: Academic performance

Another correct way to present the variables would be to include the attribute: Grade, level, type.

- a) Variable 1: Degree of emotional control
- b) Variable 2: Level of academic performance

The connectors or the determined or indeterminate articles (*el, la los, un, una*) should not be written. An incorrect wording of the variables in the operationalization would be:

- a) Variable 1: Relationship of emotional control

b) Variable 2: Academic performance

The classification of the types of variables may or may not be placed in the operationalization, the type of variable is understood through the same reading or the approach of the research methodology.

Conceptual definition of variables

In this column, terms different from those of the theoretical framework are indicated, which allow the variable to be understood in the context of the research, that is, from the population and space. To find this conceptual definition, use is made of specialized dictionaries, magazines, books, articles, among others. (Hernández-Sampieri, Fernández-Collado, y Baptista, 2006). For La Torre, Del Rincón and Arnal (2004) and Pimienta (2017), they are theoretical constructions or definitions from specialized books or dictionaries that theoretically support the study variables. It is recommended to use epistemological bibliography.

As mentioned above, it is important to establish the context where the variable will be measured. It is not the same to conceptually define emotional control in children and in teachers (the capacities and abilities that teachers have developed due to their activity and age are different) For example: If the variable is emotional control and the population is children; the conceptual definition would be: Ability to understand and express feelings between colleagues (Unicef, 2018). In case it is emotional control in a population of teachers; the conceptual definition of the variable would be: Ability so that family conflicts do not influence work activities (Aguaded and Valencia. 2017). Also, this definition may change according to each author. For example:

General problem: What is the relationship between **emotional control** and **children's academic performance** in an educational institution?

Table 2
Variables and its conceptual definition

Variables	Conceptual definition
Emotional control (Qualitative)	Ability to understand and express feelings between colleagues
Academic performance (Qualitative)	Evaluation of knowledge, skills, and attitudes acquired in the school year

Note: Verify context (population and space)

Source: Own elaboration

Operational definition of variables

It is a set of activities that are carried out after the theoretical and practical analysis of the variables. This is done to establish how the variables are to be measured, in other words, the operational definition allows us to know which instrument or tool should be used to obtain clear and true results of the variable. Various criteria and ways can be used to operationally define the variable. For example, if you want to identify the level of anxiety in a population, the way to obtain the results would be through an anxiety test made up of various items or questions. If you want to know the weight of the people, the tool used must be a scale. The example is shown in table 3.

Dimensions

The dimensions are the factors that are obtained and measured from the variables, they are written and are broken down into indicators. (Tamayo, 2003), (Aquino y Barrón, 2007). The dimensions should be considered taking into account the context of the research, as well as in the conceptual definition of the variable. It is important to differentiate the population since it is not the same to measure emotional control in infant students and teachers. Each variable must have at least two dimensions, these dimensions are normally composed of a word or a phrase, phrases of more than three words are not recommended for dimensions.

Main care must be taken when proposing the dimensions, since previously, to establish them, an exhaustive review of the theoretical foundations for the variable must be carried out. Concerning this, there are two ways to raise the dimensions correctly:

- a) Carry out an exhaustive search for the theory (theoretical framework).
- b) Choose dimensions of a scale already validated in scientific articles (it must take the context into account: Population and demographic space).

There is no set or recommended number of dimensions per variable; however, the researcher should try to measure the variable with the number of dimensions that allow them to fully address the variable. For example:

Overall problem: What is the relationship between emotional control and children's academic performance in an educational institution?

Table 3
Variables and dimensions

Variables	Dimensions
Emotional control	Showing emotions
	Empathy
	Interpersonal relations
Academic performance	Behavior
	Academic notes of courses
	Responsibility

Note: Verify context (population and space). Dimensions obtained from reviewing the theory of each variable

Source: own elaboration

INDICATORS

The indicators are the concrete elements of the dimensions and express the measurable reality of the variable (Baena, 2017). Indicators refer to a process that begins with variables and dimensions; some indicators are more objective than others, which makes them less or more difficult to observe (Rojas, 2013).

Indicators are established when, with the dimensions or categories, they have not yet been able to effectively measure the variables; this indicator is the proof that the researcher observes to determine that the variable exists. (Mejia, 2005)

The indicators are those values that allow the variable to be observed, arise from the dimensions, and can be expressed in words, phrases, or numbers. Some examples of indicators in words would be from the simple variable, marital status: married, single, widowed, divorced. For indicators in sentences they would be according to the emotional control variable: Basic emotions, social emotions, and for indicators in numbers, it would be according to the variable Age: Between 15 and 20 years, between 21 and 30 years.

As in the dimensions, an exhaustive search of the theoretical foundations of the variable and the dimensions must be carried out, which is normally written in the theoretical framework. For example:

Overall problem: What is the relationship between emotional control and children's academic performance in an educational institution?

Table 4
Variables, dimensions, and indicators

Variables	Dimensions	Indicators
Emotional control	Showing emotions	Basic emotions
		Social emotions
	Empathy	Identifying emotions
		Understanding emotions
		Communication
Academic performance	Interpersonal relations	Collaboration
		Respect
	Behavior	Courtesy
Academic notes of courses	Academic notes of courses	Mathematical
		Communication
	Responsibility	Others (keep counting)
		Assistance
		Punctuality

Note: Verify context (population and space). Dimensions obtained from reviewing the theory of each variable

Source: own elaboration

It is important to remember that these indicators are based on a certain context; they can change according to what the researcher wants to get out of the study. There must be at least two measures for each dimension, if there was only one measure, this would become the dimension.

Variable measurement scales

This study does not present an epistemic or theoretical contrast on the name that this section carries, the researcher can name it according to the author of preference. In this case, the name of the measurement scale is required according to the authors highlighted.

Caballero (2014) specifies that the variables must be evaluated using four types of scales: nominal, ordinal, ratio, and interval scales. Scales typically arise from both quantitative and qualitative types of variables. The qualitative variables are made up of Nominal and ordinal; the quantitative variables are made up of Interval and ratio. (Díaz, 2009).

- a) Nominal scale: In this case, the scale adopts discrete states, which cannot be ordered; this means that it is not possible to establish a hierarchy or an order for the measurement of the variables (Corbetta, 2007), in this case, the variables could be: sports, which

can be divided into its dimensions: Water sports with its indicators swimming and surfing and table sports dimension with its table tennis and chess indicators.

- b) Ordinal scale: It expresses a quality, but in an orderly way; in a sense from high to low, from good to bad (Cea, 2012), this type of scale is presented when the variables are qualitative: emotional control, academic performance, organizational climate, work motivation, among others. Normally, the Likert-type scale is used. Some authors such as Aceituno, Silva, and Cruz (2020) suggest the use of the attribute to identify the dimensions, a serious example: types of organizational climate, level of academic performance.
- c) Interval scale: Equal distances are established for each value; that is, the interval value is equal to the previous one (Mejía, 2005). For example, if the variable is temperature, it can be divided into its dimensions according to the three natural regions of Peru and its indicators would be the ranges that temperatures can have: Between 10th and 15th, between 16th and 25th.
- d) Ratio scale: Zero (0) implies that the category being measured does not exist. Example: Number of students, the weight of students, number of children (Cruz, Olivares, and Gonzáles, 2014). For example, if the variable is height, the dimensions would be male and female, the indicators can be segmented into groups: Between 20 and 30 kilos, between 31 and 50 kilos.

As mentioned above, there are two types of variables: quantitative (ratio and interval scale), and qualitative (nominal and ordinal scale); to differentiate them, one must be aware that qualitative variables are not susceptible to be measured numerically and for this, the Likert-type scale can be used; while the quantitative variables are. Example:

If the variable is the Work environment, it is an ordinal qualitative variable because it cannot be measured by establishing that the work environment is 2 work environments or 20 work environments, for this type of variable an ordinal scale must be used that allows measurement based on the representation of the variable. Example: Always, sometimes, never. Which will allow you to obtain a positive or negative rating.

If the variable is Gender, it is a nominal qualitative variable because there is no rating range or scale, only female and male, among others. You cannot say that there are zero genders, nor can you add or subtract genders.

If the variable is the Number of students, it is a quantitative interval variable because it can be indicated that there are 25 students in a classroom. It is interval because we cannot say that there are 25.5 students.

If the variable is Salary, it is a quantitative ratio variable because we can state that the salary is \$1,550. It is of ration because the zero (0) indicates that it earns zero (0) soles and it does not exist.

Operationalization of variables

Taking into account the theory and the development set out above, the operationalization of the variables is made up of the following way:

Overall problem: What is the relationship between emotional control and children's academic performance in an educational institution?

Table 5
Operationalization of variables

Variables	Conceptual Definition	Operational Definition	Dimensions	Indicators	Measurement scale
Emotional control (Qualitative)	Ability to understand and express feelings among peers	Emotional control measurement scale made up of 25 items	Showing emotions	Basic emotions Social emotions Identifying emotions	Ordinal
			Empathy	Understanding emotions	
			Interpersonal relations	Communication Collaboration Respect	
			Behavior	Courtesy	
Academic performance (Qualitative)	Evaluation of knowledge, aptitudes and attitudes acquired during the school year	Academic performance questionnaire consisting of 18 items	Academic notes of courses	Mathematics Communication Other (keep counting)	Ordinal
			Responsibility	Assistance Punctuality	

Source: Author's elaboration

FINAL THOUGHTS

The variables should be raised through a presentation of the research problem and the dimensions and indicators should be formulated under an exhaustive review of the theory; they should not be drafted deliberately.

The operationalization of variables is a process that occurs only in the quantitative approach because the variables must be susceptible to being observed and measured. This process is carried out in an orderly manner, from general to specific; it works as a decomposition of the variables into

their parts, which are the dimensions, and the decomposition of the dimensions into their parts, which are the indicators.

The dimensions and indicators of the same variable may be different in other studies, this will depend on the context of the study. It is important to establish the scale of measurement of the variables because it will allow establishing the correct hypothesis test, in addition, it will allow selecting the type of techniques and instruments to collect the information for the investigation.

Operationalization can present the number of variables that the researcher sees fit; one, two, or three; this will depend on the research problem and the proposed methodology.

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