Step 7: Identifying, Labeling, and Defining Your Variables

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Introduction

Your variables are introduced in your purpose statement, questions, and hypotheses, but it is also useful to identify each variable, to label it, and to define it.

Topical Discussion: Types of Variables

There are 6 basic types of variables.

- 1. Independent Variables (Predictor Variables)
- 2. Dependent Variables (Criterion Variables)
- 3. Variables of Interest
- 4. Confounding (Control) Variables
- 5. Moderating Variables
- 6. Mediating Variables

Independent Variables (Predictor Variables)

Independent variables are variables that affect, influence, or cause (or possibly cause) the outcome, the dependent variable. They are the treatment, what is manipulated in a study, or the intervention that the researcher chooses to study. In a regression study, the independent variable is the predictor variable.

Independent variables are often, but not always, categorical in nature. That is, the researcher is usually interested in the presence versus the absence of a treatment or condition. Most research studies involve more one independent variable.

Example: In the question we have been posing, Is the difference in the second grade students' attitudes toward math as measured by the Attitudes Toward Mathematics Inventory who participate in the Math 2.0 program as opposed to second grade students who participate in a traditional math class? let's identify our independent variable.

Independent variable: type of program.

Since we have both a treatment group, those participating in the Math 2.0 program, and a control group, those participating in a traditional math course, our independent variable has 2 levels.

Tips: When writing about a planned regression study, it is important to note when to use the terms independent variable and when to use the term predictor variable. Use the term independent variable when you as the research manipulate the variable. If you do not manipulate the variable for the study, then use the term predictor variable.

Dependent Variables (Criterion Variables)

Dependent variables are the variables that are influenced by or depend upon the independent variables. They are the outcomes or effects. They are the factors that are being observed or measured.

Dependent variables are often continuous in nature; that is, they have a value. However, some researchers do measure dependent variables that are discrete. A more in depth discussion about types of data is in the analysis lesson.

Example: In the question we have been posing, Is the difference in the second grade students' attitudes toward math as measured by the Attitudes Toward Mathematics Inventory who participate in the Math 2.0 program as opposed to second grade students who participate in a traditional math class? let's identify our dependent variable.

Dependent variable: attitudes toward math as measured by the Attitudes Toward Mathematics Inventory

Tips: When writing about a planned regression study, it is important to note when to use the terms dependent variable and when to use the term criterion variable. Use the term dependent variable when you as the research conduct an experiment, manipulate the independent variable. If you do not manipulate any variable for the study, then use the term criterion variable.

Variables of Interest

When considering the relationship between two variables, deciding which is indepdnet and which is dependent can be arbitrary. As such, they can simply be referred to as variables of interest. Let's look at this a little more in depth.

In correlational research, the relationship between variables is considered; whereas, in experimental research, we manipulate a variable and measure the effects of that manipulation on the other variable. In a correlational study, we do not seek to prove causation.

By definition, an independent variable is a factor that can be varied or manipulated. A dependent variables value, according the mathematical texts, depends on the value of x or the independent variable. Thus, by definition, you can conclude that defining variables as independent or dependent in a correlational study does not seem appropriate. As such, the variables in a correlation study that are not being manipulated can be labeled as variables of interest rather than independent or dependent or dependent variables.

It is important to note that some research tests refer to the variables in a correlational study as independent and dependent. Although I prefer that researchers distinguish between variables of interest and independent and dependent variables, I usually recommend that students use the terminology consistent with the text they are citing to justify their statistical procedures.

Confounding (Control) Variables

Confounding variables are variables that influence the dependent variable. When a researcher knows that a confounding variable(s) is present, he or she should try to neutralize the effect of the variable(s).

When the variable is controlled for it is controlled for, it is called a control variable. The research may choose to control the variable in a variety of ways. For example, the research may try to make the variable constant by eliminating a certain population or characteristic within a population. If gender is a confounding variable, the researcher may choose to only study males. In the case of the parenting class example we have been considering, only fathers. If we were controlling for a variable in this manner, we would discuss it in the methods section.

The research may also use a statistical analysis such as an analysis of covariance to control for the variables influence. As such, this type of confounding variable is called a control variable. Researchers often control for variables such as age, gender, and ethnicity. If statically controlling for the variable, it should be noted in the hypothesis.

Example: In the question we have been posing, Is the difference in the second grade students' attitudes toward math as measured by the Attitudes Toward Mathematics Inventory who participate in the Math 2.0 program as opposed to second grade students who participate in a traditional math class?, we may recognize that the gender of the student is likely to influence math motivation and identify it as a variable that needs to be statistically controlled. If we decide that gender is a control variable, then, our hypothesis would be, There is no difference in the second grade students' attitudes toward math as measured by the Attitudes Toward Mathematics Inventory who participate in the Math 2.0 program as opposed to second grade students students' attitudes toward math as measured by the Attitudes Toward Mathematics Inventory who participate in the Math 2.0 program as opposed to second grade students who participate in a traditional math class , while controlling for the gender.

Let's Practice:

Read the following example. Identify the independent variable, the dependent variable, and the control variable. There will be a statistically significant increase in computer competence of freshman education students who are provided with the teacher technology program in their Introduction to Education course as opposed to freshman education students who are not provided with the teacher technology program.

Answer: Participation is the independent variable, computer competence is the dependent variable. The control variable is class level, freshman.

Moderating Variables

A moderating variable influences the strength of a relationship between two other variables "In general terms, a moderator is a qualitative (e.g., sex, race, class) or quantitative (e.g., level of reward) variable that affects the direction and/or strength of the relation between an independent or predictor variable and a dependent or criterion variable." (Barron & Kenny, 1986, p. *1174*). A moderating variable is often considered as a second independent variable in a research study.

Example: In the question we have been proposing, age may be a moderating variable. The Math 2.0 program may have a significant influence on younger student's communication styles but may be less strong or nonexistent for older students.

Mediating Variables

A **mediating variable** explains the relationship between the two other variables. "In general, a given variable may be said to function as a mediator to the extent that it accounts for the relation between the predictor and the criterion. Mediators explain how external physical events take on internal psychological significance. Whereas moderator variables specify when certain effects will hold, mediators speak to how or why such effects occur" (Barron & Kenny, 1986, p. *1176*)

Let's Practice:

Read the following example. Identify the independent variable and the dependent variable. Determine if there is a mediating or moderating variable. If one exists, identify it. Fathers who are offered a parent skill program tend to improve their parental communication skills, while mothers who do not participate in a parent skill program have good parental communication skills.

Answer: Participation is the independent variable, parental communication skill is the dependent variable. The moderating variable is gender of the parent.

Defining Variables: Operational Definitions

In our discussion of research questions, we briefly discussed operational definitions. Let's revisit operational definitions here.

Remember that an operational definition is a clear, concise definition of how a variable is being measured or the observable condition (LaFountian & Bartos, 2002). This is not simply a dictionary definition. In a methodology plan, each variable should be listed, labeled, and operationally defined. The operational definition should be congruent with the theoretical and conceptual framework.

Example: In the following question, Is there a difference parents' level of encouragement for their children, reasonable expectations for their children, and the type of limits they set for their children based on type of parenting program the parent participated in? The dependent variables are limits and consequences, reasonable expectations, and encouragement. These three variables will be measured, thus, operationally defined as the subscale score a parent receives of the interactive parenting skills instrument. If using a survey instrument to measure the variable, the survey is used to operationally defined the instrument. When using subscales or specific items on a survey, it is useful to relate the variable and the items on the survey so the reader can understand exactly how the variable was measured. I find that one of the easiest ways to do this is to use a table as displayed below. The Table below provides an example of one way to list variables, label, and defined them. A narrative is fine also.

Variable	Descende Question (and/an	Operational Definition
variable	Research Question (and/or	Operational Definition
	hypothesis)	(include survey and specific
		items on the survey where
		applicable) & Citation
Dependent Variable 1:	Is there a difference in the	The Attitudes Toward
External	second grade students'	Mathematics Inventory
	attitudes toward math as	(Tapia & Marsh, 2004;
	measured by the Attitudes	external); Questions
	Toward Mathematics	3,5,7,11
	Inventory who	
	participate in the Math 2.0	
	program as opposed to	
	second grade students who	
	participate in a traditional	
	math class?	
	H_{01} : There is no difference	
	in second grade students'	
	external attitudes toward	
	math as measured by the	
	Attitudes Toward	
	Mathematics Inventory who	
	participate in the Math 2.0	
	program as opposed to	
	second grade students who	
	participate in a traditional	

	math class.	
Dependent Variable 2: introjected	H_{03} : There is no difference in second grade students' introjected attitudes toward math as measured by the Attitudes Toward Mathematics Inventory who participate in the Math 2.0 program as opposed to second grade students who participate in a traditional math class.	The Attitudes Toward Mathematics Inventory (Tapia & Marsh, 2004; introjected); Questions 2,4,6,9
Dependent Variable 3: identified regulation	H_{04} : There is no difference in second grade students' identified regulation attitudes toward math as measured by the Attitudes Toward Mathematics Inventory who participate in the Math 2.0 program as opposed to second grade students who participate in a traditional math class.	The Attitudes Toward Mathematics Inventory (Tapia & Marsh, 2004; identified regulation); Questions 1,8,10,12

Writing a Narrative for an Identification of Variables Section

In a methodology plan each variable should be listed, labeled, and operationally defined. This can be done in chart form; however, it may also be done in narrative form. In the narrative, each variable needs to be listed, labeled (e.g., independent, dependent), and operationally defined. All definitions in this section need to be supported by the literature; citations need to be included.

Here is an example from a dissertation: "The predictor variables in this study will be four factors of cultural intelligence. Cultural intelligence is "an individual's capability to function and manage effectively in culturally diverse settings...a multidimensional construct targeted at situations involving cross-cultural interactions arising from differences in race, ethnicity, and nationality" (Ang, et al., 2007, p. 336; Earley & Ang, 2003). Cultural intelligence is comprised of the following four factors: metacognitive cultural intelligence, cognitive cultural intelligence, motivational cultural intelligence, and behavioral cultural intelligence. The Cultural Intelligence Scale (CQS) Ang et al. (2004) will be used to measure these four factors of cultural intelligence. The CQS uses 20 items that describe individuals' capabilities to be culturally intelligent in each of the four factors and asks the individuals to use a scale from one to seven to assess their agreement with the statements." (Kueng, 2011, p.12)

All variables and definitions should also be derived from the theoretical framework. For example, if a researcher interested in examining the effectiveness of a distance education intervention and part of the conceptual framework for the study is the Community of Inquiry Framework (Garrison, Anderson, and Archer, 2000), effectiveness may be defined as the students' sense of community. The assumption underlying the model is that effective learning occurs within a community in which three essential elements are present: social presence, cognitive presence, and teaching presence. Social presence is "the ability of participants in the Community of Inquiry to project their personal characteristics into the community, thereby presenting themselves to the other participants as real people" (Garrison, et al, 2000, p. 89), and cognitive presence is "the extent to which the participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication" (Garrison et al., 2000, p. 89). Teaching presence is the design and the facilitation that guides the cognitive and social processes for the purpose of educational meaningful learning outcomes (Garrison, 2000, et al.). The underpinning assumption that the optimal educational experience occurs when there are interactions among these three elements is what makes it a useful tool for the evaluation of effective online education. As such sense of community is comprised of three elements; thus, three dependent variables, social presence, cognitive presence, and teaching presence.

The following hypothesis may be proposed: Online students who utilize a combination of synchronous and asynchronous systems for online discussion as opposed to online students who utilize only an asynchronous systems for online discussion will have statistically significant differ in terms of the combination of social presence, cognitive presence, and teaching presence.

The COI Framework survey (Arbaugh et al., 2008), a 34-item self-report consisting of three subscales of social presence, cognitive presence, and teacher presence, can be used to measure the identified dependent variables. The COI Framework survey is the operational definition or the way the three dependent variables will be measured.

The Case of Charlie

Based on the proposed questions and hypotheses, Charlie answers the following questions:

- What is my independent variable?
 - Participation in type of freshman orientation structured small group. This independent variable has two levels: traditional (control) and the EI CBT freshman orientation (treatment)
- What are my dependent variables?
 - Anxiety levels (as measured by the Beck Anxiety Inventory® (BAI®); Beck & Steer, 1990)
 - o Academic achievement as measured by first semester college GPA
 - Interpersonal skills as measured by the Positive Relations With Others scale (Ryff, 1989; Ryff & Keyes, 1995).

- Are there any variables that knowingly influence my dependent variable? If so, do I need to statistically control for it?
 - Previous anxiety levels (as measured by the Beck Anxiety Inventory® (BAI®); Beck & Steer, 1990)
 - Previous academic achievement as measured by high school GPA
 - Previous interpersonal skills as measured by the Positive Relations With Others scale (Ryff,1989; Ryff & Keyes, 1995).

He then completed the following chart:

Variable	Research Question	Operational Definition & citation (include survey and specific items on the survey where applicable)
Independent Variable 1: Participation in type of freshman orientation structured small group. This independent variable has two levels: traditional (control) and the EI CBT freshman orientation (treatment)	All three listed below	
Dependent Variable 1: Anxiety Level	Is there a difference in the anxiety levels (as measured by the Beck Anxiety Inventory® (BAI®); Beck & Steer, 1990) of college freshman diagnosed with generalized anxiety disorder when participating in a traditional freshman orientation as compared with the EI CBT freshman orientation while controlling for anxiety scores?	The 21 items of the Beck Anxiety Inventory® (BAI®); Beck & Steer, 1990) Posttest
Control Variable 1: Previous Anxiety Level	See above	The 21 items of the Beck Anxiety Inventory® (BAI®); Beck & Steer, 1990) Pretest
Dependent Variable 2: Academic Achievement	What is the effect of participation in a traditional freshman orientation as	First Semester GPA derived from college transcripts

	compared with the EI CBT freshman orientation on college freshman's academic achievement as measured by first semester GPA while controlling for previous achievement (i.e. High school GPA)?	
Control Variable 2:	See above	High School GPA derived
Previous Academic		from high school transcripts
Achievement		
Dependent Variable 3: Interpersonal skills	What is the effect of participation in a traditional freshman orientation as compared with the EI CBT freshman orientation on college freshman's interpersonal skills as measured by the Positive Relations With Others scale (Ryff,1989; Ryff & Keyes, 1995) while controlling for previous interpersonal skills?	The Positive Relations With Others scale Posttest (Ryff,1989; Ryff & Keyes, 1995)
Control Variable 2:	See above	The Positive Relations With
Previous Interpersonal		Others scale (Ryff,1989;
Skills		Ryff & Keyes, 1995) Pretest

Application: Developing My Research Plan

Examine each of your research questions and hypotheses separately, and answer the following questions:

- What is my independent (or criterion) variable?
- What is my dependent (or predictor) variable?
- What is my variable of interest?
- Are there any variables that knowingly influence my dependent variable? If so, do I need to statistically control for it?

Then, complete the chart. Add more rows as needed. Or, simply create a list in narrative form. Many dissertations and theses include an "Identification of Variables" section.

Variable	Research Question	Operational Definition & citation (include survey and specific items on the survey where applicable)
Independent Variable 1 (Variable of Interest):		
Dependent Variable 1(Variable of Interest):		
Control Variable 1:		
Independent Variable 2(Variable of Interest):		
Dependent Variable 2(Variable of Interest):		
Control Variable 2:		

Now, use the chart to write a narrative.

Review the narrative:

Is each variable listed? Yes/ No Is each variable labeled (e.g., independent, dependent)? Yes/ No Is each variable operationally defined? Yes/ No Are appropriate citations included? Yes/ No

If the answer to any of these questions is "no," revise.

Now let's review and edit your problem statement (from Lesson 3), again.

- Does the statement include all the variables that are being studied? Yes/ No
- Does the statement include a brief definition of each variable under study? Yes/ No
- Does the statement include identification of ech of the variables (i.e., Independent, Dependent, Variable of Interest, Covariate)? Yes/ No

Revise and refine your purpose statement as needed:

"The purpose of the present study is . . .

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