Measurement & Instrumentation

Research Proposal Preparation Writeshop

January 26-28, 2011

BUCN Function Hall

Objectives of the lecture

- To build the connection between theory, concepts, operational definitions and empirical indicators
- To identify concepts, given hypotheses and transform them into empirical indicators and questionnaire items
- To perform exercises relative to the topic at hand

Measurement and Instrumentation Defined

- **Measurement** – the process of determining the quantity of a variable by means of appropriate measuring instruments
- **Instrumentation** – the whole process of preparing to collect data. It involves not only the selection or design of the instruments but also the procedures and the conditions under which the instruments will be administered.

Questions to ask:

- **Where** will the data be collected?

  [Refers to the location of the data collection]
- **When** will the data be collected?

  [Refers to the time of collection]
- **How often** are the data to be collected?

  [Frequency of data collection]
- **Who** is to collect the data?

  [Refers to the administration of the instrument]

Instrumentation cont.

- Researchers need to answer the questions **before, they begin to collect the data they need.**
- A researcher's decisions about **location, time, frequency,** and **administration** are always affected by the kind(s) of instrument to be used.
- For an instrument to be of any value, it should allow researchers to draw accurate conclusions about the capabilities or other characteristics of the people being studied.

Validity, Reliability and Objectivity

- **Validity** – measures what it is supposed to measure. More accurate definition revolves around the defensibility of the inferences researchers make from the data collected through the use of an instrument
- **Reliability** – Consistency of results
- **Objectivity** - Absence of subjective judgments

Methods section

- Describe the sample

- Identify each instrument used

  * Identify the theory concept measured by each instrument

  *Describe the psychometric properties of each instrument, including validity ad reliability for the study sample

  * Describe the items on each instrument and the scale used to rate the items

  *Identify the range of possible scores and explain how the scores are interpreted.

- Describe the procedures used to collect the data

Conceptual Models

- A conceptual model is a set of abstract and general concepts and propositions that provides a distinctive frame of reference or perspective for phenomena within the domain of inquiry of a particular discipline.
- A conceptual model contributes to theory development by focusing on certain things and ruling them as relevant. Other things are ruled out because of their lesser importance.

Conceptual model cont:

Examples:

- One conceptual model may declare that **interventions are designed to help the person adapt to environmental stressors.**
- Another may emphasize **individuals' abilities to care for themselves**.

Conceptual model cont:

- In the first example, nothing is said about **self-care**.
- In the second, no mention is made of **adaptation** or **stressors.**
- Thus, when a concept or phenomenon is not mentioned, it is, in effect, ruled out of the domain of interest.

Conceptual model, cont.

- "**Conceptual model**" is synonymous with "**paradigm**" or "**disciplinary matrix.**" It reflects the:

  *philosophic stance

  *cognitive orientation

  *research tradition &

  *practice tradition

  of a particular group of scholars (Fawcett & downs, 1994).

Conceptual model, cont.

- The concepts and propositions of a theory ‘are not created out of nothing… no one ever starts out with a completely clean slate to create a theory … One already has a general point of view or frame of reference (Babbie, 1989)
- The frame of reference (conceptual model) guides theory generation and testing by directing “the questions one asks and the theories one proposes and subsequently tests.”

Conceptual model, cont.

- Conceptual model provides a network within which questions, theories, and data fit together and makes possible the identification of needed areas of theory development (Newman, 1979).
- Conceptual models act as guides for the development of new theories by focusing attention on certain concepts and their relationships in a distinctive context.

Conceptual models & theories

- Many theories are needed to fully describe, explain, and predict all the phenomena encompassed by a conceptual model.
- At times it may be appropriate to link an existing theory with a conceptual model rather than develop a new theory
- Ensure that the conceptual model and the theory are logically congruent.

Conceptual models & theories, cont.

<u>Example</u>

- A conceptual model that includes the proposition that a person actively engages in interactions with the surrounding environment rather than being a passive reactor to external forces will NOT use **behavior modification theory** because it is not compatible with the conceptual model.

Conceptual model and theories, cont.

- In contrast, the client-centered theory of personality is compatible with the conceptual model for his or her behavior.
- Each conceptual model guides research by identifying the phenomena to be investigated, the methods to be used to investigate the phenomena, how theories about these phenomena are to be generated and tested, and **how data are to be collected.**

Six guidelines for inquiry guided by conceptual model

- The phenomena that are to be studied
- The distinctive nature of the problems to be studied and the purposes to be fulfilled by the research
- The subjects who are to provide the data and the settings in which data are to be gathered
- The research designs, instruments, and procedures to be employed
- Methods to be employed in reducing and analyzing the data
- The nature of contributions that the research will make to the advancement of knowledge

Hypotheses, concepts, definitions and empirical indicators

- Study: "The Relationship between Social Support and Self-Care Practices"
- Primary hypothesis: That a strong, positive association would be found between the social support and health practices variables.
- Secondary hypothesis: That married participants would score significantly higher on both the social support and health practices instruments than would their non-married counterparts.

Cont.

- Additional hypothesis: That participants with a confidant would have significantly higher scores on both the social support and health practices instruments.

EXERCISE:

Diagram the relationship between social support and health practices.

Cont.: Hypotheses stated in general empirical indicators

- There is a positive association between the social support and health practice variables.
- Married participants will score significantly higher on both the social support and health practice instruments than would their non-married counterparts
- Participants with a confidant will have higher scores on both the social supports and the health practice instruments.

Cont.: Hypotheses stated more formally in specific empirical indicators

- There is a positive relationship between scores on the Personal Resources Questionnaire, Part II and the Lifestyle Questionnaire
- There is a positive relationship between the sociodemographic datum of marital status and scores on the Personal Resources Questionnaire, Part II (PRQ-II) such that married subjects will have higher scores on the PRQ – II than non-married subjects

Cont.

- There is a positive relationship between the sociodemographic datum of marital status and scores on the Lifestyle Questionnaire such that married subjects will have higher scores on the Questionnaire than nonmarried subjects.
- There is a positive relationship between the response to the confidant question and scores on the Personal Resources Questionnaire, Part II (PRQ-II), such that subjects responding “Yes” to the confidant question will have a higher scores on the PRQ-II than the subjects responding “No.”

- EXERCISE

  Diagram the conceptual maps of the relationships of marital status and confidant to social support and health practices

TIPS about DEVELOPING an INSTRUMENT

- Be sure you are clear about what variables are to be assessed. Much time and effort can be wasted by definitions that are too ambiguous. If more than one variable is involved, be sure that both the meaning and the items for each variable are kept distinct. In general, a particular item or question sould be used for only one variable.

Cont.

- Review existing instruments that measure similar variables in order to decide upon a format and to obtain ideas on specific terms [Refer to ERIC database at the following Web site: http://searcheric.org]
- Decide on a format for each variable. Although it is sometimes appropriate to mix multiple-choice, true false, matching, rating and open-ended items, doing so complicates scoring and is usually undesirable. Remember: **Different variables often require different formats [e.g.** age, income, marital status**]**

Cont.

- Begin compiling and/or writing items. Be sure that, in your judgment, each is logically valid – that is, that the item is consistent with the definition of the variable. Try to ensure that the vocabulary is appropriate for the intended respondents.
- Have colleagues review the items for logical validity. Supply colleagues with a copy of your definitions and a description of the intended respondents. Be sure to have them evaluate format as well as content.

Cont.

- Revise items based on colleague feedback. At this point, try to have about twice as many items as you intended to use in the final form (generally at least 20). Remember that more items generally provide higher reliability.
- Locate a group of people with experience appropriate to your study. Have them review your items for logical validity. Make any revisions needed, and complete your items. You should have half again as many items as intended in the final form.

Cont.

- Try out your instrument with a group of respondents who are as similar as possible to your study respondents. Have them complete the instruments, and then discuss it with them, to the extent that this is feasible, given their age, sophistication, and so forth.
- If feasible, conduct a statistical item analysis with your tryout data (at least 20 respondents are necessary).

Cont.

- Such analyses are not difficult to carry out, especially if you have a computer, The information provided on each item indicates how effective it is and, sometimes, even suggests how to improve it.
- Select and revise items as necessary until you have the number your want.

Examples of Data Collection Instruments

A. <u>Researcher completes</u>

-Rating scales

-Interview schedules

-Observation forms

-Tally sheets

-Flow charts

-Performance checklists

- Anecdotal records

- Time-and-motion logs

Cont.

- <u>Subject completes</u>

  -Questionnaires

  -Self-checklists

  -Attitude scales

  -Personality (or character inventories

  -Achievement/ aptitude tests

  -Performance tests

  -Projective devices

  -Sociometric devices

Direct approach to Interview

- Concept: Motive patterns
- Question: “What is most important to you, the need to achieve – that is, the need to gain success through your own efforts, -- or the need for affiliation – that is, the need for close relationships with others?”
- Use of <u>fixed alternative pattern</u>

Cont.

- How important is it to you to achieve success through your own efforts?

  a. extremely important

  b. fairly important

  c. sometime important, sometimes not

  d. fairly unimportant

  e. extremely unimportant.

Cont.

- How important is it to you to enjoy close relationships with others?

  a. extremely important

  b. fairly important

  c. sometimes important, sometimes not

  d. fairly unimportant

  e. extremely unimportant.

Cont.

- If you are in a situation where you have to choose between achieving success through your own efforts and achieving a close relationship with someone, how likely is it that you will act to achieve success?

  a. extremely likely

  b. somewhat likely

  c. a toss-up

  d. somewhat unlikely

  e. extremely unlikely

Open-ended form

- “Tell a little about the relative importance for you of achieving success through your own efforts. I am particularly interested in how that goal compares in importance with the goals of achieving close relationships with other people.”

Types of measurements

- **Nominal level of measurement** – numbers or other symbols are assigned to a set of categories for the purpose of naming, labeling, or classifying the observations; Nominal variables vary in quality but not in quantity; often called qualitative
- Example of nominal level variable – sex, citizenship

Cont.

- **Ordinal level of measurement** – number assigned to rank-ordered categories ranging from low to high

  Examples:

  *Social class: upper, middle, working class

  (magnitude of the differences not known)

  *Attitudes

  (Respondents asked to mark the number representing their degree of agreement or disagreement with statements along a ranking scale; The distance between any two numbers does not have a precise numerical meaning.)

Cont.

- **Interval-Ratio Level of Measurement** - categories (or values) of a variable can be ranked ordered, and the measurements for all the cases are expressed in the same units.
- Comparison of values can be done, not only in terms of which is larger or smaller, but also in terms of how much larger or smaller one is compared with another.

- **Ratio variables** – have a natural zero point
  (where zero means the absence of the property)
- **Interval variables** - Zero is an arbitrary point

Levels of measurement compared: Variable: Education

- Nominal measurement (Comparing difference or equivalence): Graduated from public high school; Graduated from private high school
- Ordinal measurement (Ranking or ordering, one person is higher in education than the others): Holds a high school diploma, Holds a college diploma; Holds a Ph. D.
- Interval-ratio measurement – (How much higher or lower); Has 8 years of education; Has 12 years of education; has 16 years of education.

Qualitative vs Quantitative Variables

- Statisticians/Researchers call any quantity or characteristic you measure on an individual a **variable.**

Qualitative variable – classifies the individual based on categories **(categorical variable**)

Quantitative variable – measures or counts a quantifiable characteristic, such as height, weight, fertility, etc.

Statistics for Quantitative Variables

- **Quantitative data** are numbers that represent measurements or counts, so it makes sense that your can order, add, subtract, and multiply or divide them – and the results all have numerical meaning.
- **Bias** is the bane of a statistician's existence.
- The statistical definition of **bias** is the systematic overestimation or underestimation of the actual value.

Looking at bias through statistical glasses

- <u>Selecting the sample from the population</u>

  Bias occurs when you leave some intended groups out of the process, and/or give certain groups too much weight.

  Example: TV surveys (the ones where they ask you to phone in your opinion) are biased because no one has selected a prior sample of people to represent the population – people call in on their own. When people participate in a survey on their own, they're more likely to have stronger opinions than those who don't choose to participate. Such samples are called self-selected samples and are typically biased.

Cont.

- <u>Designing the data-collection instrument</u>

  Poorly designed instruments (including surveys) can result in inconsistent or even incorrect data.

  For example, a survey question's wording plays a large role in whether or not results are biased. "Don't you think the President should be allowed to have a personal life? Who would feel they should say no to that?"

Cont.

- <u>Collecting the data</u>

  In this case, bias can infiltrate the results if someone makes errors in the recording of the data or if interviewers deviate from the script.

- <u>Deciding how and when the data is collected</u>

  The time and place you collect data can affect whether your results are biased. For example, if you conduct a telephone survey during the middle of the day, people who work from eight to five aren't able to participate. Depending on the issue, the timing of this survey could lead to biased results.

Best way to deal with bias

- Use a random process to select the sample from the population.
- Be sure than the data is collected in a fair and consistent way.

Statistics for Qualitative Variables

- Suppose you want to know whether two qualitative variables are related (e.g. gender and political affiliation)
- Put data into a two-way table and analyze the data using Chi-square test
- Use the term “association” for two qualitative (categorical) variables; “correlation” for two quantitative variables

- DATA ANALYSIS will depend on the kind of data you have collected.

- Recapitulation

END