Quantitative Research

QuaNtitative Paradigm

- "an inquiry into a social or human problem based on testing a theory composed of variables, measured with numbers, and analyzed with statistical procedures, in order to determine whether the predictive generalizations of the theory hold true."

(Creswell, J. *Research Design: Qualitative and Quantitative Approaches. Sage:* 1994.)

"a formal, objective, systematic process in which numerical data are utilized to obtain information about the world"

(Burns & Grove, as cited by Cormack, 1991, p. 140).

Characteristics of Quantitative Studies

- Quantitative research is about quantifying the relationships between **variables**.
  - We measure them, and
  - construct statistical models to explain what we observed.
- The researcher knows in advance what he or she is looking for.
- Goal: Prediction, control, confirmation, test hypotheses.

Characteristics of Quantitative Studies

- All aspects of the study are carefully designed before data are collected.
- Quantitative research is inclined to be *deductive* -- it tests theory. This is in contrast to most qualitative research which tends to be inductive --- it generates theory
- The researcher tends to remain objectively separated from the subject matter.

Major Types of Quantitative Studies

- Descriptive research
  - Correlational research
  - Evaluative
  - Meta Analysis
- Causal-comparative research
- Experimental Research
  - True Experimental
  - Quasi-Experimental
  - Shared with full permission from IDTL Journal.

Descriptive Research

- **Descriptive research** involves collecting data in order to test hypotheses or answer questions regarding the participants of the study. Data, which are typically numeric, are collected through surveys, interviews, or through observation.
- In descriptive research, the investigator reports the numerical results for one or more variable(s) on the participants (or unit of analysis) of the study.

Correlational Research

- **Correlational research** attempts to determine whether and to what degree, a relationship exists between two or more quantifiable (numerical) variables.
- It is important to remember that if there is a significant relationship between two variables it does not follow that one variable causes the other. CORRELATION DOES NOT MEAN CAUSATION.
- When two variables are correlated you can use the relationship to predict the value on one variable for a participant if you know that participant's value on the other variable.
- Correlation implies prediction but not causation. The investigator frequently reports the correlation coefficient, and the p-value to determine strength of the relationship.

Meta-Analysis

- Meta-analysis is essentially a synthesis of available studies about a topic to arrive at a single summary.

Meta-Analysis

- From data that is after the fact that has occurred naturally (no interference from the researcher), a hypothesis of possible future correlation is drawn. Correlation studies are not cause and effect, they simply prove a correlation or not (Simon & Francis, 2001).
- **Meta-analysis** combines the results of several studies that address a set of related research hypotheses. "The first meta-analysis was performed by Karl Pearson in 1904, in an attempt to overcome the problem of reduced statistical power in studies with small sample sizes; analyzing the results from a group of studies can allow more accurate data analysis" (Wekipedia., 2006, para 1).
- Pearson (1904) reviewed evidence on the effects of a vaccine against typhoid.
  - Pearson gathered data from eleven relevant studies of immunity and mortality among soldiers serving in various parts of the British Empire.
  - Pearson calculated statistics showing the association between the frequency of vaccination and typhoid for each of the eleven studies, and then synthesized the statistics, thus producing statistical averages based on combining information from the separate studies.
  - Begins with a systematic process of identifying similar studies.
  - After identifying the studies, define the ones you want to keep for the meta-analysis. This will help another researcher faced with the same body of literature applying the same criteria to find and work with the same studies.
  - Then structured formats are used to key in information taken from the selected studies.
  - Finally, combine the data to arrive at a summary estimate of the effect, it's 95% confidence interval, and a test of homogeneity of the studies.

Meta-Analysis

- Begins with a systematic process of identifying similar studies.
- After identifying the studies, define the ones you want to keep for the meta-analysis. This will help another researcher faced with the same body of literature applying the same criteria to find and work with the same studies.
- Then structured formats are used to key in information taken from the selected studies.
- Finally, combine the data to arrive at a summary estimate of the effect, it's 95% confidence interval, and a test of homogeneity of the studies.

Causal-Comparative

- **Causal-comparative research** attempts to establish cause-effect relationships among the variables of the study.
- The attempt is to establish that values of the independent variable have a significant effect on the dependent variable.

Causal-Comparative

- This type of research usually involves group comparisons. The groups in the study make up the values of the independent variable, for example gender (male versus female), preschool attendance versus no preschool attendance, or children with a working mother versus children without a working mother.
- In causal-comparative research the independent variable is not under the researchers control, that is, the researcher can't randomly assign the participants to a gender classification (male or female) or socio-economic class, but has to take the values of the independent variable as they come. The dependent variable in a study is the outcome variable.

True Experimental Design

- **Experimental research** like causal-comparative research attempts to establish cause-effect relationship among the groups of participants that make up the independent variable of the study, but in the case of experimental research, the cause (the independent variable) is under the control of the researcher.
- The researcher randomly assigns participants to the groups or conditions that constitute the independent variable of the study and then measures the effect this group membership has on another variable, i.e. the dependent variable of the study.
- There is a control and experimental group, some type of "treatment" and participants are randomly assigned to both: Control Group, manipulation, randomization).

Quasi-Experimental Design

- Quasi-experimental designs provide alternate means for examining causality in situations which are not conducive to experimental control.
- The designs should control as many threats to validity as possible in situations where at least one of the three elements of true experimental research is lacking (i.e. manipulation, randomization, control group).

Should I do a Quantitative Study?

- Problem definition is the first step in any research study.
- Rather than fitting a technique to a problem, we allow the potential solutions to a problem determine the best methodology to use.
- Problem drives methodology…most of the time.

Variables

- A variable, as opposed to a constant, is anything that can vary, or be expressed as more than one value, or is in various values or categories (Simon, 2006).
- Quantitative designs have at least two types of variables: independent and dependent (Creswell, 2004).
- independent variable (*x*-value) can be manipulated, measured, or selected prior to measuring the outcome or dependent variable (y-value).

Variables

- *Intervening or moderating variables* affect some variables and are affected by other variables.
- They influence the outcome or results and should be controlled as much as possible through statistical tests and included in the design (Sproull, 1995; 2004).
- **(ANCOVA)** may be used to statistically control for extraneous variables. This approach adjusts for group differences on the moderating variable (called a **covariate**) that existed before the start of the experiment.

Research Questions and Hypotheses

- The aim is to determine what the relationship is between one thing (an independent variable) and another (dependent variable); the difference between groups with regard to a variable measure; the degree to which a condition exists.

Research Questions and Hypotheses

- Although a **research** question may contain more than one independent and dependent variable, each **hypothesis** can contain only **one** of each type of variable. There must be a way to measure each type of variable. A correctly formulated hypotheses, should answer the following questions:
- - What variables am I, the researcher, manipulating, or is responsible for a situation? How can this be measured?
  - What results do I expect? How can this be measured?
  - Why do I expect these results? The rationale for these expectations should be made explicit in the light of the review of the literature and personal experience. This helps form the conceptual or theoretical framework for the study.

Research Questions and Hypotheses

- A hypothesis is a logical supposition, a reasonable guess, or an educated conjecture. It provides a tentative explanation for a phenomenon under investigation.
- Research hypothesis are never proved or disproved. They are supported or not supported by the data.
- If the data run contrary to a particular hypothesis, the researcher rejects that hypothesis and turns to an alternative as being a more likely explanations of the phenomenon in question, (Leedy & Ormrod, 2001).

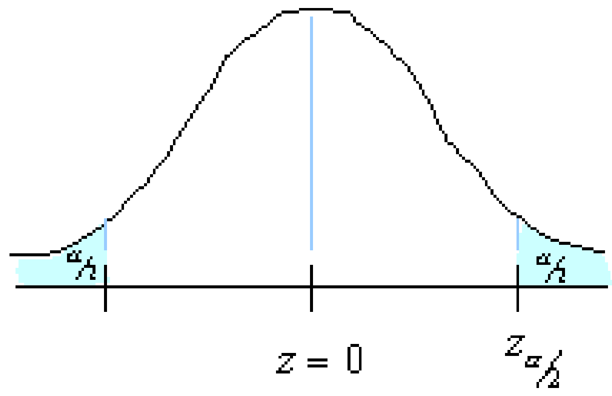
σ

Sample Size –sigma known

- Note: We can use the following formula to determine the sample size necessary to discover the "true" mean value from a population.

$$n = \left[\frac{z_{\alpha/2} \sigma}{E} \right]^2$$

- where za/2 corresponds to a confidence level (found on a table or computer program). Some common values are 1.645 or 1.96, which might reflect a 95% confidence level (depending on the statistical hypothesis under investigation), and 2.33, which could reflect a 99% confidence level in a one-tailed test and 2.575 for a two-tailed test σ is the standard deviation, and *E* is the margin of error.
- Example: If we need to be 99% confident that we are within 0.25 lbs of a true mean weight of babies in an infant care facility, and σ = 1.1, we would need to sample 129 babies:
- *n* = [2.575 (1.1)/0.25]2 = 128.3689 or 129.


α/2
α/2
z = 0
z α/2

Sample Size -sigma unknown

In most studies, 5% sampling error is acceptable.

More on Sample Size

- Gay (1996, p. 125) suggested general rules similar to Suskie's for determining the sample size.
  - For small populations ($N < 100$), there is little point in sampling and surveys should be sent to the entire population.
  - For population size $\approx$ 500 50% of the population should be sampled
  - For population size $\approx$ 1,500, 20% should be sampled
  - At approximately $N = 5{,}000$ and beyond, the population size is almost irrelevant and a sample size of 400 is adequate. Thus, the larger the population, the smaller the percentage needed to get a representative sample.

Other Considerations in Selecting a sample

- *Characteristics of the sample*. Larger samples are needed for heterogeneous populations; smaller samples are needed for homogeneous populations (Leedy & Ormrod, 2001, p. 221).
- *Cost of the study*. A minimum number of participants is needed to produce valid results.
- *Statistical power needed*. Larger samples yield greater the statistical power. In experimental research, power analysis is used to determine sample size (requires calculations involving statistical significance, desired power, and the effect size).
- *Confidence level desired* (reflects accuracy of sample; Babbie, 2001)
- *Purpose of the study*. Merriam (1998) stated, "Selecting the sample is dependent upon the research problem" (p. 67).
- *Availability of the sample*. Convenience samples are used when only the individuals that are convenient to pick are chosen for the sample. It is sometimes known as a location sample as individuals might be chosen from just one area.

Data Analysis

- **S^3d^2CANDOALL**
- Sample Size (n), Statistic (descriptive), substantive hypothesis
- Data Type (NOIR), Distribution

Determines the type of Test:

T-test, chi-square, ANOVA, Pearson, Spearman,

CANDOALL

- Hypothesis testing is a method of testing claims made about populations by using a sample (subset) from that population.
  - Like checking out a carefully selected hand full of M&Ms to determine the makeup of a Jumbo Size bag.
- After data are collected, they are used to produce various statistical numbers such as means, standard deviations, and percentages.

CANDOALL

- These descriptive numbers summarize or describe the important characteristics of a known set of data.
- In hypothesis testing, descriptive numbers are standardized (Test Values) so that they can be compared to fixed values (found in tables or in computer programs) (Critical Values) that indicate how *unusual* it is to obtain the data collected.
- Once data are standardized and significance determined, we can make inferences about an entire population (universe).

Drawing Conclusions

- *A p*-value (or probability value) is the probability of getting a value of the sample test statistic that is at least as extreme as the one found from the sample data, assuming the null hypothesis is true.
- Traditionally, statisticians used alpha (a) values that set up a dichotomy: reject/fail to reject null hypothesis. *P*-values measure how confident we are in rejecting a null hypothesis.

Important Note

- Note: If the null hypothesis is not rejected, this does not lead to the conclusion that no association or differences exist, but instead that the analysis did not detect any association or difference between the variables or groups.
- Failing to reject the null hypothesis is comparable to a finding of not guilty in a trial. The defendant is not declared innocent. Instead, there is not enough evidence to be convincing beyond a reasonable doubt. In the judicial system, a decision is made and the defendant is set free.

P-value	Interpretation
$p < 0.01$	Very strong evidence against H0
$p < 0.05$	Moderate evidence against H0
$p < 0.10$	Suggestive evidence against H0
$p > 0.10$	Little or no real evidence against H0

Threats to validity

- *Rosenthal Effect or Pygmalion Effect*: Changes in participants' behaviors brought about by researcher expectations; a self-fulfilling prophecy. The term originally comes from Greek mythology and was popularized by G.B. Shaw. Named from a controversial study by Rosenthal and Jackson in which teachers were told to expect some of their students' intelligence test scores to increase. They did increase based solely on the teachers' expectations and perceptions.
- Note: A double-blind procedure is a means of reducing bias in an experiment by ensuring that both those who administer a treatment and those who receive it do not know (are blinded to) which study participants are in the control and experimental groups.

Threats to validity

- *The Halo Effect*: This is a tendency of judges to overrate a performance because the participant has done well in an earlier rating or when rated in a different area. For example, a student that has received high grades on earlier papers may receive a high grade on a substandard paper because the earlier work created a halo effect.
- *The Hawthorne Effect*: A tendency of participants to change their behavior simply because they are being studied. So called because the classic study in which this behavior was discovered was in the Hawthorne Western Electric Company Plant in Illinois. In this study, workers improved their output regardless of changes in their working condition.

Threats to validity

- *John Henry Effect*: A tendency of people in a control group to take the experimental situation as a challenge and exert more effort than they otherwise would; they try to beat the experimental group. This negates the whole purpose of a control group. So called because this was discovered at the John Henry Company where a new power tool was being tested to see if it could improve productivity. The workers using the old tool took it as a challenge to work harder to show they were just as good and should get the new tool.

References

- Best, J. W. & Kahn, J. V. (1993). *Research in education* (7th ed.). Boston: Allyn and Bacon.
- Babbi, E. (2001). *The practice of social research*. Australia: Wadsworth Thomson Learning.
- Burns, n., & Grove, K. (1993). *The practice of nursing research: Conduct, critique and utilization* (2nd ed.). Philadelphia: Saunders.
- Cooper, D. R., & Schindler, P.S. (2002). *Business research methods* (8th ed.). Boston: Irwin.
- Cormack, D. (1991). *Team spirit motivation and commitment team leadership and membership, team evaluation*. Grand Rapids, MI: Pyranee Books.
- Creswell, J. W. (2004). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (2nd ed.). Columbus, Ohio: Merrill Prentice Hall.
- Emerson, R. W. (1983).*New England Reformers', lecture to the Society*, 3 March 1844
- Gay. L. R. (1996). Educational research: Competencies for analysis and application (4th ed.). Beverly Hills, CA: Sage.
- Leedy, P., & Ormrod, J. E. (2001). *Practical research planning and design* (8th ed.). New York: Macmillan.
- Merriam, S. B. (1997). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass.
- Pearson, K (1904). *Report on certain enteric fever inoculation statistics*. BMJ 3:1243-1246.
- Simon, M. K. (2006). *Dissertation and scholarly research: A practical guide to start and complete your dissertation, thesis, or formal research project*. Dubuque, Iowa: Kendall/Hunt.
- Simon, M. K., & Francis, B. J. (2001). *The dissertation cookbook: From soup to nuts a practical guide to start and complete your dissertation* (3rd. Ed.). Dubuque, Iowa: Kendall/Hunt.
- Sproull, N. D. (1995). *Handbook of research methods: A guide for practitioners and Students in the social sciences* (2nd. Ed.). New Jersey: The Scarecrow Press.
- Sproull, N. D. (2004). *Handbook of research methods: A guide for practitioners and Students in the social sciences* (3rd Ed.). New Jersey: The Scarecrow Press.
- Suskie, L. (1996). Survey Research: What works. Washington D.C.: International Research.
- Wekipedia. (2005). Meta-analysis. Retreived January 5, 2006, from, http://www.answers.com/topic/meta-analysis
- Yakoobian, V. (2005). *Successful leadership styles of elementary school principals and parent-teach organization leaders*. Doctoral Dissertation. University of Phoenix.