What is Quantitative Research?

Differences between Qualitative and Quantitative Research

- In-depth understanding vs. generalizing knowledge
- Perspective vs. causality
- Deductive vs. Inductive

The general process for Quantitative Research

1. Creating a question

Conceptualization

Feasibility

Social Importance

Scientific Relevance

2. Literature Review

consulting already published material relevant to the research question(s)

3. Hypothesis and Null Hypothesis

A Hypothesis is:

A probability statement about the relationship among factors (statement of causality to be tested)

There are two forms of hypothesis:

Two-tailed (non-directional)

One-tailed (directional)

The null hypothesis is created from the hypothesis

Statement that there is no relationship between variables. It is the testing hypothesis.

4. Identifying variables for the study

Independent vs. Dependent Variables:

causes change in other variables (catalyst)

variable that is influenced (changes)

How a variable is conceptualized will impact the level of measurement used in a study. Levels of measurement categorize the degree of precision that can be obtained about a given phenomenon.

There are four levels of measurement

1. Nominal

2. Ordinal

3. Interval

4. Ratio

Operationalization is:
specifying how a variable will be measured
linking hypothesis to measurement

It is important to know the measurement level before Operationalization occurs for a study (as measurement level can impact statistical analysis and comparison)

To create research objectives you must be clear on:

- what you are trying to accomplish
- intended process for answering questions
- who will be involved
- how you will protect your participants

5. Selecting a research design

The most basic research designs are known as "pre-experimental". These designs are most appropriate for exploratory and descriptive level research studies.

One group post-test only ("one shot" case study)

XO

can not rule out any other factors for outcome

One group pretest / post-test

O_1XO_2

controls for selection as a threat

Static group comparison

XO
O

comparison group used for outcome

"Quasi-experimental" designs are more complex types of research and address more threats to internal and external validity than pre-experimental designs.

Interrupted time series

$O_1O_2O_3 \ X \ O_4O_5O_6$
controls for other variables and events (regression)

Pretest / post-test comparison

O_1XO_2
$O_1 \quad O_2$

identifies differences in groups, therefore observed change may be more significant

"Experimental" designs allow for better manipulation and isolation of the independent variable. This allows the researcher to make the strongest claims of causality.

Experimental designs use random assignment to groups. Randomly assigned groups are called "control" groups.

Pretest / Post-test control group ("classical design")

$$_rO_1XO_2$$
$$_rO_1 \quad O_2$$

random assignment rules out may threats to internal validity
comparison can not

Post-test only control group

$$_rXO$$
$$_r \quad O$$

assumes that random assignment controls for differences

Solomon Four group

$$_rO_1XO_2$$
$$_rO_1 \quad O_2$$
$$_r \quad XO$$
$$_r \quad \quad O$$

controls for everything possible (rare)

6. Selecting participants and getting a sample

Terms to know:

Element

Population

Sampling Frame

Unit of Analysis

Sampling Error

Confidence Levels

The ultimate purpose of sampling is to select a set of elements from a population that will accurately portray the parameters of the population. Random selection is the key to this process.

Random selection

allows equal opportunity for an element to be chosen for a sample

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There are two main methods of sampling: probability and non-probability

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Probability sampling:

selecting a sample where each element has a known chance of being selected

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Types of probability sampling techniques:

- Simple random sampling
- Systematic Random sampling
- Stratified random sampling
- Cluster sampling

Non-probability sampling (purposive)

sampling where there is no known chance of selection for an element in the population (not random)

Types of non-probability sampling techniques, include:

- Availability sampling
- Quota sampling
- Snowball sampling
- Key informants

What influences the sample size needed?

- type of research and size of population
- diversity within population
- desired confidence level for results
- level of differences being studied
- concern over sampling error

When to use which type of sampling:

Decide probability vs. non-probability

Then ask: Do you want to generalize?
Can you obtain an accurate sample?
Do you want subgroups represented?
What form is your sampling frame?
Can you identify your desired elements?
What are your research goals?

7. Collecting Data

Interviews as a data collection technique

- unstructured
- semi-structured
- structured

If possible, interviews should be conducted face-to-face, why?

Advantages of interviews:

- clarification
- in-depth questions
- no need to be literate
- can reach those without address/phone
- personal

Disadvantages of interviews:

- expensive
- time consuming
- respondent is not anonymous
- potential for reactive effects

Using questionnaires as a data collection technique

Most common forms: mailed, face-to-face and group

Advantages of mailed

- cheaper than an interview
- respondents can be anonymous
- individuals can work at their own pace

Disadvantages of mailed

- respondents must be literate
- respondents must have access to questionnaire
- questions can not be clarified
- low response rates

Advantages of face-to-face

- can flow like a structured interview
- questions can be clarified
- literacy less of an issue (depending on format)

Disadvantages of face-to-face

- participants may feel time pressure or pressure to answer all questions
- can not be anonymous to interviewer (responses can be kept anonymous)

Advantages of group

- many questionnaires can be given at once (lowering cost and time constraints)
- responses can be more anonymous
- questions can be clarified

Disadvantages of group

- Participants may feel time pressure
- Participants may feel social pressure

Observation(s) as a data collection technique:

- Unstructured
- Structured
- Participant observation

Logs and journals as a data collection technique:

structure or unstructured
researcher or participant

Scales as a data collection technique:

combine items into a composite score
used with observations and interviews

Types of scales:

- Likert scale

- Thurstone scale

- Semantic differential scale

- Guttman scale

Use of secondary data as a technique:

accessing existing data (must be mindful of collection methods and neutrality of information)

When more than one form of data collection is used in a study it is referred to as "triangulation." Triangulation is very common in validating data from qualitative research techniques.

8. Determining Validity and Reliability

There are two types of validity: internal and external.

(measuring what you intend to measure)
Each type of validity has threats to the confidence one has in the outcome of the measurement.

Internal validity is

the extent to which changes in the dependent variable are due to interaction with the independent variable and not some other factor

There are nine threats to internal validity

1. History

2. Maturation

3. Testing

4. Instrumentation error

5. Statistical regression

6. Selection bias

7. Mortality

8. Diffusion

9. Reactive effects

External validity is

the extent to which research results can be generalized to the wider population

There are six threats to external validity

1. Pretest - treatment interaction

2. Selection - treatment interaction

3. Multiple - treatment interference

4. Researcher bias

5. Reactivity (the Hawthorne effect)

6. Placebo effect

Reliability is

the extent to which a measure reveals actual differences in what is being measured, rather than differences in the instrument

Common methods to determine Reliability

- Test-retest (stability)

- Alternate form

- Split-half

- Representative

- Observer reliability (interrater)

*Reliability can exist without validity. You can consistently measure the wrong thing.... but validity CAN NOT occur without reliability. You will not be accurate in your measurements if you are not consistent.

Sources of measurement error include:

- Random error
- Systematic error
  - demographic variables
  - response set errors (two forms)

Response set errors due to respondents

- Social desirability
- Acquiescence
- Deviation

Response set errors due to observers

- Contrast error
- Halo effect
- Error of leniency
- Error of severity
- Error of central tendency

9. Organizing the Data

"You need to be thinking about how the data will be organized as early in the research process as possible. This is especially important when you use a questionnaire to collect data, because the way questions are structured can influence the way data can ultimately be organized."
Marlow & Boone, 2005.

Organizing quantitative data

transfer data into information that can be manipulated

- convert responses to numerical codes
- assign names to variables
- develop a code book
- use a statistical package to do analysis

Coding the data

- be specific about how variables were chosen and assigned (exhaustive and exclusive)
- know your measurement level before attempting to analyze coded data

The coding procedures for quantitative research studies are often developed before any data collection takes place. Once coding has taken place the next step in quantitative research is to do a statistical analysis.

There are two basic types of statistical analysis - descriptive and inferential

Descriptive Statistics

summarize the characteristics of a sample or relationship among variables

Inferential Statistics

determine whether an observed relationship is by chance or in fact reflects a relationship among variables

10. Analysis of the Data

One of the easiest ways to describe numerical data is to use a frequency distribution.

Considerations for a frequency distribution:

- accurately describing the number of times a value occurs in a sample
- incomplete data is important to consider
- use of visual representation

PSS Score	Absolute Frequency	Cumulative Frequency	Percentage Distribution
95	1	1	5
93	3	4	15
90	2	6	10
84	2	8	10
82	2	10	10
80	2	12	10
79	5	17	25
72	1	18	5
71	1	19	5
55	1	20	5
Totals...	20		100

Cumulative frequency and percentage distributions of parental skill scores (Williams, Unrau and Grinnell, 2003)

| PSS Scores	Absolute Frequency	Cumulative Frequency	Absolute Percentage
90 - 100	6	6	30
80 - 89	6	12	30
70 - 79	7	19	35
60 - 69	0	19	0
50 - 59	1	20	5

Grouped frequency distribution of parental skill scores (Williams, Unrau and Grinnell, 2003)

At times you may want to look at the average of a value and to summarize information into a single perspective - this can be done by using the measures of central tendency.

Measures of central tendency

- Mode

- Median

- Mean

If the values form a normal distribution it will present as a "bell-shaped" curve. In a normal distribution, the three measures of central tendency are equal.
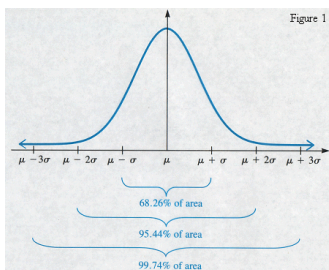
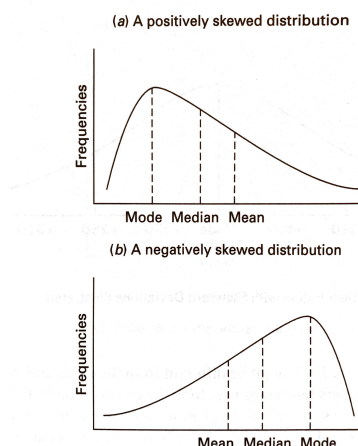If the values are not equal the result is a skewed distribution.

FIGURE 4.5 Skewed Distributions

The measures of central tendency summarize the characteristics of the middle of the distribution.

Other characteristics of a distribution include:

- the spread
- dispersion
- deviation

  These characteristics are referred to as the measures of variability or measures of dispersion.

Range

- the distance between the highest and lowest values
- used at interval and ratio level
- to calculate subtract the lowest value from the highest value = range

Percentile

a number that divides the range of a data set so that a given percentage lies below this number

Standard deviation

- most comprehensive and widely used measure of variation
- used at ratio or interval levels
- a measure of variability that averages the distance of each value from the mean
- only calculated by hand when there are few cases
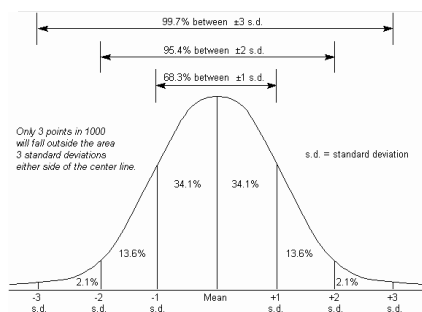
Z score

- used to describe a single score in a distribution
- mathematical way to relate raw score to the mean and standard deviation of the distribution
- raw scores above the mean are +
- raw scores below the mean are -

What kind of analysis occurs when the data involves two or more variables (called bivariate or multivariate analysis)?

Cross-tabulation (contingency table)

- measure of association
- examination of the dependent variable using the independent variable
- useful at any measurement level
- distribution of cases into categories to show which are "contingent" upon other variables
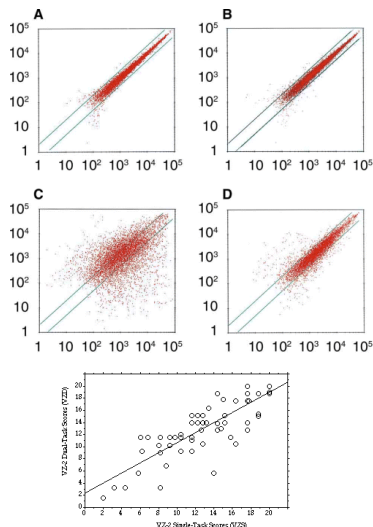
		Grades on Exam 2, By Discipline			
Grade	Nursing	Health Science	Psychology	Sociology	Total
A	6	2	8	6	22
B	10	8	2	10	30
C	6	10	4	2	22
D	4	4	6	8	22
F	2	0	2	0	4
Total	28	24	22	26	100

FIGURE 12.14

Correlation

- plotted on a chart called a scattergram
- correlation is shown by how closely the values approximate a straight line (+ - or curved)

In using descriptive statistics (whether univariate or multivariate) the most effective way to describe them is to display the results visually.
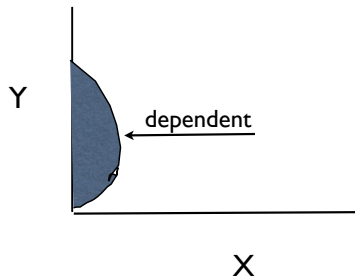
Interpreting graphs

- Level (change = discontinuity)
- Stability
- Trends (pattern within phase = slope, pattern across phases = drift)

In graphing data

X axis = independent variable (horizontal)

Y axis = dependent variable (vertical)

Y

dependent ⟵

X

Graphs and statistics can be deceiving. Be aware of any graph that does not have an absolute zero point for "Y" or that has a discontinuous scale.

Going beyond simply describing the data with descriptive statistics, you will use inferential statistics to test a hypothesis.

Inferential statistics:

- precise method for deciding confidence in results from a sample
- method for deciding if a relationship between variable exists
- relies on probability theory

A finding is considered to be statistically significant when the null hypothesis can be rejected and the probability that the result is due to chance falls at or below the study's given significance level.

The power of a statistical test is its ability to reject the null hypothesis, and the power to reject the null hypothesis increases with the sample size.

Errors in judgment concerning the acceptance or rejection of the null hypothesis are referred to as Type I and Type II errors.

Type I error

rejection of null hypothesis
false conclusion that a relationship exists
when it fact it does not

Type II error

acceptance of null hypothesis
failure to recognize that a relationship does in
fact exist between variables

There are many types of statistical tests to determine which hypothesis is correct, and we will look at a few of the most common.

When a study has a normal distribution and the dependent variable is measured at least at the interval level and the independent variable has been measured at the nominal level - the differences between the groups of data can be found using a T-Test.

A T-Test

a bivariate statistical test used to determine whether two groups are significantly different based on a particular characteristic

To calculate a T-Test (and many other statistical tests) you must know the degrees of freedom in your data (df).

degrees of freedom (df)

- the number of values in the final calculation of a statistic that are free to vary

- you know that value of the mean, therefore it is not free to vary, to calculate df take the total number of cases (-) one (n-1)

- T-test involve two means, therefore to calculate a df take the total number of cases (-) two (n-2)

The T-Test is a very efficient method of testing the significance of the difference between two means. When three or more means must be compared an analysis of variance is used (ANOVA).

ANOVA

used to test differences between the means of three or more groups (one-way anova)

Even though ANOVA looks at the differences between two or more groups - do not forget we are dealing with bivariate analysis at this point (one dependent variable and one independent variable).
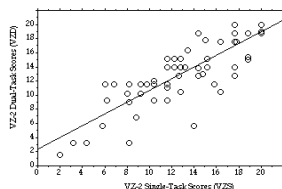
Another way to analyze bivariate data is to examine the strength of the relationships between variables using correlation coefficients.

Correlation coefficients

provide information about the direction and the intensity of the relationship

Pearson's r:

correlation coefficient
used to asses the strength of a relationship
ranges from -1 to +1

The regression line in a scatterplot graph is used to show how much change has occurred in the dependent variable are due to changes in the independent variable (prediction of change).

Chi-Square analysis (X^2):

- one of the most widely used statistical tests in social work research.

  As a descriptive statistic: strength of association between variables

  As an inferential statistic: probability that association between variables is due to chance

As a descriptive statistic

describes the strength of association between two variables

As an inferential statistic

summarizes the discrepancy between observed and expected frequencies

To use chi-square:

- you must first know what to expect from data (did results differ from expected)
- if a difference exists, there may be an association between variables

  $X^2 = 0$ then independence

  $X^2 = $ more, then there is an association

What is effect size (magnitude) and why is it important?

- compare difference between two means from different studies
- way to standardize deviation units to allow comparison between studies

Meta-analysis involves:

creating a synthesis of statistical results from previous research (reducing risk of errors in one study)

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