COMP 7036
Applied Research Methods in Software Development

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Quantitative and Qualitative Research

Overview

Qualitative research

- Approaches
- Nature and planning
- Research designs
- Data Collection
- Interviews
- Data organization/analysis
- Evaluation criteria

Quantitative research and statistics

- Using statistics
- Tendency and variability
- Hypothesis testing
- Meta-Analysis
- Data Interpretation

Qualitative: Approaches

- Focus is on phenomena that occur in natural settings
- Involves studying those phenomena in all their complexity
- Researchers recognize multifaceted form of issue they are studying
- The researcher is the instrument

Qualitative: Nature and planning

- Formulate only general research problems and ask only general questions about phenomena to study
- May not identify ahead of time exact methods to use
- Methodology may continue to evolve over course of study
- Requires considerable preparation/planning
- Studies do not allow researcher to identify cause-and-effect relationships

Qualitative: Research designs

- Case Study
- Ethnography
- Grounded Theory Study
- Content Analysis

Qualitative: Case Study

- Definition: particular individual / program / event studied in depth; findings may not be generalizable

- Method: Researcher collects extensive data on individual(s) / program(s) / event(s)

Qualitative: Case Study

- Data Analysis:
  - organization of details about case
  - categorization of data
  - interpretation of single instances
  - identification of patterns
  - synthesis and generalizations

Qualitative: Case Study

- Research Report:
  - rationale for studying case
  - detailed description of related facts
  - description of data collected
  - discussion of patterns found
  - connection to larger scheme of things

Qualitative: Ethnography

- Definition: Researcher looks in depth at entire group that shares common culture
  - especially useful for understanding complexities of particular, intact sociocultural group

- Method: Essentially site-based fieldwork
  - researcher depends on a gatekeeper and key informants and is a careful observer

Qualitative: Ethnography

- Data Analysis: collection and analysis occur somewhat simultaneously
  - description
  - analysis
  - interpretation
  - strives for rigorous subjectivity

Qualitative: Ethnography

- Research Report: Often written in personal, literary style
  - introduction providing rationale for study
  - description setting and methods
  - analysis of group studies
  - conclusion

Qualitative: Grounded Theory Study

- Definition: major purpose: begin with data and use to develop a theory
  - uses prescribed set of procedures for analyzing data and constructing theoretical model
  - theory "grounded" in data
- Method: data collection is field-based, flexible, and likely to change over course of study
  - interviews typically play major role
  - *constant comparative method* is used: data analysis drives later data collection

Qualitative: Grounded Theory Study

- Data Analysis:
  - Includes:
    - open coding
    - axial coding
    - selective coding
    - development of a theory
  - No matter what form theory takes, based entirely on data collected

Qualitative: Grounded Theory Study

- The Research Report: writing is objective and impersonal and includes:
  - description of research question
  - review of related literature
  - description of methodology and data analysis
  - presentation of theory
  - discussion of implications

Qualitative: Content Analysis

- Definition: detailed and systematic examination of contents of particular body of material
  - purpose: identifying patterns, themes, or biases
  - typically performed on forms of human communication
  - involves greatest amount of planning at front end of project

Qualitative: Content Analysis

- Method: systematic and includes:
  - identification of material to be studied
  - definition of characteristics to be studied
  - breakdown of complex items into smaller segments
  - scrutiny of material for identified characteristics under study

Qualitative: Content Analysis

- Data Analysis: involves tabulation of frequency of each characteristic found in material studied
  - tabulations and statistical analyses used to interpret data
- The Research Report: includes:
  - description of material studied
  - precise definitions of material characteristics
  - coding or rating procedures
  - tabulations for each characteristic

Qualitative: Data Collection

- Multiple forms of data used
- Data collected early in investigation may influence subsequent data
- Potential sources of data are unlimited
- Data collection takes a great deal of time
- Data collection methods should be consistent with ethical principles of research studies

Qualitative: Data Collection

- **Sampling**:
  - choice of sample depends on research question
  - selection of data sources tends to be nonrandom
  - purposeful
- **Observations**:
  - researcher may be outsider/participant observer
  - intentionally unstructured and free-flowing
  - can be problematic and lack objectivity
- **Interviews**:
  - can yield great deal of information
  - tend to be unstructured and open-ended
  - occasional use of focus groups

Qualitative: Data organization and analysis

Employ a *data analysis spiral*:

1. Organize data
2. Peruse data to get sense of what it contains as a whole
3. Identify general categories or themes (and possible subthemes), then classify data accordingly
4. Integrate and summarize the data

Using Statistics

Statistics: computational procedures used to find patterns/meaning in numerical data

Two major functions:

1. *Descriptive*: describe what data looks like
2. *Inferential*: allow us to make inferences about large populations by collecting data on relatively small samples

   Two main functions of inferential statistics:

   a) estimate population parameter from random sample
   b) test statistically based hypotheses

Characteristics of Statistics

- Estimates of population parameters
- Different statistics are appropriate for different kinds of data
- Single-group versus multi-group data
- Continuous versus discrete variables
- Scales of measurement (nominal, ordinal, interval, ratio)
- Normal and non-normal distributions
- Parametric versus nonparametric statistics

Central Tendency

- **Mode**: single number that occurs most frequently
- **Median**: numerical center of set of data
- **Mean**: arithmetic average within data set
- **Geometric Mean**: central tendency based on geometric progression, such as growth

Note: configuration of data dictates measure of central tendency most appropriate for that particular situation

Variability

- **Range**: spread of data from lowest to highest value
- **Average Deviation**: average of differences of each score and mean score in a set of scores
- **Standard Deviation**: square of score-mean differences (variability most commonly used in statistical procedures)
- **Norm-Referenced Scores**: scores that reflect where each person is relative to other members of group
- **Standard Score**: how far an individual's performance is from mean (in standard deviation units)

Choosing Appropriate Statistics

- Statistics related to central tendency and variability provide beginning point from which to view data
- Statistical manipulation of the data is not research
- Research demands interpretation of the data

Testing Hypotheses

- Null Hypothesis: statistical hypothesis which
- postulates that any result observed is the result of chance alone
- Testing the Null Hypothesis: process of comparing observed data with what we would expect from chance alone
- Significance Level: probability used as cutoff point to decide that result has not occurred by chance

Errors in Hypothesis Testing

- Type I Error: erroneous conclusion that result was not due to chance when in fact it was due to chance
  - incorrectly reject null hypothesis
- Type II Error: erroneous conclusion that result was due to chance when in fact it was not
  - Incorrectly failing to reject null hypothesis that is actually false
  - also known as a *beta error*

Increasing Statistical Power

- Use as large a sample as is reasonably possible
- Maximize validity and reliability of measures
- Use parametric rather than nonparametric statistics whenever possible

Note: *Whenever we test more than one statistical hypothesis, we increase the probability of making at least one Type I error*

Meta-Analysis

Used to analyze and draw conclusions about other researchers' statistical analyses

1. Conduct extensive search for relevant studies
2. Identify appropriate studies to include
3. Convert each study's results to common statistical index

Interpretation of the Data

- Relate findings to original research problem and to specific research questions and hypotheses
- Relate findings to preexisting literature, concepts, theories, and research studies
- Determine whether findings have practical significance as well as statistical significance
- Identify limitations of study

Summary

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