

Course : Research Research methodology

Lecturer : Prof. Saliha CHELLI

Level : L3

Lecture : 3

Quantitative Research

Lecture objectives

In this lecture, the student will

- Know what quantitative research is.
- Identify and describe types of quantitative designs.
- Identify and describe quantitative research methods
- Identify and describe types of quantitative analysis.

1. Definition of Quantitative Research

Quantitative social research was originally inspired by the spectacular progress of natural sciences in the 19th century, and therefore early social researchers set out what was called 'the scientific method' in their investigations. The scientific method postulated three key stages in the research process:

- Observing a phenomenon or identifying a problem
- Generating an initial hypothesis
- Testing the hypothesis by collecting and analysing empirical data using standardized procedures.
Once the hypothesis has been successfully tested and further validated through replication, it becomes accepted as a scientific theory or law.

Quantitative research involves data collection procedures that result primarily in numerical data which is then analyzed primarily using statistical methods. Typical example: survey research using a questionnaire, analysed by statistical software such as SPSS (Dornëy, 2007, p. 24). Quantitative research seeks to describe situations, establish relationships between variables or tries to explain causal relationships. Its purpose is narrow focusing on measurable variables.

2. Types of quantitative research designs

The approaches used in quantitative research fall into two categories: non-experimental and experimental designs. Non-experimental designs are descriptive in nature, they include survey research, observational research, correlational research and causal comparative research in which there is no manipulation of a variable. The experimental design consists of a group of techniques during which the researcher uses different treatments to see their effects on participants. This means that the independent variable is manipulated to see its effect on the dependent one. These types of research design include: the pre-experimental research design, the quasi-experimental research design, the experimental design and the single research design.

2. Non-experimental designs (Descriptive)

The goal of descriptive research is to describe a phenomenon and its characteristics. This research is more concerned with what rather than how or why. Therefore, observation and survey tools are often used to gather data (Gall, Gall, & Borg, 2007). This kind of research may be qualitative, but it is often analyzed quantitatively using frequencies, percentages or statistical analysis to determine relationships. Such studies look at individuals, groups, institutions, methods and materials in order to describe, compare, contrast, classify, analyze and interpret the entities and the events that constitute their various fields of inquiry (Cohen, 2007, p. 205).

2.1 Survey Research

In one sense, the word 'survey' means to view comprehensively and in detail. In another sense, it refers specifically to the act of 'obtaining data for mapping' (Denscombe, 2012, p. 6). Surveys are useful mainly for describing patterns in large groups rather than in-depth analysis of individual views (Guthrie, 2010, p. 77). Survey studies aim at describing the characteristics of a population by examining a sample of that group. Their purpose is to develop generalizations using a sample that is representative. Surveys come in a wide variety of forms, but the most used is the questionnaire. Although survey data can be collected by means of a structured interview, the questionnaire is the main data collection method in surveys (DornËy, 2007, p.101). There are two types of surveys : **cross-sectional surveys** and **longitudinal surveys**. Cross-sectional surveys represent a particular population at a particular time while longitudinal surveys repeat cross-sectional surveys (Guthrie, 2010, p. 79).

2.2 Observational research

The distinctive feature of observation as a research process is that it offers an investigator the opportunity to gather 'live' data from naturally occurring social situations (Cohen, 2007, p.396). The observation is important in the realm of qualitative research and it is also used to gather quantitative data. The occurrence of the participants behaviour can be counted to determine its frequency. A structured observation is very systematic and enables the researcher to generate numerical data from the observation. Flick (1998, p. 137, cited in Cohen, 2007) suggests that observation has to be considered along five dimensions:

- structured, systematic and quantitative observation versus unstructured and unsystematic and qualitative observation
- participant observation versus non-participant observation
- overt versus covert observation
- observation in natural settings versus observation in unnatural, artificial settings (e.g. a 'laboratory' or contrived situation)
- self-observation versus observation of others.

Cooper and Schindler (2001, p. 375, cited in Cohen, 2007) suggest that observation can be considered along three dimensions:

- whether the observation is direct or indirect: the former requiring the presence of the observer, the latter requiring recording devices (e.g. video cameras)
- whether the presence of the observer is known or unknown (overt or covert research),
- whether the researcher is concealed (e.g. through a one-way mirror or hidden camera) or partially concealed, i.e. the researcher is seen but not known to be a researcher (e.g. the researcher takes up a visible role in the school)
- the role taken by the observer (participant to non-participant observation)

2.3 Correlational research

Correlational research is a quantitative research in which the researcher aims find out if there is a relationship between variables; its direction (whether it is positive or negative) and its strength. This kind of research lacks manipulation. Correlational research is carried out for one of two basic purposes—either to help explain important human behaviors or to predict likely outcomes behaviors (Fraenkel, 2012, p. 332).

2.4 Causal comparative research

Causal comparative research also called 'ex post facto research (after the fact in Latin). It is an investigation which attempts to determine the causes or consequences of differences that already exist between or among groups of individuals. Or the researcher investigates the effect of an independent variable on a dependent variable by comparing two or more groups of individuals. A causal-comparative design is a research design that seeks to find relationships between independent and dependent variables after an action or event has already occurred (Salkind, 2010, p.214). For example, an educational teacher may want determine whether an institutional programme has a positive effect on exam scores, after the completion of that programme.

Both causal-comparative and correlational studies are examples of associational research—that is, researchers who conduct them seek to explore relationships among variables. Causal-comparative studies typically compare two or more groups of subjects, while correlational studies require a score on each variable for each subject. Correlational studies investigate two (or more) quantitative variables, whereas causal-comparative studies typically involve at least one categorical variable (group membership). Correlational studies often analyze data using scatterplots and/or correlation coefficients, while causal-comparative studies often compare averages or use crossbreak tables (Fraenkel, 2012, p. 368).

3. Experimental designs

Experimental research design includes: the pre-experimental research design, the quasi-experimental research design, the experimental design and the single subject research design.

3.1 Pre-research designs

The pre-experimental design is the simplest form of research. It is a preliminary investigation of the problem before the main one. It is of three types :

- The one-shot case study involves a single group exposed to a treatment then post-tested.
- The one group pretest-posttest design lacks a control group.
- The static-group comparison design involves an experimental and a control group but lacks a pretest.

3.2. Quasi-experimental designs

The Quasi-experimental design is similar to the experimental design but lacks randomization.

1. Non-equivalent control group posttest only design.
2. Non-equivalent control group pretest posttest design (similar to the previous including a pretest.
3. Basic time-series design (Observations are made over a period of time before after a treatment (no control group)
4. Interrupted-time series design (Many observations are made over a period of time before and after a treatment (no control group)
5. Control-time series design (A time series design with a non-equivalent group)

The most used type is the non-equivalent control group pretest-posttest design.

3.3 Experimental design

True experimental research design involves choosing the participant randomly. Random assignment is one of the most powerful techniques for controlling extraneous threats to validity (Fraenkel et al, 2012).

The posttest-only control group design: the participants are randomly assigned to the experimental and control group. Only posttest is given to the two groups

Pretest-posttest control group design comprises at least two groups. It is considered the most powerful one.

The solomon four- group design: this involves four groups randomly selected. Two groups are pre-tested and two are not. Then, one the pre-tested and one of the non-tested receive the treatment. Finally all the four groups receive the posttest.

3.4 Single- subject research design is a design that involves studying in detail the behavior of each of a small number of participants mainly in the field of psychology. It consists of measuring the dependent variable repeatedly over time and changing conditions to assess whether the participant's behaviour improved. Among its types, the reversal design called ABA studies the effect of a treatment on a certain behaviour, the it is removed and observations are made to check if the behaviour reverses to the initial phase.

4. Quantitative data analysis

Quantitative analysis involves using numerical data and statistical methods to understand patterns, test hypotheses, and make predictions. Below are the main types, grouped by purpose:

4.1. Descriptive Quantitative Analysis

Summarizes and describes the main features of a dataset.

Common techniques: Mean, median, mode, standard deviation & variance, percentages and frequency distributions and data visualization (charts, histograms)

Example:

Analyzing average monthly sales of a company over a year.

4.2. Inferential Quantitative Analysis

Uses sample data to make predictions or generalizations about a population.

Common techniques: Hypothesis testing, t-tests, ANOVA, Chi-square tests...

Example:

Determining whether a new teaching method improves student performance compared to the old method.

4.3. Predictive Analysis (in education)

Linear Regression used for: Predicting continuous outcomes (e.g, test scores).

- Examines how independent variables (attendance, study hours, SES) predict academic performance.
- Provides information about strength and direction of relationships.

Example:

Example: Attendance Predicting Final Exam Score

Research Question:

Does class attendance predict final exam performance?

- Independent Variable (IV): Attendance rate (%)
- Dependent Variable (DV): Final exam score (out of 100)

Multiple Regression

Used for: Understanding the combined effect of several predictors.

Example: Predicting academic performance using Multiple Factors

Research Question: What factors predict students' GPA?

- IV₁: Attendance rate

- IV₂: Study hours
- IV₃: Parental education level
- DV: academic achievement

Summary of Types of Quantitative Analysis

Types quantitative analysis	purpose	Key question	Common technique	example
Descriptive analysis	Summarizes And organizes data	What is happening?	Mean, median, mode, percentages, standard deviation, charts	Calculating the average test score of Grade 10 students
Inferential analysis	Makes generalizations from a sample to a population	Is there a significant difference or relationship?	t-test, ANOVA, chi-square test, correlation, confidence intervals	Determining whether male and female students differ in math performance
Predictive analysis	Forecasts future outcomes based on existing data	What is likely to happen?	Linear regression Multiple regression	Predicting students at risk of failing based on attendance and prior scores

References

- Cohen, L, Manion, L & Morison, K. (2007). *Research methods in education*. New York: Routledge
- Dörnyei, Z. (2007). *Research methods in applied linguistics: Quantitative, qualitative & mixed methodologies*. Oxford: Oxford University Press
- Fraenkel, Jack, R, Wallen, Norman, E & Hyun, Helen, H. (2012). *How to design and evaluate research in education (8th ed.)*. Mc Graw Hill.
- Guthrie, G. (2010). *Basic research methods : An entry to social science research*. London : Sage Publications.
- Nassaji , H. (2015). Qualitative and descriptive research: Data type versus data analysis
University of Victoria, Canada. *Language Teaching Research* . Vol. 19(2) 129–132 DOI: 10.1177/1362168815572747 ltr.sagepub.com
- Salkind, Neil, J . (Ed.). (2010). *Encyclopedia of research design*. London : Sage Publications.