Lecture eight: Quantitative data analysis

8.1. Definition and characteristics of quantitative data

The main characteristic of quantitative data is that it consists of information that is, in some way or the other, quantifiable. In other words, we can put quantitative data into numbers, figures, and graphs, and process it using statistical procedures. When using quantitative analysis, we are usually interested in how much and how many there is/are of whatever we are interested in. (Rasinger, 2013)

Characteristics of quantitative research:

The following are some of the main characteristics of quantitative research.

1) Using numbers and the language of statistics: the single most important feature of quantitative research is, naturally, that is centered around numbers. Statistical analysis can range from calculating average of several figures on a pocket calculator to running complex statistical analyses on a computer.

2) A priori categorization: While in qualitative research themes and categories can emerge after data collection, in quantitative research, the researcher has to define their themes and categories in order to accurately quantify them later. If, for example, respondents are asked to tick a box in a multi-choice survey item, the researcher has to identify the categories and what they represent in order to make sure that each respondent gives their answer based on the same understanding.

3) Variables rather than cases: Quantitative researchers are less interested in individuals than in the common features of groups of people. Therefore, in contrast to the qualitative emphasis on the individual cases, quantitative research is centered around the study of variables that capture these common features and which are quantified by counting, scaling, or by assigning values to categorical data.

4) Standardized procedures to assess objective reality: Quantitative research aspire to eliminate any individual-based subjectivity from the various phases of the research process by developing systematic canons and rules for every facet of data collection and analysis.

5) Quest for generalizability and universal laws: Numbers, variables, standardized procedures, statistics, and scientific reasoning are all part of the ultimate quantitative quest for facts that are generalizable beyond the particular and add up to wide-ranging, ideally universal, laws.

(Dörnyei, 2007, p. 30)

8.2. Descriptive statistics

Descriptive statistics can help to provide a simple summary or overview of the data, thus allowing researchers to gain a better overall understanding of the data set. Because raw data are not in and of themselves revealing, they must be organized and described in order to be informative. In this section, we present an overview of three different types of descriptive statistics: (1) measures of frequency; (2) measures of central tendency; and (3) measures of variability or dispersion.

8.2.1. Measures of frequency

Measures of frequency are used to indicate how often a particular behavior or phenomenon occurs. For example, in second language studies, researchers might be interested in tallying how often learners make errors in forming the past tense, or how often they engage in a particular classroom behavior. One of the most common ways to present frequencies is in table format.

Example: Frequency of phonemic pronunciation errors made by beginner EFL learners

Participants	Vowel errors	Consonant errors	Totals
Participant 1	17	3	20
Participant 2	15	8	23
Participant 3	25	9	34
Participant 4	18	6	24
Participant 5	14	2	16
Totals	**89**	**28**	**117**

8.2.2. Measures of central tendency

Second language researchers often use one or more measures of central tendency to provide precise quantitative information about the typical behavior of learners with respect to a particular phenomenon. There are three commonly used measures of central tendency, namely: 1) the *mode*, 2) the *median*, and 3) the *mean*.

1) Simply put, the **mode** is the most frequent score obtained by a particular group of learners. For example, if the ESL proficiency test scores recorded for a group of students were 78, 92, 92, 74, 89, and 80, the mode would be 92 because two students in this sample obtained that score.

2) The **median** is the score at the center of the distribution—that is, the score that splits the group in half. For example, in our series of ESL proficiency test scores (78, 92, 92, 74, 89, and 80), we would find the median by first ordering the scores (74, 78, 80, 89, 92, 92) and then finding the score at the center. Since we have an even number of scores in this case (namely, six), we would take the midpoint between the two middle scores (80 and 89), or 84.5.

3) The **mean** is the average of the numbers. It is easy to calculate: add up all the numbers, then divide by how many numbers there are. In other words, it is the sum divided by the count. For our scores (78, 92, 92, 74, 89, and 80), the mean would be the sum of all scores divided by the number of observations, or ($\sum x / n =$) 84.2. It should be kept in mind that even though the mean is commonly used, it is sensitive to extreme scores especially if the number of participants is small.

8.2.3. Measures of spread (dispersion)

A more common way of measuring variability is through the calculation of the **standard deviation**. Simply put, the standard deviation is a number that shows how scores are spread around the mean; specifically, it is the square root of the average squared distance of the scores from the mean. In other words, one takes the differences between each score and the mean and squares that difference. The next step is to add up these squared values, and divide by the sample size. The resulting number is called the variance. The standard deviation is the square root of the variance. As an example, consider the scores given above, 45, 99, 57, 17, 63, and 100. To calculate the standard deviation, the following steps are taken:

1. Calculate the mean. $\sum x / n = 63.5$
2. Subtract the mean from each score and square the difference $(63.5–x)^2$.
3. Sum the differences squared and divide by the number of scores (6) to arrive at variance.
4. Take the square root of the variance (SD = 29.27).

8.3. Inferential statistics and hypothesis testing

Inferential statistics refer to statistical tests that allow the researchers to infer the results obtained with a random sample to the general population (hence the name inferential). Such tests are very important as they ensure the researcher that the difference found between tests or groups is not due to chance but rather to a real relationship (causal or correlational) between the variables being studied.

Before conducting an inferential test, it is important to check the distribution of the data set. If the data is normally distributed, the researcher can proceed to using parametric tests (e.g. t-test, One-Way ANOVA, Pearson correlation). However, if the data is not normally distributed, non-parametric tests should be used (e.g. Mann-Whitney test, Kruskal walis test, Spearman correlation).

A normal distribution (also known as a bell curve) describes the clustering of scores/behaviors. In a normal distribution, the numbers (for example, scores on a particular test) cluster around the midpoint. There is an even and decreasing distribution of scores in both directions. The Figure below shows a normal distribution. As can be seen, the three measures of central tendency (mean, mode, median) coincide at the midpoint. Thus, 50 percent of the scores fall above the mean and 50 percent fall below the mean.

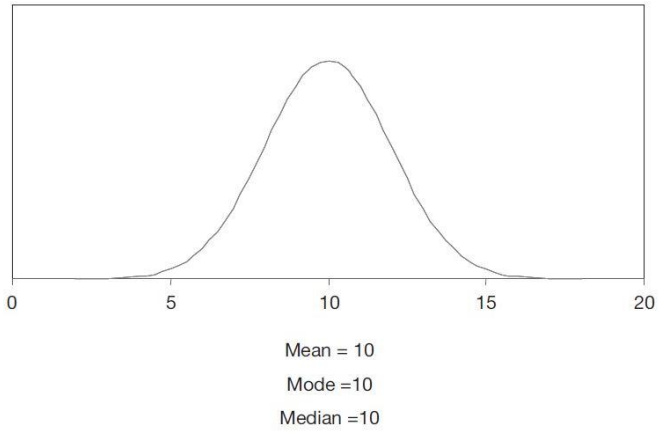

FIGURE 10.7 Normal distribution

The two well-known tests of normality, namely, the *Kolmogorov–Smirnov* test and the *Shapiro–Wilk* test are most widely used methods to test the normality of the data. Normality tests can be conducted in the statistical software "SPSS" (analyze → descriptive statistics → explore → plots → normality plots with tests).

The following table details some of the most commonly used parametric and non-parametric tests.

Parametric tests	**Equivalent non-parametric tests**	**Purpose**
Paired t-test	Wilcoxon Rank sum test	To compare the means of the same group (e.g. pre-test/ post-test situations)
Unpaired t-test	Mann-Whitney U test	To compare the means of two different groups (e.g. Experimental group vs. control group)
One way analysis of variance (One-Way ANOVA)	Kruskal Wallis Test	To test the statistical significance between the means of three or more groups (e.g. Control group vs. Experimental group1 vs. Experimental group 2)
Pearson correlation r	Spearman correlation	To measures correlation between two sets of data