

Basic Concepts of Research Methodology

Research

Research in common parlance refers to a search for knowledge. One can also define research as a scientific and systematic search for pertinent information on a specific topic. In fact, research is an art of scientific investigation. The Advanced Learner's Dictionary of Current English lays down the meaning of research as "a careful investigation or inquiry specially through search for new facts in any branch of knowledge." Redman and Mory define research as a "systematized effort to gain new knowledge." Some people consider research as a movement, a movement from the known to the unknown. It is actually a voyage of discovery.

A broad definition of research is given by **Martyn Shuttleworth**

"In the broadest sense of the word, the definition of research includes any gathering of data, information and facts for the advancement of knowledge."

Another definition of research is given by Creswell who states - "Research is a process of steps used to collect and analyze information to increase our understanding of a topic or issue". It consists of three steps: Pose a question, collect data to answer the question, and present an answer to the question.

Objectives of Research

The purpose of research is to discover answers to questions through the application of scientific procedures. The main aim of research is to find out the truth which is hidden and which has not been discovered as yet. Though each research study has its own specific purpose, we may think of research objectives as falling into a number of following broad groupings:

- ◆ To gain familiarity with a phenomenon or to achieve new insights into it (studies with this object in view are termed as exploratory or formulative research studies);
- ◆ To portray accurately the characteristics of a particular individual, situation or a group (studies with this object in view are known as descriptive research studies);

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- ◆ To determine the frequency with which something occurs or with which it is associated with something else (studies with this object in view are known as diagnostic research studies);
- ◆ To test a hypothesis of a causal relationship between variables (such studies are known as hypothesis-testing research studies).

Characteristics of Good Research

- ◆ Good research is systematic;
- ◆ Good research is logical
- ◆ Good research is empirical
- ◆ Good research is replicable

Social Research

Social research refers to research conducted by social scientists, which follows by the systematic plan. Social research methods can generally vary along a quantitative/qualitative dimension.

- ◆ Quantitative designs approach social phenomena through quantifiable evidence, and often rely on statistical analysis of many cases (or across intentionally designed treatments in an experiment) to create valid and reliable general claims. Related to quantity.
- ◆ Qualitative designs emphasize understanding of social phenomena through direct observation, communication with participants, or analysis of texts, and may stress contextual and subjective accuracy over generality. Related to quality.

Social research is the scientific study of society. More specifically, social research examines a society's attitudes, assumptions, beliefs, trends, stratifications and rules. The scope of social research can be small or large, ranging from the self or a single individual to spanning an entire race or country. Social research determines the relationship between one or more variables.

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A broad comprehensive definition of social research has been given by P.V. Young which is as follows:

“Social Research may be defined as a scientific undertaking which by means of logical and systematized techniques, aims to discover new factor verify a test old facts, analyze their sequence, interrelationship and causal explanation which were derived within an appropriate theoretical frame of reference, develop new scientific tolls, concepts and theories which would facilities reliable and valid study of human behavior. A researcher’s primary goal distant and immediate is to explore and gain an understanding of human behavior and social life and thereby gain a greater control over time”.

Objectives of Social Research

Social Research is a scientific approach of adding to the knowledge about society and social phenomena. Knowledge to be meaningful should have a definite purpose and direction. The growth of knowledge is closely linked to the methods and approaches used in research investigation. Hence the social science research must be guided by certain laid down objectives enumerated below:

- ◆ **Development of Knowledge:** Social science helps us to obtain and add to the knowledge of social phenomena. This is one of the most important objectives of social research.
- ◆ **Scientific Study of Social Life:** Social research is an attempt to acquire knowledge about the social phenomena. Man being the part of a society, social research studies human being as an individual, human behavior and collects data about various aspects of the social life of man and formulates law in this regards.
- ◆ **Welfare of Humanity:** The ultimate objective of the social science study is often and always to enhance the welfare of humanity. No scientific research makes only for the sake of study. The welfare of humanity is the most common objective in social science research.

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- ◆ **Classification of facts:** According to Prof. P.V.Young, social research aims to clarify facts. The classification of facts plays important role in any scientific research.
- ◆ **Social control and Prediction:** “The ultimate object of many research undertaking is to make it possible, to predict the behavior of particular type of individuals under the specified conditions. In social research we generally study of the social phenomena, events and the factors that govern and guide them.”

Criteria for Selecting Research Problem

The following points may be observed by a researcher in selecting a research problem or a subject for research

1. Subject which is overdone should not be normally chosen, for it will be a difficult task to throw any new light in such a case;
2. Controversial subject should not become the choice of an average researcher;
3. Too narrow or too vague problems should be avoided;
4. The subject selected for research should be familiar and feasible so that the related research material or sources of research are within one's reach.

Characteristics of Good Research Title

- ◆ Describe the content of the paper
- ◆ Catch the reader's attention and interest
- ◆ Avoid dual meaning word
- ◆ Avoid ambiguous word
- ◆ Simple, sharp and short

Abstract

An **abstract** is a brief summary of a research article, thesis, review, conference proceeding or any in-depth analysis of a particular subject or discipline, and is often used to help the reader quickly ascertain the paper's purpose.

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Structure of Abstract

An academic abstract typically outlines four elements relevant to the completed work:

- ◆ The research focus (i.e. statement of the problem(s)/research issue(s) addressed);
- ◆ The research methods used (Method/Nature/Sampling/Population/Study Area.);
- ◆ The results/findings of the research; and
- ◆ The main conclusions and recommendations

Background of the Study

Background research refers to accessing the collection of previously published and unpublished information about a site, region, or particular topic of interest and it is the first step of all good archaeological investigations, as well as that of all writers of any kind of research paper.

Statement of the Problem

This statement signifies the need for defining a research problem. The problem to be investigated must be defined unambiguously for that will help to discriminate relevant data from the irrelevant ones. A proper definition of research problem will enable the researcher to be on the track whereas an ill-defined problem may create hurdles.

Defining a research problem properly and clearly is a crucial part of a research study and must in no case be accomplished hurriedly. However, in practice this a frequently overlooked which causes a lot of problems later on. Hence, the research problem should be defined in a systematic manner, giving due weightage to all relating points. The

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technique for the purpose involves the undertaking of the following steps generally one after the other:

- ◆ Statement of the problem in a general way;
- ◆ Understanding the nature of the problem;
- ◆ Surveying the available literature
- ◆ Developing the ideas through discussions; and
- ◆ Rephrasing the research problem into a working proposition

Literature Review

A literature review is a text written by someone to consider the critical points of current knowledge including substantive findings, as well as theoretical and methodological contributions to a particular topic. It provides an overview and a critical evaluation of a body of literature relating to a research topic or a research problem. It analyzes a body of literature in order to classify it by themes or categories, rather than simply discussing individual works one after another.

Characteristics of Good Literature Review

- ◆ It is organized around issues, themes, factors, or variables that are related directly to the thesis or research question.
- ◆ It demonstrates the researcher's familiarity with the body of knowledge by providing a good synthesis of what is and is not known about the subject in question, while also identifying areas of controversy and debate, or limitations in the literature sharing different perspectives.
- ◆ It indicates the theoretical framework that the researcher is working with.
- ◆ It places the formation of research questions in their historical and disciplinary context.
- ◆ It identifies the most important authors engaged in similar work.
- ◆ It offers an explanation of how the researcher can contribute toward the existing body of scholarship by pursuing their own thesis or research question

Objective of the Study

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The objectives of a research project summarize what is to be achieved by the study. These objectives should be closely related to the research problem.

The general objective of a study states what researchers expect to achieve by the study in general terms. It is possible (and advisable) to break down a general objective into smaller, logically connected parts. These are normally referred to as specific objectives. Specific objectives should systematically address the various research questions. They should specify what you will do in your study, where and for what purpose.

Hypothesis of the Study

Hypothesis is a tentative conjecture explaining an observation, phenomenon, or scientific problem that can be tested by further observation, investigation, or experimentation. Hypotheses are testable explanations of a problem, phenomenon, or observation. Both quantitative and qualitative research involve formulating a hypothesis to address the research problem. Hypotheses that suggest a causal relationship involve at least one independent variable and at least one dependent variable; in other words, one variable which is presumed to affect the other.

Type of Hypothesis

1. **Null Hypothesis:** The null hypothesis states that there is no association between the predictor and outcome variables in the population. The null hypothesis is the formal basis for testing statistical significance.
2. **Alternative Hypothesis:** The null hypothesis states that there is association between the predictor and outcome variables in the population. The alternative hypothesis cannot be tested directly; it is accepted by exclusion if the test of statistical significance rejects the null hypothesis.

One and Two-tailed Hypotheses

A one-tailed (or one-sided) hypothesis specifies the direction of the association between the predictor and outcome variables. A two-tailed hypothesis states only that an association exists; it does not specify the direction.

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Characteristics of Hypothesis

- ◆ A hypothesis should state the expected pattern, relationship or difference between two or more variables;
- ◆ A hypothesis should be testable;
- ◆ A hypothesis should offer a tentative explanation based on theories or previous research;
- ◆ A hypothesis should be concise and lucid.

Variables of the Study

Variable is observation that can take different values. It is a measurable characteristic that varies. It may change from group to group, person to person, or even within one person over time. A variable is an object, event, idea, feeling, time period, or any other type of category you are trying to measure. There are two types of variables-independent and dependent.

1. **Independent Variable:** An independent variable is exactly what it sounds like. It is a variable that stands alone and isn't changed by the other variables you are trying to measure. For example, someone's age might be an independent variable.
2. **Dependent Variable:** Just like an independent variable, a dependent variable is exactly what it sounds like. It is something that depends on other factors. (Independent variable) causes a change in (Dependent Variable) and it isn't possible that (Dependent Variable) could cause a change in (Independent Variable).

Conceptual Framework

Conceptual Framework is a written or visual presentation that explains either graphically, or in narrative form, the main things to be studied – the key factors, concepts or variables and the presumed relationship among them. The main objective in forming a conceptual framework is to help the researcher give direction to the research. The conceptual framework identifies the research tools and methods that may be used to carry out the research effectively.

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Theoretical Framework

The objective of forming a theoretical framework is to define a broad framework within which a researcher may work. The theoretical framework enhances overall clarity of the research. It also helps the researcher get through the research faster as he has to look only for information within the theoretical framework, and not follow up any other information he finds on the topic.

Difference between the Conceptual and the Theoretical Framework

- A conceptual framework is the researcher's idea on how the research problem will have to be explored. This is founded on the theoretical framework, which lies on a much broader scale of resolution. The theoretical framework dwells on time tested theories that embody the findings of numerous investigations on how phenomena occur.
- The theoretical framework provides a general representation of relationships between things in a given phenomenon. The conceptual framework, on the other hand, embodies the specific direction by which the research will have to be undertaken. Statistically speaking, the conceptual framework describes the relationship between specific variables identified in the study. It also outlines the input, process and output of the whole investigation. The conceptual framework is also called the research paradigm.
- The theoretical framework looks at time-tested theories in relation to any research topic. The conceptual framework is the researcher's idea on how the research problem will be explored, keeping in mind the theories put forth in the theoretical framework.
- The theoretical framework looks at the general relationship of things in a phenomenon, while conceptual framework puts forth the methods to study the relationship between the specific variables identified in the research topic.
- Conceptual framework gives a direction to the research that is missing in theoretical framework by helping decide on tools and methods that may be employed in the research.

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Methodology

Research Methodology

Research methodology describing how the study was conducted. It includes; research design, Study population, sample and sample size, methods of data collection, methods of data analysis and anticipation of the study. Research methodology refers to a philosophy of research process. It includes the assumptions and values that serve a rationale for research and the standards or criteria the researcher uses for collecting and interpreting data and reaching at conclusions (Martin and Amin, 2005:63). In other words research methodology determines the factors such as how to write hypothesis and what level of evidence is necessary to make decisions on whether to accept or reject the hypothesis. Research Methodology is the complete plan of attack on the central research problem. It provides the overall structure for the procedures that the researcher follows, the data that the researcher collects, and the data analyses that the researcher conducts, thus involves planning. It is a plan with the central goal of solving the research problem in mind.

Research Method

1. **Survey Method:** Surveys involve collecting information, usually from fairly large groups of people, by means of questionnaires but other techniques such as interviews or telephoning may also be used. There are different types of survey. The most straightforward type (the “one shot survey”) is administered to a sample of people at a set point in time. Another type is the “before and after survey” which people complete before a major event or experience and then again afterwards.
2. **Experiments Method:** People who take part in research involving experiments might be asked to complete various tests to measure their cognitive abilities (e.g. word recall, attention, concentration, reasoning ability etc.) usually verbally, on paper or by computer. The results of different groups are then compared. Participants should not be anxious about performing well but simply do their best.

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The aim of these tests is not to judge people or measure so-called intelligence, but to look for links between performance and other factors.

3. **Case Study Method:** Case study research involves an in-depth study of an individual or group of individuals. Case studies often lead to testable hypotheses and allow us to study rare phenomena. Case studies should not be used to determine cause and effect, and they have limited use for making accurate predictions.
4. **Observation Method:** Observational trials study health issues in large groups of people but in natural settings. Studies which involve observing people can be divided into two main categories, namely participant observation and non-participant observation.
 - a) In participant observation studies, the researcher becomes (or is already) part of the group to be observed. This involves fitting in, gaining the trust of members of the group and at the same time remaining sufficiently detached as to be able to carry out the observation.
 - b) In non-participant observation studies, the researcher is not part of the group being studied. The researcher decides in advance precisely what kind of behaviour is relevant to the study and can be realistically and ethically observed. The observation can be carried out in a few different ways.

Research Type or Nature of the Research

1. **Descriptive Research:** Descriptive research attempts to describe systematically a situation, problem, phenomenon, service or programme, or provides information about , say, living condition of a community, or describes attitudes towards an issue.
2. **Explanatory Research:** Explanatory research attempts to clarify why and how there is a relationship between two or more aspects of a situation or phenomenon.
3. **Exploratory Research:** Exploratory research is undertaken to explore an area where little is known or to investigate the possibilities of undertaking a particular research study (feasibility study/ pilot study).

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- 4. Quantitative Research:** The emphasis of Quantitative research is on collecting and analysing numerical data; it concentrates on measuring the scale, range, frequency etc. of phenomena. This type of research, although harder to design initially, is usually highly detailed and structured and results can be easily collated and presented statistically.
- 5. Qualitative Research:** Qualitative research is more subjective in nature than Quantitative research and involves examining and reflecting on the less tangible aspects of a research subject, e.g. values, attitudes, perceptions. Although this type of research can be easier to start, it can be often difficult to interpret and present the findings; the findings can also be challenged more easily.

Unit of Analysis

The unit of analysis is the major entity that you are analyzing in your study. It is the 'what' or 'who' that is being studied. Units of analysis are essentially the things we examine in order to create summary descriptions of them and explain differences among them. Units of analysis that are commonly used in social science research include individuals, groups, organizations, social artifacts, and social interactions.

Population of the Study

Population for study, such a population must be specific enough to provide readers a clear understanding of the applicability of your study to their particular situation and their understanding of that same population.

Sampling

A sample is a subset of the population being studied. It represents the larger population and is used to draw inferences about that population. It is a research technique widely used in the social sciences as a way to gather information about a population without having to measure the entire population.

- 1. Simple Random Sampling:** The simple random sample is the basic sampling method assumed in statistical methods and computations. The main benefit of the

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simple random sample is that each member of the population has an equal chance of being chosen. This means that it guarantees that the sample chosen is representative of the population. In turn, the statistical conclusions drawn from analysis of the sample will be valid (Lottary Method).

2. **Purposive sampling (Non-probability):** A purposive sample, also commonly called a judgmental sample, is one that is selected based on the knowledge of a population and the purpose of the study. The subjects are selected because of some characteristic. Purposive sampling can be very useful for situations where you need to reach a targeted sample quickly and where sampling for proportionality is not the main concern.
3. **Stratified sampling:** A stratified sample is a probability sampling technique in which the researcher divides the entire target population into different subgroups, or strata, and then randomly selects the final subjects proportionally from the different strata. This type of sampling is used when the researcher wants to highlight specific subgroups within the population.
4. **Systematic sampling:** In a systematic sample, the elements of the population are put into a list and then every kth element in the list is chosen (systematically) for inclusion in the sample. For example, if the population of study contained 2,000 students at a high school and the researcher wanted a sample of 100 students, the students would be put into list form and then every 20th student would be selected for inclusion in the sample. To ensure against any possible human bias in this method, the researcher should select the first individual at random. This is technically called a 'systematic sample with a random start'.
5. **Cluster sampling:** Cluster sampling may be used when it is either impossible or impractical to compile an exhaustive list of the elements that make up the target population. Usually, however, the population elements are already grouped into subpopulations and lists of those subpopulations already exist or can be created.
6. **Snowball sampling (Non-probability):** A snowball sample is a non-probability sampling technique that is appropriate to use in research when the members of a population are difficult to locate. A snowball sample is one in which the researcher collects data on the few members of the target population he or she can

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locate, then asks those individuals to provide information needed to locate other members of that population whom they know.

Difference between Pre-test and Pilot-Study

Most of the times these terms are used interchangeably. The International Development Research Centre Canada site mentions this difference between them:

- ➡ **A PRE-TEST** usually refers to a small-scale trial of particular research components. Before planning a pilot census, the conduct of a series of pre-test surveys is highly desirable. The objective of the pre-test surveys should be confined mainly to the formulation of concepts and definitions, census questionnaires, instruction manuals, etc., and the evaluation of alternative methodologies and data collection techniques.
- ➡ **A PILOT STUDY** is the process of carrying out a preliminary study, going through the entire research procedure with a small sample. The pilot census, unlike the pre-test surveys, is a 'dry run' for the main census but on a limited scale. It should evaluate all aspects of the census operation including the concepts and definitions, the adequacy of the questionnaires, the training of field enumerators and supervisory staff, field organization, census methodology, sampling design and estimation procedure, data processing and data tabulation. The results should be used when drawing up the final plans for the census and to provide a basis for the final calculations of resource requirements for the census.

Methods of Data Collection

1. **Focus Groups:** Excellent approach to gather in-depth attitudes, beliefs, and anecdotal data from a large group of patrons at one time. Group dynamics might generate more ideas than individual interviews. Can be effectively used to focus on details regarding issues found through surveys or other data collection methods. Participants are not required to read or write. Technique relies on oral communication. Requires staff time to set up and facilitate focus group. Requires staff time to identify and schedule participants for focus group. Requires strong facilitator to guide discussion and ensure participation by all members. Usually requires special equipment to record and transcribe focus group discussion.

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- Interviews:** Good approach to gather in-depth attitudes, beliefs, and anecdotal data from individual patrons. Personal contact with participants might elicit richer and more detailed responses. Provides an excellent opportunity to probe and explore questions. Participants do not need to be able to read and write to respond. Requires staff time and quiet area to conduct interviews. Requires special equipment to record and transcribe interviews.
- Observation:** Excellent approach to discover behaviors Provides indicators of the impact of programs that might be more reliable than data gained by asking people. Good technique when there are observable products and outcomes. Requires staff time to observe and record observations. Cannot ask questions of participants during observation. Might want to use follow-up interviews to verify observations.
- Surveys:** Best for gathering brief written responses on attitudes, beliefs regarding library programs. Can include both close-ended and open-ended questions. Can be administered in written form or online. Personal contact with the participants is not required. Staff and facilities requirements are minimal, since one employee can easily manage the distribution and collection of surveys, and issues such as privacy, quiet areas, etc. are typically not concerns. Responses are limited to the questions included in the survey. Participants need to be able to read and write to respond. Takes time to pre-test a written survey to make sure that your questions are clearly stated. Relies on participants' perceptions. Be aware of potential gaps between participants' responses and reality. Surveys work better after you have determined the range of outcomes that the survey can target. Therefore, surveys may not be the best initial data collection tool. Questions on surveys can be misunderstood, especially if they are self-administered and/or if participants do not understand the context for the survey questions. Survey questions (especially closed-ended questions) can be limited to what the provider thinks may be the range of responses.

Tools of Data Collection

- Interview Schedule (Open-ended/Close-ended):** This method of data collection is very much like the collection of data through questionnaire, with little difference which lies in the fact that schedules (proforma containing a set of

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questions) are being filled in by the enumerators who are specially appointed for the purpose. These enumerators along with schedules, go to respondents, put to them the questions from the proforma in the order the questions are listed and record the replies in the space meant for the same in the proforma. In certain situations, schedules may be handed over to respondents and enumerators may help them in recording their answers to various questions in the said schedules. Enumerators explain the aims and objects of the investigation and also remove the difficulties which any respondent may feel in understanding the implications of a particular question or the definition or concept of difficult terms.

- 2. Questionnaire (Open-ended Question):** This method of data collection is quite popular, particularly in case of big enquiries. It is being adopted by private individuals, research workers, private and public organisations and even by governments. In this method a questionnaire is sent (usually by post) to the persons concerned with a request to answer the questions and return the questionnaire. A questionnaire consists of a number of questions printed or typed in a definite order on a form or set of forms. The questionnaire is mailed to respondents who are expected to read and understand the questions and write down the reply in the space meant for the purpose in the questionnaire itself. The respondents have to answer the questions on their own.
- 3. Checklist:** Checklists structure a person's observation or evaluation of a performance or artifact. They can be simple lists of criteria that can be marked as present or absent, or can provide space for observer comments. These tools can provide consistency over time or between observers. Checklists can be used for Case Study method.
- 4. Rating Scale:** This is a recording form used for measuring individual's attitudes, aspirations and other psychological and behavioural aspects, and group behaviour.

Data Processing

Data processing is an intermediary stage of work between data collection and data analysis. The completed instruments of data collection, like interview schedules/questionnaires/ data sheets/field notes contain a vast mass of data. They cannot straightaway provide answers to research questions. They, like raw materials, need

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processing. Data processing involves classification and summarisation of data in order to make them amenable to analysis. Data processing consists of a number of closely related operations, like (1) editing, (2) classification and coding, (3) transcription and (4) tabulation.

1. **Editing:** The first step in processing of data is editing of complete schedules/questionnaires. Editing of data is a process of examining the collected raw data (specially in surveys) to detect errors and omissions and to correct these when possible. As a matter of fact, editing involves a careful scrutiny of the completed questionnaires and/or schedules. Editing is done to assure that the data are accurate, consistent with other facts gathered, uniformly entered, as completed as possible and have been well arranged to facilitate coding and tabulation. Editing is done at two stages: first at the fieldwork stage and second at office.

- ◆ **Field editing:** During the stress of interviewing the interviewer cannot always record responses completely and legibly. Therefore after each interview is over, he should review the schedule to complete abbreviated responses, rewrite illegible responses and correct omissions.

- ◆ **Office editing:** All completed schedules/questionnaires should be thoroughly checked in the office for Completeness, accuracy and uniformity

2. **Coding:** Coding refers to the process of assigning numerals or other symbols to answers so that responses can be put into a limited number of categories or classes. Such classes should be appropriate to the research problem under consideration. They must also possess the characteristic of exhaustiveness (i.e., there must be a class for every data item) and also that of mutual exclusivity which means that a specific answer can be placed in one and only one cell in a given category set. Another rule to be observed is that of unidimensionality by which is meant that every class is defined in terms of only one concept.
3. **Tabulation:** After the transcription of data is over, data are summarised and arranged in a compact form for further analysis. This process is called tabulation. Thus, tabulation is the process of summarising raw data and displaying them on

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compact statistical tables for further analysis. It involves counting of the number of cases falling into each of several categories.

- 4. Classification:** Most research studies result in a large volume of raw data which must be reduced into homogeneous groups if we are to get meaningful relationships. This fact necessitates classification of data which happens to be the process of arranging data in groups or classes on the basis of common characteristics. Data having a common characteristic are placed in one class and in this way the entire data get divided into a number of groups or classes.

Analyze of Data

Data analysis can take the form of simple descriptive statistics or more sophisticated statistical inference. Data analysis techniques include univariate analysis (such as analysis of single-variable distributions), bivariate analysis, and more generally, multivariate analysis. Multivariate analysis, broadly speaking, refers to all statistical methods that simultaneously analyze multiple measurements on each individual or object under investigation (Hair et al., 1995); as such, many multivariate techniques are extensions of univariate and bivariate analysis.

- ➡ **Descriptive Statistics:** Descriptive statistics includes statistical procedures that we use to describe the population we are studying. The data could be collected from either a sample or a population, but the results help us organize and describe data. Descriptive statistics can only be used to describe the group that is being studying. That is, the results cannot be generalized to any larger group. Descriptive statistics are useful and serviceable if you do not need to extend your results to any larger group. However, much of social sciences tend to include studies that give us “universal” truths about segments of the population, such as all parents, all women, all victims, etc. Frequency distributions, measures of central tendency (mean, median, and mode), and graphs like pie charts and bar charts that describe the data are all examples of descriptive statistics.
- ➡ **Inferential Statistics:** Inferential statistics is concerned with making predictions or inferences about a population from observations and analyses of a sample. That is, we can take the results of an analysis using a sample and can generalize it to

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the larger population that the sample represents. In order to do this, however, it is imperative that the sample is representative of the group to which it is being generalized. To address this issue of generalization, we have tests of significance. A Chi-square or T-test, for example, can tell us the probability that the results of our analysis on the sample are representative of the population that the sample represents. In other words, these tests of significance tell us the probability that the results of the analysis could have occurred by chance when there is no relationship at all between the variables we studied in the population we studied. Examples of inferential statistics include linear regression analyses, logistic regression analyses, ANOVA, correlation analyses, structural equation modeling, and survival analysis, to name a few.

Interpretation of Data

Interpretation refers to the task of drawing inferences from the collected facts after an analytical and/or experimental study. In fact, it is a search for broader meaning of research findings. The task of interpretation has two major aspects viz., (i) the effort to establish continuity in research through linking the results of a given study with those of another, and (ii) the establishment of some explanatory concepts.

Necessity of Data Interpretation

1. It is through interpretation that the researcher can well understand the abstract principle that works beneath his findings. Through this he can link up his findings with those of other studies, having the same abstract principle, and thereby can predict about the concrete world of events. Fresh inquiries can test these predictions later on. This way the continuity in research can be maintained.
2. Interpretation leads to the establishment of explanatory concepts that can serve as a guide for future research studies; it opens new avenues of intellectual adventure and stimulates the quest for more knowledge.
3. Researcher can better appreciate only through interpretation why his findings are what they are and can make others to understand the real significance of his research findings.

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4. The interpretation of the findings of exploratory research study often results into hypotheses for experimental research and as such interpretation is involved in the transition from exploratory to experimental research. Since an exploratory study does not have a hypothesis to start with, the findings of such a study have to be interpreted on a post-factum basis in which case the interpretation is technically described as 'post factum' interpretation.

Test of Hypothesis

Hypothesis testing helps to decide on the basis of a sample data, whether a hypothesis about the population is likely to be true or false. Statisticians have developed several tests of hypotheses (also known as the tests of significance) for the purpose of testing of hypotheses which can be classified as: (a) Parametric tests or standard tests of hypotheses; and (b) Non-parametric tests or distribution-free test of hypotheses.

Parametric Test: Parametric tests usually assume certain properties of the parent population from which we draw samples. Assumptions like observations come from a normal population, sample size is large, assumptions about the population parameters like mean, variance, etc., must hold good before parametric tests can be used. But there are situations when the researcher cannot or does not want to make such assumptions. (T-test and Z-Test)

Non-parametric Test: In such situations we use statistical methods for testing hypotheses which are called non-parametric tests because such tests do not depend on any assumption about the parameters of the parent population. Besides, most non-parametric tests assume only nominal or ordinal data, whereas parametric tests require measurement equivalent to at least an interval scale (X^2 -Test and F-Test).

Chi-square: Chi-square is a statistical test commonly used to compare observed data with data we would expect to obtain according to a specific hypothesis. The chi-square test is always testing what scientists call the null hypothesis, which states that there is no significant difference between the expected and observed result.

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Chi-square test

$$\text{Chi Square test} = \frac{\sum(f_o - f_e)^2}{f_e}$$

f_o = observed frequency

$$f_e = \text{expected frequency} = \frac{RT \times CT}{GT}$$

RT = Row total

CT = Column total

GT = Ground total

$$\text{Degree of freedom} = (R-1)(C-1)$$

Characteristics of Chi-square test

- ◆ This test is based on frequency not on the parameters like mean or standard deviation
- ◆ This test is useful for testing hypothesis not for the estimation
- ◆ X^2 should not be calculated if the expected value in any category is less than 5
- ◆ This test can also be applied to a complex contingency table with several classes and as such is a very useful test in research work.
- ◆ This test is an important non-parametric test as no rigid assumptions are necessary in regard to the type of population, no need of parameter values and relatively less mathematical details are involved.

Degrees of Freedom

In statistics, the number of degrees of freedom (d.o.f.) is the number of independent pieces of data being used to make a calculation. The number of degrees of freedom is a measure of how certain we are that our sample population is representative of the entire population - the more degrees of freedom, usually the more certain we can be that we have accurately sampled the entire population.

The d.o.f. can be viewed as the number of independent parameters available to fit a model to data. Generally, the more parameters you have, the more accurate your fit will be. However, for each estimate made in a calculation, you remove one degree of freedom. This is because each assumption or approximation you make puts one more restriction on

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how many parameters are used to generate the model. Put another way, for each estimate you make, your model becomes less accurate.

Degrees of freedom are commonly discussed in relation to chi-square and other forms of hypothesis testing statistics. It is important to calculate the degree(s) of freedom when determining the significance of a chi square statistic and the validity of the null hypothesis.

Measurement Scales

The "levels of measurement", or scales of measure are expressions that typically refer to the theory of scale types developed by the psychologist Stanley Smith Stevens. Stevens proposed his theory in a 1946 Science article titled "On the theory of scales of measurement". In that article, Stevens claimed that all measurement in science was conducted using four different types of scales that he called "nominal", "ordinal", "interval" and "ratio", unifying both qualitative (which are described by his "nominal" scale) and quantitative (to a different degree, all the rest of his scales)

1. **Nominal:** A scale that measures data by name only. For example, religious affiliation (measured as Christian, Jewish, Muslim, and so forth), political affiliation (measured as Democratic, Republican, Libertarian, and so forth), or style of automobile (measured as sedan, sports car, SUV, and so forth).
2. **Ordinal:** A scale that measures by rank order only. Other than rough order, no precise measurement is possible. For example, medical condition (measured as satisfactory, fair, poor, guarded, serious, and critical); socioeconomic status (measured as lower class, lower-middle class, middle class, upper-middle class, upper class); or military officer rank (measured as lieutenant, captain, major, lieutenant colonel, colonel, general). Such rankings are not absolute but rather relative to each other: Major is higher than captain, but we cannot measure the exact difference in numerical terms.
3. **Interval:** A scale that measures by using equal intervals. Here you can compare differences between pairs of values. The Fahrenheit temperature scale, measured in degrees, is an interval scale, as is the centigrade scale. The temperature

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difference between 50°C and 60°C (10 degrees) equals the temperature difference between 80°C and 90°C (10 degrees). Note that the 0 in each of these scales is arbitrarily placed, which makes the interval scale different from ratio.

4. **Ratio:** Similar to an interval scale, a ratio scale includes a 0 measurement that signifies the point at which the characteristic being measured vanishes (absolute zero). For example, income (measured in dollars, with 0 equal to no income at all), years of formal education, items sold, and so forth, are all ratio scales.

Table Analysis

Univariate Data	Bivariate Data
<ul style="list-style-type: none">• Involving a single variable	<ul style="list-style-type: none">• Involving two variables
<ul style="list-style-type: none">• Does not deal with causes or relationships	<ul style="list-style-type: none">• Deals with causes or relationships
<ul style="list-style-type: none">• The major purpose of univariate analysis is to describe	<ul style="list-style-type: none">• The major purpose of bivariate analysis is to explain
<ul style="list-style-type: none">• Central tendency - mean, mode, median• Dispersion - range, variance, max, min, quartiles, standard deviation.• Frequency distributions• Bar graph, histogram, pie chart, line graph, box-and-whisker plot	<ul style="list-style-type: none">• Analysis of two variables simultaneously• Correlations• Comparisons, relationships, causes, explanations• Tables where one variable is contingent on the values of the other variable.• Independent and dependent variables
Sample question: How many of the students in the freshman class are female?	Sample question: Is there a relationship between the number of females in Computer Programming and their scores in Mathematics?

Graph, Chart and Figure

- ➡ Chart is circular and represents 100% of a category; each segment or pie is a percentage of the whole- like a bar-chart
- ➡ A figure can be any picture that goes with the text of what someone is writing
- ➡ Graph shows values that are related then comparisons are made such as the tallest and the shortest.

Raw Data

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The term raw data is used most commonly to refer to information that is gathered for a research study before that information has been transformed or analyzed in any way. The term can apply to the data as soon as they are gathered or after they have been cleaned, but not in any way further transformed or analyzed. The challenge for most researchers who collect and analyze data is to extract useful information from the raw data they start with.

Characteristics of Conclusion

The conclusion of a research paper needs to summarize the content and purpose of the paper without seeming too wooden or dry. Every basic conclusion must share several key elements, but there are also several tactics you can play around with to craft a more effective conclusion and several you should avoid in order to prevent yourself from weakening your paper's conclusion. Here are some writing tips to keep in mind when creating the conclusion for your next research paper.

- ◆ Restate the topic
- ◆ Summarize the main points
- ◆ Add the points up
- ◆ Make a call to action when appropriate

Confidence Interval

A confidence interval gives an estimated range of values which is likely to include an unknown population parameter, the estimated range being calculated from a given set of sample data.

If independent samples are taken repeatedly from the same population, and a confidence interval calculated for each sample, then a certain percentage (confidence level) of the

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intervals will include the unknown population parameter. Confidence intervals are usually calculated so that this percentage is 95%, but we can produce 90%, 99%, 99.9% (or whatever) confidence intervals for the unknown parameter. The width of the confidence interval gives us some idea about how uncertain we are about the unknown parameter (see precision). A very wide interval may indicate that more data should be collected before anything very definite can be said about the parameter.

Fact

A fact is something that has really occurred or is actually the case. The usual test for a statement of fact is verifiability, that is whether it can be proven to correspond to experience.