Lecture outline

- Classification of Research Studies
  - Experimental studies
    - True or Controlled Experiments
    - Natural or Quasi Experiments
  - Observational studies
    - Cohort studies (Retrospective, Prospective & Ambi-directional studies)
    - Cross-sectional studies (Prevalence studies)
    - Case-control studies.

- Research Principles
  - Choice of Research Topic or Topic of Study
  - Background to a Study or Justification
  - Statement of the Problem
  - Research Questions.
  - Hypothesis of the Study.
  - Aim and Objectives of the Study
  - Significance of the Study

Classification of Research Studies

Studies done in research are broadly classified into two – experimental studies (experiments) and observational studies.

Experimental Studies

An experiment is an orderly procedure done with the goal of verifying, falsifying, or establishing the validity of a hypothesis. Experimental studies provide insight into cause-and-effect by demonstrating what outcome occurs when a particular factor is manipulated. Experiments vary greatly in their goal and scale, but always rely on repeatable procedure and logical analysis of the results. Experiments can vary from
personal and informal (e.g. tasting a range of fruits to find which one is sweeter), to highly controlled (e.g. tests requiring complex apparatus overseen by many scientists that hope to discover information about subatomic particles). The uses of experiments vary considerably between the natural and social sciences.

In the scientific method, an experiment is an empirical method that arbitrates between competing models or hypotheses. Experimentation is also used to test existing theories or new hypotheses in order to support them or disprove them. An experiment usually tests a hypothesis, which is an expectation about how a particular process or phenomenon works. However, an experiment may also aim to answer a "what-if" question, without a specific expectation about what the experiment will reveal, or re-test previous results to replicate results.

If an experiment is carefully conducted, the results usually either support or disprove the hypothesis. An experiment can never "prove" a hypothesis, it can only add support. Similarly, an experiment that provides a counterexample can disprove a theory or hypothesis.

An experiment must also control the possible confounding factors – any factors that would mar the accuracy or repeatability of the experiment or the ability to interpret the results. Confounding factors are commonly eliminated through scientific control and or, in randomized experiments, through random assignment.

In medicine and the social sciences, the use and application of experimental research varies widely across disciplines. When used, however, experiments typically follow the form of a clinical trial, where experimental units (usually individual animals or human beings) are randomly assigned to a treatment or control condition where one or more outcomes are assessed. The focus is typically on the average treatment effect (the difference in outcomes between the treatment and control groups) or another test statistic produced by the experiment. A single study will typically not involve replications of the experiment, but separate studies may be aggregated through systematic review and meta-analysis.

In agricultural research, experimental studies commonly involve randomized experiments (e.g., to test the comparative effectiveness of different fertilizers). Experimental economics however often involves experimental tests of theorized human behaviors without relying on random assignment of individuals to treatment and control conditions. In engineering and other physical sciences, experiments are used used to test theories and hypotheses about how physical processes work under particular
conditions, and in this area experiments will focus on replication of identical procedures with the hope of producing identical results in each replication. Random assignment is uncommon.

Experiments are categorized into two broad types – ‘true experiments’ (controlled experiments) and natural or quasi experiments.

A 'true experiment' is one in which there are two kinds of variables. The independent variable is manipulated by the experimenter, and the dependent variable is measured. The signifying characteristic of a true experiment is that it randomly allocates the subjects in order to neutralize the potential for experimenter bias and ensures, over a large number of iterations of the experiment, that all confounding factors are controlled for.

A true/controlled experiment generally compares the results obtained from an experimental sample against a control sample, which is practically identical to the experimental sample except for the one aspect whose effect is being tested (the independent variable). A good example would be a drug trial. The sample or group receiving the drug would be the experimental group (treatment group); and the one receiving the placebo (no drug) would be the control one. In many laboratory experiments it is good practice to have several replicate samples for the test being performed and have both a positive control and a negative control. The results from replicate samples can often be averaged, or if one of the replicates is obviously inconsistent with the results from the other samples, it can be discarded as being the result of an experimental error. Most often, tests are done in duplicate or triplicate. A positive control is a procedure that is very similar to the actual experimental test but which is known from previous experience to give a positive result. A negative control is known to give a negative result. The positive control confirms that the basic conditions of the experiment were able to produce a positive result, even if none of the actual experimental samples produce a positive result. The negative control demonstrates the base-line result obtained when a test does not produce a measurable positive result. Most often the value of the negative control is treated as a "background" value to be subtracted from the test sample results.

In true/controlled experiments, the experimenter begins by creating two or more sample groups that are probabilistically equivalent, which means that measurements of traits should be similar among the groups and that the groups should respond in the same manner if given the same treatment. This equivalency is determined by statistical methods that take into account the amount of variation between individuals and the
number of individuals in each group. In fields such as microbiology and chemistry, where there is very little variation between individuals and the group size is easily in the millions, these statistical methods are often bypassed and simply splitting a solution into equal parts is assumed to produce identical sample groups. Once equivalent groups have been formed, the experimenter tries to treat them identically except for the one variable that he or she wishes to isolate.

Human experimentation requires special safeguards against outside variables such as the placebo effect. Human experiments are generally double blind, meaning that neither the volunteer nor the researcher knows which individuals are in the control group or the experimental group until after all of the data have been collected. This ensures that any effects on the volunteer are due to the treatment itself and are not a response to the knowledge that he/she is being treated.

In the design of experiments, two or more "treatments" are applied to estimate the difference between the mean responses for the treatments.

Experimentation is the step in the scientific method that helps people decide between two or more competing explanations – or hypotheses. These hypotheses suggest reasons to explain a phenomenon, or predict the results of an action. Formally, a hypothesis is compared against its opposite or null hypothesis. The null hypothesis is that there is no explanation or predictive power of the phenomenon through the reasoning that is being investigated. Once hypotheses are defined, an experiment can be carried out - and the results analysed - in order to confirm, refute, or define the accuracy of the hypotheses.

In circumstances where true/controlled experiments are impossible or prohibitively difficult to carry out, researchers commonly resort to natural experiments or quasi-experiments. Natural experiments rely solely on observations of the variables of the system under study, rather than manipulation of just one or a few variables as occurs in controlled experiments. To the degree possible, they attempt to collect data for the system in such a way that contribution from all variables can be determined, and where the effects of variation in certain variables remain approximately constant so that the effects of other variables can be discerned. The degree to which this is possible depends on the observed correlation between explanatory variables in the observed data. When these variables are not well correlated, natural experiments can approach the power of controlled experiments. Usually, however, there is some correlation between these variables, which reduces the reliability of natural experiments relative to what could be concluded if a controlled experiment were performed. Also, because
natural experiments usually take place in uncontrolled environments, variables from undetected sources are neither measured nor held constant, and these may produce illusory correlations in variables under study.

Much research in several important science disciplines, including economics, political science, geology, paleontology, ecology, meteorology, and astronomy, rely on quasi-experiments.

Field experiments are so named in order to draw a contrast with laboratory experiments, which enforce scientific control by testing a hypothesis in the artificial and highly controlled setting of a laboratory. Often used in the social sciences, and especially in economic analyses of education and health interventions, field experiments have the advantage that outcomes are observed in a natural setting rather than in a contrived laboratory environment. For this reason, field experiments are sometimes seen as having higher external validity than laboratory experiments. However, like natural experiments, field experiments suffer from the possibility of contamination: experimental conditions can be controlled with more precision and certainty in the laboratory. Field experiments are necessary because some phenomena cannot be easily studied in a laboratory.

By placing the distribution of the independent variable(s) under the control of the researcher, an experiment, particularly when it involves human subjects, introduces potential ethical considerations, such as balancing benefit and harm, fairly distributing interventions (e.g., treatments for a disease), and informed consent. For example in psychology or health care, it is unethical to provide a substandard treatment to patients. Therefore, ethical review boards are supposed to stop clinical trials and other experiments unless a new treatment is believed to offer benefits as good as current best practice. It is also generally unethical (and often illegal) to conduct randomized experiments on the effects of substandard or harmful treatments, such as the effects of ingesting lead on human health. To understand the effects of such exposures, scientists sometimes use observational studies.

Observational studies

Observational studies are so named because the investigator simply observes; no interventions are carried out by the investigator. A research study comparing the risk of developing lung cancer, between smokers and nonsmokers, would be a good example of an observational study. The main reason for performing any observational research is
due to ethical concerns. With the smoking example, a scientist cannot give cigarettes to non-smokers for 20 years and compare them with a control group. This also brings up the other good reason for such studies, in that few researchers can study the long-term effects of certain variables, especially when it runs into decades. For this study of long-term and subtle effects, they have to use pre-existing conditions and medical records. The researcher may want to study an extremely small sample group, so it is easier to start with known cases and works backwards. The thalidomide cases, for example, are an example of an observational study where researchers had to work backwards, and establish that the drug was the cause of disabilities.

The main problem with observational studies is that the experimenter has no control over the composition of the control groups, and cannot randomize the allocation of subjects. This can create bias, and can also mask cause and effect relationships or, alternatively, suggest correlations where there are none (error in research). For example, in the smoking example, if the researcher found that there is a correlation between smoking and increased rates of lung cancer, without knowing the full and complete background of the subjects, there is no way of determining whether other factors were involved, such as diet, occupation or genetics. Randomization is assumed to even out external causal effects, but this is impossible in an observational study. There is no independent variable, so it is dangerous to assume cause and effect relationships. Despite these limitations, an observational study allows a useful insight into a phenomenon, and side-steps the ethical and practical difficulties of setting up a large and cumbersome medical research project.

There are three forms of observational studies – cohort, cross sectional and case-control studies.

**Cohort studies**

A **cohort study** is a research program investigating/observing a particular group with a certain trait over a period of time. Some examples of cohorts may be people who have taken a certain medication, or have a medical condition. Outside medicine, it may be a population of animals that has lived near a certain pollutant or a sociological study of poverty. A cohort study can delve even further and divide a cohort into sub-groups, for example, a cohort of smokers could be sub-divided, with one group suffering from obesity. In this respect, a cohort study is often interchangeable with the term
naturalistic observation. There are three main sub-types of cohort study, the retrospective, the prospective and the ambi-directional cohort study.

Retrospective cohort study

A retrospective cohort study, also called a historic cohort study, (from Latin ‘retr’, "look back") generally means to take a look back at events that already have taken place. For example, the term is used in medicine, describing a look back at a patient's medical history or lifestyle. The retrospective case study is therefore historical in nature. Whilst still beginning with the division into cohorts, the researcher looks at historical data to judge the effects of the variable. For example, it might compare the incidence of bowel cancer over time in vegetarians and meat eaters, by comparing the medical histories. It is a lot easier than the prospective, but there is no control, and confounding variables can be a problem, as the researcher cannot easily assess the lifestyle of the subject. A retrospective study is a very cheap and effective way of studying health risks or the effects of exposure to pollutants and toxins. It gives results quickly, at the cost of validity, because it is impossible to eliminate all of the potentially confounding variables from historical records and interviews alone.

Prospective cohort study

In a prospective cohort study, the effects of a certain variable are plotted over time, and the study becomes an ongoing process. To maintain validity, all of the subjects must be initially free of the condition tested for. For example, an investigation, over time, into the effects of smoking upon lung cancer must ensure that all of the subjects are free of the disease. It is also possible to subgroup and try to control variables, such as weight, occupation type or social status. They are preferable to a retrospective study, but are expensive and usually require a long period of time to generate useful results; prospective studies are thus more expensive and difficult.

A prospective study is important for research on the etiology of diseases and disorders in humans because for ethical reasons people cannot be deliberately exposed to suspected risk factors as in controlled experiments. Prospective cohort studies are typically ranked higher in the hierarchy of evidence than retrospective cohort studies. One of the advantages of prospective cohort studies is that they can help determine risk factors for being infected with a new disease because they are a longitudinal
observation over time, and the collection of results is at regular time intervals, so recall error is minimized.

**Ambi-directional cohort study**

An *ambi-directional cohort study* combines retrospective and prospective aspects. The researcher studies and analyzes the previous history of the cohorts and then continues the research in a prospective manner. This gives the most accurate results, but is an extremely arduous undertaking, costing time and a great deal of money.

The ambidirectional study shares one major drawback with the prospective study, in that it is impossible to guarantee that any data can be followed up, as participants may decline to participate or die prematurely. These studies need to look at very large samples to ensure that any attributional losses can be absorbed by the statistics.

**Cross-sectional studies**

A *cross-sectional study* is a class of observational research method that involves observation of all of a population, or a representative subset, at one specific point in time. They differ from case-control studies in that they aim to provide data on the entire population under study, whereas case-control studies typically include only individuals with a specific characteristic, with a sample, often a tiny minority, of the rest of the population. Cross-sectional studies are descriptive studies (neither longitudinal nor experimental). Unlike case-control studies, they can be used to describe, not only the odds ratio, but also absolute risks and relative risks from prevalence (sometimes called *prevalence risk ratio*, or PRR). They may be used to describe some feature of the population, such as prevalence of an illness, or they may support inferences of cause and effect. Cross-sectional studies are also known as *cross-sectional analyses*, *transversal studies*, *prevalence study*.

In human and veterinary medicine, cross-sectional studies are often used to assess the prevalence of acute or chronic conditions, or to answer questions about the causes of disease or the results of medical intervention. They may also be described as censuses. Cross-sectional studies may involve special data collection, including questions about the past, but they often rely on data originally collected for other purposes. They are moderately expensive, and are not suitable for the study of rare diseases. Difficulty in recalling past events may also contribute bias.
The use of routinely collected data allows large cross-sectional studies to be made at little or no expense. This is a major advantage over other forms of epidemiological study. A natural progression has been suggested from cheap cross-sectional studies of routinely collected data which suggest hypotheses, to case-control studies testing them more specifically, then to cohort studies and trials which cost much more and take much longer, but may give stronger evidence. In a cross-sectional survey, a specific group is looked at to see if an activity, say alcohol consumption, is related to the health effect being investigated, say cirrhosis of the liver. If alcohol use is correlated with cirrhosis of the liver, this would support the hypothesis that alcohol use may cause cirrhosis.

However, routinely collected data does not normally describe which variable is the cause and which the effect. Cross-sectional studies using data originally collected for other purposes are often unable to include data on confounding factors, other variables that affect the relationship between the putative cause and effect. For example, data only on present alcohol consumption and cirrhosis would not allow the role of past alcohol consumption, or of other causes, to be explored.

**Case-control study**

A *case-control study* is a type of *observational study* in which two existing groups differing in outcome are identified and compared on the basis of some supposed causal attribute. Case-control studies are often used to identify factors that may contribute to a medical condition by comparing subjects who have that condition/disease (the “cases”) with patients who do not have the condition/disease but are otherwise similar (the “controls”). Case-control studies require fewer resources but provide less evidence for causal inference than a *randomized controlled trial*. In case-control studies the subjects are not randomized to the exposed or unexposed groups, rather the subjects are *observed* in order to determine both their exposure and their outcome status and the exposure status is thus not determined by the researcher. A case-control study can thus be described as an observational epidemiological study of persons with the disease (or another outcome variable) of interest and a suitable control group of persons without the disease (comparison group, reference group). The potential relationship of a suspected risk factor or an attribute to the disease is examined by comparing the diseased and non-diseased subjects with regard to how frequently the factor or attribute is present (or, if quantitative, the levels of the attribute) in each of the groups (diseased and non-diseased). For example, in a study trying to show that people who smoke (the *attribute*) are more likely to be diagnosed with lung cancer (the *outcome*), the *cases* would be
persons with lung cancer, the *controls* would be persons without lung cancer (not necessarily healthy), and some of each group would be smokers. If a larger proportion of the cases smoke than the controls, that suggests, but does not conclusively show, that the hypothesis is valid.

The case-control study is frequently contrasted with *cohort studies*, wherein exposed and unexposed subjects are observed until they develop an outcome of interest.

In a case-control study, controls need not be in good health; inclusion of sick people is sometimes appropriate, as the control group should represent those at risk of becoming a case. Controls should come from the same population as the cases, and their selection should be independent of the exposures of interest. Controls can carry the same disease as the experimental group, but of another grade/severity, therefore being different from the outcome of interest. However, because the difference between the cases and the controls will be smaller, this results in a lower power to detect an exposure effect. As with any epidemiological study, greater numbers in the study will increase the power of the study. Numbers of cases and controls do not have to be equal. In many situations, it is much easier to recruit controls than to find cases. Increasing the number of controls above the number of cases, up to a ratio of about 4 to 1, may be a cost effective way to improve the study.

Case-control studies are a relatively inexpensive and frequently used type of epidemiological study that can be done by small teams or individual researchers in single facilities in a way that more structured experimental studies often cannot be. Case-control studies have pointed the way to a number of important discoveries and advances. The case-control study design is often used in the study of rare diseases or as a preliminary study where little is known about the association between the risk factor and disease of interest.

Compared to prospective *cohort studies*, case-control studies tend to be less costly and shorter in duration. In several situations they have greater statistical power than cohort studies, which must often wait for a ‘sufficient’ number of disease events to accrue.

Case-control studies are observational in nature and thus do not provide the same level of evidence as *randomized controlled trials*. The results may be confounded by other factors, to the extent of giving the opposite answer to better studies. It may also be more difficult to establish the timeline of exposure to disease outcome in the setting of a case-control study than within a prospective cohort study design where the exposure is ascertained prior to following the subjects over time in order to ascertain their outcome.
status. The most important drawback in case-control studies relates to the difficulty of obtaining reliable information about an individual's exposure status over time. Case-control studies are therefore placed low in the hierarchy of evidence.

Notable example of case-control study - One of the most significant triumphs of the case-control study was the demonstration of the link between tobacco smoking and lung cancer. The investigators showed a statistically significant association in a large case-control study. Opponents argued for many years that this type of study cannot prove causation, but the eventual results of cohort studies confirmed the causal link which the case-control studies suggested, and it is now accepted that tobacco smoking is the cause of about 87% of all lung cancer mortality.

Experimental versus observational study

An observational study is used when it is impractical, unethical, cost-prohibitive (or otherwise inefficient) to fit a physical or social system into a laboratory setting, to completely control confounding factors, or to apply random assignment. It can also be used when confounding factors are either limited or known well enough to analyze the data in light of them (though this may be rare when social phenomena are under examination). In order for an observational science to be valid, confounding factors must be known and accounted for. In these situations, observational studies have value because they often suggest hypotheses that can be tested with randomized experiments or by collecting fresh data.

Observational studies lack the manipulation required for standard experiments. In addition, observational studies (e.g., in biological or social systems) often involve variables that are difficult to quantify or control. Observational studies are limited because they lack the statistical properties of randomized experiments. In a randomized experiment, the method of randomization specified in the experimental protocol guides the statistical analysis, which is usually specified also by the experimental protocol. Without a statistical model that reflects an objective randomization, the statistical analysis relies on a subjective model. Inferences from subjective models are unreliable in theory and practice. In fact, there are several cases where carefully conducted observational studies consistently give wrong results, that is, where the results of the observational studies are inconsistent and also differ from the results of experiments. For example, epidemiological studies of colon cancer in humans consistently show beneficial correlations with broccoli consumption, while experiments
find no benefit. A particular problem with observational studies involving human subjects is the great difficulty attaining fair comparisons between treatments (or exposures), because such studies are prone to selection bias, and groups receiving different treatments (exposures) may differ greatly according to their covariates (age, height, weight, medications, exercise, nutritional status, ethnicity, family medical history, etc.). In contrast, randomization implies that for each covariate, the mean for each group is expected to be the same. For any randomized trial, some variation from the mean is expected, of course, but the randomization ensures that the experimental groups have mean values that are close. With inadequate randomization or low sample size, the systematic variation in covariates between the treatment groups (or exposure groups) makes it difficult to separate the effect of the treatment (exposure) from the effects of the other covariates, most of which have not been measured. The mathematical models used to analyze such data must consider each differing covariate (if measured), and the results will not be meaningful if a covariate is neither randomized nor included in the model.

To avoid conditions that render experiment far less useful, investigators conducting medical trials will quantify and randomize the covariates that can be identified. Researchers attempt to reduce the biases of observational studies with complicated statistical methods such as propensity score matching methods, which require large populations of subjects and extensive information on covariates. Outcomes are also quantified when possible (bone density, amount of some cell or substance in the blood, physical strength or endurance, etc.) and not based on a subject's or a professional observer's opinion. In this way, the design of an observational study can render the results more objective and therefore more convincing.

Research Principles

Choice of Research Topic or Topic of Study

Before one chooses a research topic, one must carefully observe and appreciate his/her area of study and recognize a problem that needs to be systematically investigated. The investigator should explore several areas of interest (have reasonable number of proposed research topics within the study area) before deciding on one, and exhaustively look at topical/current issues in his/her area of study. Factors that may need to be considered before selecting a topic for study include:
Personal interest and knowledge – personal interest will generate the zeal to investigate the topic/problem thoroughly without getting bored.

The research topic/problem to be investigated should lie within the investigator’s intellectual ability/capability, experience and capacity so as to cope with the rigours of the studying the topic.

The topic/research problem should be original, so that one does not go ahead duplicating research already undertaken by other investigators. To avoid duplication of research topics, a comprehensive review/evaluation of literature (journal articles, thesis and dissertations, abstracts, bibliographies) in the proposed area of study is absolutely necessary.

Time needed to complete the study and the resources needed – these are always limited. The investigator must consider whether it is feasible to complete the study/investigation within the time limit (for instance the two year period of an MSc programme or the four year time limit for a PhD etc) and resources available – resources, in terms of laboratory equipment, consumables, experimental animals/subjects, finances for travelling (if it is a survey), availability of respondents etc.

Accessibility to data – one should not choose a topic or area of study in which it will be difficult to collect data.

How important and how serious is the topic/problem that is proposed for investigation – a trivial or elementary problem do not merit rigorous intellectual analysis.

Background to a Study or Justification

The background to a study is a documentation of the historical development and the current state of knowledge of the topic under investigation. Information for the background of a study can be obtained by reviewing relevant literature – both old and current (new), that is, looking through relevant books, journals, conference abstracts and proceedings, thesis, dissertation and project reports. The investigator should carefully document the reference data (author(s), date, title, journal, publisher, volume, issues and pages) of all the sources of information consulted for the background of the study. The background to a study must capture all that has been done and is known (with its full references) in an area/topic to be investigated, and appreciate the salient
contributions of other scientists/investigators upon whose works the proposed topic/study builds. The background to a study must identify the pivotal work that led to the one being proposed for investigation and state explicitly what scientific questions the earlier scientists/investigators have not yet answered about the topic – this will thus highlight the ‘knowledge gap’ or ‘gap in understanding’ which the present proposed study is out address or fill in. Hence the other name for background to a study is justification for a study.

Statement of the Problem

The statement of the research problem outlines defines the problem that the study aims to tackle. A clear statement of the problem serves as a pivot around which all subsequent research activities are anchored. It gives direction to the relevant research hypothesis that will be stated and data collection instruments. A good statement of problem should specify variables which can be compared, correlated or observed, and delimit the scope of the investigation. Generally, a statement of the problem is a claim (of one, two or few sentences in length) that outlines the problem addressed by the study. The statement of the problem should answer the question: what is the problem that the research is to address?

Research Questions

Research questions are answerable inquiries into a specific research topic, concern or issue. They are questions that must be raised to which the research or investigation should be geared towards solving. Research questions arise from the statement of the problem, and when a problem is clearly stated, a lot of questions emerge which the study will be aimed at. The general purpose of the study/work will be to find answers to these research questions. The steps in writing a good research question include:

i. Specify the research topic.

ii. Decide what you want to know about the topic.

iii. Turn what you want to know and the specific topic into a question.

iv. Ensure that the question is answerable.

v. Check to make sure that the question is not too broad or too narrow.
Writing a good research question means that an investigator really has something he/she wants to study/investigate.

**Hypothesis of a study**

A hypothesis is a conjecture or tentative assumption subject to rejection or confirmation based on further or more facts. In most research works, a specific hypothesis has to be stated. Each hypothesis may take one aspect of research question.

The hypothesis may be a null or alternative hypothesis. A **null hypothesis** is the conjecture or tentative assumption that the statistical hypothesis is false, e.g., that there is no relationship between consuming sugary foods and development of diabetes mellitus or drinking a specific weight losing tea (Legend® tea) does not actually lead to loss of weight (any weight loss may be due to chance). The null hypothesis is commonly adopted because it tends to prevent bias, in that if we start the investigation with the assumption that for instance there is a relationship between consuming sugary foods and development of diabetes mellitus an element of bias is already introduced. A good research aspires to show that the null hypothesis is false. The **alternative hypothesis** is the desired outcome, e.g., consuming sugary foods leads to the development of diabetes mellitus or drinking Legend® tea leads to loss of weight.

Generally a hypothesis cannot be proven. If the outcome of the study is inconsistent with the hypothesis, then the **hypothesis is rejected**. However, if the outcome is consistent with the hypothesis, the experiment is said to **support the hypothesis**. These words are carefully chosen as researchers recognize that alternative hypotheses may also be consistent with the observations.

**Aim and or Objectives of the Study**

The aim of a study is a broad statement of the general intentions of the research or what the investigator intends to study, emphasizing what is to be accomplished. The objectives of a study are the specific breakdown statements of the components of the overall aim or purpose of the study – the objectives are subsidiary to the overall aim. The objectives are the specific steps that the investigator is going to take to answer his/her research questions or the specific list of tasks that are needed to accomplish the goals of the research project.
The aim of a study (overall purpose of the study) should be clearly and concisely defined. The specific objectives arise or are formulated from the overall aim/purpose. The aim and objectives of a study should be concise and brief, inter-related and realistic. They should not be too vague, ambitious or broad in scope. They should not contradict each other or the methods. And they should not be a highlight of the significance of the study.

**Significance of a Study**

The significance of a study usually explains the significance of the research project, its potential benefits and its overall impacts. The significance of a study explains why the research project was worth being done. It is also known as the ‘rationale’. A statement of the significance of the study highlights why the research work is important, the possible implications of the findings, and how the study might fill in knowledge gaps in the area of study and or point the way towards further study. The significance of the study should also examine what impact the study might have not just on the academic or scientific community but also on the general public. It should present practical benefits, such as how the work might inform policy, improve some aspect of people's lives, help people save money, make a process more efficient or help the environment. It should also explain the unique perspectives the investigator or his/her team brought into the research project.