Section – 3: Key Facts and Figures

Sub Unit – 1
Meaning, Characteristics and Types of Research

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1. Concept and Meaning of Research

The word 'research' means the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusion.

Some of the important ways of knowing are as under:

(i) Consecutive, authoritarian, ideology, legal precedent, universal truth, myths

(ii) Reason, formal logic

(iii) Affect, intuition, intra-personal processes and common sense

(iv) Altered consciousness, revelation, graces

(v) Empirical research

The term 'Research' consists of two words –

Research = Re + Search

'Re' means again and again and 'Search' means to find out something. Research is a process of which a person observes the phenomena again and again and collects the data and on the basis of data he draws some conclusions. Research is conducted by a person who possesses new thinking and has reasoning ability.

2. Definitions of Research

J. W. Best: "Research is considered to be the more formal, systematic, intensive process of carrying on the scientific methods of analysis. It involves a more systematic structure of investigation, usually resulting in some sort of formal record of procedures and report of results or conclusions".

C. C. Crawford: "Research is simply a systematic and refined technique of thinking employing specialized tools, instruments and procedures in order to obtain a more adequate solution of a problem, collect data or facts, analyze these critically and reach at decisions based

on the actual evidence. It involves original work instead of mere exercise of personal experiences. It evolves from a genuine desire to know rather than a desire to prove something, it is quantitative, seeking to know not only what but how much, and measurement is therefore, a central feature of it".

Random Morey: "Research is an honest, exhaustive, intelligent searching for facts and their meanings or implication with reference to a given problem. The product or findings of given piece of research should be an authentic, verifiable and contribution to knowledge in the field studies".

3. Characteristics of Research

Certain terms are very commonly used in research and the success of any research depends on the terms. These terms determine whether a research is free of biases, prejudices, and subjective errors or not. They are called the characteristics of research.

(i) Research is a scientific investigation which means to 'search again and again'.

(ii) Research originates with a question or problem.

(iii) Research requires clear articulation of a goal.

(iv) Research usually divides the principal problem into more manageable sub-problems.

(v) Research is guided by the specific research problem, question, or hypothesis.

(vi) It develops some new concepts and theories and expands the limits of knowledge.

(vii) It cannot be implemented immediately. It does not directly involve the solution to a particular problem; its findings generally cannot be implemented immediately.

4. Objectives of Research

The objective of research project summarizes what is to be achieved by the study. The research objectives are the specific accomplishments the researcher hopes to achieve by the study. A clearly defined research objective will help the researcher to focus on the study. The formation of objectives helps the individuals and teams to reach to a common goal:

(i) To become familiar with a phenomenon on to achieve new insights into it.

(ii) To encode precisely the characteristics of a particular individual situation or a group.

(iii) To determine the frequency with which something occurs or with it is associated with something else.

(iv) To test a hypothesis of a causal relationship between them.

(v) To systematically examine and critically analyze the investigations sources with objectivity.

(vi) To discover new things.

(vii) To keep pace with the advancement in knowledge.

(viii) To find out the depth of research.

(ix) To select the problem from the point of social relevance.

5. Types of Research

Types of research can be classified into several categories according to the nature and purpose of the study and other attributes.

1. **On the basis of Objectives:** Descriptive Research, Correlational Research, Explanatory Research, Exploratory Research, Experimental Research
2. **On the basis of Outcomes:** Fundamental Research, Applied Research
3. **On the basis of Logic:** Deductive Research, Inductive Research
4. **On the basis of Process:** Quantitative Research, Qualitative Research
5. **On the basis of Inquiry mode:** Structured Research Unstructured Research
6. **On the basis of Idea or Concept:** Conceptual Research, Empirical Research

6. Descriptive Research

(i) Descriptive research is used to describe characteristics of a population or phenomenon being studied. It does not answer questions about how/when/why the characteristics occurred. Rather it addresses the "what" question (what are the characteristics of the population or situation being studied?). The characteristics used to describe the situation or populations are usually some kind of categorical scheme also known as descriptive categories.

(ii) Descriptive research cannot be used as the basis of a causal relationship, where one variable affects another. In other words, descriptive research can be said to have a low requirement for internal validity.

(iii) The description is used for frequencies, averages and other statistical calculations. Often the best approach, prior to writing descriptive research, is to conduct a survey investigation. Qualitative research often has the aim of description and researchers may follow-up with examinations of why the observations exist and what the implications of the findings are.

7. Ex Post Facto Research

An ex-post-facto research is a method in which groups with qualities that already exist are compared on some dependent variable. Also known as "after the fact" research, an ex-post-facto design is considered quasi-experimental because the subjects are not randomly assigned; they are grouped based on a particular characteristic or trait. Although differing groups are analyzed and compared in regards to independent and dependent variables it is not a true experiment because it lacks random assignment. The assignment of subjects to different groups is based on whichever variable is of interest to the researchers.

(i) It is used in social sciences and business organizations.

(ii) It is conducted in context of a phenomenon after it has occurred or at the time of its occurrence.

(iii) It basically deals with non-manipulated variables of a phenomenon.

8. Historical Research

(i) Historical research is a qualitative technique.

(ii) Historical research studies the meaning of past events in an attempt to interpret the facts and explain the cause of events, and their effect in the present events.

(iii) In doing so, researchers rely heavily on primary historical data (direct accounts of events, archival data - official documents, personal records, and records of eyewitnesses) and less frequently on secondary historical data (information from persons who didn't witness the event; e.g. textbooks, newspapers, encyclopedias).

(iv) Historical research data is subject to external criticism (verification of genuineness or validity of the source) and internal criticism (exploring the meaning of the source).

(v) Historical research has time and place dimensions.

(vi) Simple chronology is not considered historical research because it does not interpret the meaning of events.

9. Analytical Research

The distinction between descriptive and analytical research is based on the question it asks. Descriptive research attempts to determine, describe, or identify what is, while analytical research attempts to establish why it is that way or how it came to be.

(i) In this method, the researcher uses facts or information already available.

(ii) It attempts to make critical evaluation of the material.

10. Correlational Research

(i) Correlational research is a type of non-experimental research method, in which a researcher measures two variables, understands and assesses the statistical relationship between them with no influence from any extraneous variable.

(ii) It is looking for variables that seem to interact with each other so that when you see one variable changing, you have a fair idea how the other variable will change.

Example: The correlation between two variables is shown through correlation coefficient (A correlation coefficient is a statistical measure that calculates the strength of the relationship between two variables), that is a value measured between -1 and +1. When the correlation coefficient is close to +1 then there is a positive correlation between the two variables and the value is close to -1, then there is a negative correlation between the two variables and when the value is close to zero then there is no relationship between the two variables.

11. Explanatory Research

(i) Explanatory Research is conducted for a problem which was not well researched before, demands priorities, generates operational definitions and provides a better-researched model.

(ii) It is actually a type of research design which focuses on explaining the aspects of your study in a detailed manner.

(iii) The researcher starts with a general idea and uses research as a tool which could lead to the subjects that would be dealt with in the incoming future.

(iv) It is meant to provide details where a small amount of information exists for a certain product in mind of that researcher.

(v) It is conducted in order to help us find the problem that was not studied before in-depth.

(vi) It is not used to give us some conclusive evidence but helps us in understanding the problem more efficiently. When conducting the research, the researcher should be able to adapt himself/herself to the new data and the new insight that he discovers as he/she studies the subject.

12. Exploratory Research

(i) It is generally done in the beginning of a research. It is undertaken to explore an area where little is known or to investigate the possibilities of undertaking a particular research study and is akin to feasibility study or pilot study.

(ii) It attempts to clarify why and how there is a relationship between two or more aspects of a situation or phenomenon.

(iii) The purpose of exploratory research is to gain background information, to define terms, to clarify the problems, to develop hypothesis, to establish research priorities and objectives, and to develop questions to be answered.

(iv) It makes use of secondary data (mainly literature review), experience surveys, case studies, interviews (mainly focus groups' interviews) and projective techniques.

13. Experimental Research

(i) Experimental research is any research conducted with a scientific approach, where a set of variables are kept constant while the other set of variables are being measured as the subject of experiment.

(ii) It is important for an experimental research to establish cause and effect of a phenomenon, which means, it should be definite that effects observed from an experiment are due to the cause.

(iii) As naturally, occurring event can be confusing for researchers to establish conclusions. For instance, if a cardiology student conducts research to understand the effect of food on cholesterol and derives that most heart patients are non-vegetarians or have diabetes. They are aspects (causes) which can result in a heart attack (effect).

Example: The simplest example of an experimental research is conducting a laboratory test. As long as research is being conducted under scientifically acceptable conditions – it qualifies as an experimental research. A true experimental research is considered to be successful only when the researcher confirms that a change in the dependent variable is solely due to the manipulation of the independent variable.

14. Fundamental Research

(i) Fundamental research, also known as basic research or pure research does not usually generate findings that have immediate applications in a practical level.

(ii) Fundamental research is driven by curiosity and the desire to expand knowledge in specific research area.

(iii) This type of research makes a specific contribution to the academic body of knowledge in the research area.

(iv) Fundamental studies tend to make generalizations about the phenomenon, and the philosophy of this type of studies can be explained as 'gathering knowledge for the sake of knowledge'. Fundamental researches mainly aim to answer the questions of why, what or how and they tend to contribute the pool of fundamental knowledge in the research area.

(v) Opposite to fundamental research is applied research that aims to solve specific problems, thus findings of applied research do have immediate practical implications.

15. Applied Research

(i) Applied research is a methodology used to solve a specific, practical problem of an individual or group.

(ii) The study and research is used in business, medicine and education in order to find solutions that may cure diseases, solve scientific problems or develop technology.

Example: The following are examples for applied research. You can notice that each of these studies aim to resolve a specific and an immediate problem.

- A study into the ways of improving the levels of customer retention for Wall-Mart in China
- An investigation into the ways of improving employee motivation in Marriot Hotel, Hyde Park
- Development of strategies to introduce change in Starbucks global supply-chain management with the view on cost reduction
- A study into the ways of fostering creative deviance amongst employees without compromising respect for authority

15.1. Action Research:

(i) Action research refers to a wide variety of evaluative, investigative, and analytical research methods designed to diagnose problems or weaknesses – whether organizational, academic, or instructional – and help educators develop practical solutions to address them quickly and efficiently.

(ii) It may also be applied to programs or educational techniques that are not necessarily experiencing any problems, but that educators simply want to learn more about and improve. The general goal is to create a simple, practical, repeatable process of iterative learning, evaluation, and improvement that leads to increasingly better results for schools, teachers, or programs.

(iii) It may also be called a cycle of action or cycle of inquiry, since it typically follows a predefined process that is repeated over time.

Example:

- Identify a problem to be studied
- Collect data on the problem
- Organize, analyze, and interpret the data
- Develop a plan to address the problem
- Implement the plan
- Evaluate the results of the actions taken
- Identify a new problem
- Repeat the process

15.1.a. Participatory Action Research:

Participatory Action Research (PAR) is an approach to enquiry which has been used since the 1940s. It involves researchers and participants working together to understand a problematic situation and change it for the better. There are many definitions of the approach, which share some common elements. PAR focuses on social change that promotes democracy and challenges inequality; is context-specific, often targeted on the needs of a particular group; is an iterative cycle of research, action and reflection; and often seeks to 'liberate' participants to have a greater awareness of their situation in order to take action. PAR uses a range of different methods, both qualitative and quantitative.

15.1.b. Usual Sequence of Action Research:

In doing action research the usual sequence of steps are:

(i) Plan

(ii) Act

(iii) Observe

(iv) Reflect

16. Deductive Research

(i) A deductive approach is concerned with "developing a hypothesis (or hypotheses) based on existing theory, and then designing a research strategy to test the hypothesis".

(ii) It has been stated that "deductive means reasoning from the particular to the general. If a causal relationship or link seems to be implied by a particular theory or case example, it might be true in many cases.

(iii) A deductive design might test to see if this relationship or link did obtain on more general circumstances".

(iv) It can be explained by the means of hypotheses, which can be derived from the propositions of the theory. In other words, deductive approach is concerned with deducting conclusions from premises or propositions.

(v) Deduction begins with an expected pattern "that is tested against observations, whereas induction begins with observations and seeks to find a pattern within them".

Example:

1. All men are mortal (general fact, applies to all men).
2. Socrates is a man.
3. (Therefore,) Socrates is mortal (specific).

17. Inductive Research

(i) Inductive approach, also known in inductive reasoning, starts with the observations and theories are proposed towards the end of the research process as a result of observations.

(ii) It involves the search for pattern from observation and the development of explanations – theories – for those patterns through series of hypotheses.

(iii) No theories or hypotheses would apply in inductive studies at the beginning of the research and the researcher is free in terms of altering the direction for the study after the research process had commenced.

(iv) It is important to stress that inductive approach does not imply disregarding theories when formulating research questions and objectives.

(v) This approach aims to generate meanings from the data set collected in order to identify patterns and relationships to build a theory; however, inductive approach does not prevent the researcher from using existing theory to formulate the research question to be explored.

(vi) It is based on learning from experience. Patterns, resemblances and regularities in experience (premises) are observed in order to reach conclusions (or to generate theory).

Example:

(i) Socrates is mortal (specific).

(ii) Alexander is mortal (specific), Pluto is mortal, and so (specific).

(iii) All men are mortal (general).

18. Quantitative Research

Quantitative research emphasize objective measurements and the statistical, mathematical, or numerical analysis of data collected through polls, questionnaires, and surveys, or by manipulating pre-existing statistical data using computational techniques. Quantitative research focuses on gathering numerical data and generalizing it across groups of people or to explain a particular phenomenon.

Characteristics:

(i) The data is usually gathered using structured research instruments.

(ii) The results are based on larger sample sizes that are representative of the population.

(iii) The research study can usually be replicated or repeated, given its high reliability.

(iv) Researcher has a clearly defined research question to which objective answers are sought.

(v) All aspects of the study are carefully designed before data is collected.

(vi) Data are in the form of numbers and statistics, often arranged in tables, charts, figures, or other non-textual forms.

(vii) Project can be used to generalize concepts more widely, predict future results, or investigate causal relationships.

(viii) Researcher uses tools, such as questionnaires or computer software, to collect numerical data.

19. Qualitative Research

(i) Qualitative Research is primarily exploratory research.

(ii) It is used to gain an understanding of underlying reasons, opinions, and motivations.

(iii) It provides insights into the problem or helps to develop ideas or hypotheses for potential quantitative research.

(iv) It is also used to uncover trends in thought and opinions, and dive deeper into the problem.

(v) Some common methods include focus groups (group discussions), individual interviews, and participation/observations.

(vi) The sample size is typically small, and respondents are selected to fulfill a given quota.

19.1. Qualitative research is appropriate when:

(i) The intended research area is not well studied or understood.

(ii) A subject needs to be studied in depth.

(iii) A holistic perspective is needed.

(iv) Behavioral aspects of people need to be studied.

(v) Management techniques like questionnaires are not considered suitable.

(vi) A researcher is more interested in the process (how it works) and not the product (the outcome).

20. Structured Research

A structured research (also known as a standardized interview or a researcher-administered survey) is a quantitative research method commonly employed in survey research. The aim of this approach is to ensure that each interview is presented with exactly the same questions in the same order.

21. Unstructured Research

The chief feature of the unstructured research is the idea of probe questions that are designed to be as open as possible. It is a qualitative research method and accordingly prioritizes validity and the depth of the interviewees' answers.

22. Conceptual Research

Conceptual research is defined as a methodology wherein research is conducted by observing and analyzing already present information on a given topic. Conceptual research doesn't involve conducting any practical experiments. It is related to abstract concepts or ideas.

23. Empirical Research

Empirical research is based on observed and measured phenomena and derives knowledge from actual experience rather than from theory or belief.

Characteristics:

(i) Specific research questions to be answered

(ii) Definition of the population, behavior, or phenomena being studied

(iii) Description of the process used to study this population or phenomena, including selection criteria, controls, and testing instruments (such as surveys)

24. Interdisciplinary Research

The definition of a "discipline" and discussions of the varieties of interdisciplinary, multidisciplinary, and trans-disciplinary research have occupied much scholarly debate. Although there is not always agreement on these definitions, it is clear that areas of research are dynamic - continually emerging, melding, and transforming. As a working definition of interdisciplinary research, we refer you to the definition set forth in a National Academies' report: "Interdisciplinary research is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice."

Sub Unit – 2
Methods of Research

25. Methods of Research

A research method is a strategy used to implement that plan. Research design and research methods are different but closely related; because good research design ensures that the data you obtain will help you answer your research questions more effectively.

The most important questions in research are which method you should be chosen. It depends on what subjects (and who) you want to study.

25.1. Experimental Method [Scientific Method]:

The prime method of inquiry in science is the experiment. The key features are control over variables, careful measurement, and establishing cause and effect relationships.

An experiment is an investigation in which a hypothesis is scientifically tested. In an experiment, an independent variable (the cause) is manipulated and the dependent variable (the effect) is measured; any extraneous variables are controlled.

An advantage is that experiments should be objective. The views and opinions of the researcher should not affect the results of a study. This is good as it makes the data more valid, and less bias.

There are three types of experiments you need to know:

1. Laboratory / Controlled Experiments

This type of experiment is conducted in a well-controlled environment (not necessarily a laboratory), where accurate measurements are possible. The researcher decides where the experiment will take place, at what time, with which participants, in what circumstances and using a standardized procedure. Participants are randomly allocated to each independent variable group.

(i) Strength: It is easier to replicate (i.e. copy) a laboratory experiment. This is because a standardized procedure is used. They allow for precise control of extraneous and independent variables. This allows a cause and effect relationship to be established.

(ii) Limitation: The artificiality of the setting may produce unnatural behavior that does not reflect real life, i.e. low ecological validity. This means it would not be possible to generalize the findings to a real life setting. Demand characteristics or experimenter effects may bias the results and become confounding variables.

2. Field Experiments

Field experiments are done in the everyday (i.e. real life) environment of the participants. The experimenter still manipulates the independent variable, but in a real-life setting (so cannot really control extraneous variables).

(i) Strength: Behavior in a field experiment is more likely to reflect real life because of its natural setting, i.e. higher ecological validity than a lab experiment. There is less likelihood of demand characteristics affecting the results, as participants may not know they are being studied. This occurs when the study is covert.

(ii) Limitation: There is less control over extraneous variables that might bias the results. This makes it difficult for another researcher to replicate the study in exactly the same way.

3. Natural Experiments

Natural experiments are conducted in the everyday (i.e. real life) environment of the participants, but here the experimenter has no control over the IV as it occurs naturally in real life.

(i) Strength: Behavior in a natural experiment is more likely to reflect real life because of its natural setting, i.e. very high ecological validity. There is less likelihood of demand characteristics affecting the results, as participants may not know they are being studied. Can be used in situations in which it would be ethically unacceptable to manipulate the independent variable, e.g. researching stress.

(ii) Limitation: They may be more expensive and time consuming than lab experiments. There is no control over extraneous variables that might bias the results. This makes it difficult for another researcher to replicate the study in exactly the same way.

25.1.a. Characteristics of a Good Experimental Method:

The characteristics of a good experimental method are classified into two categories:

1. General characteristics of experimental method –

(i) Unbiased estimation of true effect.

(ii) Precision of the estimates with a quantitative index.

(iii) The testing of clear specific hypothesis of different intention etc.

(iv) Efficiency in the sense of securing maximum results at minimum.

2. Specific characteristics of experimental method –

(i) It emphasizes objectivity and accuracy in the collection of the data and treatment part of it.

(ii) It emphasizes control of conditions and the experimentation of certain variables in controlled conditions.

(iii) It sets out the relationship between the phenomenon and this relationship is more or less of the causal type.

(iv) It eliminates spurious relations between variables or factors.

(v) It uses standardized tool for experimentation and makes the evidences very much objective.

(vi) The sample is selected with great precaution and every care is taken to safeguard extraneous factors.

(vii) It leads to the testing of a specific hypothesis and experimental evidences so called as to reject or retain the hypothesis.

(viii) The laws, postulates and theories of education are developed mostly through experimental methods. It allows for precision and exactness in the findings and their analysis and treatment, through measurement. The hypotheses is rejected or retained. Measurement is done through standardized test and tools of research.

25.2. Observational Method:

Observational research is defined as the method of viewing and recording the actions and behaviors of participants. It is described as being a systematic observation method, which implies that the observation techniques are sensible and replicable procedures so that the research could be reproduced. As the name describes, "observational" methods are all about observing the participants. There is no experiment conducted and no variables are manipulated. The observations are made without disturbing, influencing or altering the environment or the participants in any way. Researchers simply use all of their senses to observe participants in either a natural setting or a naturally occurring situation.

There are a variety of reasons that observational research is chosen as the most appropriate method of collecting data for a particular research question.

Following is a list of some of those reasons and situations:

(i) If research question is attempting to a questions of "how" or "what type".

(ii) When it is important that the research take place in a natural setting so the phenomenon or behaviour is not influenced or disturbed in any way.

(iii) When it is important to understand the setting that the observation is taking place in and how that may play a role in the results.

(iv) If a topic has not been previously studied and little is known, it may be best to begin with observation in a natural setting. This may provide the foundation for further study and hypothesis development in the future.

(v) The actual behavior of the participants has the potential to be different from what those individuals might report if they were asked.

25.2.a. Types of Observations:

There are three main types of observational methods based primarily on the extent to which the researcher controls or interacts with the environment. The following list describes the three methods and provides an example of each.

(i) **Naturalistic Observation:** This method takes place in the natural, every day setting of the participants. In naturalistic observation, there is no intervention by the researcher. This type of observational method is sometimes referred to nonparticipant observation. In fact, the researcher typically attempts to carry out the observations without the knowledge of the participants.

(ii) **Participant Observation:** In participant observation, the researcher intervenes in the environment in some manner. Typically, the researcher will insert himself/herself in to the group as a member of the group. This is done to be able to observe behaviours that may otherwise not be accessible to the researcher. The observations can either be covert or overt.

(iii) **Controlled Observation:** This type of observational method is carried out under controlled, arranged conditions, often in a laboratory setting. Controlled observations are overt as the researcher will explain the purpose of the research and the participants know they are being observed. Each test subject is exposed to the same situation in order to examine differences between individual reactions.

25.3. Survey Method:

The Survey method is the technique of gathering data by asking questions to people who are thought to have desired information. A formal list of questionnaire is prepared. Generally a non-disguised approach is used. The respondents are asked questions on their demographic interest opinion.

25.3.a. Categories of Survey Method:

This method is classified into four categories:

Descriptive Survey

Analytical Survey

School Survey

Genetic Survey

1. **Descriptive Survey:**

(i) Survey testing method

(ii) Questionnaire survey method

(iii) Interview survey method

2. **Analytical Survey:**

(i) Documentary survey

(ii) Observational survey

(iii) Rating survey

(iv) Critical incident

(v) Factor analysis

Sometimes, observation method is supplemented with survey method. This approach is most suited for gathering descriptive information, and this research may be direct or indirect. It is of two types: structured and unstructured surveys.

1. **Structured Surveys:** They use formal lists of questions to be asked from all respondents in the same manner.
2. **Unstructured Surveys:** They give the interviewer the flexibility to probe respondents and direct the interview according to their answers.

25.3.b. Information which the Survey Method collects:

The survey methods or survey studies collect the following three types of information:

(i) What exists

(ii) What we want

(iii) What to get there

The information of what exists is gathered by studying and analyzing important aspects of present situation.

The information of what we want is obtained by clarifying goods, goals, and objectives possibly through a study of the conditions existing elsewhere or what experts consider to be desirable.

The information of how to get these is collected through discovering the possible means of achieving the goals on the basis of the experience of others or of opinions of experts.

25.3.c. Advantages:

(i) Quick and low cost in comparison to observation method.

(ii) Survey method can be administered to collect many different types of information.

25.4. Case Studies:

In the social sciences and life sciences, a **case study** is a research method involving an up-close, in-depth, and detailed examination of a subject of study (the **case**), as well as its related contextual conditions.

Case studies can be produced by following a formal research method. These case studies are likely to appear in formal research venues, as journals and professional conferences, rather than popular works. The resulting body of 'case study research' has long had a prominent place in many disciplines and professions, ranging from psychology, anthropology, sociology, and political science to education, clinical science, social work, and administrative science.

25.4.a. Characteristics of a Good Case Study:

(i) It should be based on adequate and complete data.

(ii) Its data should be valid.

(iii) It should have continuity about it.

(iv) Its records should be kept confidential.

(v) Its data should be specifically synthesized and this synthesis should be as much prognostic as diagnostic.

(vi) Its follow up work should be undertaken.

25.4.b. Objectives of Case Study:

The case study has the following four main objectives:

(i) Clinical purpose (dealing with a patient)

(ii) Diagnostic purpose (educational situation to provide the remedial instruction to poor students)

(iii) Facts findings, about psychological or educational problems

(iv) Supplementing other information. It may be a follow up work.

25.4.c. Phases of Case Study:

A case study is conducted into three phases:

(i) Retrospective phase refers to the past records of the case completely which is used in diagnosing the case.

(ii) Prospective phase refers to the present status of the case, which is helpful in understanding the case. The suggestions and remediation can be offered to the case.

(iii) Consecutive phase refers to the future development and improvement of the case which is also employed to examine the effects of the remediation given to the case.

25.4.d. Types of Case Study:

Six types of case studies are conducted which are as follows:

(i) A group or community case study.

(ii) Causal comparative ca studies.

(iii) Activity analysis.

(iv) Content or document analysis.

(v) A follow up study.

(vi) Trend studies.

25.5. Test Method:

A **test method** is a method for a test in science or engineering, such as a physical test, chemical test, or statistical test. It is a definitive procedure that produces a test result. In order to ensure accurate and relevant test results, a test method should be "explicit, unambiguous, and experimentally feasible", as well as effective and reproducible.

A test can be considered an observation or experiment that determines one or more characteristics of a given sample, product, process, or service. The purpose of testing involves

a prior determination of expected observation and a comparison of that expectation to what one actually observes. The results of testing can be qualitative (yes/no), quantitative (a measured value), or categorical and can be derived from personal observation or the output of a precision measuring instrument.

Usually the test result is the dependent variable, the measured response based on the particular conditions of the test or the level of the independent variable. Some tests, however, may involve changing the independent variable to determine the level at which a certain response occurs: in this case, the test result is the independent variable.

Sub Unit – 3
Steps of Research

26. Steps of Research / Process of Research

Scientific research involves a systematic process that focuses on being objective and gathering a multitude of information for analysis so that the researcher can come to a conclusion. This process is used in all research and evaluation projects, regarding of the research method (scientific method of inquiry, evaluation research, or action research). Any research done without documenting the study so that others can review the process and results is not an investigation using the scientific research process. The scientific research process is a multiple-step process where the steps are interlinked with the other steps in the process.

The steps of a scientific research are as follows:

1. Identification of the research problem
2. Formulation of the objectives
3. Formulation of the questionnaire
4. Extensive Review of the literature
   - 4.1. Review concept and theory
   - 4.2. Review previous research finding
5. Formulation of the hypothesis
6. Design research (including sample design)
7. Collection of the Data
8. Analysis of the Data (Test hypothesis if any)
9. Interpretation and report writing
10. Bibliographical Information

26.1. Identification of the Research Problem:

The first step in the process is to identify a problem or develop a research question. The research problem may be something the agency identifies as a problem, some knowledge or information that is needed by the agency, or the desire to identify a recreation trend nationally.

At the very outset the researcher has to select the problem he wants to study. Initially the problem is stated in a broad general way and then the ambiguities, if any, relating to the problem be resolved. Then, feasibility of a particular solution has to be considered before a working formulation of the problem can be set up. The formulation of a general topic into a specific research problem, thus, constitutes the first step in a scientific inquiry. Essentially two steps are involved in formulating the research problem, viz., understanding the problem thoroughly, and rephrasing the same into meaningful terms from an analytical point of view.

26.1.a. Steps in Formulation of a Research Problem:

A reasonable level of knowledge in the broad subject area is required to work through these steps. Usually following steps are undertaken to formulate a research problem:

(i) Selecting a broad area
(ii) Dividing broad area into subareas
(iii) Focusing on an area of interest
(iv) Identifying the research gaps
(v) Formulating the of objectives

26.2. Formulation of Objectives:

Objectives can be written under two headings:

(i) Main objectives or aims
(ii) Sub-objectives

The main objective is an overall statement of the thrust of study. It is also a statement of the main associations and relationships that you seek to discover or established.

The sub-objectives are the specific aspects of the topic that you want to investigate within the main framework of your study.

26.2.a. Features of Objectives:

(i) They should be listed numerically.
(ii) The wording should be clear, complete and specific
(iii) Each objective should contain only one aspect of the study
(iv) Use action oriented words or verbs when writing objectives

26.3. Formulation of questionnaire:

Questionnaires are one of the important tools for research work and for designing a good questionnaire the following points should kept in mind:

(i) Writing primary and secondary aims of the study

(ii) Review of the current literature

(iii) Prepare a draft of questionnaire

(iv) Revision of the draft

As for example if a researcher is interested in studying the prospects of a particular political party in an urban area, this tool should he prefer for the study.

26.4. Extensive Literature Review:

Once the problem is formulated, a brief summary of it should be written down. It is compulsory for a research worker writing a thesis for M.Phil / PhD degree to write a synopsis of the topic and submit it to the necessary Committee or the Research Board for approval. At this juncture the researcher should undertake extensive literature survey connected with the problem. In this process, it should be remembered that one source will lead to another. The earlier studies, if any, which are similar to the study in hand, should be carefully studied.

26.4.a. Objectives of Literature Review:

The main objectives of literature review are:

(i) It amplifies the knowledge of researcher about the problem.

(ii) It brings better clarity to the problem.

(iii) It helps to improve the research methodology.

(iv) It helps to contextualize the findings.

26.5. Formulating Hypothesis:

After extensive literature review, researchers have to should state the working hypothesis or hypotheses clearly. Working hypothesis is tentative assumption made in order to draw out and test its logical or empirical consequences.

Researchers will have one or more hypothesis. These are questions that they want to address, which include predictions about possible relationships between the things they want to investigate (variables).

[Formulation of hypothesis may not be required in historical research]

26.5.a. Features of Hypothesis:

(i) It is a tentative proposition.

(ii) The validity of a hypothesis is unknown.

(iii) In most cases, formulating a hypothesis specifies the logical relationship between two variables.

(iv) It should be simple.

(v) It must be generalizable.

26.6. Preparing Research Design:

To formulate the research problem clearly, the researcher will be required to prepare a research design, i.e. he will have to state the conceptual structure within which research would be conducted.

In other words, the function of research design is to provide for the collection of relevant evidence with minimal expenditure of effort, time and money. But how all these can be achieved depends mainly on the research purpose. Research purposes may be grouped into four categories viz. (i) Exploration, (ii) Description, (iii) Diagnosis and (iv) Experimentation.

26.6.a. Consideration of Research Design:

(i) Objectives

(ii) Methodology

(iii) Sample design

(iv) Tools for collecting the data

(v) Analysis of data

26.6.b. Purpose of Research Design:

(i) Efficiency

(ii) Optimum utilization of resources

(iii) Flexibility

(iv) Unbiased (or minimization of bias)

(v) Reliability

(vi) Objectivity

26.6.c. Determining Sample Design:

All the items under consideration in any field of inquiry constitute a 'universe, or 'population'. A complete enumeration of all the items in the 'population' is known as census inquiry. It can be presumed that in such an inquiry when all the items are covered no element of chance is left and highest accuracy is obtained. But in practice this may not be true. Quite often we select only a few items from the universe for our study purposes. The items so selected constitute what is technically called a sample.

26.6.d. Sampling:

A finite subset of the population, selected from it with the objective of investigating its properties is called sample and the number of unites in the sample is known as the sample size. Sampling is a tool which enables us to draw conclusions about the characteristics of the populations after studying only those objects or items that are included in the sample.

- ## Main Objectives of the Sampling Theory:

The main objectives of the sampling theory are:

(i) To obtain the optimum results, i.e., the maximum information about the characteristics of the population with the available sources at our disposal in terms of times, money and manpower by studying the sample values only.

(ii) To obtain the best possible estimates of the population parameters.

- ## Several Stages of Sampling Process:

(i) Defining the population of concern

(ii) Specifying a sampling frame, a set of items or events possible to measure

(iii) Specifying a sampling method for selecting items or events from the frame

(iv) Determining the sample size

(v) Implementing the sampling plan

(vi) Sampling and data collecting

(vii) Data which can be selected

26.6.e. Different Types of Sample Design:

26.6.e.1. Probability sampling:

A probability sample is a sample in which every unit in the population has a chance (greater than zero) of being selected in the sample, and this probability can be accurately determined. The combination of these traits makes it possible to produce unbiased estimates of population totals, by weighting sampled units according to their probability of selection.

- **Example:**

We want to estimate the total income of adults living in a given street. We visit each household in that street, identify all adults living there, and randomly select one adult from each household. (For example, we can allocate each person a random number, generated from a uniform distribution between 0 and 1, and select the person with the highest number in each household). We then interview the selected person and find their income.

People living on their own are certain to be selected, so we simply add their income to our estimate of the total. But a person living in a household of two adults has only a one-in-two chance of selection. To reflect this, when we come to such a household, we would count the selected person's income twice towards the total. (The person who is selected from that household can be loosely viewed as also representing the person who isn't selected.)

In the above example, not everybody has the same probability of selection; what makes it a probability sample is the fact that each person's probability is known. When every element in the population does have the same probability of selection, this is known as an 'equal probability of selection' (EPS) design. Such designs are also referred to as 'self-weighting' because all sampled units are given the same weight.

- **Probability Sampling Includes:**

(i) Simple Random Sampling
(ii) Systematic Sampling
(iii) Stratified Sampling
(iv) Probability Proportional to Size Sampling
(v) Cluster or Multistage Sampling

These various ways of probability sampling have two things in common:

(i) Every element has a known non-zero probability of being sampled.
(ii) Involves random selection at some point.

26.6.e.2. Non Probability Sampling:

Non probability sampling is any sampling method where some elements of the population have no chance of selection or where the probability of selection can't be accurately determined. It involves the selection of elements based on assumptions regarding the population of interest, which forms the criteria for selection. Hence, because the selection of elements is non-random, non-probability sampling does not allow the estimation of sampling errors. These conditions give rise to exclusion bias, placing limits on how much information a sample can provide about the population. Information about the relationship between sample and population is limited, making it difficult to extrapolate from the sample to the population.

- **Example:**

We visit every household in a given street, and interview the first person to answer the door. In any household with more than one occupant, this is a non-probability sample, because some people are more likely to answer the door (e.g. an unemployed person who spends most of their time at home is more likely to answer than an employed housemate who might be at work when the interviewer calls) and it's not practical to calculate these probabilities.

- **Non-Probability Sampling Methods Include:**

(i) Convenience sampling,
(ii) Quota sampling
(iii) Purposive sampling

In addition, non-response effects may turn any probability design into a non-probability design if the characteristics of non-response are not well understood, since non-response effectively modifies each element's probability of being sampled.

26.6.e.3. Sampling Methods:

Within any of the types of frame identified above, a variety of sampling methods can be employed, individually or in combination. Factors commonly influencing the choice between these designs include:

Nature and quality of the frame

(i) Availability of auxiliary information about units on the frame
(ii) Accuracy requirements, and the need to measure accuracy
(iii) Whether detailed analysis of the sample is expected
(iv) Cost/operational concerns

26.6.e.4. Simple Random Sampling:

Simple random sampling is the techniques in which "sample is so drawn that each and every unit in the population has an equal and independent chance of being included in the sample". If the unit selected in any draw is not replaced in the population before making the next draw, then it is known as simple random sampling without replacement and if it is replaced back before making the next draw, then the sampling plan is called simple random sampling with replacement.

A very important and interesting feature of simple random sampling without replacement is that "the probability of selection a specified unit of population at any given draw is equal to the probability of its being selected at the first draw". This implies that in this case from a population of size N, the probability that any sampling unit is included in the sample is 1/N and this probability remains constant throughout the drawing.

26.6.e.5. Systematic Sampling:

Systematic sampling is slight variation of the simple random sampling in which only the first sample unit is selected at random and the remaining units are automatically selected in a definite sequence at equal spacing from one another. This technique of drawing samples is usually recommended if the complete and up-to-date list of the sample units, i.e., the frame is available and the units are arranged in some systematic order such as alphabetical, chronological, geographical order etc. This sampling technique is generally followed when the population is finite in nature.

26.6.e.6. Stratified Sampling:

When the population is heterogeneous with respect to the variable or characteristic under study, then the technique of stratified random sampling is used to obtain more efficient results. Stratification means division into layers or groups.

The criterion used for the stratification of the universe into various strata is known as stratifying factor. Some of the commonly used stratifying factors are age, sex, income, economic status, etc. In many fields of highly skewed distributions, stratification is very effective and valuable tools.

A stratified sampling approach is most effective when three conditions are met:

(i) Variability within strata are minimized

(ii) Variability between strata are maximized

(iii) The variables upon which the population is stratified are strongly correlated with the desired dependent variable.

- **Advantages over other sampling methods:**

(i) Focuses on important subpopulations and ignores irrelevant ones.

(ii) Allows use of different sampling techniques for different subpopulations.

(iii) Improves the accuracy/efficiency of estimation.

(iv) Permits greater balancing of statistical power of tests of differences between strata by sampling equal numbers from strata varying widely in size.

- **Disadvantages:**

(i) Requires selection of relevant stratification variables which can be difficult.

(ii) Is not useful when there are no homogeneous subgroups.

(iii) Can be expensive to implement.

26.6.e.7. Over Sampling:

Choice-based sampling is one of the stratified sampling strategies. In choice-based sampling, the data are stratified on the target and a sample is taken from each stratum so that the rare target class will be more represented in the sample. The model is then built on this biased sample. The effects of the input variables on the target are often estimated with more precision with the choice-based sample even when a smaller overall sample size is taken compared to a random sample. The results usually must be adjusted to correct for the oversampling.

26.6.e.8. Probability-Proportional-to-Size Sampling:

In some cases the sample designer has access to an "auxiliary variable" or "size measure", believed to be correlated to the variable of interest, for each element in the population. These data can be used to improve accuracy in sample design. One option is to use the auxiliary variable as a basis for stratification, as discussed above.

Another option is probability proportional to size ('PPS') sampling, in which the selection probability for each element is set to be proportional to its size measure, up to a maximum of In a simple PPS design, these selection probabilities can then be used as the basis for Poisson

sampling. However, this has the drawback of variable sample size, and different portions of the population may still be over- or under-represented due to chance variation in selections.
Systematic sampling theory can be used to create a probability proportionate to size sample. This is done by treating each count within the size variable as a single sampling unit. Samples are then identified by selecting at even intervals among these counts within the size variable. This method is sometimes called PPS-sequential or monetary unit sampling in the case of audits or forensic sampling.

- **Example:**

Suppose we have six schools with populations of 150, 180, 200, 220, 260, and 490 students respectively (total 1500 students), and we want to use student population as the basis for a PPS sample of size three. To do this, we could allocate the first school numbers 1 to 150, the second school 151 to 330 (= 150 + 180), the third school 331 to 530, and so on to the last school (1011 to 1500). We then generate a random start between 1 and 500 (equal to 1500/3) and count through the school populations by multiples of 500. If our random start was 137, we would select the schools which have been allocated numbers 137, 637, and 1137, i.e. the first, fourth, and sixth schools.

26.6.e.9. Cluster Sampling:

In this case the total population is divided, depending on the problem under study, into some recognizable subdivisions which are termed as clusters and a simple random sample of these clusters is drawn.
For example, if we are interested in obtaining the income or opinion data in a city, the whole city may be divided into N different blocks or localities (which determine the clusters) and a simple random sample of n blocks is drawn. The individuals in the selected blocks determine the cluster sample.

26.6.e.10. Quota Sampling:

In quota sampling, the population is first segmented into mutually exclusive sub-groups, just as in stratified sampling. Then judgment is used to select the subjects or units from each segment based on a specified proportion. For example, an interviewer may be told to sample 200 females and 300 males between the age of 45 and 60.
It is this second step which makes the technique one of non-probability sampling. In quota sampling the selection of the sample is non-random. For example interviewers might be

tempted to interview those who look most helpful. The problem is that these samples may be biased because not everyone gets a chance of selection. This random element is its greatest weakness and quota versus probability has been a matter of controversy for several years.

26.6.e.11. Mini-Max Sampling:

In imbalanced datasets, where the sampling ratio does not follow the population statistics, one can resample the dataset in a conservative manner called mini max sampling. The mini max sampling has its origin in Anderson mini max ratio whose value is proved to be 0.5: in a binary classification, the class-sample sizes should be chosen equally. This ratio can be proved to be mini max ratio only under the assumption of LDA classifier with Gaussian distributions. The notion of mini max sampling is recently developed for a general class of classification rules, called class-wise smart classifiers. In this case, the sampling ratio of classes is selected so that the worst case classifier error over all the possible population statistics for class prior probabilities would be the best.

26.6.e.12. Accidental Sampling:

Accidental sampling (sometimes known as grab, convenience or opportunity sampling) is a type of non-probability sampling which involves the sample being drawn from that part of the population which is close to hand. That is, a population is selected because it is readily available and convenient. It may be through meeting the person or including a person in the sample when one meets them or chosen by finding them through technological means such as the internet or through phone. The researcher using such a sample cannot scientifically make generalizations about the total population from this sample because it would not be representative enough. For example, if the interviewer were to conduct such a survey at a shopping center early in the morning on a given day, the people that he/she could interview would be limited to those given there at that given time, which would not represent the views of other members of society in such an area, if the survey were to be conducted at different times of day and several times per week. This type of sampling is most useful for pilot testing.

26.6.e.13. Line-Intercept Sampling:

Line-intercept sampling is a method of sampling elements in a region whereby an element is sampled if a chosen line segment, called a "transect", intersects the element.

26.6.e.14. Panel Sampling:

Panel sampling is the method of first selecting a group of participants through a random sampling method and then asking that group for (potentially the same) information several times over a period of time. Therefore, each participant is interviewed at two or more time points; each period of data collection is called a "wave". The method was developed by sociologist Paul Lazarsfeld in 1938 as a means of studying political campaigns. This longitudinal sampling-method allows estimates of changes in the population, for example with regard to chronic illness to job stress to weekly food expenditures. Panel sampling can also be used to inform researchers about within-person health changes due to age or to help explain changes in continuous dependent variables such as spousal interaction.

26.6.e.15. Snowball Sampling:

Snowball sampling involves finding a small group of initial respondents and using them to recruit more respondents. It is particularly useful in cases where the population is hidden or difficult to enumerate.

26.6.e.16. Multistage Sampling:

As the name suggests, multistage sampling refers to a sampling technique which is carried out in various stages.

For example, if we are interested in obtaining a sample of, say, n households from a particular state the first stage units may be districts, the second stage units will be households in the villages. Each stage thus results in a reduction of the sample size.

- **Advantages:**

(i) Cost and speed that the survey can be done in

(ii) Convenience of finding the survey sample

(iii) Normally more accurate than cluster sampling for the same size sample

- **Disadvantages:**

(i) Not as accurate as Simple Random Sample if the sample is the same size

(ii) More testing is difficult to do.

26.6.e.17. Purposive Sampling:

A sample which is selected on the basis of individual judgment of the sampler is called purposive Sampling. There is no special technique for selecting a purposive sample; but the sampler picks out a typical or representative sample according to his own judgment. It all depends on the personal factor and chance is not allowed to play at all.

26.6.f. Errors in Sample Surveys:

Survey results are typically subject to some error. Total errors can be classified into sampling errors and non-sampling errors. The term "error" here includes systematic biases as well as random errors.

- ## Sampling Errors and Biases:

Sampling errors and biases are induced by the sample design. They include:

(i) **Selection bias**: When the true selection probabilities differ from those assumed in calculating the results.

(ii) **Random sampling error**: Random variation in the results due to the elements in the sample being selected at random.

26.6.g. Sampling Error:

In statistics, sampling error is incurred when the statistical characteristics of a population are estimated from a subset, or sample, of that population. Since the sample does not include all members of the population, statistics on the sample, such as means and quantiles, generally differ from parameters on the entire population. For example, if one measures the height of a thousand individuals from a country of one million, the average height of the thousand is typically not the same as the average height of all one million people in the country. Since sampling is typically done to determine the characteristics of a whole population, the difference between the sample and population values is considered a sampling error. Exact measurement of sampling error is generally not feasible since the true population values are unknown; however, sampling error can often be estimated by probabilistic modeling of the sample. Sampling error decreases with the increase in sample size and it increases with the decrease in sample size.

25.6.h. Non-Sampling Error:

Non-sampling errors are other errors which can impact the final survey estimates, caused by problems in data collection, processing, or sample design. They include:

1. **Over-coverage**: Inclusion of data from outside of the population.
2. **Under-coverage**: Sampling frame does not include elements in the population.
3. **Measurement error**: e.g. when respondents misunderstand a question, or find it difficult to answer.
4. **Processing error**: Mistakes in data coding.
5. **Non-response**: Failure to obtain complete data from all selected individuals.

After sampling, a review should be held of the exact process followed in sampling, rather than that intended, in order to study any effects that any divergences might have on subsequent analysis. A particular problem is that of non-response.

Two major types of non-response exist: unit nonresponse (referring to lack of completion of any part of the survey) and item non-response (submission or participation in survey but failing to complete one or more components/questions of the survey). In survey sampling, many of the individuals identified as part of the sample may be unwilling to participate, not have the time to participate (opportunity cost), or survey administrators may not have been able to contact them. In this case, there is a risk of differences, between respondents and non-respondents, leading to biased estimates of population parameters. This is often addressed by improving survey design, offering incentives, and conducting follow-up studies which make a repeated attempt to contact the unresponsive and to characterize their similarities and differences with the rest of the frame.[The effects can also be mitigated by weighting the data when population benchmarks are available or by imputing data based on answers to other questions.

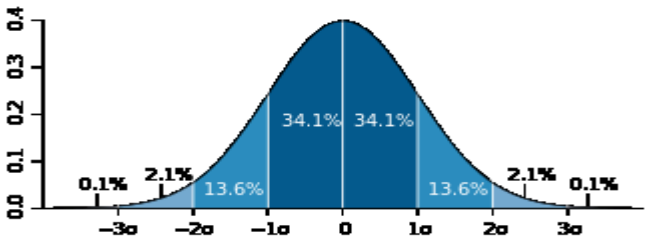
Non response is particularly a problem in internet sampling. Reasons for this problem include improperly designed surveys, over-surveying (or survey fatigue), and the fact that potential participants hold multiple e-mail addresses, which they don't use anymore or don't check regularly.

26.6.i. Standard Error:

For a value that is sampled with an unbiased normally distributed error, the above depicts the proportion of samples that would fall between 0, 1, 2, and 3 standard deviations above and below the actual value.

The standard error (SE) is the standard deviation of the sampling distribution of a statistic, most commonly of the mean. The term may also be used to refer to an estimate of that standard deviation, derived from a particular sample used to compute the estimate.

Figure 2.1: Area under standard normal curve



For example, the sample mean is the usual estimator of a population mean. However, different samples drawn from that same population would in general have different values of the sample mean, so there is a distribution of sampled means (with its own mean and variance). The **standard error of the mean** (**SEM**) (i.e., of using the sample mean as a method of estimating the population mean) is the standard deviation of those sample means over all possible samples (of a given size) drawn from the population. Secondly, the standard error of the mean can refer to an estimate of that standard deviation, computed from the sample of data being analyzed at the time.

In regression analysis, the term "standard error" is also used in the phrase standard error of the regression to mean the ordinary least squares estimate of the standard deviation of the underlying errors.

26.6.j. Skewness:

By skewness of a frequency distribution we mean the degree of its departure from symmetry. A distribution which is not symmetrical is called asymmetrical distribution or skewed distribution. The skewness is said to be positive if the longer tail of the distribution is towards the higher values of the variable and it is negative if the longer tail of the distribution is towards the lower values of the variable.

Other important features are:

(i) In a symmetrical distribution, the mean, median and mode coincide. Normal probability curve has symmetrical distribution and is zero skewed.

(ii) If the distribution is positively skewed, then mean > median > mode.

(iii) If the distribution is negatively skewed, then mean < median < mode.

26.6.k. Kurtosis:

Another method of describing a frequency distribution is to specify its degree of peakedness or kurtosis. The importance of describing kurtosis is that, two distributions may have the same mean and the same standard deviation and may be equally skew, but one of them may be more peaked than the other.

A positive value of kurtosis indicates that the distribution has high concentration of values near the central tendency and has high tails. In the same way, a negative value of kurtosis indicates that the distribution has low concentration of values in the neighbourhood of the central tendency and has low tails.

Other important features are:

(i) A normal curve is said to be mesokurtic.

(ii) A distribution with positive kurtosis is called leptokurtic.

(iii) A distribution with negative kurtosis is called platykurtic.

26.7. Collecting the Data:

In dealing with any real life problem it is often found that data at hand are inadequate, and hence, it becomes necessary to collect data that are appropriate. There are several ways of collecting the appropriate data which differ considerably in context of money costs, time and other resources at the disposal of the researcher.

Primary data can be collected either through experiment or through survey. If researcher conducts an experiment, he observes some quantitative measurements, or the data, with the help of which he examines the truth contained in his hypothesis.

But in case of survey, data can be collected by any one or more of the following ways:

(i) By observation

(ii) Through personal interview

(iii) Through telephone interviews

(iv) By mailing of questionnaires

(v) Through schedules

26.7.a. Classification of Data:

26.7.a.1. Primary Data:

Primary data (also known as raw data) is a term for data collected from a source. Primary data has not been subjected to processing or any other manipulation, and are also referred to as raw

data. Primary data is a relative term. Primary data can be input to a computer program or used in manual procedures such as analyzing statistics from a survey. The term can refer to the binary data on electronic storage devices such as hard disk drives (also referred to as low-level data).

In computing, Primary data may have the following attributes: possibly containing errors, not validated; in different (colloquial) formats; encoded or unformatted; and suspect, requiring confirmation or citation. For example, a data input sheet might contain dates as raw data in many forms: "31st January 1999", "31/01/1999", "31/1/99", "31 Jan", or "today". Once captured, these raw data may be processed stored as a normalized format, perhaps a Julian date, so as to be easier for computers and humans to interpret during later processing.

26.7.a.2. Secondary Data:

Secondary data are such numerical information which have previously been collected by someone other than the user or by some agency for one purpose and are merely compiled from that source for use in a different connection.

In fact, data collected by someone when used by another, or collected for one purpose when used for another, will be called secondary data. The same data are primary in the hands the collecting authority, but are secondary in the hands of another. For example, the Census figures published by Registrar General of India will be primary data, while the same data contained in any other publication will be called secondary data.

26.7.a.3. Cross Section Data:

Cross-sectional data or a cross section of a study population, in statistics is a type of data collected by observing many subjects (viz., individuals, firms, countries, or regions) at the same point of time or without regard to differences in time. Analysis of cross-sectional data usually consists of comparing the differences among the subjects.

26.7.a.4. Time Series Data:

A series of observations recorded in accordance with the time of occurrence is called ‘Time Series’. Such data are of particular interest in economics, business and commerce, where the values of a variable are observed chronologically by days, weeks, months, quarters, or years. Production, consumption, sales, profits, bank clearing during successive periods of time, and

population, price etc. at successive points of time are examples of time series. Symbolically, the value of the variable related to time *t* is denoted by y_t.

26.7.a.5. Panel Data:

The term 'panel data' refers to data sets where we have data on the same individual over several periods of time. In other words, in panel data the same cross sectional unit (say a family or a firm or a state) is surveyed over time. In short, panel data have space as well as time dimensions. The main advantage with having panel data as compared to a single cross section with non-overlapping cross-section units is that it allows us to test and relax the assumptions that are implicit in cross-sectional analysis.

26.7.a.6. Quantitative Data:

Quantitative data, as the name suggests is one which deals with quantity or numbers. It refers to the data which computes the values and counts and can be expressed in numerical terms is called quantitative data. In statistics, most of the analyses are conducted using this data.

Quantitative data may be used in computation and statistical test. It is concerned with measurements like height, weight, volume, length, size, humidity, speed, age, etc. The tabular and diagrammatic presentation of data is also possible, in the form of charts, graphs, tables, etc. Further, the quantitative data can be classified as discrete or continuous data.

26.7.a.7. Qualitative Data:

Qualitative data refers to the data that provides insights and understanding about a particular problem. It can be approximated but cannot be computed. Hence, the researcher should possess complete knowledge about the type of characteristic, prior to the collection of data.

The nature of data is descriptive and so it is a bit difficult to analyze it. This type of data can be classified into categories, on the basis of physical attributes and properties of the object. The data is interpreted as spoken or written narratives rather than numbers. It is concerned with the data that is observable in terms of smell, appearance, taste, feel, texture, gender, nationality and so on.

26.8. Analysis of Data:

After the data have been collected from different sources, the researcher turns to the task of analyzing them. The data collected are to be discussed vividly. So the researcher classifies the

data for study in two categories: descriptive analysis and statistical analysis. He describes the need, purpose of the data collected by applying various statistical techniques according to the stability and desirability of the results. The analysis of data requires a number of closely related operations viz. establishments of categories, the application of these categories to raw data through coding, tabulation and then drawing statistical inferences. Thus researcher should classify the raw data into some purposeful and usable categories.

26.9. Hypothesis Testing:

A statistical hypothesis is a scientific hypothesis that is testable on the basis of observing a process that is modeled via a set of random variables. A statistical hypothesis test is a method of statistical inference used for testing a statistical hypothesis.

A test result is called statistically significant if it has been predicted as unlikely to have occurred by sampling error alone, according to a threshold probability - the significance level. Hypothesis tests are used in determining what outcomes of a study would lead to a rejection of the null hypothesis for a pre-specified level of significance. In the Neyman-Pearson framework, the process of distinguishing between the null hypothesis and the alternative hypothesis is aided by identifying two conceptual types of errors (type-I and type-II), and by specifying parametric limits on e.g. how much type-I error will be permitted.

After analyzing the data, the researcher is in a position to test the hypotheses, if any, he had formulated earlier. Do the facts support the hypotheses or they happen to be contrary? This is the usual question which should be answered while testing hypotheses. Various tests, viz. Chi-square test, t-test, F-test have been developed by statisticians for the purpose. The hypotheses may be tested through the use of one or more of such tests, depending upon the nature and object of research inquiry. Hypothesis-testing will result in either accepting the hypothesis or in rejecting it. A common test in research demands much priority on reliability, usability and objectivity.

In the context of statistical analysis, we often talk about ‘null hypothesis’ and ‘alternative hypothesis’. The null hypothesis is generally symbolized as H_0 and the alternative hypothesis as H_1. Suppose we want to test the hypothesis that the population mean (μ) is equal to the sample mean ($\bar{x}$) = 100. It can symbolically be expressed as:

H_0: $\bar{x} = 100$ against the alternative

H_1: $\bar{x} \neq 100$

26.10. Generalizations and Interpretation:

If a hypothesis is tested and upheld several times, it may be possible for the researcher to arrive at generalization, i.e. to build a theory. As a matter of fact, the real value of research lies in its ability to arrive at certain generalizations. If the researcher had no hypothesis to start with, he might seek to explain his findings on the basis of some theory. It is known as interpretation. The process of interpretation may quite often trigger off new questions which in turn may lead to further researches. Generalized conclusion on the basis of a sample is technically known as Statistical inference.

26.11. Bibliographic Information:

Bibliography given in a research report helps those interested in further research. The American Psychological Association (APA) guidelines specify using sentence-style capitalization for the titles of books or articles, so we should capitalize only the first word of title and subtitle.

- **Format Example:**

26.11.a. Book Format

American Psychological Association (APA) Format:

Sen, A. (1999). Development as Freedom. Oxford University Press, Oxford.

Modern Language Association (MLA) Format:

Sen, A. Development as Freedom. Oxford: Oxford University Press, 1999

26.11.b. Encyclopedia and Dictionary Format:

Bergmann, P. G. (1993). Relativity. In The new Encyclopedia Britannica (Vol. 26, pp. 501-508). Chicago: Encyclopedia Britannica.

26.11.c. Magazine and Newspaper Articles Format:

Kayet A and Mondal D (2016). 'Public education expenditure and food inequality in rural India- An analysis with major States during 1983 to 2012', International Journal of Education Economics and Development, Vol. 7, Nos. 1/2, pp. 14–32.

26.11.d. Website or Webpage Format for Online Periodical:

Alkire, S., J.M. Roche, M.E. Santos, and S. Seth (2011) "Multidimensional Poverty Index 2011:Brief Methodological Note." Oxford Poverty and Human Development Initiative, OxfordUniversity. Available at http://www.ophi.org.uk/wp

Sub Unit – 4
Thesis and Article Writing

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27. Research Paper

27.1. Concept:

A research paper is a piece of academic writing based on its author's original research on a particular topic, and the analysis and interpretation of the research findings. It can be a term paper, a master's dissertation or a doctoral thesis.

27.2. Purpose of Research Paper:

The purpose of research paper is to facilitate the readers and other scholars to understand about work done at a glance because to go through a research report is very time consuming and difficult.

27.3. Feature of Research Paper:

The main feature of research paper is that

(i) It has the condensed version of research report.

(ii) It provides the important aspects of research report.

(iii) It takes the form of article.

(iv) It is based on both primary and secondary data.

27.4. Forms of Research Paper:

In any format of research paper, mainly four points are included, which are as follows:

(i) Introduction

(ii) Contents (main body) of the subject

(iii) Result

(iv) Conclusion

27.5. Evaluation of Research Paper:

For a researcher evaluation is very important and useful process. Different types of suggestions and criticisms are given under evaluation. Suggestions are given mainly on following topics:

(i) Context

(ii) Research problem

(iii) Related references

(iv) Methods of research

(v) Research conclusion and suggestion

28. Article

28.1. Concept:

Though an article is a write-up like that of a research paper but articles are not bound by the methodology adopted in research paper. Anything can make the subject matter of an article. Article is usually used when writing in newspaper. It has a general appeal. It covers any topic of the general life ranging from a commoner to a privileged personality, from a paper pin to a political situation.

28.2. Forms of Article:

Usually a topic has a heading, a main body, mainly covering the details of the topic, purpose of writing it, suggestions and conclusion.

Letter to the editors of newspapers can form an article. So far as educational research is concerned articles are written on the patterns of various forms of education, methods of teaching, teacher-learner relations, educational environment and like that.

28.3. Importance of Article:

An article is the easiest way of communicating one's thoughts and ideas in planned way. The interesting nature of the layout of an article makes it crisp and understandable.

29. Workshop

29.1. Concept:

A place where things are made or repaired, a class or series of classes in which a small group of people learn the methods and skills used in doing something.

29.2. Scope of Workshop:

The workshop technique is used mainly in the following areas of education:

(i) New format of lesson planning.

(ii) Writing objective in behavioral terms.

(iii) Preparing objective type tests which objective centred.

(iv) Action research projects for classroom problems.

(v) Preparing institutional material or teaching model.

(vi) Workshop on micro teaching.

(vii) Workshop on interaction analysis technique.

(viii) Workshop on test construction.

(ix) Workshop on preparing research synopsis or proposal.

(x) Workshop on non-formal education.

(xi) Workshop on designing program for teacher education.

30. Seminar

30.1. Concept:

A seminar is a form of academic instruction, either at an academic institution or offered by a commercial or professional organization. It has the function of bringing together small groups for recurring meetings, focusing each time on some particular subject, in which everyone present is requested to participate.

30.2. Objectives of Seminar Technique:

The seminar technique is employed to realize the higher objectives of cognitive and affective domains which have been enumerated as follows:

30.2.a. Cognitive Objective –

This technique creates the learning situation so that the following higher cognitive objectives may be realized.

(i) To develop the higher cognitive abilities; analysis, synthesis, and evaluation as compared to the situation involving human interaction.

(ii) To develop the ability of responding in this manner would involve higher cognitive action: evolving, organizing and characterization of quick comprehension of the situation, examination and construction of his reactions to the situation.

(iii) To develop the ability of keen observation experiences, feelings and to present them effectively.

(iv) To acquire the good manners of putting questions and answering the questions of others effectively.

(v) The human interaction under this technique develops the good manners and skills among the participants.

30.3. Characteristics of Seminar:

(i) It is a form of academic instruction.

(ii) It involves questioning, discussion and debates.

(iii) It needs involvement of skilled persons.

31. Conference

31.1. Concept:

The conference is a meeting of people who confer about a topic. Conference types include: academic conference, in science and academic, a formal event where researchers present results, workshops, and other activities.

31.2. Objectives of Conference:

31.2.a. Cognitive Objective –

The conference technique has the focus to achieve the following cognitive objective:

(i) To develop analysis, synthesis, and evaluation or creative abilities of the participants.

(ii) To develop reasoning and critical abilities.

(iii) To develop abilities of expressing his feelings and observations.

(iv) To make sensitive towards the problems of the area.

(v) To develop the abilities to study in-depth of facts, concepts and problems.

31.2.b. Affective Objective –

By using the conference technique the affective objectives are to be achieved.

(i) To develop the tendency to study a fact or concept in broader perspective.

(ii) To develop the tendency of emotional balances.

(iii) To respect and tolerate anti-ideas and criticism by others.

(iv) To develop the feelings of cooperation and freedom of thought.

32. Symposium

32.1. Concept:

A symposium is generally defined as a meeting organized so that experts in a given field can meet, present papers, and discuss issues and trends or make recommendations for a certain course of action.

32.2. Objectives of Symposium:

The following are main objectives of the symposium technique:

(i) To identify and understand various aspects of theme and problems.

(ii) To develop the ability to decision and judgement regarding a problem.

(iii) To develop the values and feeling regarding a problem.

(iv) To enable the listeners to form policies regarding a theme or problem.

33. Report Writing

The research process is not complete until a report has been written and distributed. The report may be for the guidance of the agency problem; it may be for a wider audience of people with similar problem or responsibilities; it may be for the use of administrators in formulation of policies; or it may be for the scientific community. The form and content will vary with the particular study and particular purpose.

33.1. General Guidelines for Report Writing:

(i) Fits the presentation to the special interests and needs of the audience for whom it is intended.

(ii) Aims at clarity and accuracy of statement whether audience is intended.

(iii) Includes in any section all the information necessary for thorough understanding. This is particularly necessary in tabular presentation.

(iv) Includes whatever information may be necessary for the reader to critically assess your findings and the conclusions you draw from them.

(v) Reports the inconclusive and negative findings as well as the positives.

(vi) If possible, include information about procedure, special problems and other topics that would be of particular interest to the other researcher in this area. Put them in one or more appendices if it is not appropriate to include them in the main text.

(vii) It is helpful, if you are at all writing, for other researcher to give the numerical results of tests of significance rather than just reporting that a comparison was or was not significant. Reporting the exact probability found will enable other people to make up their own minds about whether a difference is significant or not.

(viii) Remember that 'the purpose of a report is not to communicate with oneself but communication with an audience.

(ix) Use footnotes for clarifying explanations that would not fit into the next.

(x) If the report is intended for the use in an action plan, give some specification of how the findings may be used and what their limitations are.

(xi) Write your report as early as possible. Some of the earlier parts can be written as soon as the design is formulated.

(xii) Anticipate the complete report with brief interim reports, particularly if the researcher is associated with an action program.

(xiii) Make your reports as brief as it can be, while still being complete. If necessary, supplement the longer version with a summary which contains all the essential points.

33.2. Suggested Outlines of a Report:

The following outline incorporates the most usual divisions for a report:

33.2.a. Introduction:

(i) Objectives – major and minor

(ii) Statement – definition of the problem

(iii) Scope; time (including reference period), place and material of the survey

(iv) Organization and procedure of the report, methods or techniques employed; a reference to schedules, the questionnaire used may be given here. The copy of the schedules or

questionnaire should be placed in appendices with pertinent historical or comparable material.

33.2.b. Analysis and Presentation of Results:

(i) Report of fact – presentation of data, tables and graphs and chart etc.

(ii) Analysis and interpretation of data.

(iii) Conclusions based on the data presented and possible recommendations.

(iv) Condensed summary of important contents.

33.2.c. Supplementary Material

(i) Appendices

(ii) Bibliography

(iii) Index

(iv) Glossary of terms

(v) Corrigendum, if any

34. What is meant by Thesis?

A thesis is an idea or theory that is expressed as a statement and is discussed in a logical way. A thesis is a long piece of writing based on the own ideas and research that researchers do as part of a university degree, especially a higher degree such as a M. Phil or a PhD.

Thesis writing is the final stage of any research work. It provides the achievement of detailed knowledge over the problems. When a researcher takes a problem for study he finds modifications of his study. He applies some new techniques. There are three types of researchers who take their study in different ways: the M.Phil students take their study for the partial fulfillment, the doctoral degree also takes researches and professional research workers like scientists, sociologists, psychologists and anthropologists take their study for the achievement of detailed knowledge over the problem.

34.1. Characteristics of Thesis

It has following characteristics:

(i) It is the final stage of the research.

(ii) It provides overall view and solution to the problem.

(iii) It provides all the element of the project taken for study to other researchers.

(iv) It bears the total summary of the work.

(v) It satisfies all its researchers by providing partial or detailed knowledge over their problems.

34.2. Benefits of Thesis Writing

(i) The investigator classifies and systematizes his work.

(ii) The other researchers also may follow the same principle.

(iii) The students and the educators who could make use of the findings of the investigation.

34.3. Considerations of Thesis Writing

The researcher takes some major considerations which help him in writing the report in a very developed way:

(i) What should the general structure of his report be?

(ii) What form should the development, evaluation and organization of his ideas take?

(iii) What language medium should he use for his report?

(iv) What other media can he use for reinforcing his verbal report?

(v) What steps should he take to get it typed correctly?

34.4. Format of Thesis Writing

For the preparation of research report, the researcher should follow some steps through which he will be able to make his report a critical and synthetic one.

a. Preliminary section

b. Main Body of the report

c. Reference section

34.4.1. The Preliminary section

(a) Title Page

(b) Acknowledgment

(c) Table of Contents

(d) List of Tables (if any)

(e) List of Figures (if any)

(f) List of Abbreviations (If any): Alphabetically ordered

34.4.2. Main Body of the report

a. Introduction

b. Literature Review

c. Methodology

d. Findings (Either a certain number of chapters or an extended essay which has clearly identified sections)

e. Discussion

f. Conclusion

34.4.3. Reference section

(a) Bibliography (A list of books, journal articles, web sites, newspapers and other sources that have used in the thesis)

(b) Appendices (e.g., questionnaires, interview transcripts, pilot reports, detailed tables etc.)

(c) Index

Sub Unit – 5
Application of ICT in Research

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35. Concept of Information and Communication Technology

Information and Communication Technologies (ICTs) are referred to as the varied collection of technological gear and resources which are made use of to communicate. They are also made use of to generate, distribute, collect and administer information. It consists of the hardware, software, networks, and media for collection, storage, processing, transmission and presentation of information (voice, data, text, images), as well as related services. ICTs can be divided into two components: Information and Communication Infrastructure (ICI) which refers to physical telecommunications systems and networks (cellular, broadcast, cable, satellite, postal) and the services that utilize those (Internet, voice, mail, radio, and television), and Information Technology (IT) that refers to the hardware and software of information collection, storage, processing, and presentation. The concept of a 'Digital Divide' has been around almost as long as ICT has been publicly available. Introducing ICT as a tool to support the education sector has initiated substantial discussions since the late 1990s. A decade ago the emphasis was on Technical and Vocational Education and Training and training teachers. During the last few years, an increasing number of international development agencies have embraced the potential of ICT to support the education sector. UNESCO has played a major role in spearheading the Education for All initiative to harness the potential of ICT. The widely subscribed Dakar Framework for Action recognizes that, „these technologies (ICTs) have great potential for knowledge dissemination, effective learning and the development of more efficient education services. When looking at the integration of ICT to support the achievement of educational objectives, it can be found that after almost a decade of using ICT to stimulate development, it is not yet fully integrated in development activities and awareness rising is still required. The main objectives of the paper are to evaluate the importance of ICT in higher education and to analyze the government initiatives for development of ICT in higher education.

36. ICT in Research

Applications of ICTs are particularly powerful and uncontroversial in higher education's research function. Four areas are particularly important:

(i) The steady increases in bandwidth and computing power available have made it possible to conduct complex calculations on large data sets.

(ii) Communication links make it possible for research teams to be spread across the world instead of concentrated in a single institution.

(iii) The combination of communications and digital libraries is equalizing access to academic resources, greatly enriching research possibilities for smaller institutions and those outside the big cities.

(iv) Taking full advantage of these trends to create new dynamics in research requires national policies for ICTs in higher education and the establishment of joint information systems linking all higher education institutions.

The application of ICTs in academic research has grown steadily in the past 10 to 15 years in both developing and developed countries, although there are wide variations in usage both within and between countries and regions. The most straightforward use of ICTs in research is in data processing. The unprecedented growth in bandwidth and computing power provide opportunities for analyzing/processing huge amounts of data and performing complex computations on them in a manner that is extremely fast, accurate and reliable. Computer data processing not only frees researchers from the cumbersome task of manually analyzing data but more importantly facilitates quick and accurate analysis of huge amounts of data from national samples or even multi-national samples covering tens of thousands of respondents. Another important dimension of ICTs in research is the use of online full text databases and online research libraries/virtual libraries which are the direct outcome of the growth in telecommunications networks and technology. These databases and libraries provide researchers with online access to the contents of hundreds of thousands of books from major publishing houses, research reports, and peer- reviewed articles in electric journals.

37. Benefits of ICT in Research

37.1. General Benefits:

(i) ICT provides opportunities for the teaching of historical enquiry, including the generation and testing of historical hypotheses and problems, as opposed to only learning historical facts.

(ii) ICT and multimedia fit well with the multi-source nature of history – they can give a total picture and can allow pupils to integrate evidence into their work (Hennessey et al., 2003; Brown and Purvis, 2001).

(iii) The use of ICT promotes collaboration between pupils and can contribute to the development of historical thinking (Brown and Purvis, 2001).

37.2. Benefits for Pupils:

(i) ICT helps to alleviate the constraints of writing and allows pupils to concentrate on the specific topic for discussion – this encourages reflection, analysis and understanding (Hennessey et al., 2003). (v) Using databases to work with large volumes of data can help pupils to look for patterns, frame hypotheses, question accepted theories and place events into wider contexts (Martin, 2003; TTA, 1999a).

(ii) The use of computer-mediated communications (CMC), including online discussion groups, enables students to better develop and communicate historical arguments, thinking and understanding, and these skills can be transferred to essay writing (Thompson and Cole, 2003; Wellman and Flores, 2002).

(iii) The use of hypertexts (documents embedded with hyperlinks) to investigate sets of historical documents and sources can help develop pupils‟ understanding and interpretation skills (Nichol et al., 2003; Brown, 2001), and allows pupils to see connections between historical issues.

(iv) Computer simulations allow complex historical processes to be represented in a more dynamic way, and allow students to gain a better understanding of how key decisions in history were affected by the environment and the pressure of time (Taylor, 2003).

(v) Digital video can provide students with a model for gathering oral history before they conduct their own oral history interviews, allowing them to develop and retain the required skills more effectively (Wolfrum et al., 2001).

37.3. Benefits for Teachers:

(i) ICT (particularly the internet), gives teachers access to a wide range of information, historical sources and media types, which would otherwise not be readily available (TTA, 1999a; Brown, 2001; Brown and Purvis, 2001).

(ii) The use of computer-mediated communications (CMC), including online discussion groups, allows teachers to identify misconceptions in pupils‟ historical thinking, which might not otherwise have been apparent in more structured classroom discussions (Thompson and Cole, 2003; Wellman and Flores, 2002).

(iii) ICT can enable teachers to present historical materials in ways most suited to individual and personal needs

(iv) ICT can be used to help teachers support, or scaffold, the development of historical thinking and understanding at all levels (Wellman and Flores, 2002; Masterman and Rogers, 2002).

38. Factors for Effective Use

(i) Preparation in advance is critical when using the internet for historical research (Hennessey et al., 2003).

(ii) ICT use in history teaching is most beneficial when coupled with effective teacher intervention, to ensure pupils learn at a good pace and can concentrate on the history rather than aspects of the ICT (Ofsted, 2002; Munro, 2000).

(iii) Pupils need to be taught how to interpret information and make judgments and inferences about it, in order to make historical research using electronic sources more effective (Moore, 2000; Hennessy et al., 2003).

(iv) When using a word processor to investigate a text, teachers must ensure the activity encourages effective comprehension of the content, and that it is not only a mechanical reading or cutting and pasting activity (Prior and John, 2000).

39. Effects of ICT on Research

ICT had effects on many facets of social science research. They can be classified into three categories which include: a) ICT application in pre-data analysis, b) ICT application in data analysis, and c) ICT application in post data analysis.

ICT application in pre-data analysis refers to examples how ICTs are applied on activities of social science research before reaching the stage of data analysis. ICT application in pre-data analysis includes:

(i) Article Availability

(ii) Thesis and Dissertation Availability

(iii) Literature Search

(iv) Content Search

(v) Literature Tracking

(vi) Quantitative Data Collection

(vii) Qualitative Data Collection

(viii) Big Data and Its Analytics

ICT application in data analysis includes examples how ICTs are applied on activities during the stage of data analysis and can be divided into:

(i) Quantitative Data Analysis

(ii) Qualitative Data Analysis

Lastly, ICT application in post-data analysis refers to examples how ICTs are applied on activities of social science research after completing the stage of data analysis which covers:

(i) References and Bibliography Compilation

(ii) Article and Thesis / Dissertation's Discussion among Researchers, Supervisors, Supervisees and during Viva Voce

(iii) Plagiarism Detection

(iv) Journal Manuscripts Submission

Sub Unit – 6
Research Ethics

40. Research Ethics

Most people learn ethical norms at home, at school, in church, or in other social settings. Although most people acquire their sense of right and wrong during childhood, moral development occurs throughout life and human beings pass through different stages of growth as they mature. Ethical norms are so ubiquitous that one might be tempted to regard them as simple common sense. On the other hand, if morality were nothing more than common sense, then why are there so many ethical disputes and issues in our society?

One plausible explanation of these disagreements is that all people recognize some common ethical norms but interpret, apply, and balance them in different ways in light of their own values and life experiences. For example, two people could agree that murder is wrong but disagree about the morality of abortion because they have different understandings of what it means to be a human being.

40.1. Components of Ethical Research:

(i) **Fabrication:** Making up data or results and recording or reporting them.

(ii) **Falsification:** Manipulating research materials, or changing or omitting data or results such that the research is not accurately represented in the research record.

(iii) **Plagiarism:** The appropriation of another person's ideas, processes, results, or words without giving appropriate credit.

(iv) Research misconduct does not include honest error or differences of opinion.

40.2. Reasons:

There are several reasons why it is important to adhere to ethical norms of research:

Research ethics provides guidelines for the responsible conduct of research. In addition, it educates and monitors scientists conducting research to ensure a high ethical standard. The following is a general summary of some ethical principles:

Honesty:

Honestly report data, results, methods and procedures, and publication status. Do not fabricate, falsify, or misrepresent data.

Objectivity:

Strive to avoid bias in experimental design, data analysis, data interpretation, peer review, personnel decisions, grant writing, expert testimony, and other aspects of research.

Integrity:

Keep your promises and agreements; act with sincerity; strive for consistency of thought and action.

Carefulness:

Avoid careless errors and negligence; carefully and critically examine your own work and the work of your peers. Keep good records of research activities.

Openness:

Share data, results, ideas, tools, resources. Be open to criticism and new ideas.

Respect for Intellectual Property:

Honor patents, copyrights, and other forms of intellectual property. Do not use unpublished data, methods, or results without permission. Give credit where credit is due. Never plagiarize.

Confidentiality:

Protect confidential communications, such as papers or grants submitted for publication, personnel records, trade or military secrets, and patient records.

Responsible Publication:

Publish in order to advance research and scholarship, not to advance just your own career. Avoid wasteful and duplicative publication.

Responsible Mentoring:

Help to educate, mentor, and advise students. Promote their welfare and allow them to make their own decisions.

Respect for Colleagues:

Respect your colleagues and treat them fairly.

Social Responsibility:

Strive to promote social good and prevent or mitigate social harms through research, public education, and advocacy.

Non-Discrimination:

Avoid discrimination against colleagues or students on the basis of sex, race, ethnicity, or other factors that are not related to their scientific competence and integrity.

Competence:

Maintain and improve your own professional competence and expertise through lifelong education and learning; take steps to promote competence in science as a whole.

Legality:

Know and obey relevant laws and institutional and governmental policies.

Animal Care:

Show proper respect and care for animals when using them in research. Do not conduct unnecessary or poorly designed animal experiments.

Human Subjects Protection:

When conducting research on human subjects, minimize harms and risks and maximize benefits; respect human dignity, privacy, and autonomy.