UNIT 1 BASIC PROCESS/CONCEPT IN RESEARCH

Structure

1.0 INTRODUCTION

Let us start our journey into the realm of human mind. A scientific quest for understanding will be the foremost in our journey. We want to know why we think, feel and behave as we do. What makes each of us different from all other people? Why we do often behave as alike in some situations. Psychologists, as scientists, answer these questions systematically, develop the principles to explain them and use those principles to solve various problems. They are actively engaged in process of doing research.

Research is a process through which new knowledge is discovered. A theory, such as a theory of motivation, or development, or learning, for example, helps

us to organise this new information into a coherent body, a set of related ideas that explain events that have occurred and predict events that may happen. Conducting research requires to follow a sequence of steps. The exact sequence and steps vary somewhat with the type of research. The steps vary slightly by whether a study involves a quantitative or a qualitative approach and data.

This unit attempts to acquaint you with the nature and relevance of research. This is followed by the qualities of a good research. Further, you will find the process of psychological research within the context of discovery (getting and idea) and context of justification (Testing hypothesis). This unit will provide a quick glance at the whole process of research to acquaint you with the various tasks you faced to undertake to carry out your research. It will give your some idea of what the research journey involved. Finally, this unit will cover the total spectrum of research and endeavor starting from the problem through to writing a research report and its publication.

1.1 OBJECTIVES

After reading this unit, you will be able to:

- Define research;
- Describe the meaning of research;
- Explain the relevance of research;
- Describe the process of conducting research;
- Elucidate how to evaluate a research;
- Analyse how to maintain objectivity and minimize bias in psychological research;
- Explain the role of theory, hypothesis and paradigm in psychological research;
- Enlist the various steps needed for conducting a research;
- Explain how theoretical knowledge can be further applied to undertake a research; and
- Analyse the importance of each steps involved in research process.

1.2 DEFINITION AND MEANING OF RESEARCH

The word research is composed of two syllables, *re* and *search*. The dictionary defines the former as a prefix meaning again, a new or over again and the latter as a verb, meaning to examine closely and carefully, to test and try, or to probe. Together they form a noun describing a careful, systematic, patient study and investigation in some field of knowledge, undertaken to establish facts or principles (Grinnell 1993). The simplest meaning of research is to search for facts, answers to research question and solution for the problem.

Scientific Research is a systematic and objective attempt to provide answers to certain questions. The purpose of scientific research is to discover and develop an organised body of knowledge. Therefore, scientific research may be defined as the systematic and empirical analysis and recording of controlled observation,

which may lead to the development of theories, concepts, generalisations and principles, resulting in prediction and control of those activities that may have some cause-effect relationship. Some of the definitions of research in literature are given below which can help you to understand proper meaning and concept of research.

Encyclopaedia of Social Science defines research as, "the manipulation of generalising to extend, connect or verify knowledge…" Manipulation incorporates experimentation adopted for the purpose of arriving at generalisation.

Kerlinger (1973) defines research as a "systematic, controlled, empirical and critical investigation of hypothetical propositions about the presumed relationship about various phenomena."

Burns (1994) also defines research as 'a systematic investigation to find answers to a problem'.

Thus, the term research refers to the systematic method consisting of enunciating the problem, formulating a hypothesis, collecting the facts or data, analysing the facts and reaching certain conclusions either in the form of solution (s) towards the concerned problem or in certain generalisations for some theoretical formulation.

1.3 CRITERIA OF GOOD RESEARCH

The criteria for good research are as follows:

Purpose of research should be clearly defined and common concepts that are used should be operationally defined.

The research procedure should be precisely planned, focused and appropriately described in order to enable other researcher to do research for further advancement.

Research design should be carefully planned to generate results to maintained objectivity.

The research report should be as much as possible frank enough to gauge effects of the findings.

Data analysis in the research report should be adequate to reveal its significance and the method of analysis employed be appropriate and

Validity and reliability of data should be examined carefully.

1.4 OBJECTIVES OF GOOD RESEARCH

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

1) To gain familiarity with a phenomenon or to achieve new insights into it (studies with this object in view are termed as exploratory research studies);

2) To portray accurately the characteristics of a particular individual, situation or group (studies with this object in view are known as descriptive research studies);

3) To determine the frequency with which something occurs or with which it is associated with something else (studies with this object in view are known as diagnostic research studies)'

4) To test a hypothesis of a causal relationship between variables (such studies are known as hypothesis- testing research studies/experimental studies).

Thus, research is the fountain of knowledge for the sake of knowledge and an important source of providing guidelines for solving different business, personal, profession governmental and social problems. It is a sort of formal training which enables one to understand the new developments in one's field in a better way.

1.5 QUALITIES OF A GOOD RESEARCH

Good research possesses certain qualities which are as follows:

Good research is systematic: it means that research is structured according to set of rules to follow certain steps in specified sequence. Systematic research also invites creative thinking, and certainly avoids use of guessing and intuition for arriving at the conclusion.

Good research is empirical: it implies that any conclusion drawn is based upon hardcore evidence gathered from information collected from real life experiences and observations. This provides a basis for external ability to research results.

Good research is valid and verifiable: Research involves precise observation and accurate description. The researcher selects reliable and valid instruments to be used in the collection of data and uses some statistical measures for accurate description of the results obtained. Whatever you conclude on the basis of finding is correct and can be verified by yourself and others.

Good Research is logical: it suggests that research is guided by the rules of reasoning and logical process of induction (general to specific) and deduction (specific to general) that plays an important role in carrying out research. In fact, logical reasoning makes research feasible and more meaningful in the context of decision making.

Good research develops theories and principles: which are very helpful in accurate prediction regarding the variables under study. On the basis of the sample observed and studied, the researcher makes sound generalisations regarding the whole populations. Thus, research goes beyond immediate situations, objects or groups being investigated by formulating a generalisation or theory about these factors.

Research is replicable: the designs, procedures and results of scientific research should be replicable so that any person other than the researcher himself may assess their validity. Thus, one researcher may use or transit the results obtained by another researcher. Thus, the procedures and results of the research are replicable as well as transmittable.

1.6 RESEARCH PROCESS: BASIC CONSIDERATIONS

Before we examine what researchers have found in the major areas of psychology, we need to identify the ways psychologists gather data about behaviour and mental processes. Recall that psychology is the scientific study of behaviour and mental functioning of individuals. It is scientific because it uses the principles and practices of the scientific method.

Let us turn now how psychologists know *what* they know.

Empirical investigation in any field requires the use of the scientific method to observe, measure, and experiment. Even if you never do any scientific research in your life, mastering information on psychological research will be useful. You can improve your critical thinking skills by learning how to ask the right questions about behaviour and how to evaluate the answers you find.

Psychological research process can be divided into two major categories that usually occur in sequence that is (i) getting an idea [context of discovery] and then (ii) testing it (context of justification).

1.6.1 Context of Discovery

This is the initial phase of research during which observations, belief, information, and general knowledge etc., lead someone to come up with a new idea or a different way of thinking about phenomena.

1.6.1.1 Role of Theories, Hypotheses and Paradigms in Psychological Researches

Researchers begin with the assumption of determinism, the idea that all events (physical, mental and behavioural) result from specific causal factors. Researchers also assume that behaviour and mental processes follow set patterns of relationships that can be discovered and revealed through research.

Psychological theories, in general, attempt to understand how brain, mind, behaviour, and environment function and how they may be related. Any particular theory focuses on a more specific aspect of this broad conception, using a body of interrelated principles to explain or predict some psychological phenomenon.

The value of a theory is often measured in terms of the new ideas, or hypotheses, that can be derived from it and tested. A hypothesis is a tentative and testable explanation of the relationship between two or more events or variables. A **variable** is any factor that changes, or varies, in size or quality. To illustrate this mood may be a variable, since people's moods may vary from one situation to another. Test performance is another variable, since a person's score may vary from one test to the next.

Finally, our understanding of a complex process is also aided by using the correct paradigm. A *paradigm* is a model of the functions and interrelationships of a process, a "way of thinking" about the world and how to study it. Entire field of knowledge, including psychology, can change directions when new paradigm challenges existing ones. When paradigms shift, revolutions of knowledge usually

follow (Kuhn, 1970).Before a new theory, hypothesis, or paradigm makes a difference in science, it has to undergo an "ordeal of proof." Most often this happens when researchers publish (i.e. make public) their findings, and other scholars investigate whether they find the same patterns in their own data. This process of publication and communication moves scientific research into the public eye, where ideas are tested and proven.

1.6.1.2 Research Biases

One of the challenges, while doing research is to remain objective and free from biases. Most of your ideas and beliefs are probably linked with certain bias because they are influenced by your opinions or values. A variety of biases have been found to distort people's impressions of collected data. *External influences* such as one's culture or the media can influence people to accept a particular world view. *Personal bias* distorts estimating or evaluating processes as a result of personal beliefs, attributes, or past experiences. *Observer bias* operates when some events are taken as meaningful by some and not taken meaningful by others. It must be kept in mind that researchers themselves were raised in certain cultures and societies. They also might have been exposed to certain gender role expectations. These background factors can all affect the way that researchers observe and interpret events in their lives. *Expectancy bias* can affect observations of behaviour by encouraging reactions to the events being observed. Researchers sometimes expect to find specific outcomes, they may see what they expect to see rather than remain objective. Unfortunately, if one is not alert to the possibility of expectancy bias, it may seem as though the observed events are being "discovered" instead of created by the observer's expectations.

Finally, *placebo biases* operate when people strongly want to believe a treatment is successful. For example, many people may claim to feel better after taking a placebo such as a sugar pill. In those cases where the outcome involves a subjective judgment about results, that is, how well a person feels well or whether the pain has been reduced or relieved, the desire for a drug or therapeutic method to work may be enough to achieve the desired result.

1.6.2 Context of Justification

The context of justification is the second phase of research in which results are prepared for useful communication with other scientists. Psychologists face a difficult challenge when they try to get accurate data and reliable evidence that will generate valid conclusions. They rely on one ally to succeed: the scientific method. Scientific method is a general set of procedures for gathering and interpreting evidence in ways that limit errors and yield dependable conclusions. The scientific method also demands special attitudes and values on the part of research scientists.

1.6.2.1 Scientific Attitudes and Values Associated with Research Process

Scientists are motivated by a curiosity about the unknown and the uncertain. Since the truth may be disguised, the scientific method demands a critical and skeptical attitude toward any conclusion until it has been duplicated repeatedly by independent investigations. Secrecy is banned from the research procedure because all data and methods must eventually be open for public verifiability and domain. Other researchers must have the opportunity to review the data and

conclusions and then attempt to replicate the results. Thus, science is not a set of rules but rather a process of asking, observing, explaining, testing, and retesting explanations of reality.

1.6.2.2 Objectivity Safeguards in Research Process

This consists of (i) procedural safeguards (ii) standardisation (iii) operationalisation (iv) avoiding of bias. Let us take each of these and discuss.

Since subjectivity must be minimized in the data collection and analysis phases of scientific research, **procedural safeguards** are used to increase objectivity. These safeguards begin with keeping complete records of observations and data analyses in a form that other researchers can understand and evaluate. As a result, most scientific reports are written in a similar form and published by organisations of scientists. These reports communicate ideas to the entire scientific community and open those ideas to criticism. A second safeguard is standardisation. **Standardisation** means using uniform, consistent procedures in all phases of data collection. All subjects should receive the same instructions and be treated in the same way. By applying a standard treatment for all participants in the course of study, researchers ensure they will have the same basic experience.A third safeguard involves standardising the meaning of concepts, known as **operationalisation**. An operational definition of a concept defines that concept in terms of how it is measured or what operations produce it. Researchers must also safeguard objectivity by avoiding bias. As explained earlier, bias from external influences, personal beliefs, observers' perspectives, and human expectations can all distort data. Researchers use various control procedures to avoid such biases and test hypotheses in ways that are fair and error-free.

Self Assessment Questions

1) An investigator comes up with a new idea or a different way of thinking is known as context of discovery (True/False)
2) Use of uniform consistent procedure in all faces of data collection is known as standardisation. (True/False)
3) Scientific knowledge is not based on empirical evidences. (True/False)
4) Psychologists should not maintain objectivity by avoiding biases. (True/False)
5) Psychological researches should be replicable (True/False)
6) Operational definition of a concept is not necessary in scientific research. (True/False)

Answers: (1) T, (2) T, (3) F, (4) F, (5) T, (6) F

1.7 STEPS IN RESEARCH PROCESS

Research process consists of series of actions and steps needed for conducting scientific research, if the researcher follows certain steps in conducting the research, the work can be carried out smoothly with least difficulty. These steps are described as beneath—

1.7.1 Step-I: Identification of the Problem

The first and most important step for identifying a problem is asking a question or identifying a need that arises as a result of curiosity and to which it become necessary to find an answer. The psychological studies are focused on one or many of the following kinds of questions:

What are the events that cause or determine a given behaviour or response?

What is the nature of behaviour or action (i.e., its structure) and how it is linked with other actions and behaviours?

What are the relationships of internal psychological processes with behavioural phenomenon?

The research question determines the direction of study and researchers have to struggle a lot in identifying and articulating the same. Essentially two steps are involved in formulating the research problem, viz, understanding the problem thoroughly, and rephrasing the same into meaningful terms. The main function of formulating a research problem is to decide what you want to find out about.

It is extremely important to evaluate the research problem in the light of funds, time and expertise and knowledge available at your disposal. It is equally important to identify any gaps in your knowledge of relevant disciplines, such as statistics required for analysis.

Once the question has been asked, that next step is to identify the factors that have to be examined to answer the question. Such factors might range from the most simple, such as a child's age or socioeconomic status, to more complicated measures such as the effects of violent cartoons on a child's behaviour. The factors may be age of the child, degree of violence in programs, emotional arousal, facial expression, family communication patterns etc. Besides this, following factors should be considered by the researcher for identifying in research problem:

Have not been investigated before;

Will contribute to the understanding of your question;

Are available to investigate;

Lead to another question!

For identifying a good solvable problem, the investigator undertakes the **review of literature.** A body of prior work related to a research problem is referred to as literature. Scientific research includes a review of the relevant literature. When a researcher reviews the previous researches in related fields, he becomes familiar with several known and unknowns. Therefore one obvious advantage of review of the literature is that it helps to eliminate duplication of what has already been done and provide guidance and suggestions for further research. The main purpose of review of the literature is fourfold. First it gives an idea about the variables which have been found to be conceptually and practically important and unimportant in the related field. Thus the review of literature helps in discovering and selecting variables relevant for the given study. Second the review of the literature provides as estimate of the previous work and provides an opportunity for the meaningful extension of the previous work.

Third, a review of the literature helps the researcher in systemising the expanding and growing body of knowledge. This facilitates in drawing useful conclusions

regarding the variables under study and provides a meaningful way of their subsequent applications. Fourth, a review of the literature also helps in redefining the variables and determining the meanings and relationships among them so that the researcher can build up a case as well as a context for further investigation that has merit and applicability. There are different sources of review of the literature such as journals, books, abstracts, indexes and periodicals. If you are not sure what journals and other resources to examine for research idea, you should know that the computer search engine **PsycINFO** is a very effective tool for going through the technical literature. The print companion to PsycINFO is psychological abstracts and both of theses contain abstracts of articles from almost all journals that publish psychological research. If you find an abstract of interest, you can then read the entire articles for additional information.

1.7.2 Step-II: Formulating a Hypothesis

When the researcher has identified the problem and reviewed the relevant literature he formulates a hypothesis which is a kind of suggested answer to the problem Hypothesis plays the key role in formulating and guiding any study. The hypotheses are generally derived from earlier research findings existing theories, and personal observations and experiences. From a careful examination of relevant theory and previous findings, the psychologist would be able to state one or more prepositions whose validity could be tested. Ideally these hypotheses would be based on a deductive theory but they may simply be new hypotheses or hypothesis based on previous research findings. Hypothesis may be defined as a tentative statement showing a relationship between variables under study. It is stated in the form of a declarative sentence. For instance suppose you are interested to know the effect of reward on learning. You have analysed the past research and found the indication that the two variables are positively related. You need to convert this idea in terms of a testable statement. At this point you may develop the following hypothesis. *Those who are rewarded shall require lesser number of trials to learn the lesson than those who are not rewarded*. For unbiased research the researcher must formulate a hypothesis in advance of the data – gathering process. No hypothesis should be formulated after the data are collected.

1.7.3 Step-III: Identifying, Manipulating and Controlling Variables

While talking about the hypothesis you will encounter this word i.e. variable in the scientific literature in the psychology. Variables are defined as those characteristics which are manipulated, controlled and observed by the experimenter. At least three types of variables must be recognised at the outset - the dependent variable, the independent variable and the extraneous variable. The dependent variable is one about which the prediction is made on the basis of the experiment. In the other words the dependent variable is the characteristics or condition that changes as the experimenter changes the independent variables. The independent variable is that condition or characteristics which is manipulated or selected by the experimenter is order to find out its relationship to some observed phenomena. A extraneous variable is the uncontrolled variable that may affect the dependent variable. The experimenter is not interested in the changes, produced due to the extraneous variable and hence, he tries to control it as far as practicable. The extraneous variable is known as the relevant variable. In order to make a variable clear precise and easy to communicate it is important

that it is operationally defined. An operational definition involves specifying the actual operations that define a given variable. Operational definition is also important for the purpose of measurement. Since psychological variables are complex and their measurement posses special problems. Therefore, psychologists are very eager to use operational definitions. They frequently use verbal measures, behavioural measures and psychological measures of variables in their studies, which are able to help him or her to specify the operations and may allow quantification.

1.7.4 Step-IV: Formulating a Research Design

A research design may be regarded as the blueprint of those procedures which are adapted by the researcher for testing the relationship between the dependent variable and the independent variable. There are several kinds of experimental designs and the selection of any one is based upon the purpose of the research, types of variables to be controlled and manipulated as well as upon the conditions under which the experiment is to be conducted. The main purpose of experimental design is to help the researcher in manipulating the independent variables freely and to provide maximum control of the extraneous variables so that it may be said with all certainty that the experimental change is due to only the manipulation of the experimental variable. The main function of a research design is to explain how you will find answers to your research questions. The research design sets out the logic of your inquiry. A research design should include the following; logistical arrangements have to made according to proposed research design , the measurement procedures, the sampling strategy, the frame of analysis and the time frame. For any investigation, the selection of an appropriate research design is crucial in enabling you to arrive at valid findings, comparisons and conclusions. A faulty design may derive misleading findings. Empirical investigation is primarily evaluated in the light of the research design adopted. While selecting a research design it is important to ensure it is valid workable and manageable.

1.7.4.1 Constructing Devices for Observation and Measurement

When the research design has been formulated, the next step is to construct or choose appropriate tools of research for scientific observation and measurement. Questionnaire and interview schedule are the most common tools which have been developed for the psychological research. If the readymade tools are not available then the researcher may have develop appropriate tools before undertaking the study. All these tools of research are ways through which data are collected by asking for information from person rather than observing them.

1.7.4.2 Sample Selection and Data Collection

After deciding the tools for the study the researcher also decides about the participants of the study. Usually a small sample is drawn which represents the population. The participants could be children, adolescents, college students, teachers, managers, clinical patients or any group of the individual in whom/ where the phenomenon under investigation is prevalent. Depending on the nature of research problem a researcher may choose particular method (e.g. observation, experiment, case study, and survey) for data collection. The researcher also decides how the tools to be administered to collect data that is individual or group.

In data collection phase, researcher must consider recruitment of staff and assignment to them, way of increasing response rate and cost of training of staff etc. Effect of each of these must be evaluated in terms of cost, accuracy, reliability and validity.

1.7.5 Step-V: Data Analysis and their Interpretation

After making observation the data collected are analysed with the help of various quantitative / statistical and qualitative techniques .Careful scrutiny of the data is a critical aspect of scientific method. The purpose of the analysis is to make sense of the data and see what light they throw on the problem and the hypotheses of the study and draws conclusion accordingly. Data analysis can be done by using univariate analysis in which research deals with a single characteristics of interest, bivariate analysis in which researcher deals with two characteristics of interest and by using multivariate analysis in which more then two characteristics are involves.

Depending upon the nature of data and purpose of the experiment, either a parametric statistic or a non-parametric statistic is chosen for statistical analysis. In general, the purpose of carrying out the statistical analysis is to reject the null hypothesis so that the alternative hypothesis may be accepted.

1.7.6 Step-VI: Drawing Conclusions

The investigator, after analysing the results, draws some conclusions. In fact the investigator wants to make some statement about the research about the research problem which he could not make without conducting his research. Whatever conclusion drawn, researcher generalises it to the whole population. During this phase, hypotheses are accepted or rejected. At the same time the conclusions of the study are related to the theory or research findings from which the hypotheses originally came. Depending on the new findings the original theory may have to be modified.

1.7.7 Step-VII: Preparation of Report and Publication

This is the last step in most of the research studies. The researcher documents all the steps of his or her research in clear terms this report inform that what you have done, what you have discovered and what conclusion you have drawn from findings. If you are clear about the whole process you will also be clear about the way you want to write in your report. This helps the reader to understand the study and use it for various purposes. It allows one to replicate the study. The publication of study in scientific journals or books and in public domain makes the work available for wider dissemination.

Self Assessment Questions

1) The first step of research process is identifying a problem. T/F
2) Hypotheses are formed after formulating a research design. T/F
3) Preparation of report and publications of research study allow the other researchers to replicate the study. T/F
4) An operational definition of the variables is not necessary for the purpose of measurement. T/F
5) Selection of particular data collection method depends on the nature of study. T/F

Answers: (1) T, (2) F, (3) T, (4) F, (5) T

1.8 IMPORTANCE OF RESEARCH IN PSYCHOLOGY

Importance and relevance of psychological research is well recognised almost in every sphere of human life. Notable progress has been reported in the field of organisational behaviour, applied aspects of human being, medical sciences and education, through application of psychological research findings.

Empirical and theoretical researches in psychology are taking place in various fields, such as learning, motivation, perception, concept learning and memory and so on. In the quest of psychological facts, laws and theories, psychologists have found research studies very helpful in gauging human and animal behaviour.

Practical gains of psychological research are many, yet include discoveries such as improved methods of treating psychologically disordered people, better designs of vehicles to make them easier and safe to use, and new ways of enhancing the performance and happiness of workers.

In psychological researches experimental methods are widely used. Therefore, nature of majority of psychological researches is highly scientific. Psychological researches have successfully led to control and manipulation of the variables associated with widely used generic and comparative methods. Psychologists have developed such effective experimental designs that that they have helped to isolate effect of other variables from independent variables.

In psychological researches, rigorous scientific norms and statistical methods are applied in collection, organisation, description and analysis of the data. By turning psychological facts into quantitative form, the nature of most of the psychological researches remains method oriented (scientific).

1.9 LET US SUM UP

Scientific research may be defined as the systematic and empirical analysis and recording of controlled observation, which may lead to the development of theories, concepts, generalisations and principles, resulting in prediction and control of those activities that may have some cause-effect relationship. Qualities of good research are empirical, logical, verifiable, based on theories and principles and replicable. Psychological researches use the scientific method to test the ideas developed within the context of discovery and the context of justification. In the discovery phase of research, observation, belief and information lead to a new way of thinking about a phenomenon. External and internal biases can distort the discovery phase because our conclusions are often subject to personal biases, observer biases, expectancy biases, and placebo biases. Psychologists use scientific theories, testable hypothesis, and creative paradigms to unravel the mysteries of mind and behaviour. In the justification phase, ideas are tested and either disconfirmed or proven. Psychologist must maintain objectivity by keeping complete records, standardise procedures, make operational definitions, minimize biases and control errors. A reliable result is one that can be repeated in similar conditions by independent investigators. This unit has provided an overview of the research process. The steps of research process includes problem identification, formulation of hypothesis, identification manipulation and controlling of the

variable, formulation of research design, constructing devices for observation, sample selection and data collection, data analysis and interpretation, drawing conclusions and preparation of report and publications.

1.10 UNIT END QUESTIONS

1) What is research? Discuss qualities of good research.
2) In your opinion, what may be various criteria of a good research?
3) Discuss importance and relevance of psychological research.
4) How can you minimize research biases in psychological research?
5) What is the role of discovery of justification in psychological research?
6) List the steps involved in research process?
7) Explain the importance of research questions in psychological research?
8) What is the role of review of literature in research process?
9) Why formulates of hypothesis is necessary while conducting it?
10) How the steps in the research process do helps a person to get knowledge?

1.11 GLOSSARY

Empirical Investigation : Research that relies on sensory experience and observation as research data.

Context of Discovery : Initial phase of research during which an investigator comes up with a new idea or a different way of thinking about phenomena.

Theory : A body of interrelated principles used to explain or predict some psychological phenomenon.

Hypothesis : A tentative and testable explanation of the relationship between two or more events or variables.

Paradigm : A model of the functions and interrelationships of a process; a "way of thinking" about the world and how to study it.

Context of Justification : Second phase of research, in which results are tested and prepared for useful communication with the scientific community.

Standardisation : The use of uniform consistent procedures in all phases of data collection.

Operational definition : Definition of a concept in terms of how the concept is measured or what operations produce it.

Placebo Control : A control strategy where researchers compare those who received actual treatment with those who received only attention or a "dummy drug."

Variable : something that can occur with different values and can be measured.

Independent Variable : a variable that represents the hypothesised "cause" that is precisely controlled by the experimenter and independent of what the participant does.

Dependent Variable : a variable that represents the hypothesised "effect "whose values ultimately depend on the values of independent variable.

1.12 SUGGESTED READINGS AND REFERENCES

Aylward, E.H., Richards, T.L., Berwinger, V.W., Nagy, W.E., Field, K.M., Grimme, A.C., Richard, A.L., Thomson, J.B. & Cramer, S.C. (2003). *Instructional Treatment Associated with Changes in Brain Activities in Children with Dyslexia.* Neurology, 61, 212-219.

D; Amato, M.R. (1970): *Experimental Psychology*. Tokoya : McGraw – Hill.

References

Grinnell, Richard Jr (ed.) 1988, *Social Work Research and Evaluation* (3rd edition) Itasca, Illinois, F.E. Peacock Publishers.

Kerlinger, F. N. (1979) *Foundation of Behavioural Research*, New York, : H 107, Rinehart and Winstem Inc.

Kuhn, T.S. (1970). *The Structure of Scientific Revolutions* (2nd edition) Chicago : University of Chicago Press.

Kumar. R (2006) *Research Methodology*. New Delhi: Dorling Kingsley

McGuigan, F.J. (1990): *Experimental Psychology: A Methodological Approach*. New York : Printice Hall.

Shaywitz, S.E. (1996): *Dyslexia. Scientific American*, 275 (5) 98-104.

Townsend, J.C. (1953): *Introduction to Experimental Method*. Tokyo : McGraw Hill.

UNIT 2 RELIABILITY AND VALIDITY (EXTERNAL AND INTERNAL)

Structure

2.0 INTRODUCTION

Most research is designed to draw the conclusion about the cause and effect relationship among the variables. The goal of the research remains to develop a theory that explains the relationship found among variables. This unit mainly concerns about various problems that can threaten the reliability and validity of conclusions drawn by the researcher.

There are two goals of research design;

1) Obtain information relevant to the purposes of the study.

2) Collect this information with maximal reliability and validity.

How can a researcher be sure that the data gathering instrument being used will measure what it is supposed to measure and will do this in a consistent manner?

This is a question that can only be answered by examining the definitions for and methods of establishing the validity and reliability of a research instrument.

Reliability and validity are central issues in all measurement. Both concern connecting measures to constructs. Reliability and validity are salient because constructs are often ambiguous, diffused and not directly observable. Perfect reliability and validity are virtually very difficult to achieve. These two very important aspects of research design will be discussed in this unit. All researchers want their measures to be reliable and valid. Both ideas help to establish the truthfulness, credibility, or believability of findings. This unit will be discussed in two parts. First part covers the concept of reliability and the definitions of reliability. This is followed by various methods of establishing reliability of a research instrument of this unit. Second part of this unit discusses the concept of validity in research. You will familiarise with the various types of validity. Finally, some problems that constitute threats to validity are described.

2.1 OBJECTIVES

After reading this unit, you will be able to:

- Define reliability;
- Describe the various methods of calculating reliability;
- Explain how test retest reliability is accessed;
- Differentiate between tests of reliability;
- Define validity;
- Describe various methods of validity;
- Identify the problems that constitute threats to internal external validity; and
- Differentiate between internal and external validity.

2.2 RELIABILITY

Meaning of Reliability

The idea behind reliability is that any significant results must be repeatable. Other researchers must be able to perform exactly the same experiment, under same conditions and generate the same results. This will vindicate the findings and ensure that all researchers will accept the hypothesis. Without this replication of statistically significant results, experiment and research have not fulfilled all of the requirements of testability. This prerequisite is essential to a hypothesis establishing itself as an accepted scientific truth. For example, if you are performing a time critical experiment, you will be using some type of stopwatch. Generally, it is reasonable to assume that the instruments are reliable and will keep true and accurate time. However, scientists take measurements many times, to minimize the chances of malfunction and maintain validity and reliability. At the other extreme, any experiment that uses human judgment is always going to come under question. Human judgment can vary as individual observer may rate

things differently depending upon time of day and current mood. This means that such experiments are more difficult to repeat and are inherently less reliable. Reliability is a necessary ingredient for determining the overall validity of a scientific experiment and enhancing the strength of the results.

Reliability is the consistency of your measurement, or the degree to which an instrument measures the same way each time it is used under the same condition with the same subjects. In short, it is the repeatability of measurement. A measure is considered reliable if a person's score on the same test given twice is similar. It is important to remember that reliability is not measured, it is estimated. For instance, if a test is constructed to measure a particular trait; say, neuroticism, then each time it is administered, it should yield same results. A test is considered reliable if we get same result repeatedly.

According to Anastasi (1957), the reliability of test refers to the consistency of scores obtained by the individual on different occasions or with different sets of equivalent items.

According to Stodola and Stordahl (1972), the reliability of a test can be defined as the correlation between two or more sets of scores of equivalent tests from the same group of individuals.

According to Guilford (1954), reliability is the proportion of the true variance in obtained test scores.

The reliability of test is also defined from another angle. Whenever we measure something, measurement involves some kind of measure. Error of measurement is generally between true scores and the observed score. However, in psychological term, word error does not imply the mistake has been made. In other words, error in psychological testing implies that there is always some inaccuracy in measurement. Hence, goal of psychological measurement remains to find out the magnitude of such error and develop ways to minimize them.

2.3 METHODS OF ESTIMATING RELIABILITY

There are number of ways of estimating reliability of an instrument. Various procedures can be classified into two groups:

External consistency procedures

Internal consistency procedures

2.3.1 External Consistency Procedures

External consistency procedures compare findings from two independent process of data collection with each other as a means of verifying the reliability of the measure. Two methods are as beneath.

2.3.1.1 Test Re-test Reliability

The most frequently used method to find the reliability of a test is by repeating the same test on same sample, on two different time periods. The reliability coefficient in this case would be the correlation between the score obtained by the same person on two administrations of the test.

Test-Retest reliability is estimated, when same test is administered on same sample. Therefore, if refers to the consistency of a test among on two different time periods different administrations. The assumption behind this approach is that there will be no substantial changes in the measurement of the construct in question, upon administration on separate occasions. The time gap that is given between measures is of critical value, the shorter the time gap, higher the correlation value and vice versa. If the test is reliable, the scores that are attained on first administration should be more or less equal to those obtained on second time also. The relationship between the two administrations should be highly positive.

Limitations of this approach

There are a few limitations which include the following: (i) Memory Effect/ carry over Effect (ii) Practice effect, (iii) Absence. These are being discussed below:

i) **Memory effect /carry over effect:** One of the common problems with test-retest reliability is that of memory effect. This argument particularly holds true when, the two administrations takes place within short span of time, for example, when a memory related experiment including nonsense syllables is conducted whereby, the subjects are asked to remember a list in a serial wise order, and the next experiment is conducted within 15 minutes, most of the times, subject is bound to remember his/her responses, as a result of which there can be prevalence of artificial reliability coefficient since subjects give response from memory instead of the test. Same is the condition when pre-test and post-test for a particular experiment is being conducted.

ii) **Practice effect:** This happens when repeated tests are being taken for the improvement of test scores, as is typically seen in the case of classical IQ where there is improvement in the scores as we repeat these tests.

iii) **Absence:** People remaining absent for re-tests.

2.3.1.2 Parallel Forms Reliability

Parallel-Forms Reliability is known by the various names such as Alternate forms reliability, equivalent form reliability and comparable form reliability.

Parallel forms reliability compares two equivalent forms of a test that measure the same attribute. The two forms use different items. However, the rules used to select items of a particular difficulty level are the same. When two forms of the test are available, one can compare performance on one form versus the other. Sometimes the two forms are administered to the same group of people on the same day.

The Pearson product moment correlation coefficient is used as an estimate of the reliability. When both forms of the test are given on the same day, the only sources of variation are random error and the difference between the forms of the test. Sometimes the two forms of the test are given at different times. In these cases, error associated with time sampling is also included in the estimate of reliability.

The method of parallel forms provides one of the most rigorous assessments of reliability commonly in use. Unfortunately the use of parallel forms occurs in practice less often than is desirable. Often test developers find it burdensome to

develop two forms of the same test, and practical constraints make it difficult to retest the same group of individuals. Instead many test developers prefer to base their estimate or reliability on a single form of a test.

In practice, psychologists do not always have two forms of a test. More often they have only one test form and must estimate the reliability for this single group of items. You can asses the different sources of variation within a single test in many ways. One method is to evaluate the internal consistency of the test by dividing it into subcomponents.

2.3.2 Internal Consistency Procedures

The idea behind internal consistency procedures is that items measuring same phenomena should produce similar results. Following internal consistency procedures are commonly used for estimating reliability-

2.3.2.1 Split Half Reliability

In this method, as the name implies, we randomly divide all items that intends to measure same construct into two sets .The complete instrument is administered on sample of people and total scores are calculated for each randomly divided half; the split half reliability is then, the simply the correlation between these two scores.

Problem in this approach

A problem with this approach is that when the tests are shorter, they run the risk of losing reliability and it can most safely be used in case of long tests only. It is, hence, more useful in case of long tests as compared to shorter ones. However to rectify the defects of shortness, Spearman- Brown's formula can be employed, enabling correlation as if each part were full length:

$r = (2rhh)/(1 + rhh)$ (Where rhh is correlation between two halves)

2.3.2.2 Kudar-Richardson Estimate of Reliability

The coefficient of internal consistency could also be obtained with the help of Kudar-Richardson formula number 20. One of the techniques for item analysis is item difficulty index. Item difficulty is the proportion or percentage of those answering correctly to an item. For example – symbol 'p' is used to represent the difficulty index. Suppose an item 'X' has p=0.67.this means item 'X' was answered correctly by 74% of those who answered the item. To compute reliability with the help of Kuder-Richardson formula number 20, the following formula is used:

$$KR\text{-}20 = \frac{N}{N-1}\left(1 - \frac{\Sigma pq}{\sigma^2}\right)$$

Where

N = the number of items on the test,

σ^2 = the variance of scores on the total test,

p = the proportion of examinees getting each item correct,

q = the proportion of examinees getting each item wrong.

Kuder-Richardson formula 20 is an index of reliability that is relevant to the special case where each test item is scored 0 or 1 (e.g., right or wrong).

2.3.2.3 Cronbach's Alpha (α)

As proposed by Cronbach (1951) and subsequently elaborated by others (Novick & Lewis, 1967; Kaiser & Michael, 1975), coefficient alpha may be thought of as the mean of all possible split-half coefficients, corrected by the Spearman-Brown formula .The formula for coefficient alpha is

$$r_\alpha = \left(\frac{N}{N-1}\right)\left(1 - \frac{\Sigma \sigma^2_j}{\sigma^2}\right)$$

Where $r\alpha$ is coefficient alpha,

N is the no. of items,

σ^2_j is the variance of one item,

$\Sigma\sigma^2_j$ is the sum of variances of all items, and

$\sigma^2$is the variance of the total test scores.

As with all reliability estimates, coefficient alpha can vary between 0.00 and 1.00.

Coefficient alpha extends the Kuder-Richard-son method to types of tests with items that are not scored as 0 or 1. For example, coefficient alpha could be used with an attitude scale in which examinees indicate on each item whether they strongly agree, agree, disagree, or strongly disagree.

2.4 COMPARISON OF RELIABILITY ESTIMATORS

All of the reliability estimators listed above have certain pros and cons, like for example: inter-rater is best suited when the measure involves observation, it however requires multiple observers as an alternative one can look at of rating of a single observer repeated on single occasion. It can also be used if the examiner is interested in using a team of raters.

In a situation that involves use of two forms as alternate measure of the same thing, parallel forms estimator is best suited. However, this and the internal consistency measures of reliability have constrains, i.e. one has to have multiple items engineered to measure same construct.

Cronbach's Alpha is useful in case, where lots of items are present. The test-retest reliability is mostly employed in case of experimental and quasi-experimental designs. This also depends upon string of availability of a control group that is measured on two different occasions and until post-test is done, one does not have information about reliability. Accordingly, each one of the above mentioned estimators will give a different value for reliability. Generally, test-retest and inter-rater reliability estimates will be lower in value as compared to parallel forms and internal consistency due to involvement in measurement at different times or with different raters.

Self Assessment Questions

1) Internal Consistency Concerns whether the various items on a test are measure the same thing. T / F

2) Memory effect / carry over effect is possible in parallel form method. T / F

3) K.R. Formula is applied in which each test item is scored 0 or 1. T / F

4) Scores from the two halves of a test are correlated with one another in split half reliability. T / F

5) Spearman Brown formula is used for adjusting split half correlation T / F

Answer: 1) T, 2) F, 3) T, 4) T, 5) T

2.5 VALIDITY

As you know that the merit of the psychological test is determine first by its reliability but then ultimately by its validity. Validity refers to the degree to which a test measures, what it claims to measure. It is very necessary for a test to be valid for its proper administration and interpretation.

According to Standard for Educational and Psychological testing (AERA, APA & NCME 1985, 1999); a test is valid to the extent that inferences drawn from it are appropriate, meaningful and useful.

According to Cronbach (1951) validity is the extent to which a test measures what it purports to measure.

According to Freeman (1971) an index of validity shows the degree to which a test measures what it purports to measure when compared with accepted criteria.

According to Anastasi (1988) the validity of a test concerns what the test measures and how well it does so.

The above definitions pointed out that for determining the validity of the test, the test must be compared with some ideal independent measures or criteria. The correlation coefficients computed between the test and an ideal criterion is known as the validity coefficients. Independent criteria refer to some measure of the trait or group of the traits (out side the test) that the test itself claims to measure.

2.6 TYPES OF VALIDITY

There are six types of validity, viz., (i) Content validity (ii) Criterion-related validity (iii) Con current validity (iv) Predictive validity (v) Construct validity (vi) Convergent validity (vii) Discriminate validity and (viii) Face validity. These are being discussed below:

2.6.1 Content Validity

According to Mc Burney and White (2007); content validity is the notion that a test should sample range of behaviour that is represented by the theoretical concept being measured.

It is a non-statistical type of validity with involvement of assessment of the content of the test to ascertain whether it includes the sample representative of the behaviour that is intended to be measured. When a test has content validity, the items on the test represent the entire range of possible items the test should cover. For instance, if researcher wants to develop an achievement test of spelling for the third grade children then a researcher could identify nearly all the possible words that third grade children should know. Individual test items may be taken from a huge group of items that include a broad range of items.

A test has content validity inbuilt in it. Items are selected in accordance with their compliance with the requirements of the test after a careful examination of the subject area.

In certain cases, where a test measures a trait which is difficult to define, an expert can rate the relevance of items. Since, each judge have their own opinion on their rating, two independent judges will rate the test separately. Items which are rated as highly relevant by both judges would be included in the final test.

2.6.2 Criterion-related Validity

Criterion related validity is the idea that a valid test should relate closely to other measure of the same theoretical concept. A valid test of intelligence should correlate highly with other intelligence test. If a test demonstrates effective predicting criterion or indicators of the construct, it is said to possess criterion – related validity. There are two different types of criterion validity-

2.6.2.1 Concurrent Validity

Its occurrence is found when criterion measures are achieved at the same time as the test scores. It reflects the degree to which the test scores estimate the individual's present status with regards to criterion. For instance, if a test measures anxiety, it would be said to have concurrent validity if it rightly reflects the current level of anxiety experienced by an individual. Concurrent evidence of test validity is usually desirable for achievement tests and diagnostic clinical test.

2.6.2.2 Predictive Validity

Predictive validity occurs when criterion measures are obtained at a time after the test. For example, aptitude tests are useful in identifying who will be more likely to succeed or fail in a particular subject. Predictive validity is part curly relevant for entrance examination and occupational test.

2.6.3 Construct Validity

Construct validity approach is complex than other forms of validity. Mc Burney and White (2007) defined construct validity as the property of a test that the measurement actually measures the constructs they are designed to measure. There are several ways to determine whether a test generate data that have construct validity.

i) The test should actually measure whatever theoretical construct it supposedly tests, and not something else. For example a test of leadership ability should not actually test extraversion.

ii) A test that has construct validity should measure what it intends to measure but not measure theoretically unrelated constructs. For example, a test of musical aptitude should not require too much reading ability.

iii) A test should prove useful in predicting results related to the theoretical concepts it is measuring. For example, a test of musical ability should predict who will benefit from taking music lessons, should differentiate groups who have chosen music as a career from those who haven't should relate to other tests of musical ability and so on.

There are two types of construct validity— 'convergent validity' and 'divergent validity' (or discriminant validity).

2.6.3.1 Convergent Validity

It means the extent to which a measure is correlated with other measure which is theoretically predicted to correlate with.

2.6.3.2 Discriminant Validity

This explains the extent to which the operationalisation is not correlated with other operationalisations that it theoretically should not be correlated with.

2.6.4 Face Validity

Face validity refers to what appears to measure superficially. It depends on the judgment of the researcher. Each question is scrutinised and modified until the researcher is satisfied that it is an accurate measure of the desired construct. The determination of face validity is based on the subjective opinion of the researcher.

Self Assessment Questions

Fill in the blanks

1) If a test measures what it purports to measure it is caleed …….

2) If a test is correlated against a criterion to be made available at the present time it is a type of validity known as……validity.

3) The property of a test that measurement actually measure the constructs they are design to measure are known as…….validity

4) A test should sample the range of behaviour represented by the theoretical concept being tested, is known as …….. validity.

5) ……. refers to what appears to measure superficially.

Answers: (1) Validity (2) Criterion Validity (3) Construct (4) Content (5) Face Validity

2.6.5 Internal Validity

Internal validity is the most fundamental type of validity because it concerns the logic of the relationships between the independent variable and dependent variable. This type of validity is an estimate of the degree to which inferences about causal relationship can be drawn, based on the measures employed and research design. Properly suited experimental techniques, where the effect of an independent variable upon the dependent one is observed under highly controlled conditions makes possible higher degree of internal validity.

2.6.5.1 Threats to Internal Validity

These include (i) confounding, (ii) selection bias, (iii) history, (iv) maturation, (v) repeated testing ,(vi) instrument change, (vii) regression toward the mean, (viii) mortality, (ix) diffusion, (x) compensatory rivalry, (xi) experimenter bias.

i) *Confounding:* Confounding error that occurs when the effects of two variables in an experiment cannot be separated, resulting in a confused interpretation of the results. Confounding is one of the biggest threat to validity in experimentation. The problem of confounding is particurly acute in research in which the experimenter cannot control the independent variable. When participants are selected according to presence or absence of a condition, subject variable can affect the results. Where a false relationship cannot be avoided, a rival hypothesis may be developed to the original cause and inference hypotheses.

ii) *Selection bias:* Any bias in selecting a group can undermine internal validity. Selection bias indicates the problem that occurs as a result of its existence at the pre-test differences between groups, may interact with the independent variable and thus influence the observed outcome and creates problems; examples would be gender, personality, mental capabilities, and physical abilities, motivation level and willingness to participate.

If at the time of selection, an uneven number of subjects to be tested have similar subject-related variables, there could be a threat to the internal validity, for instance, if two groups are formed i.e. experimental and control group, the subjects in the two groups are different with regards to independent variable but alike in one or more subject related variables. It would then be difficult for the researcher to identify if the difference between in the groups is the result of independent variable or subject related variable as well as randomisation of group assignment. It is not possible always as some significant variables may go unnoticed.

iii) *History*: Events outside the experiment or between repeated measures of dependent variables may influence participants' responses, attitudes and behaviour during process of experiment, like; natural disasters, political changes etc. In this condition, it becomes impossible to determine whether change in dependent variable is caused by independent variable or historical event.

iv) *Maturation:* Usually, it happens that subjects change during the course of an experiment or between measurements. For instance, in longitudinal studies young kids might grow up as a result of their experience, abilities or attitudes which are intended to be measured. Permanent changes [such as physical growth] and temporary changes [like fatigue and illness] may alter the way a subject would react to the independent variable. Thus, researcher may have trouble in ascertaining if the difference is caused by time or other variables.

v) *Repeated testing*: Participants may be driven to bias owing to repeated testing. Participants may remember correct answers or may be conditioned as a result of incessant administration of the test. Moreover, it also causes possibility of threat to internal validity.

vi) *Instrument change*: If any instrument is replaced/changed during process of experiment, then it may affect the internal validity as alternative explanation easily available.

vii) *Regression toward the mean*: During the experiment, if subjects are selected on the basis of extreme scores, then there are chances of occurrence of such an error. For example, when subjects with minimum mathematical abilities are chosen, at the end of the study if there is any improvement chances are that it would be due to regression towards the mean and not due to effectiveness of the course.

viii) *Mortality*: It should be kept in mind that there may be some participants who may have dropped out of the study before its completion. If dropping out of participants leads to relevant bias between groups, alternative explanation is possible that account for the observed differences.

ix) *Diffusion*: It might be observed that there will be a lack of differences between experimental and control groups if treatment effects spread from treatment groups to control groups. This, however, does not mean that, independent variable will have no effect or that there would not be a no relationship between dependent and independent variable.

x) *Compensatory rivalry/resentful demoralisation*: There will be a change in the behaviour of the subject if the control groups alter as a result of the study. For instance, control group participants may work extra hard to see that expected superiority of the experimental group is not demonstrated. Again, this does not imply that the independent variable created no effect or that there would be no relationship between dependent and independent variable. Vice-versa, changes in the dependent variable may only be effected due to a demoralised control group, working less hard or demotivated.

xi) *Experimenter bias:* Experimenter bias happens while experimenters, without any intention or reluctance, behave differently to the participants of control and experimental groups, that in turn, affect the results of the experiment. Experimental bias can be reduced by keeping the experimenter from knowing the condition in the experiment or its purpose and by standardising the procedure as much as possible.

2.6.6 External Validity

According to McBurney and White(2007), external validity concerns whether results of the research can be generalised to another situation, different subjects, settings, times and so on.

External validity lacks from the fact that experiments using human participants often employ small samples collected from a particular geographic location or with idiosyncratic features (e.g. volunteers). Because of this, it cannot be made sure that the conclusions drawn about cause-effect-relationships are actually applicable to the people in other geographic locations or in the absence of these features.

2.6.6.1 Threat to External Validity

How one may go wrong in making generalisations, is one of the major threats to external validity. Usually, generalisations are limited when the cause (i.e. independent variable) is dependent upon other factors; as a result, all the threats to external validity interact with the independent variable

a) *Aptitude-Treatment-Interaction*: The sample might have some features that may interact with the independent variable causing to limit generalisability,

for instance, conclusions drawn from comparative psychotherapy studies mostly use specific samples (example; volunteers, highly depressed, hardcore criminals).

b) *Situations:* All the situational factors, for example, treatment conditions, light, noise, location, experimenter, timing, scope and degree of measurement etc may limit generalisations.

c) *Pre-Test Effects*: When the cause-effect relationships can only be found out after the pre-tests are carried out, then, this also tends to limit the generality of the findings.

d) *Post-Test Effects:* When cause-effect relationships can only be explored after the post-tests are carried out, then this can also be a cause for limiting the generalisations of the findings.

e) *Rosenthal Effects*: When derivations drawn from the cause-consequence relationships cannot be generalised to other investigators or researchers.

Self Assessment Questions

1) Results can not be generalised to another situation or population in external Validity. T / F

2) Dropping out of some subjects before an experiment is completed causing a threat to internal validity. T / F

3) Any bias in selecting the groups can enhance the internal validity. T / F

4) Internal Validity concern the logic of relationship between the independent variable and dependent variable. T / F

5) Confounding error occurs when the effects of to variable in an experiment can not be separated. T / F

Answers: (1) F, (2) T, (3) F, (4) T, (5) T

2.7 LET US SUM UP

In psychological testing, reliability refers to the attribute of consistency of measurement. There are various types of reliability. The Pearson product-moment correlation coefficient can be used to gauge the consistency of psychological test scores. This form of reliability is referred to as test-retest reliability. Alternate-forms reliability is computed by correlating scores on two equivalent forms, administered in counterbalanced fashion to a large group of heterogeneous subjects. Internal consistency approaches to reliability include split-half reliability, in which scores on half tests are correlated with each other, and coefficient alpha, which can be thought of as the mean of all possible split-half coefficients. For tests that require examiner judgment for assignment of scores, inter scorer reliability is needed. Computing inters corer reliability is straightforward: A sample of tests is independently score by two or more examiners and scores for pairs of examiners are then correlated.

The validity of a test is the degree to which it measures what it claims to measure. A test is valid to the extent that inferences made from it are appropriate, meaningful, and useful. There are various kinds of validity – content validity

determine by the degree to which the question, task or items on a test are representative of the universe of behaviour the test was designed to sample. A test has face validity if it looks valid to test users, examiners, and especially the examinees. Criterion-related validity is demonstrated when a test is effective in predicting performance on an appropriate outcome measure. An investigation has internal validity is a cause-effect relationship actually exists between the independent and dependent variables. Confounding occurs when the effects of two independent variables in an experiment cannot be separately evaluated. External validity concerns whether the results of the research can be generalised to another situation: different subjects, settings, times, and so forth. Treats to the internal validity of an experiment include events outside the laboratory, maturation, effects of testing, regression effect, selection and mortality. Threats to external validity include problems arising from generalising to other subjects, other times, or other settings. Experimenter bias can be reduced by keeping the experiment from knowing he conditions in the experiment or its purpose and by standardising procedure as much as possible.

2.8 UNIT END QUESTIONS

1) Define reliability. Discuss any two methods of estimating reliability of test scores.
2) What is meant by internal consistency reliability. Discuss any two methods of assessing internal consistency reliability.
3) What are some problems associated with reliability assessed via the test-retest.
4) State the strengths and drawbacks of parallel forms reliability.
5) Write short notes on:
   K-R formula 20
   Spearman Brown formula
   Cronback alfa
6) Define validity and distinguish between reliability and validity.
7) Explain construct validity. How does it differ from content validity.
8) What is internal validity? Discuss various threats of internal validity.
9) What is external validity? Discuss various threats of external validity.
10) Write short notes on :
    Convergent and divergent validity
    Concurrent and predictive validity

2.9 GLOSSARY

Concurrent validity : a type of criterion-related validity in which the criterion measures are obtained at approximately the same time as the test scores.

Confounding : error that occurs when the effects of two variables in an experiment cannot be separated, resulting in a confused interpretation of he results.

Construct : a theoretical, tangible quality or trait in which individuals differ.

Construct validity : the property of a test that the measurements actually measure the constructs they are designed to measure, but no others.

Content validity : idea that a test should sample the range of behaviour represented by the theoretical concept being tested.

Criterion validity : idea that a test should correlate with other measures of the same theoretical construct.

Cronback alpha : an index of reliability that may be thought of as the mean of all possible split-half co-efficient, corrected by the Spearman-Brown formula.

External validity : how well the findings of an experiment generalise to other situations or populations.

Inter observer reliability : the typical degree of agreement between scores. Internal consistency: the degree to which the various items on a test are measures of the same thing.

Internal validity : extent to which a study provides evidence of a cause-effect relationship betwen the independent and dependent variables.

Kuder-Richardson formula 20 : an index of reliability that is relevant to the special case where each test item is scored 0 or 1 (example, right or wrong)

Maturation : a source of error in an experiment related to the amount of time between measurements.

Regression effect : regression effect tendency of subjects with extreme score on a first measure to score closer to the mean on a second testing.

Reliability : the property of consistency of a measurement that gives the same result on different occasions.

Spearman-Brown formula: a formula for adjusting split-half correlations so that they reflect the full length of a scale.

Split-half reliability : a form of reliability in which scores from the two halves of a test (e.g. even items versus odd items) are correlated with one another; the correlation is then adjusted for test length.

Test – retest reliability : the degree to which the same test score would be obtained on another occasion.

Validity : of a measurement the property of a measurement that tests what it is supposed to test.

2.10 SUGGESTED READINGS AND REFERENCES

Anastasi, Anne. (1988). *Psychological Testing* (6th edition.) London: Mac-Millan.

Freeman, F. S. (1971). *Theory and Practice of Psychological Testing*. New Delhi: Oxford (India).

References

Guilford, J.P. (1954). *Psychometric Methods.* New Delhi: Tata McGraw Hill.

Cronbach, L.(1951). *Coefficient Alpha and the Internal Structure of Tests*. Psychometrika, 16, 297-334.

Kaiser, H.F., & Michael, W.B. (1975). *Domain Validity and Gernalisability. Educational and Psychological Measurement,* 35, 31-35.

McBurney, D.H. & White, T. L. (2007) *Research Methods,* New Delhi; Akash Press.

Novick, M.R., & Lewis, C. (1967). *Coefficient Alpha and the Reliability of Composite Measurements.* Psychometrika, 32, 1-13.

Stodola, Q. and Stordahl, K. (1972*). Basic Educational Tests and Measurement*. New Delhi: Thomson (India).

UNIT 3 VARIABLES AND CONSTRUCTS

Structure

3.0 INTRODUCTION

In the process of formulating a research problem there are two important considerations; the use of constructs/concepts and the construction of hypotheses. Constructs/concepts are highly subjective as their understanding varies from person to person and therefore, as such, may not be measurable. In a research study, it is important that the concepts used should be operationalised in measurable terms so that the extent of variation in respondents understanding is reduced if not eliminated. Knowledge about constructs and variables are very important to understand conceptual clarity and quantitative accuracy as they provide the 'fine tuning' to research.

This unit attempts to acquaint you with the term variables and constructs which are used by the psychologists in gaining knowledge about the behaviour and mental processes. It begins with definition of variables then you will find the details about the types of variables along with the examples. Further, you will be exposed to the nature of the scientific concept or construct and the way in which behavioural scientist travel from the construct level to observation level. Finally, types of constructs are described.

3.1 OBJECTIVES

After reading this unit, you will be able to:

- Define the term variable and construct;

- Discuss the types of variable and constructs;
- Identify different types of variables i.e. independent variable, dependent variable, extraneous variables etc. in a research study;
- Distinguish between variable and constructs; and
- Differentiate hypothetical concept and intervening variable.

3.2 MEANING OF VARIABLES

A variable, as the name implies, is something that varies. This is the simplest way of defining a variable.

Webster says that a variable is "a thing that is changeable" or "a quantity that may have a number of different values." True, a variable is something that has at least two values: however, it is also important that the values of the variable be observable. Thus, if what is being studied is a variable, it has more than one value and each value can be observed. For example, the outcome of throwing a dice is a variable. That variable has six possible values (each side of the dice having one to six dots on it), each of which can be observed.

However, a behavioural scientist attempts to define a variable more precisely and specifically. Kerlinger (1986) defined variable 'a property that taken as different values'. According to D'Amato (1970) variables may be defined as those attributes of objects, events, things and beings, which can be measured. According to Postman and Egan (1949) a variable is a characteristic or attribute that can take on a number of values, for example, number of items that an individual solves on a particular test, the speed with which we respond to a signal, IQ, sex, level of anxiety, and different degree of illumination are the examples of variables that are commonly employed in psychological research.

Self Assessment Questions

1) Variable is a property that taken as different values. T / F
2) Unchangeable physiological and psychological characteristics of organism are called the organism variables. T / F
3) Variable are tangible. T / F
4) Variables are not related to theoretical concepts. T / F
5) Variables can be manipulated, controlled or observed by the experimenter. T / F

Answers: (1) T, (2) F, (3) T, (4) F, (5) T

Before discussing the types of variables, it is important to know how the variables of study related to theoretical concepts. Because the variables exist in the world but the theory is an idea, researcher makes certain assumption to relate the two. These assumptions are guide ropes that tie a theory to the real world. The variables are tangible: duration, frequency, rate, or intensity of bar presses; items checked on a questionnaire; murders committed; books written. The theoretical concept is intangible: hunger, motivation, anxiety. The variables are related to the theoretical concepts by means of the operational definitions used to measure the concepts.

Suppose a theory reveals that increasing anxiety will increase the affiliation motive. To test out this theory, you may take the theoretical concepts of anxiety and affiliation motive and relate them to variables by means of operational definitions. The theory is an abstract statement. .For example, anxiety can be measured by the Anxiety Scale and affiliation by how close people sit to each other in the experiment. These two measures constitute the variables of the study. The scores on the variables of anxiety and distance apart are related to one another as test of the hypothesis. The relationship between the variable is taken as providing support for or against the particular theory that generated the experiment.

3.3 TYPES OF VARIABLES

To understand how variables are used and discussed in psychological researches, you would like to understand several distinctions that are made among the type of variables. The descriptions of different types of variables are given below:

3.3.1 Stimulus, Organism and Response Variables

Psychologists are interested in studying the behaviour or causes of behaviour as variables. Many psychologists have adopted a theoretical viewpoint or model called the **S-O-R** model to explain all behaviour. The symbols **S, O,** and **R** represent different categories of variables. **S** is the symbol of stimuli, and the category may be referred to in general as stimulus variables. A stimulus variable is some form of energy in the environment, such as light, to which the organism is sensitive. **O** is the symbol for organism variables , that is the changeable physiological and psychological characteristics of the organisms being observed. Examples of such variables are anxiety level, age and heart rate etc. Finally, **R** is the symbol for response and, in general, response variables, which refer to some behaviour or action of the organism like pressing a lever, and reaction to any stimulus, are the examples of responses variables. You can understand an application of **S-O-R** model through the following example .

Suppose that an experiment is conducted in which a rat is placed on a metal grid floor, the grid is electrified, and the length of time it takes the rat to jump from the grid to a platform is measured. Using the **S-O-R** model, the electrical shock would be called a stimulus variable. The intensity of shock would be the value of the variable. The particular state of the organisms would be measured by the organismic variables. For example, the skin resistant of the rat at the time of shock was introduced would be an organismic variables. A response variable would be the latency (i.e. the elapsed time between the onsets of the shock and when the rat reaches the platform).

3.3.2 Independent and Dependent Variables

An *independent variable* or stimulus variable (as Underwood calls it) is that factor manipulated or selected by the experimenter in his attempt to ascertain its relationship to an observed phenomenon.

Dependent upon the mode of manipulation, some experts have tried to divide the independent variable into 'Type E' independent variable and 'Type S' independent variable (D'Amato, 1970). Type E independent variable is one of which is directly or experimentally manipulated by the experimental and type S

independent variable is one which is manipulated through the process of selection only. For example the experimenter wants to study the effect of noise upon the task performance in an industry. Here the IV (Independent Variable) is the noise and the DV(Dependent Variable) is the task performance. He may manipulate the noise by dividing into three categories — continuous noise, intermittent noise and no noise and examine its effect upon the task performance. Here the noise is being directly manipulated by the experimenter and hence, it constitutes the example of Type-E independent variable. Suppose, for the time being, that the experimenter is interested in answering the question: Is the rate of production dependent upon the age of the workers? Age is here the independent variable. For investigating this problem, the experimenter will have to select groups of workers on the basis of their age in a way by which he can get an appropriate representation from different age groups ranging from say, 16 to 55 years. Subsequently, he will compare the rate of production obtained by each age group and finally, conclude whether or not age is a factor in enhancement of the performance .Hence this constitutes the examples of S-independent variables.

A dependent variable is the factor that appears, disappears, or varies as the experimenter introduces, removes or varies the independent variable. (Townsend,1953). The dependent variable is a measure of the behaviour of the subject. The dependent variable is the response that the person or animal makes. This response is generally measured using at least one of several different dimensions (Alberto & Troutman 2006). The dimensions are – (a) frequency – Number of times that a particular behaviour occurs, (b) duration - the amount of time that a behaviour lasts. (c) latency –the amount of time between and when the behaviour is actually performed (d) force – the intensity or strength of a behaviour.

Here, you can examine the relationship between independent and dependent variables. The relationship is that of dependence. One variable depends upon the other. Suppose you find a relationship between meaningfulness of the learning material and speed of learning. Speed of learning then depends upon meaningfulness; the greater the meaningfulness, the faster the learning. The speed of learning is, therefore, called dependent variable; meaningfulness is independent variable. Similarly, rest between work periods is independent variables; output of work is dependent variable. Sudden noise is independent variable; change in breathing is dependent variable. In an experiment one discovers and confirms a relationship between an independent variable and a dependent variable.

Self Assessment Questions

Identify the independent and dependent variables?

1) As the number of trials increases error decreases.

.....

.....

.....

.....

.....

.....

2) Intensity of lights affects the task performance.

.....

.....

.....

.....

.....

3) Healthy parent child relationship facilitated emotional adjustment of the children.

.....

.....

.....

.....

.....

4) Teaching methods affects learning.

.....

.....

.....

.....

.....

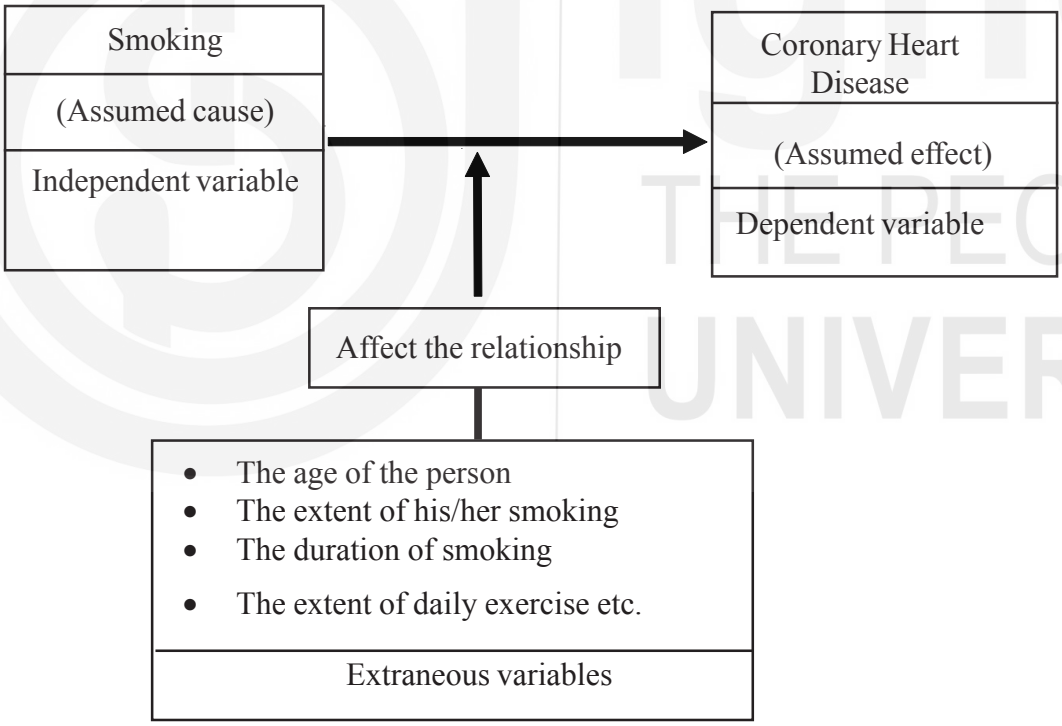
3.3.3 Extraneous and Confounded Variables

Any and all other variables that may 'mask' the relationship between independent variable and dependent variable are known as extraneous variables. *Extraneous variables* may directly affect the dependent variable or may combine with the independent variable to produce an affect. Therefore, extraneous variables must be controlled so that the experimenter can determine whether the dependent variable changes in relation to variation in the independent variable. Several others factors operating in a real life situation may affect changes in the dependent variable. These factors, not measured in the study, may increase or decrease the magnitude or strength of the relationship between independent and dependent variables. Extraneous variables are relevant in nature, and in experimental studies, they belong to three major types i.e., organismic variables, situational variables and sequential variables. The subject related variables include age, sex, intelligence, personality etc. are organismic variables. The situational variables include environmental variables operating in the experimental setting (e.g. noise, temperature, humidity) and variables related to the experimental task. The sequence related variables deal with sequence effects. They arise when participants in experiments are required to be tested in several conditions. Exposure to many conditions may result in adaptation, fatigue or practice effects which, if allowed to operate, may make the results difficult to interpret.

Confounding variables is one that varies with the independent variable. While doing a study if we are not careful then two variables may get combined so that the effect of one cannot be separated from the effect of other. This is known as confounding. For instance, if you conducted a study of the effect of television viewing on perception of violence and the experimental group contained only adolescents, whereas the control group only adults, the age of participants would be confounded with the independent variable under study. Confounding makes the conclusions of the study doubtful. It is ,therefore, necessary that effort should be made to unconfound the variables.

To explain these variables let us take one example. Suppose you want to study the relationship between smoking and coronary heart disease. You assume that affecting this relationship, such as a number of cigarettes or the amount of tobacco smoked every day; the duration of smoking; the age of the smoker; dietary habits; and the amount of exercise undertaken by the individuals. All of these factors may affect the extent to which smoking might cause coronary heart disease. These variables may either increase or decrease the magnitude of the relationship. In this example, the extent of smoking is the independent variable, coronary heart disease is the dependent variable and all the variables that might affect this relationship, either positively or negatively, are extraneous variables.

Independent, dependent & extraneous variables in a causal relationship



3.3.4 Active and Attribute Variables

Any variable that is manipulated is called *active variables*. Examples of active variables are reward, punishment, methods of teaching, creating anxiety through instructions and so on. *Attribute variable* is that variable which is not manipulated but measured by the experimenter. Variables that are human characteristics like intelligence, Aptitudes, sex, socio economic status, education, field dependence and need for achievement are the example of attributes variables. The word 'attribute' is more accurate enough when used within animated objects or references. Organisations, institutions, groups, population and geographical areas

have attributes. Organisations are variably productive; groups differ in cohesiveness; geographical areas vary widely in resources.

3.3.5 Quantitative and Categorical Variables

Quantitative variables is one that varies in amount whereas categorical variables varies in kind. Speed of response, intensity of sound, level of Illumination, intelligence etc. are the example of quantitative variables and gender, race, religion are the example of categorical variables. Precise and accurate measurement are possible with the quantitative variables because they can be easily ordered in terms of increasing and decreasing magnitude categorical variables can be of three types: Constant, dichotomous and polytomous.

When a variable can have only one value or category, for example taxi, tree and water, it is known as a constant variables. When a variable can have only two categories as in yes/no, good/bad and rich/poor, it is known as dichotomous variables. When variables can be divided into more than two categories, for example: religion (Christian, Muslim, Hindu); political parties (Labor, Liberal, Democrat); and attitudes (strongly favorable, favorable, uncertain, unfavorable, strongly unfavorable), it s called a polytomous variable.

Self Assessment Questions

1) The event manipulated or altered by the experimenter is termed as ....

2) The ..... is the response that the person or animal makes.

3) Any and all other variables that may mask the relationship between independent variable and dependent variables are known as .....

4) Manipulated variables are called ..... and measures variable are called .....

5) ..... is one that varies in amount whereas ..... varies in kind.

Answer: (1) Independent variables (2) Dependent variables (3) Extraneous variables (4) Active variables, Attribute variables (5) Quantitative variables & Categorical variables.

3.3.6 Continuous Variables and Discrete Variables

Quantitative variables are further divided into two categories, namely, continuous variables and discrete variables. A distinction between continuous and discrete variables is especially useful in planning of research and analysis of data. A *continuous variable* is one which is capable of being measured in any arbitrary degree of fineness or exactness. Age, height, intelligence, reaction time, etc., are some of the examples of a continuous variable. The age of the person can be measured in years, month and days. Thus, all such variables which can be measured in the smallest degree of fineness are called continuous variable. The *discrete variables* are those variables which are not capable of being measured in any arbitrary degree of fineness or exactness because the variables contain a clear gap. For example, the number of members in a family, no. of females in particular group, no of books in library and so on constitutes the examples of a discrete variable.

Activity -1

Check whether the following are continuous or discrete variables:

	C	D
a) the bar presses that a rat makes in a Skinner box	( )	( )
b) the height of six-year-old boys and girls in Chicago	( )	( )
c) the score you make on a true-false exam	( )	( )
d) the distance various people can travel in 5 hours	( )	( )

Activity -2

Identity Types of Variables

A researcher wants to administer an intelligence test to 30 college students. After collecting information on subjects' age, sex, height, weight, political preference, career goals, and socioeconomic status, the researcher administers and attitude survey on current issues to all 30 subjects.

Required:

Identify examples of the following types of variables in the paragraph and the scales by which they would be measured:

a) discrete

b) continuous

c) categorical

d) quantitative

3.4 CONSTRUCTS

The terms 'concept' and 'construct' have similar meanings. Yet, there is an important distinction. A concept may be defined as any describable regularity of real or imagined events or objects (Bourne, Ekstrand, & Dominowski, 1971). A concept is a set of features connected by some rule (Hulse, Egeth, Deese 1980) Concepts are building block of thinking. They allow us to organise knowledge in systematic ways. Concept represents objectives of activities, ideas or living organism. Concept also represents properties, abstraction and relations between the features. For example – 'achievement'. It is an abstraction formed from the observation of certain behaviours of children. These behaviours are associated with the mastery or "learning" of school tasks – reading words, doing arithmetic problems, drawing pictures, and so on. The various observed behaviours are put together and expressed in a word – 'achievement'. 'Intelligence', 'aggressiveness,' 'conformity', and 'honesty' are all concepts used to express varieties of human behaviour of interest to behavioural scientists. Researcher often invents or constructs new concepts for special scientific purposes; such concepts are called constructs.

Thus, you may well explain construct as concept. It has the added meaning i.e invented or adopted for a special scientific purpose. For example, "Intelligence" is a concept, an abstraction from intelligent and nonintelligent behaviours. But, as a scientific construct, "intelligence" means both more and less than a concept. It means that scientists consciously and systematically use it in two ways. One, it

enters into theoretical schemes and related in various ways to other constructs. In this sense, school achievement may also be, in part, a function of intelligence and motivation. Two, "intelligence" is so defined and specified that it can be observed and measured. We can make observations of the intelligence of children by administering X intelligence test to them, or we can ask teachers to tell us the relative degrees of intelligence of their pupils.

Constructs are created and used for a wide variety of reasons, but generally have two common characteristics. First, the construct is a part of a theoretical framework and is related in various ways to other constructs. Second, a construct usually operationally defined so as to allow its observation and measurement. An example of a commonly employed psychological construct would be reinforcement. On a theoretical level, reinforcement can be, and is, related to other constructs such as drive, motivation, association, and habit strength.

Further reinforcement may be operationally defined as any stimulus or event which increases the probability of the occurrence of a (desired) response.

3.5 TYPES OF CONSTRUCTS

As Mac-Corquodale & Meehl, (1948) Indicated that there are two types of constructs which are often employed by psychologist and behavioural scientist:

Intervening variables

Hypothetical construct

3.5.1 Intervening Variables

An intervening variable is construct which is utilised as a summary term for a group of other construct; It has no meaning apart from context in which it is utilised. As you know, Clark Hull, a behaviourist who proposed hypothetical deductive method of learning, utilised intervening variables in the formation of the learning theory. Hull defined reaction potential as the combination of habit strength and drive (Hilgard & Bower, 1966). Reaction potential is an intervening variable, since it only summarizes other constructs (habits strength and drive) and has meaning only in relation to them. An example of intervening variable is, hostilitywhich is inferred from hostile and aggressive acts.

3.5.2 Hypothetical Constructs

In contrast, a hypothetical construct is a theoretical term which is employed to describe something "real." That is, it is an intermediary which has tangible characteristics. Habit strength, defined by Hull as the number of reinforced trials, is a hypothetical construct. As another example, the word "reflex" refers to certain readily observable characteristics. The patellar reflex or "knee jerk" occurs when a small force is sharply applied at the appropriate point on the knee. The term "reflex" refers t the chain of events that occurs within the organism after the application of the stimulus and before the response. Hence, reflex is a hypothetical construct.

As a further example, suppose an equation could be developed which would tell us how much a person knows:

$$K = AC \times IQ$$

Where:

K = knowledge

AC = amount of conditioning

IQ = intelligence

AC could be defined as the number of reinforced trials a person receives and IQ as that person's score on a standard intelligence test. K could be defined as being a function of AC and IQ. Therefore, AC and IQ are hypothetical constructs (they describe something real and are defined directly by the operations that established them or by which they were measured). On the other hand, K is an intervening variables (it has no meaning of its own, but only summarizes or stands for other constructs). However, if K were defined as the number of correct solutions a person achieved on the "knowledge test," then K would also be a hypothetical construct.

Self Assessment Questions

Which of the following constructs (as used) would be classified as an Intervening Variable(IV) or a Hypothetical Construct (HC)?

		IV	HC
1)	Thinking is the mental activity leading to problem solving.	( )	( )
2)	Arousal is he increase in neural activity in the lower brain stem following stimulation.	( )	( )
3)	A reinforcement is something that makes you want to repeat the behaviour that was rewarded.	( )	( )
4)	The id is the deepest part of the psyche and motivates our "base" desires.	( )	( )

3.6 LET US SUM UP

Knowledge of different types of variables and constructs play a crucial role in research. Variables and constructs are important in bringing clarity and specificity to the conceptualising of a research problem, to formulation of hypothesis and to the development of a research instrument. They affect how the data can be analysed, what statistical test can be applied to the data, what interpretation can be made and what conclusion can be drawn. A variable is some property of an event that takes on different values. There are different kinds of variables such as independent variables, dependent variables, quantitative variables and categorical variables, active and attribute variables, continuous and discrete variables, extraneous and intervening variables and so on. A construct is a concept. It has an added meaning and it is adopted for a special scientific purpose. Constructs are of two types; intervening and hypothetical constructs. Intervening variables is a term which is internal and directly unobservable psychological processes that, in turn, inferred from behaviour. A hypothetical construct is a theoretical term which is employed to describe something "real." That is, it is an intermediary which has tangible characteristics.

3.7 UNIT END QUESTIONS

1) Defined variable and discuss the various kinds of variable.
2) Explain Intervening variables and Hypothetical constructs in your own words.
3) Differentiate between variables and constructs. Giving suitable example elucidate the different types of variables.
4) Write short notes on any two:
   i) Independent & dependent variables.
   ii) Quantitative & categorical variables.
   iii) Active & attribute variables.
5) Explain the nature of extraneous variable with suitable examples.

3.8 GLOSSARY

Variable : A variable is a property that taken as different values.

Independent variables : The condition manipulated or selected by the experimenter to determine its effect on behaviour.

Dependent variables : A measure of the subject's behaviour that reflects that independent variable's effects.

Quantitative variable : One that varies in amount.

Categorical variable : One that varies in kind.

Continuous variable : One that falls along a continuum and is not lifted to a certain number of values.

Discrete variable : One that that falls into separate bins with no intermediate values possible.

Active variables : Manipulated variables are active variables.

Attribute variables : Measured variables are attribute variables.

Constructs : Is a concept, used for scientific purpose, is a part of theoretical framework.

Intervening variables : Is a construct which is utilised as a summary term for a group of other constructs.

Hypothetical constructs : Is a theoretical term which is employed to describe something real.

3.9 SUGGESTED READINGS AND REFERENCES

Alberto, P.A. & Troutman, A.C. (2006). *Applied Behaviour Analysis for Teachers* (7th ed). Columbus: OH: Merill.

D'Amato, M. R. (1970). *Experimental Psychology: Methodology, Psychophysics and Learning*. Tokyo: McGraw-Hill Kogakusha, Ltd.

References

Hilgard, E., & Bower, G. *Theories of Learning*. New York: Appleton-Century-Crofts.

Kerlinger, F. N. (1986). *Foundations of Behavioural Research*. New York: Holt Rinehart and Winston.

Bourne, L.E., Ekstrand, B., & Dominowski, R. 1971. *The Psychology of Thinking*. Englewood Cliffs, N.J.: Prentice-Hall.

MacCorquodale, K., & Meehl, P.E.(1948). On a distinction between hypothetical constructs and intervening variables. *Psychological Review*, 55, 95-107.

Postman , L. and Egan, J.P. (1949). *Experimental Psychology.* New York; Harper & Row

Townsend, J. C. (1953). *Introduction to Experimental Methods*. New York: McGraw-Hill.

UNIT 4 HYPOTHESIS FORMULATION AND SAMPLING

Structure

4.0 INTRODUCTION

Scientific process or all empirical sciences are recognised by two inter-related concepts, namely; (a) context of discovery (getting an idea) and (b) context of justification (testing and results). Hypotheses are the mechanism and container of knowledge moving from the unknown to known. These elements form techniques and testing ground for scientific discovery. Hypotheses are tentative explanation and potential answer to a problem. Hypothesis gives the direction and helps the researcher interpret data. In this unit, you will be familiarised with the term hypothesis and its characteristics. It is, then, followed by the hypothesis formulation and types of hypothesis. Errors in hypothesis testing are also highlighted.

Further, In order to test the hypothesis, researcher rarely collects data on entire population owing to high cost and dynamic nature of the individual in population. Therefore, they collect data from a subset of individual – a sample - and make the inferences about entire population. This leads us to what we should know about the population and sample. So, researcher plans sample design and uses

various method of sampling. This unit will acquaint you with the meaning of sampling and basic terminology which is used in sampling design.

Now, it will move to purpose of sampling. And finally, various probability and non-probability sampling methods along with advantages and disadvantages are described.

4.1 OBJECTIVES

After reading this unit, you will be able to:

- Define and describe hypothesis and its characteristics;
- explain formulation of hypothesis;
- Enumerate the possible difficulties in formulating hypothesis;
- Explain types of hypotheses;
- Identify in hypotheses testing;
- Define sampling;
- Explain the purpose of sampling; and
- Analyse various probability and non-probability sampling methods.

4.2 MEANING AND CHARACTERISTICS OF HYPOTHESIS

In conducting research, the important consideration after the formulation of a research problem is the construction of hypothesis. As you know, any scientific inquiry starts with the statement of a solvable problem, when the problem has been stated, a tentative solution in the form of testable proposition is offered by the researcher.

Hypothesis is often considered a tentative and testable statement of the possible relationship between two or more events / variables under investigation.

According to Mcguigan (1990), 'a testable statement of a potential relationship between two or more variables, i.e. advance as potential solution to the problem'. Kerlinger (1973) defined 'a hypothesis is a conjectural statement of the relation between two or more variables'. In order to be useful in any study, the hypothesis needs to be stated in such a way that it might be subjected to empirical testing. The researcher is responsible to suggest or find some way to check how the hypothesis stands against empirical data. When a hypothesis is formulated, the investigator must determine usefulness of the formulated hypothesis. There are several criteria or characteristics of a good research hypothesis. A good hypothesis is one which meets such criteria to a large extent. Some of these characteristics are enumerated below:

1) Hypothesis should be conceptually clear;
2) Hypothesis must be testable;
3) Hypothesis should be related to the existing body or theory and impact;
4) Hypothesis should have logical unity and comprehensiveness;
5) Hypothesis should be capable of verification; and
6) Hypothesis should be operationisable.

4.3 FORMULATION OF HYPOTHESIS

Science proceeds with observation, hypothesis formulation and hypothesis testing. After testing the hypothesis, through various statistical tests, researcher can accept or reject the hypothesis. If the hypothesis is accepted then researcher can replicate the results, if hypothesis is rejected then researcher can refined or modify the results.

By stating a specific hypothesis, the researcher narrows the focus of the data collection effort and is able to design a data collection procedure which is aimed at testing the plausibility of the hypothesis as a possible statement of the relationship between the terms of the research problem.

It is, therefore, always useful to have a clear idea and vision about the hypothesis. It is essential for the research question as the researcher intents to verify, as it will direct and greatly help to interpretation of the results.

4.4 POSSIBLE DIFFICULTIES IN FORMULATION OF A GOOD HYPOTHESIS

There are three major possible difficulties; a researcher could face during formulation of hypothesis. First, the absence of knowledge of a theoretical framework is a major difficulty in formulating a good research hypothesis. Second, if detailed theoretical evidences are not available or if the investigator is not aware of the availability of those theoretical evidences, a research hypothesis cannot be formulated. Third, when the investigator is not aware of the scientific research techniques, she/he will not be able to frame a good research hypothesis.

Despite these difficulties, the investigator attempts in her/his research to formulate a hypothesis. Usually the hypothesis is derived from the problem statement. The hypothesis should be formulated in a positive and substantive form before data are collected. In some cases additional hypothesis may be formulated after collection of data, but they should be tested on a new set of data and not on the old set which has suggested it. The formulation of a hypothesis is a creative task and involves a lot of thinking, imagination and innovation. Reichenbach (1938) has made a distinction between the two processes found commonly in any hypothesis formulation task. One is the context of discovery and another is the context of justification. The manner or the process through which a scientist arrives at a hypothesis illustrates the context of justification. A scientist is concerned more with a context of justification in the development of a hypothesis. He never puts his ideas or thoughts as they nakedly occur in the formulation of a hypothesis. Rather, he logically reconstructs his ideas or thoughts and draws some justifiable inferences from those ideas and thoughts. He never cares to relate how he actually arrived at a hypothesis. He does not say, for example, that while he was shaving, this particular hypothesis occurred to him. He usually arrives at a hypothesis by the rational reconstruction of thoughts. When a scientist reconstructs his thoughts and communicates them in the form of a hypothesis to others, he uses the context of justification. When he arrives at a hypothesis, he extensively as well as intensively surveys a mass of data, abstracts them, tries to find out similarities among the abstracted data and finally makes a generalisation or deduces a preposition in the form of a hypothesis.

Here is an important distinction to be made between formulating a hypotheses and choosing one. Although a researcher often becomes interested in a question about human behaviour for personal reasons, the ultimate value of research study depends on the researcher bringing methodological criteria to bear on the selection of the hypothesis to be tested. In other words, Good hypothesis are made, not born.

Hypothesis plays a key role in formulating and guiding any study. The hypotheses are generally derived from earlier research findings, existing theories and personal observations and experience. For instance, you are interested in knowing the effect of reward on learning. You have analysed the past research and found that two variables are positively related. You need to convert this idea in terms of a testable statement. At this point you may develop the following hypothesis.

Those who are rewarded shall require lesser number of trails to learn the lesson than those who are not rewarded.

A researcher should consider certain points while formulating a hypothesis:

i) Expected relationship or differences between the variables.

ii) Operational definition of variable.

iii) Hypotheses are formulated following the review of literature

The literature leads a researcher to expect a certain relationship.

Hypotheses are the statement that is assumed to be true for the purpose of testing its validity.

As suggested by Russell and Reichenback (1947), the hypotheses should be stated in the logical form on the general implications. A hypothesis can be put in the form of an if ..... then statement; if A is true then B should follow. For example, verbal development theory of amnesia states that childhood amnesia caused by the development of language. To test this theory, researcher can make a hypothesis like this – if the lack of verbal ability is responsible for childhood amnesia, then the children should not be able to verbally recall events usually words that they did not know at the time of events.

Self Assessment Questions

Fill in the blanks

1) Hypothesis is considered as ..... and ..... statement of the possible relationship between two or more variables.

2) Hypothesis can be put in the form of an if ….. statement.

3) Hypothesis is formulated……. to review of literature.

4) …… of knowledge of a theoretical framework is a major difficulty in formulating a hypothesis.

5) Formulation of a hypothesis enhances ..... in the study.

Answers: (1) tentative, testable, (2) then, (3) Prior, (4) Absence, (5) Objectivity.

4.5 TYPES OF HYPOTHESES

As explained earlier, any assumption that you seek to validate through investigation is called hypotheses. Hence theoretically, there should be one type of hypotheses on the basis of the investigation that is, research hypothesis. However, because of the conventions in scientific enquiries and wording used in the constructions of the hypothesis, Hypotheses can be classified into several types, like; universal hypotheses, existential hypotheses, conceptual hypotheses etc. Broadly, there are two categories of the hypothesis:

i) Null hypothesis

ii) Alternative hypothesis

4.5.1 Null Hypothesis

Null hypothesis is symbolised as Ho. Null hypothesis is useful tool in testing the significance of difference. In its simplest form, this hypothesis asserts that there is no true difference between two population means, and the difference found between sample means is, accidental and unimportant, that is arising out of fluctuation of sampling and by chance. Traditionally null hypothesis stated that there is zero relationship between terms of the hypothesis. For example, (a) schizophrenics and normal do not differ with respect to digit span memory (b) There is no relationship between intelligence and height.

The null hypothesis is an important component of the decision making methods of inferential statistics. If the difference between the samples of means is found significant the researcher can reject the null hypothesis. It indicates that the differences have statistically significant and acceptance of null hypothesis indicates that the differences are due to chance. Null hypothesis should always be specific hypothesis i.e. it should not state about or approximately a certain value.

The null hypothesis is often stated in the following way:

$$H_o: \mu_{HV} \leq \mu_{LV}$$

Thus, the null hypothesis is that mean of the population of those children who have the high vocabulary (group1) is less than or equal to mean of those who lack the vocabulary (Group 2).

4.5.2 Alternative Hypothesis

Alternative hypothesis is symbolised as H_1 or Ha, is the hypothesis that specifies those values that are researcher believes to hold true, and the researcher hopes that sample data will lead to acceptance of this hypothesis as true. Alternative hypothesis represents all other possibilities and it indicates the nature of relationship.

The alternative hypothesis is stated as follows:

$$H_1: \mu_{HV} > \mu_{LV}$$

The alternative hypothesis is that the mean of population of those who have the vocabulary is grater than the mean of those to lack the vocabulary. In this example the alternative hypothesis is that the experimental population had higher mean than the controls. This is called directional hypothesis because researcher predicted

that the high vocabulary children would differ in one particular direction from the low vocabulary children. Sometimes researcher predicts only that the two groups will differ from each other but the researcher doesn't know which group will be higher. This is non directional hypothesis.

The null and alternative hypothesis in this case would be stated as follows:

$$H_o: \mu_1 = \mu_2$$

$$H_1: \mu_1 ? \mu_2$$

Thus, the null hypothesis is that mean of group 1 equals the mean of group 2, and the alternative hypothesis is that the mean of group 1 does not equal the mean of group 2.

4.6 ERRORS IN TESTING A HYPOTHESIS

You have already learned that hypotheses are assumptions that may be prove to be either correct or incorrect. It is possible to arrive at a incorrect conclusion about a hypothesis for the various reasons if –

- Sampling procedure adopted faulty
- Data collection method inaccurate
- Study design selected is faulty
- Inappropriate statistical methods used
- Conclusions drawn are incorrect

Two common errors exist when testing a hypothesis.

Type I error – Rejection of a null hypothesis when it is true.

Type II error - Acceptance of a null hypothesis when it is false.

Self Assessment Questions (State True and False)

1) Null hypothesis is denoted by H_1. T/F

2) If the hypothesis is accepted then researcher can replicate the results. T/F

3) Rejection of a null hypothesis when it is true is called type II error. T / F

4) Hypothesis can be stated directional and non directional. T / F

5) Alternative hypothesis specifies values that researcher believes to hold true. T / F

Answers : (1) F, (2) T, (3) F, (4) T, (5) T

4.7 IMPORTANCE OF HYPOTHESIS FORMULATION

Hypothesis is the basic function of the scientific research. If simple, brief and clear scientific hypothesis has been formulated, there shall be no problem for the investigator to proceed in the research field. Its utility or importance for and research may be studied as under.

Accordingly to Goode and Hatt ('without' hypothesis formulation the research is unfocussed, a random empirical wandering. The results can not be studied as facts with clear meaning. Formulation of hypothesis links between theory and investigation which lead to discovery of addition to knowledge.

Self Assessment Questions

Study the following research questions and state the possible hypothesis with specify their types specify their types.

1) Is physical attractiveness related to friendship?

.....

.....

.....

.....

.....

.....

2) Does meaningful of material affect the rate of learning?

.....

.....

.....

.....

.....

.....

3) Does reinforcement improve the learning for solving simple discrimination task?

.....

.....

.....

.....

.....

4) Does onset of fatigue reduce the efficiency of the worker?

.....

.....

.....

.....

.....

.....

4.8 SAMPLING

Researchers usually can not make direct observation of every individual in the population under study. Instead, they collect data from a subset of individuals- a sample – and use those observations to make inferences about the entire population.

Ideally, the sample corresponds to the larger population on the characteristics of (s) of interest. In that case, the researcher's conclusions from the samples are properly applicable to the entire population.

Sampling is the process of selection of units (e.g. people, organisation) from a population of interest so that by studying the sample may fairly generate results back to the population from which they were chosen.

4.8.1 Definition of Sampling

According to Young (1992) "A statistical sample is miniature picture of cross selection of the entire group or aggregate from which the sample is taken".

According to Goode and Hatt(1981) "A sample, as the name implies, is a smaller representative of a large whole".

According to Blalock (1960) "It is a small piece of the population obtained by a probability process that mirrors with known precision, the various patterns and sub-classes of population".

4.8.2 Sampling Terminology

Before we explain the purpose, uses and method of sampling, it will be better to describe those fundamental terms which are concerned to sampling concepts and principles.

Population: Population is a well defined set up of all elements pertaining to a given characteristic. It refers to the whole that include all observations or measurements of a given characteristic. Population is also called universe or population. It may be defined as any identifiable and well specified group of individual for example. All primary teachers, nonumber of all college teachers and all university students are the example of population. A population may be finite or infinite.

A finite population is one where all the members can be easily counted. An infinite population is one whose size is unlimited, and can not count easily. Population of college teachers is an example of finite population and production of wheat, and fishes in river are the example of infinite population. A measure based upon the entire population is called a parameter.

Sample: A sample is any number of persons selected to represent the population according to some rule of plan. Thus, a sample is a smaller representation of the population. A measure based upon a sample is known as a statistic.

Sample size: No. of selected individual for example, no. of students, families from whom you obtain the require information is called the sample size and usually denoted by the letter (n).

Sampling design or strategy: The way researcher selects the sample or students or families etc. is called the sampling design and strategy. It refers to the techniques or procedures the researcher would adopt in selecting some sampling units from which inferences about the population are drawn.

Sampling unit: Each individual or case that becomes the basis for selecting a sample is called sampling unit or sampling elements.

Sampling frame: The list of people from which the sample is taken. It should be comprehensive, complete and up-to-date. Examples of sampling frame: Electoral Register; Postcode Address File; telephone book.

Self Assessment Questions (Fill in the blanks)

1) Any identifiable and well specified group of individual is known as .....
2) List of all the units of the population is called .....
3) Purposes of sampling is to derive the desired information about the population at the minimum ..... and maximum .....
4) The way the researcher selects the sample is known as .....
5) ..... is the miniature picture of entire group.

Answers: (1) population, (2) sampling frame, (3) cost, reliability, (4) sampling design, (5) sample.

4.8.3 Purpose of Sampling

The objective of sampling is to derive the desired information about the population at the minimum cost or with the maximum reliability. Further, the aims in selecting a sample are to achieve maximum precision in estimates within a given sample size and to avoid bias in the selection of sample. Bias in the selection of sample can take place if: (a) the researcher selects the sample by non random method and influenced by human choice. (b) The researcher does not cover the sampling population accurately and completely (c) A section of a sample population is impossible to find or refuses to cooperate.

4.9 SAMPLING METHODS

Blalock (1960) indicated that most sampling methods could be classified into two categories:

i) Non probability sampling methods
ii) Probability sampling methods

4.9.1 Non Probability Sampling Methods

Non probability sampling is one is which there is no way of assessing the probability of the element or group of elements, of population being included in the sample. In other words, non-probability sampling methods are those that provide no basis for estimating how closely the characteristics of sample approximate the parameters of population from which the sample had been obtained. This is because non probability sample do not use the techniques of random sampling. Important techniques of non probability sampling methods are:

i) Haphazard, Accidental, or Convenience Sampling

Haphazard sampling can produce ineffective, highly unrepresentative samples and is not recommended. When a researcher haphazardly selects cases that are convenient, he or she can easily get a sample that seriously misrepresents the population. Such samples are cheap and quick; however, the systematic errors that easily occur make them worse than no sample at all. The person-on-the-street interview conducted by television programs is an example of a haphazard sample. Likewise, television interviewers often select people who look "normal" to them and avoid people who are unattractive, poor, very old, or inarticulate. Such haphazard samples may have entertainment value, but they can give a distorted view and seriously misrepresent the population.

For example, an investigator may take student of class X into research plan because the class teacher of the class happens to be his / her friend. This illustrates accidental or convenience sampling.

ii) Quota Sampling

Quota Sampling is an improvement over haphazard sampling. In quota sampling, a researcher first identifies relevant categories of people (e.g., male and female; or under age 30, ages 30 to 60, over age 60, etc.), then decides how many to get in each category. Thus, the number of people in various categories of the sample is fixed. For example, a researcher decides to select 5 males and 5 females under age 30, 10 males and 10 females aged 30 to 60, and 5 males and 5 females over age 60 for a 40-person sample. It is difficult to represent all population characteristics accurately.

Quota sampling ensures that some differences are in the sample. In haphazard sampling, all those interviewed might be of the same age, sex, or background. But, once the quota sampler fixes the categories and number of cases in each category, he or she uses haphazard or convenience sampling. Nothing prevents the researcher from selecting people who act friendly or who want to interviewed. Quota sampling methods are not appropriate when the interviewers choose who they like (within above criteria) and may therefore select those who are easiest to interview, so, sampling bias can take place. Because not using the random method, it is impossible to estimate the accuracy. Despite these limitations, quota sampling is a popular method among non-probability methods of sampling, because it enables the researcher to introduce a few controls into his research plan and this methods of sampling are more convenient and less costly then many other methods of sampling.

iii) Purposive sampling

Purposive sampling is a valuable kind of sampling for special situations. It is used in exploratory research or in field research. It uses the judgment of an expert in selecting cases or it selects cases with a specific purpose in mind. With purposive sampling, he researcher never knows whether the cases selected represent the population. Purposive sampling is appropriate to select unique cases that are especially informative.

For example, a researcher wants to study the temperamental attributes of certain problem behaviour children. It is very difficult to list all certain problem behaviour children and sample randomly from the list. The researcher uses many different

methods to identity these cases and approach them to obtain the relevant information. The primary consideration in purposes sampling is the judgment of researcher as to who can provide the best information to achieve the objectives of the study. The researcher only goes to those people who in his / her opinion are likely to have the required information and be willing to share it.

For studying attitude toward any national issue, a sample of journalists, teacher and legislators may he taken as an example of purposive sampling because they can more reasonably be expected to represent the correct attitude than other class of people residing in country.

Purposes sampling is some what less costly, more readily accessible, more convenient and select only those individual that are relevant to research design.

Despite these advantages of purposes sampling, there is no way to ensure that the sample is truly represent of the population and more emphasis is placed on the ability of researcher to assess the elements of population.

iv) **Snowball sampling**

Snowball sampling is also known as network, chain referral or reputation sampling method. Snowball sampling which is a non probability sampling method is basically sociometric. It begins by the collection of data on one or more contacts usually known to the person collecting the data. At the end of the data collection process (e.g., questionnaire, survey, or interview), the data collector asks the respondent to provide contact information for other potential respondents. These potential respondents are contacted and provide more contacts. Snowball sampling is most useful when there are very few methods to secure a list of the population or when the population is unknowable.

Snowball sampling has some advantages— 1) Snowball sampling, which is primarily a sociometric sampling technique, has proved very important and is helpful in studying small informal social group and its impact upon formal organisational structure, 2) Snowball sampling reveals communication pattern in community organisation concepts like community power; and decision-making can also be studied with he help of such sampling technique.

Snowball sampling has some limitations also— 1) Snowball sampling becomes cumbersome and difficult when is large or say it exceeds 100, 2) This method of sampling does not allow the researcher to use probability statistical methods. In fact, the elements included in sample are not randomly drawn and they are dependent on the subjective choices of the originally selected respondents. This introduces some bias in the sampling.

v) **Systematic sampling**

Systematic sampling is another method of non-probability sampling plan, though the label 'systematic' is somewhat misleading in the sense that all probability sampling methods are also systematic sampling methods. Due to this, it often sounds that systematic sampling should be included under one category of probability sampling, but in reality this is not the case.

Systematic sampling may be defined as drawing or selecting every ninth person from a predetermined list of elements or individuals. Selecting every 5th roll

number in a class of 60 students will constitute systematic sampling. Likewise, drawing every 8th name from a telephone directory is an example of systematic sampling. If we pay attention to systematic sampling plan, it become obvious that such a plan possesses certain characteristics of randomness (first element selected is a random one) and at the same time, possesses some non-probability traits such as excluding all persons between every ninth element chosen.

Systematic sampling is relatively quick method of obtaining a sample of elements and it is very easy to check whether every ninth number or name has been selected. Further Systematic sampling is easy to used.

Despite these advantages, systematic sampling ignores all persons between every ninth element chosen. Then it is not a probability sampling plan. In Systematic sampling there is a chance to happen the sampling error if the list is arranged in a particular order.

Activity
Make a list of some research studies where some of the non probability methods could be used. Also justify the choice of particular sampling method you have selected for the study.

4.9.2 Probability Sampling

Probability sampling methods are those that clearly specify the probability or likelihood of inclusion of each element or individual in the sample. Probability sampling is free of bias in selecting sample units. They help in estimation of sampling errors and evaluate sample results in terms of their precision, accuracy and efficiency and hence, the conclusions reached from such samples are worth generalisation and comparable to similar population to which they belong. Major probability sampling methods are:

i) **Simple random sampling**

A simple random sample is a probability sample. A simple random sample requires (a) a complete listing of all the elements (b) an equal chance for each elements to be selected (c) a selection process whereby the selection of one element has no effect on the chance of selecting another element. For example, if we are to select a sample of 10 students from the seventh grade consisting of 40 students, we can write the names (or roll number) of each of the 40 students on separate slips of paper – all equal in size and colour – and fold them in a similar way. Subsequently, they may be placed in a box and reshuffled thoroughly.

A blindfolded person, then, may be asked to pick up one slip. Here, the probability of each slip being selected is 1-40. Suppose that after selecting the slip and noting the name written on the slip, he again returns it to the box. In this case, the probability of the second slip being selected is again 1/40. But if he does not return the first slip to the box, the probability of the second slip becomes 1/39. When an element of the population is returned to the population after being selected, it is called sampling with replacement and when it is not returned, it is called sampling without replacement.

Thus random sampling may be defined as one in which all possible combinations of samples of fixed size have an equal probability of being selected.

Advantages of simple random sampling are:

1) Each person has equal chance as any other of being selected in the sample.
2) Simple random sampling serves as a foundation against which other methods are sometimes evaluated.
3) It is most suitable where population is relatively small and where sampling frame is complete and up-to-date.
4) As the sample size increases, it becomes more representative of universe.
5) This method is least costly and easily assessable of accuracy.

Despite these advantages, some of the disadvantages are:

1) Complete and up-to-date catalogued universe is necessary.
2) Large sample size is required to establish the reliability.
3) When the geographical dispersion is so wider therefore study of sample item has larger cost and greater time.
4) Unskilled and untrained investigator may cause wrong results.

Activity

In a class of 140 students, select a simple random sample of size 20 students with replacement technique. Also mention the probability of each one of 140 students being included in the sample.

ii) **Stratified random sampling**

In stratified random sampling the population is divided into two or more strata, which may be based upon a single criterion such as sex, yielding two strata-male and female, or upon a combination of two or more criteria such as sex and graduation, yielding four strata, namely, male undergraduates, male graduates, female undergraduates and female graduates. These divided populations are called subpopulations, which are non-overlapping and together constitute the whole population.

Having divided the population into two or more strata, which are considered to be homogeneous internally, a simple random sample for the desired number is taken from each population stratum. Thus, in stratified random sampling the stratification of population is the first requirement.

There can be many reasons for stratification in a population.

Two of them are:

1) Stratification tends to increases the precision in estimating the attributes of the whole population.
2) Stratification gives some convenience in sampling. When the population is divided into several units, a person or group of person may be deputed to supervise the sampling survey in each unit.

Advantages of stratified Random Sampling are:

1) Stratified sampling is more representative of the population because formation of stratum and random selection of item from each stratum make it hard to exclude in strata of the universe and increases the sample's representation to the population or universe.

2) It is more precise and avoids the bias to great extent.

3) It saves time and cost of data collection since the sample size can be less in the method.

Despite these advantages, some of the disadvantages of stratified sampling are:

1) Improper stratification may cause wrong results.

2) Greater geographical concentration may result in heavy cost and more time.

3) Trained investigators are required for stratification.

iii) **Cluster sampling**

A type of random sample that uses multiple stages and is often used to cover wide geographic areas in which aggregated units are randomly selected and then sample are drawn from the sampled aggregated units or cluster

For example, if the investigator wanted to survey some aspect of 3rd grade elementary school going children. First, a random sample of number of states from the country would be selected. Next, within each selected state, a random selection of certain number of districts would be made. Then within district a random selection of certain number of elementary schools would be made. Finally within each elementary school, a certain number of children would be randomly selected. Because each level is randomly sampled, the final sample becomes random. However, selection of samples is done to different stages. This is also called multi stage sampling.

This sampling method is more flexible than the other methods. Sub-divisions at the second stage unit needs be carried out only those unit selected in the first stage. Despite these merits, this sampling method is less accurate than a sample, containing the same number of the units in single stage samples.

Self Assessment Questions

1) Non probability sampling is one which there is way of assessing the probability of the element or group of element of population, being included in the sample. T/F

2) Simple random sampling is the core technique and attaches equal probability to each unit of the population to be selected. T/F

3) Cluster sampling method sometimes known as multi stage sampling method. T/F

4) Snowball technique is a probability sampling method. T/F

5) Stratified sampling is more representative for the population than other methods. T/F

Answer: (1) F, (2) T, (3) T, (4) F, (5) T.

4.10 IMPORTANCE OF SAMPLING

In research, sampling method has obtained great importance. Sampling studies are becoming more and more popular in all type of studies. The vastness of the population, the difficulties of contacting people, high refusal rate, difficulties of ascertaining the universe make sampling the best alternative in case of social studies. The census method is rarely, if ever tried in matters of social research.

Recent developments in sampling technique have made this method more reliable and valid. The results of sampling have attained a sufficiently high standard of accuracy.

The three main advantage of sampling are that cost in lowest, data collection is faster, and since the data set is smaller, it is possible to ensure homogeneity and to improve the accuracy and quality of data (Ader, Mellenbergh & Hard (2008)

4.11 LET US SUM UP

In this unit you have learnt about hypothesis formulation and sampling. A hypothesis is a speculative statement that is subjected to verification through a research study. In formulating a hypothesis it is important to ensure that it is simple, specific and conceptually clear; is able to be verified; is rooted in an existing body of knowledge; and able to be operational zed. There are two broad types of hypothesis: a null hypothesis and an alternate hypothesis.

Sampling is the act, process, or technique of selection a suitable sample, or a representative part of a population for the purpose of determining parameters or characteristics of the whole population.

Researchers rarely survey the entire population for two reasons: The cost is too high, and the population is dynamic in that the individual making up the population may change over time. Sampling methods are of two types i.e. Non probability and probability sampling methods. Probability sampling methods are those in which some probability to each unit of the population to be included in the sample and this is more representative. Three different probability sampling method are discussed as simple random sampling, stratified random sampling and cluster / multi stage sampling. The other non probability sampling methods discussed are convenience sampling, Quota sampling, Purposive sampling, Snowball sampling and systematic sampling. These methods are also used but lack the representative character of samples.

4.12 UNIT END QUESTIONS

1) Define hypothesis and explain its characteristics.
2) Write short notes on:
   a) Formulation of hypothesis
   b) Null hypothesis
   c) Alternative hypothesis
3) Write a hypothesis which incorporates each pair of concepts listed below:
   a) academic achievement and teaching methods
   b) education and social prestige
   c) frustration and need for achievement
4) What is sampling? Discuss its importance.
5) What is simple random sampling. Discuss its advantages and disadvantages.
6) What do you mean by probability sampling method. Discuss any two types of probability sampling methods.

7) Define the following:
   1) Sampling unit
   2) Population
   3) Sampling frame

4.13 GLOSSARY

Hypothesis : A tentative and testable statement of a potential relationship between two or more variables.

Null hypothesis : The hypothesis that is of no scientific interest; sometimes the hypothesis of no difference.

Alternative hypothesis : Statistical term for research hypothesis that specifies values that researcher believes to hold true.

Population : It is the aggregate from which a sample is drawn. In statistics, it refers to any specified collection of objects, people, organisation etc.

Population size : It is the total number of units present in the population.

Sampling units : They are members of the population.

Sampling frame : It is the list of all the units of population.

Sampling design : It is a definite plan for obtaining a sample from a given population.

Sample size : It is the total number of units in the sample.

Simple random sample : It is a sample in which each unit of the population has an equal chance of being selected in the sample.

4.14 SUGGESTED READINGS AND REFERENCES

Ader, H.J., Mellenbergh, G.J., & Hand, D.J. (2008). *Advising on Research Methods: A Consultant's Companion.* Huizen, The Netherlands: Johannes van kessel Publishing.

Blalock, HM (1960), *Social Statistics*, NY: McGraw-Hill.

Goode, WJ & Hatt, PK (1981). *Methods in Social Research*. Tokyo: McGraw hill Book Company.

References

Kerlinger, FN (1973). *Foundations of Behavioural Research*. New York: Rinehart and Winston.

McGuigan, FJ (1990). *Experimental Psychology: A Methodological Approach,* Englewood Cliffs, New Jersey: Prentice-hall.

Reichenbach, H (1938). *Experience and Prediction*. Chicago: University of Chicago press.

Reichenbach, H (1947). *Elements of Symbolic Logic,* New York: Macmillan.

Young, PV (1992). *Scientific Social Survey and Research*,New Delhi: Prentice-hall of India.