SELF LEARNING MATERIAL

M.A. EDUCATION

COURSE : EDU - 104

(1st Semester)

METHODOLOGY OF EDUCATIONAL RESEARCH-I

BLOCK : 1, 2 & 3

Directorate of Open and Distance Learning
DIBRUGARH UNIVERSITY
DIBRUGARH-786004

EDUCATION

COURSE : EDU - 104

METHODOLOGY OF EDUCATIONAL RESEARCH

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EDUCATION

COURSE : EDU - 104

METHODOLOGY OF EDUCATIONAL RESEARCH

CONTENTS

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METHODOLOGY OF EDUCATIONAL RESEARCH

BLOCK : 4 & 5

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EDUCATION

COURSE : EDU - 104

METHODOLOGY OF EDUCATIONAL RESEARCH

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EDUCATION

COURSE : EDU - 104

METHODOLOGY OF EDUCATIONAL RESEARCH

CONTENTS

UNIT—I : SCIENTIFIC THINKING AND RESEARCH

Structure

1.0 OBJECTIVES :

After studying this unit, you will be able to:

(a) explain the meaning of knowledge.

(b) analyses different method and sources of acquiring knowledge.

(c) identify different characteristics of scientific thinking

(d) prepare list of the steps used in scientific method.

(e) explain the meaning of research.

(f) describe the meaning, nature and scope of educational research.

(g) explain the needs of educational research

(h) prepare list about areas of educational research

(i) identify different specific topic on educational research areas like psychological, philosophical, sociological, administration etc.

(j) illustrate the meaning of inter-disciplinary research

1.1 INTRODUCTION :

Research is essentially a systematic enquiry seeking facts through objective verifiable methods in order to discover answers to problems of the universe. The main objectives of the research are providing progress and better life to human beings. In this unit we will discuss scientific thinking and research. This unit may supply adequate information about the concept of educational research and also analyses it. The classification of the areas can be made in a variety of ways depending upon how we define education. In this unit you will learn how to classify different areas and important themes of

educational research. The unit also includes a conceptual description of the inter-disciplinary research.

1.2.1 Knowledge and its Sources :

Scientific observation, significant evidence or systematic body of proof is very important for the increase of new knowledge. New facts, new concepts and new ways of doing things increase our knowledge with the passage of time. Before discuss what is scientific thinking, it is important to have a proper understanding of the meaning of knowledge. Knowledge is the totality of what is known by us. Generally the things or facts which we can be aware of and may come through perception and sensation is called knowledge. Dictionary has given various meanings to knowledge like information and skills gain through experience, awareness gained through experience; awareness gained by experience of fact; information about the facts etc. The meaning of the word knowledge is wisdom which enlightens our brain and mind. The concept of knowledge is quite different in nature. It varies from man to man, subject to subject, and period to period. So, there is no any specific definition of it. Different thinkers have defined knowledge in their own justification. Some of them are mentioned below:

"Knowledge is of two kinds- we know a subject ourselves or we know where we can find information upon it."

-**SamuelJohnson**.

"Knowledge is the consequence of a filterized process through intellectual system."

-**Dr. Shera**

"Knowledge is the intellectual acquaintance with perception of fact or truth; clear and certain mental apprehension; the fact, state or condition of understanding"

-**Oxford Dictionary**.

Knowledge is the sum total of known and unknown entities and is the result of human endeavours and past experiences accumulated through generalizations. In fact, knowledge is dynamic in character, multi-dimensional in size and ever growing in its range and scope. Knowledge takes the form of beliefs or judgment about a particular phenomenon. Some beliefs may be supported by evidence and some may not. Ordinary beliefs which are not supported by evidence are not knowledge. Only those which are supported by evidence is called justified beliefs. Only justified beliefs are knowledge. Justified belief consists of two types of judgments i.e. direct or intuitive judgement and derived judgement.

I think you have some idea about the term, knowledge. But there also come up a question “from which we obtain knowledge?” or “What are the sources of knowledge?” The sources from which we get knowledge are of two types. These are reliable and unreliable sources. Here unreliable sources of knowledge are that which are untested generalization and these are usually accepted on faith, tradition, authority etc. and there no effort is made to verify their validity. On the other hand, reliable sources of knowledge are based on objective observation and generalization.

1.2.2 Method of Acquiring Knowledge :

The acquisition and expansion of knowledge is not an easy or automatic and self-perpetuating process. How did our world come into existence? Why is it inhabited by such a great variety of living beings? All the above questions are perplexing people from thousands of years. To answer these questions people have to develop their knowledge. Man in his search for truth or for answering these questions, has applied some specific methods. These are:

Authority: One of the oldest methods of acquiring knowledge is to accept the solution or explanation given by authority. A child asks questions to his parents or elders to learn about different things. For a child, their parents and elders are the sources of knowledge. Leaders are one of the important types of authority. Like that Expert opinion also is another type of authority. Because of intellect, training, experience or skill some are better informed than others. People turn to them for solution rather than tying independently. Accepting expert's opinions unconditionally and for all times is not a wise practice.

Tradition: Man depends upon traditions to solve many of his day to day problems. He accepts the traditions of their ancestors. For example, in solving the problems of dress, manners, food habits etc. the individual accepts the traditions of their society. In an educational institution, the administrates and the teachers often rely on the past traditions of their institutions. However, tradition can not be considered as a authentic source of knowledge, as it is seen that a number of theories based upon traditions had to be discarded later as they were found to be erroneous.

Experience: One of the important sources of knowledge is personal experience. Whenever confronted with a problem, people try to recall or find a personal experience to solve it. We try to use our past experience and apply that to a present problem. For example, sudden flood in the rivers during the rainy season is due to the fact that water does not generally stay on hills. When confronted with a problem, modern man often tries to seek its answers from his own personal experiences or from others who are familiar with the problem. It is a subjective source. Here personal prejudice may lead to wrong conclusions.

Deductive Reasoning: Deductive reasoning leads to conclusions which are true only when based on correct premises. A significant contribution towards the development of correct premises for obtaining reliable knowledge was made by the ancient Greek philosopher Aristotle. He developed syllogism, which can be described as a thinking process in which one proceeds from general to specific statements by deductive reasoning. It provides a means of testing the validity of any given conclusion or idea by proceeding from the known to unknown. For example-

Major premise- All men are mortal.

Minor premise- Ram is a man.

Conclusion- Ram is mortal.

Inductive reasoning: The conclusions derived from generalities and from statement of presumed authorities by deductive reasoning are true only if they are based upon true premises. Bacon was the profounder of this reasoning. Here general conclusions are based upon specific facts gathered through direct observations. This is known as inductive reasoning, i.e. going from the particular to general.

Scientific Enquiry: Scientific enquiry is a synthesis of reason and observation. Here is a combination of inductive and deductive reasoning. The inductive method which is the essence of the modern scientific method consists of a back and forth movement in which the investigator first operates inductive observation to formulate hypothesis and then deduct from this these hypothesis to their implication in order to check their validity from the standpoint of the compatibility of the implications with accepted knowledge. This is the inductive-deductive method or scientific method which was introduced by Charles Darwin (1809-1882), an English naturalist.

1.2.3 Science and Scientific Thinking or Scientific Method :

According to Good and Hatt "Science is an accumulation of systematic knowledge". The word science is derived from the Latin word '**scienta**' which means 'to know'. The term has been defined in different ways like- an objective investigation of empirical phenomena, science denotes an accumulation of systematic knowledge etc. Science is empirical in nature which deals with empirical facts. Science is a system of knowledge. A system consists of a number of things which are related to each other in a particular way so as to serve a particular purpose. The proper understanding and explanation of facts lead to the development of science. There is a natural urge to know and understand facts and this is done by relating the facts together. The idea of science is to achieve systematic inter: connection of facts. The finding out of facts is the first significant step towards the development of systematic knowledge, which a science represents. The relating of facts is done in science by connecting them to laws. The search for laws is one of the important distinguishing features of every science. In fact, this aspect differentiates science from ordinary knowledge. In science, law is explained by constructing theories which relate the laws into system. But formation of laws or the construction of theories is not simply a matter of observation. It involves reflection and reasoning. Science is self-corrective in nature. Before the period of Galileo, people believed that the Sun moved round the Earth. But after it was proved that the Earth moves round the Sun by Galileo, the old law was closed down. If new facts are discovered and new reasoning is developed, the old conclusion are revised and reformulated. With the help of developed laws, science undertakes predictions for the future course of certain events.

What is scientific thinking? Scientific thinking means a systematic method of analysis where reasoning is used. Inductive and deductive reasoning-both are used in scientific thinking. It simply means a systematic method of analysis. So scientific method, scientific thinking and scientific enquiry are often used as synonyms. Scientific thinking is a very important aspect of science. Science is an intellectual model describing facts of experience in various terms. This thinking process use a systematic order where includes observation, construction of hypothesis, data collection, data analysis, interpretation and generalization etc. These generalizations are the laws of science. The merit of science enquiry lies in its emphasis on verification and proof. The term scientific thinking or scientific method is defined by different scholars differently. A few of them are-

L.L. Bernard has defined the term scientific thinking as "Science may be defined in terms of its major process that takes place within it. These are testing, verification, definition, classification, organization including prediction and application."

Prof. Wolf has defined scientific method -"in a wide sense as a mode of investigation by which science has been built up and is developed, and it is entitled to be called a scientific method."

Encyclopedia Britannica explains the meaning of scientific method as "Scientific method is a collective form denoting various processes by the aid of which sciences are built up. In a wide sense any method of investigation by which scientific or other impartial and systematic knowledge is acquired is called a scientific method."

The scientific method is practiced within a context of scientific thinking, and scientific (and critical) thinking is based on three things: using empirical evidence (empiricism), practicing logical reasoning (rationalism), and possessing a skeptical attitude (skepticism) about presumed knowledge that leads to self-

questioning, holding tentative conclusions, and being undogmatic (willingness to change one's beliefs). These three ideas or principles are universal throughout science; without them, there would be no scientific or critical thinking.

1.2.4. Characteristics of Scientific Thinking:

Scientific thinking is the most powerful tool that people have invented for pursuing empirical knowledge. There are some specific characteristics which represent the scientific method or scientific thinking. These are:

1. **Observation:** Accurate, insightful and objective observation is important in scientific thinking. It starts with observation of the phenomenon to be studied.

2. **Formulation of hypothesis**: For providing a right direction to any study to discover truth, it is necessary to have well-formulated hypothesis. It gives proper understanding of the scope of the study.

3. **Objectivity:** When we accept science as a particular way of knowing things, we accept a framework that permits and demands subjectivity. A piece of information is said to possess objectivity when it is describe in terms of some public standard rather than a private or subjective one. Simply there is no place of subjectivity in scientific thinking.

4. **Classification:** The data collection from various sources must be classified into certain groups. This classification helps in examining and determining the relationship of the facts and their implied meaning.

5. **Predictability:** predictability is one of the important characteristic of scientific thinking. Scientific thinking always aims at predicting the occurrence of an event under the same conditions, anywhere and anytime.

6. **Verification:** One of the fundamental needs of scientific method is verification. The validity of the hypothesis or generalization of the study cannot be established or accepted without verification.

7. **Generalization:** The ultimate aim of any scientific enquiry is to draw generalization about the problems of the study from different data's or facts. If generalization is not possible than it cannot be scientific thinking or research.

8. **Systematization:** Scientific method is always based on well-organized, logical, inter-related and theory-oriented study of analysis.

9. **Quantification:** Science is always based on mathematical formulas and measurements. To be precise and accurate, all observations must be quantified.

10. **Techniques:** Scientific method presupposes a great deal of importance to the adoption of correct techniques and interpretation.

Thus, from the above mentioned characteristics, we can say that scientific thinking implies an objective, logical and systematic method of analysis. We also know from the above characteristics observation, hypothesis, verification etc. are the important component of scientific enquiry.

1.2.5. Steps of Scientific Thinking :

When using systematic enquiry man engages himself in a thinking process. We have already pointed out that scientific thinking is a systematic process where logical steps must be involved. Different investigators have directed steps of scientific thinking in their own process. Some of them are:

According to ***Theodorson and Theodorson***, there are seven steps of scientific thinking. These are:

1. Define the Problem.
2. State the problem in terms of a particular theoretical framework and relate to relevant findings of previous works.
3. A hypothesis relating to the problem is devised utilizing previously- accepted theoretical principles.
4. A procedure to be used in gathering data to test whether the hypothesis is determined or not.
5. The data are gathered.
6. Analyse to determine if the hypothesis is verified of rejected.
7. Conclusions of the study are related to the original body of theory, which is modified in accordance with the new findings.

Hennery Manheim has suggested nine steps in scientific thinking which are:

1. Casual observation of event/phenomenon
2. Wonder/curiosity about how, why, what etc.
3. Hypothesis (about relationship between two variables)
4. Preparing design of research.
5. Data collection, processing, analysis and interpretation.
6. Hypothesis is true/false.
7. Description/inference.
8. Prediction(using inductive process)
9. Practical application.

Horton and Hunt pointed out eight steps of scientific thinking. These are:

1. Defining the problem
2. Review of literature
3. formulate the hypothesis
4. Plan the research design.
5. Collect the data.
6. Analyses the data.
7. Draw conclusion.
8. Replicate the study.

John Dewey indicates five steps of reflective thinking. These are:

1. Occurrence of a felt difficulty.
2. Identification and definition of the difficulty in terms of a problem statement.
3. Suggested solutions of the problem-hypothesis.
4. Deriving consequences of the suggested solutions with the help of deductive reasoning.
5. Experimental verification of the hypothesis.

From the above, we see that different thinkers have mentioned different steps of scientific thinking. So there are no any specific steps in scientific thinking. What are the essential steps of scientific thinking? Generally there are five steps in scientific research which are more essential. These are:

1. **Felt Difficulty:** The first step in the scientific thinking or method is felt difficulty. This is realizing or sensing that some problem exists. This may be like not being able to explain something or not finding the way of attaining the goal.

2. **Clarification:** In the second step, the problem is clarified. The difficulty is located and defined. At this stage the nature, scope and specifies of the problem are identified by observations and collecting of facts and the problem is thus defined precisely.

3. **Planning:** The third step is devising the plan for research. This is formulation of hypothesis. Here intelligent guesses are made of the solution to the problem.

4. **Data Collection:** The fourth step involves deductive reasoning out of the consequences of the suggested solution. Before the data is collected, in the previous step the proposed solution is evaluated. If the data supports the solution, it is accepted.

5. **Hypothesis Testing:** The fifth step is testing the hypothesis by action. This step involves the interpretation and generalization of the findings.

All types of scientific research will have these five steps. The scientific method of research in the steps given, involves the inductive and deductive ways of enquiry. Thus, facts are observed and generalization is done which is verified and used to explain individual cases.

CHECK YOUR PROGRESS-l

1. Justified beliefs are Knowledge. (true/false)

……

2. Reliable sources of knowledge are based on observation and generalization. (true/false)

.....

1.3 RESEARCH :

1.3.1 Concept of Research :

We have already discussed knowledge and scientific thinking which are related to the research process. So, what is research? Do have any idea about the meaning of research? Research is an important process for the advancement of knowledge. The word 'Research' consists of two words: 'Re' and 'Search'. 'Re' means again and again, and 'search' means to find out. So etymologically meaning of research is the process by which a person observes the phenomenon again and again to find out something accordingly.

Generally research is an attempt to find answer to the questions- what, why how and when. Research began with question what it is? and followed the questions, why it is so, how it happens, and when it happens. All these are the fundamental questions of every research. To lead life in a comfortable way man face many problems, overcomes various difficult situations, observe different unusual things, natural facts etc. The solution of all these problems is a never-ending process. Once a problem is solved then another one may come to the fore. How can we solve these questions and problems? Research starts from this questions i.e. research always start with a questions or problem. Simply, research is a endeavor to discover answers to a problem both intellectual and practical, through the application of scientific or systematic process. It is used to establish or confirm facts, re-affirm the results of previous work, solve new or existing problems and develop new theories. So research is a purposeful and planned activity to solve different problems related with our life as well as the universe.

Research is a scientific process in which a person observes the phenomenon again and again, collects data and finds out a solution. In short, the search for knowledge through objective and systematic method, and to find out solution to a problem is research. Research is

not new to humanity. The Biblical story tell us that our forefather **Adam** and **Eve**, when started life on earth, faced many problems. To live as human beings, **Eve** first ate the fruit of the forbidden tree and **Adam** followed her. That was also a type of research in the rudimentary form.

There is no any universal definition of research. To make your idea of research very clear enough, following definitions are included herewith. These are:

"Research may be defined as the systematic and objective analysis and recording of controlled observations that may lead to the development of generalizations, principles or theories, resulting in prediction and possible ultimate control of events."

–John W. Best.

"Research may be defined as a method of studying problems whose solutions are to be desired partly or wholly from facts. The facts dealt within research may be of options, historical facts, those contained in records and reports, the results of tests, answers to questionnaires, experimental data of any sort, and so forth"

– W.S. Monroe.

"Scientific research is systematic, controlled, empirical and critical investigation of hypothetical propositions about the presumed relations among natural phenomena."

– Kerlinger.

"Research is an honest, exhaustive, intelligent searching for facts and their meaning or implications with reference to a given problems."

– P.M. Cook.

"Research is essentially an investigation, a recording and an analysis of evidence for the purpose of gaining knowledge."

– Robert Ross.

"Research is a scientific undertaking which, by means of logical and systematic techniques aims to: (1) discover new facts or verify and test old facts, (2) analyses their sequences, interrelationships and casual explanations, (3) develop new scientific tools, concepts and theories which would facilitate reliable and valid study of human behavior"

– ***Young***.

As a summary in these definitions, we can say that research is an act of systematic, critical and scientific investigation of materials and sources in order to establish facts and reach new conclusions. These investigations are increasing the stream of knowledge. At last, researches means investigations consisting of determination and search something which may satisfy the curiosity of the investigator.

1.3.2 Characteristics of Research :

There are some distinctive qualities or properties of research. These qualities or properties are hidden in different definitions of research. Can you identify these qualities or properties? Some specific qualities or properties or characteristics of research are:

1. Research is a systematic approach.
2. Research is directed towards the solution of a problem.
3. Research is based on empirical or observable evidence.
4. Research requires expertise.
5. Research demands accurate observation and description.
6. Research may be conducted with the help of quantitative or qualitative or with the help of both the research method.
7. Experience and the old stoke of knowledge play a vital role in the process of research.

8. Research requires skill of writing and reproducing the report.
9. There is no any personal view of researcher's about the answer to the problem. It is objective in nature.
10. Research can be reproduced.

CHECK YOUR PROGRESS-ll

1. What is meant by research?

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2. Mention any two characteristics of research.

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……..

1.4 EDUCATIONAL RESEARCH :

1.4.1. Meaning:

We have already discussed the meaning of research. It is a systematic process to find out different answers about the problems of universe. Can you categories the different problems of the universe? There are unlimited problems related with our life as well as the universe which are not able to classified easily. Because some problems are inter related in different aspects like social, mental, emotional, economical etc. of our life. Among them some are specific problems which are generally faced in educational institutions. These are like- problems of education for all, problems of universalization of primary education, problems of classroom management etc. Application of research procedure in the field of education for the solving of different problems is nothing but educational research.

Educational more simply means research in education. It is that activity which is directed towards the development of a science of behavior in educational situations. The ultimate aim of such a science is to provide knowledge that will permit the educator to achieve his goals by the most effective methods. So, educational research helps to find out new ways and means to bring changes to human behavior in a more scientific way. It is a systematic way for the growth and development of human life and society as a whole.

Educational research is a systematic, objectives and deliberate attempt to answer meaningful questions, pertaining to educational processes. The goal educational research is to discover laws or generalizations concerning educational issues in order to make prediction and control educational events and improve the quality of teaching and learning by taking effective decisions and proper utilization of resources.

Thus it is not difficult to explain that research in education is extremely necessary very worthwhile. But the question – what is educational research? There may not be an absolute definition. Some definitions regarding educational research are:

"Educational research is that activity which is directed towards development of a science of behavior in educational institutions. The ultimate aim of such a science is to provide knowledge that will permit the educator to achieve his goals by the most effective methods."

— Travers.

"By educational research is meant here the whole of the efforts carried out by public or private bodies in order to improve educational methods and educational activity in general, whether involving scientific research at a high level or more modest experiments concerning the school system and educational methods."

— Paul F. Lazarsfeld & Sam D. Sibek.

"To realize this goal, the nation of the world will have greatly to expand their educational efforts; more facilities must be provided; more teachers must be trained; new curriculum must be developed; and new teaching materials must be provided. It is the inconceivable that this is can be done efficiently or indeed that it can be ever done at all, without detailed guidance from the facts collected and the principles established through educational research."—

Report of the first International Conference on Educational Research.

"Educational research……represents an activity directed towards the development of an organized body of scientific knowledge about the events with which educators are concerned. Of central importance are the behavior patterns of pupils and particularly those to be learned through the educational process. A scientific body of knowledge about education should enable the educators to determine just what teaching and other learning conditions to provide in order to produce desired aspects of learned behavior among young people who attend school."—**Travers**.

Educational research is considered to be a 'prominent key' which is essential to the opinion of new doors in education. It is systematic attempt to gain a better understanding of the educational process, with a view to improve its efficiency. Educational research cannot be simply 'library research'; it must be research and development, tied to action. The goal of educational research is to discover laws or generalizations concerning educational issues in order to make prediction and control educational events and improve the quality of teaching and learning by taking effective decisions and proper utilization of resources.

1.4.2 Nature of Educational Research:

Education is both a science as well as art. As a science, education has a corpus of knowledge concerning the laws of learning, educational policies and planning. As an art, it seeks to impart

knowledge effectively. But to the question- 'what are the nature or characteristics of educational research?' From the earlier discussion about the meaning of educational research, we can to summarize the meaning of educational research as follows:

1. Educational research consists of description, explanation, interpretation and sympathetic or intuitive understanding methods which are mainly speculative and deductive in character and which rarely furnish results that can be subjected to measurement of mathematical procedure.
2. Educational research must be related to the study of complex relationships of various facts. It requires an inter-disciplinary approach.
3. Educational research should be concern directly with the problems of educational institutions. It should properly concern itself with such matters as child development, class organization, teacher pupil relationships, interaction with the community, teaching techniques, and many others.
4. Educational research is based is based on the subjectivity and intangibility of social phenomena.
5. Educational research does not require any costly apparatus. Paper and pencil, human material- like children, knowledge of elementary statistics, library facilities etc. are the main apparatus of educational research.
6. A sound philosophy of education must from the basis of evaluating any principles and activities of educational results.
7. Educational research is a systematic ways for the growth and development of human life and society as a whole.
8. Educational research cannot be a mechanical process. There is no educational problem worth studying which does not include unknown elements and does not require a fresh approach.

9. Educational research can be undertaken by any teacher, educators etc. with commonsense, intelligence and insight. In the beginning such workers may require some guidance and training but this can be made easily available to them at the hands of experts.

10. Educational research usually employs deductive reasoning. Much educational research which deals with historical, philosophical or comparative data involves a good deal of subject interpretation and deductive reasoning.

1.4.3 Scope Educational Research:

Education directs the growth and development of the child, it is concern with the fullest development of the whole personality and extends to, and is planned for the whole period of living. So, the scope of education is related with the scope of educational research because educational research is that activity which is directed towards the development of science of behavior in education.

Educational research aims at exploring facts, finding out immediate solutions to problems mainly at methodological level and organizing facts and critically appraising the existing concepts. Any discovery of knowledge will first attempt at an explanation of the 'fact' or 'phenomenon' observed. When once this knowledge is established, endeavor to apply this knowledge to make live more comfortable and secure will be made. In any research endeavor, the aims are generally three fold. These are—explanation, control and prediction.

The aims of educational research are the same as those of any other scientific research. In education too we want to understand or explain a problem, control or manipulate the factors, variables that

work for or against the desirable outcome and also to predict the problem laden or problem free situation.

The major areas of educational research are included in the scope of educational research. There are some major dimensions of educational research. These are:-

1. Determination of the past and present status of phenomenon.
2. Ascertaining the nature, composition and processes that characterize selected phenomenon.
3. Tracing growth and development, history, change and status of certain phenomenon. And
4. Findings the cause and effect relationships among and between certain phenomenons.

1.4.4. Need and Importance of Educational Research :

As an essential and powerful tool in leading man towards progress, research has very importance place in education. The degree of usability of knowledge can be increased with help of research. Educational research helps to determine the effectiveness of different principles, ideas, thoughts, procedures etc. in the field of education. To justify correctly the need of educational research, the under mention point may be broadly consider:

1. Education has strong roots in the field like-philosophy, history, economics, psychology and sociology. It is through an intensive process of scientific enquiry about the above subjects, that the various aspects of education and sound theories can be established.
2. Educational research helps to makes education more and more realistic and scientific.

3. Knowledge is expanding in all subjects. Research is needed to discover new methods of teaching in accordance with the new subject matter.
4. Educational research is needed for the development of appropriate tools for making objective measurements of educational research.
5. Proficient and resourceful workers required for the reconstruction of our country can be produced only by setting up an appropriate educational system through research.
6. To implementation of new policies and practice which can be achieved through research needs careful empirical testing.
7. Due to the changing socio-economic and political conditions, there is always needed to modify educational theories and practices which would need research.
8. Man has a craving to know history; hence there is need of historical research in education too.
9. Research is needed in the field of education to find effectively in the teaching learning process.
10. For the proper understanding of the nature of education and to know the bearing of education in life, society, politics, religious studies etc. there is the need of educational research.

From the above discussion we can summaries that educational research has a special need in the field of education to know the past, problems of present, principles and theories- its impact and relevance in the present system.

CHECK YOUR PROGRESS-lll

1. Mention any two nature of educational research.

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……

2. Mention any two major dimension of educational research.

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……..……

3. Mention any two necessities of educational research.

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……

1.5 AREAS OF EDUCATIONAL RESEARCH :

Educational research, as it is known today, is a relatively new branch of knowledge. Students, teachers, supervisors, educationist and even laymen face numerous educational problems and unsolved difficulties in every aspects of education. All those areas, directly or indirectly affecting pupils developments, in which problems exist, are the areas for educational research. Can you classify different areas of educational research? Before going to the selection of the research problems, it is necessary to classify the areas of educational research. There are various possibilities for the categorizing of educational research area. The classification of the areas is depends upon how we define education and how we interpret the need for conducting research in education. Different educationists have classified the areas of educational research in different ways. Various classification of educational research area are going to be discussed below:

S.P Naidu, classified four areas of educational research areas. These are:

1. The Philosophical Problems: Aims of Indian National Education.
2. a. The Sociological Problem
   b. Educational Surveys
3. The Psychological Problems.
4. The Technological Problems.

According to J. Lahiri, the main fields in which educational research is needed are:-

1. Psychology in classroom.
2. Empirical Child Study.
3. Secondary School Curriculum.
4. Examination System.
5. History of Education.
6. Philosophy of Education.
7. Educational Administration and Organization.
8. Moral Education.
9. Method of Teaching.

The sub-committee in the Seminar on Promotion of Research in Training College identifies the following areas of educational research in India :

1. Experimental work in Curriculum Construction.
2. Organization and Administration.
3. Teaching Personnel(e.g. the teaching load)
4. Improvement of Instructional Techniques and methods.

5. Psychology of Indian Child (e.g. backward, gifted, and delinquent)
6. Testing and Guidance.
7. Educational Sociology.

V.V.Kamat, listed the following educational areas for research in India .

1. Vocabulary of children of various age groups in different mother tongues.
2. The Public school in India.
3. Errors committed in learning languages.
4. Voluntary activities of boys and girls of various age groups.
5. Height, Weights and other physical indices of boys and girls of various age groups.
6. Self government in schools.
7. Methods of teaching Geography and History.
8. Reading Interest of boys and girls.
9. Education of Superior Children.
10. Education of Backward Children.
11. Administrative Practice.
12. Group method of teaching in primary schools.
13. L.E.A's in state of Bombay.
14. Educational contributions of various educationists in India.
15. Hobbies of boys in various age groups in secondary schools.

16. Hobbies of girls in various age groups in secondary schools.
17. Voluntary schools in primary schools.
18. Educational qualification of primary school teachers.
19. Differential attainments of children or urban and rural areas.
20. Compression of attainments of children who have attended nursery schools and who have not.

Sixth conference of the All India Association of Training Colleges held in Bangalore in June 1961, identified the following areas of educational research:

1. Education and Development Psychology.
2. Indian Philosophy.
3. Educational Administration.
4. Educational Evaluation and Management.
5. Educational and Vocational Guidance.
6. Methodology of teaching various school subjects.
7. Syllabus, Text-books and Teacher Training.

L. Koul identifies the three major areas of educational research:

1. Problems Relating to Content of Education:-
    a. Psychology.
    b. Philosophy.
    c. Sociology.
    d. Economics
    e. Educational Management and Administration.
    f. Comparative Education.
    g. Educational Measurement and Tests.

h. Curriculum, Text-Book and Methods

i. Teacher Education and Teaching behavior.

j. Guidance and Counseling.

k. Educational Technology.

2. Problems Relating to the Different Stages and Sectors of Education.

a. Pre-Primary Education.

b. Primary Education.

c. Secondary Education.

d. Higher Secondary Education.

e. Higher Education.

f. Vocational and Technical Education.

g. Non-Formal Education.

h. Open and Distance Education.

3. Problems Relating to Teaching Process:-

a. Instructional Objectives.

b. Entering Pupils Behavior.

c. Instructional Procedures.

d. Evaluation.

So from the above, we find that there are several possibilities for categorizing of areas of educational research. Here we are going to discuss some specific areas of educational research ----

1. Philosophy of Education: The relative merits of the various schools of philosophy related to educational aspects are certainly being evaluated. The structure and process of education are generally built upon some philosophy. The progress of any aspect of education is limited to the extent, the educational philosophy governing that aspects permits its. Educational theories have also been objectively

examined whenever there is a problem of conflicting principles or retarded growth. Sound educational philosophies must lay foundation whenever reorientations of objective, curriculum methods, evaluation or guidance are to be implemented. Naidu (1968) has listed eight areas of philosophy of education in which research can be undertaken.

2. History of Education: Historical studies form the basis for a theory and deduction for such a theory may provide hypothesis for subsequent inquiry. The study of history in different aspects of education is significant in that it gives proper guidance for future planning. No research work proceeds with a study, without first knowing the historical background of the problem. Each aspects of education has a history such as primary, secondary, tertiary or any professional education, system of evaluation, programme of guidance and educational technology and each has its academic importance.

3. Sociology of Education: The study of Educational system goes beyond the individual and gives significant consideration to the social factors affecting the individual. The educational process is not a one way process and there is interaction between the teacher and student, between the teacher and group of the students and among the pupils themselves. The educational process and the educational system have significant sociological considerations. The major aspects of sociology of education are the economic background, religion, class, status and environment of the students, teacher and other personnel of the profession and the interactions of these aspects which influence educational outcome.

4. Comparative Education: The area of comparative education deals with educational system, process, patterns, administration, programme, students activities, constitutional provisions etc. in different places in a comparative basis. Comparative studies give valuable suggestions in the specific aspects with which the studies deal. Many innovations are initiated through such studies and they also render good motivations and encouragement for educators and educational administrators.

5. Economics of Education: Education and economics are mutually dependent and the recognition of the potentiality of education towards growth of national economy results in an experimental approach to education. It is being increasingly recognized that expenditure on education is not merely of the nature of consumption but is more of an investment. Study related to finance of education, expenditure and educational growth, education and productivity and costs of education with special reference to cost effectiveness of educational programme come within the purview of economics of education.

6. Psychology of Education: Research in educational psychology has great significance for a teacher. It deals with personality variables like intelligence, adjustment, academic achievement, sociability, emotional stability, fear, inferiority, values, attitudes, curiosity etc. and factors pertaining to learning and motivation specially achievement, motivation etc. These aspects of psychology are directly or closely related to the educational outcomes. Teachers confront many problems in this domain and solutions to these problems bring about useful and significant knowledge which can be of practical values.

7. Test and Measurement: Educational measurement is primarily concern with the quantification of certain educational outcome in the form of the acquisition of certain attitudes, behaviors and skills. We need valid and reliable tools for measuring such educational outcomes. This is being done by tests and tools of measurement with increased objectivity. Foreign instruments of measurements may be adapted to the conditions of our country after making suitable alternations as per standards required for measuring instruments. Research in educational measurement and test development is concerned with the critical evaluation of the existing forms of tests, the construction and standardization of valid and reliable tests.

8. Educational Technology: Educational technology helps students to learn at their own pace but does not envisage a total displacement of the teacher in an institutional situation. In India research in the field of educational technology is confined mainly to the area of programmed learning. Teaching machines available at present are too restrictive in the model of presentation and response facilities to be useful to the class room teacher or student. Different forms and different uses of programmed learning materials, development of programmed approach to teaching, programmed learning and instructional media etc. are the major aspects which can be considered for research studies.

9. Teacher Education: Research in the area of teacher education attempts to improve programmes of training and education of prospective teachers. Aim and objectives of teacher education, curriculum, syllabus, method of teaching etc. are productive fields of research in the realm of teacher education. Research may be conducted on selection criteria, abilities and qualities of teachers' pre-service and in-service training of teachers, workload, processes and practices of teacher education or personality variables of teachers.

10. Higher Education: Higher education is concerned with the education provide by colleges and universities. Higher education should be an important responsibility in the nation's effort for economic and social development and social justice. There three main problems in higher education which are conceder main aspects of research works. These are: Access to education, Quality of Education and Management of higher education.

The areas of research cited above in the field of education, are not clear cut and their boundaries may intersect many fields and that these are the areas in which investigators are involved. Knowledge of these areas is helpful to an investigator in selecting the area of his interest and to restrict the scope of his study.

1.5.1 Interdisciplinary Research:

The word 'inter-disciplinary' means combination of more than two different subjects into one activity. This word is applied in the different science and social science. Generally it is applied in the subjects of education and teaching techniques to describe studies that used methods and insights of several established disciplines or traditional fields of study. It involves researchers, students and teachers in the goal of connecting and integrating several academic schools of thoughts, professions and technologies- along with their specific perspective- in the pursuit of a common task. When researchers from two or more disciplines pool their approaches and modify them so that they are better, then we use the term inter-disciplinary. For example, the subject of money may appear differently when examined in different disciplines like political science, sociology, economics etc. So money is an inter-disciplinary subject.

Physical science is absolute, definite and deliberate but on the other hand social science is neither definite nor absolute. So the

subject matter of social science is much more complex. Every discipline of social science is concerned with social or human relationships and it studies man from a particular viewpoint. For example, economics studies the economic aspects of man while education studies the educational conditions of the people. This type of peculiarities distinguishes them from each other. Although there have been some specific characteristics among the different disciplines of social science, some social problems are such that they are connected with two or more than two social sciences. In other words, different aspects of these social problems may be studied in different social science subjects. The study of such problems therefore requires the use of methods peculiar to several social sciences. This is known as inter-disciplinary research. So, inter-disciplinary research means, attempting to evolve an approach to a research, incorporating all the relevant findings of different disciplines.

Sometimes, the concept of inter-disciplinary is misinterpreted. Interdisciplinary research dose not mean that a sociologist, a psychologist, an economist and a political scientist should be assemble together to produce a meaningless mosaic. The concept of interdisciplinary research only implies that the research should take into account the possibilities and perspective of different kinds of processes that may operate in influencing the phenomena being studied. Interdisciplinary research is not an additive concept. It is more a chemical concept, where the approaches and findings of disciplines should be blended to provide a more meaningful and valid approach to a problem. According to National Academy' report "Inter-disciplinary research is a mode of research by terms of individuals that integrates information, data, techniques, tools, perspectives, concepts and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are of research practice." The aim of interdisciplinary research is to ensure every researcher on overall awareness of the field of social sciences.

Do you think that inter-disciplinary research is necessary in the field of education? Education is a composite discipline. The subject of education has strong roots in the fields such as philosophy, sociology economics, psychology etc. So its foundation is to be explored for a study of the subject as an inter-disciplinary approach. It is therefore, almost imperative to study education in its proper perspective. Philosophy is the cornerstone of the foundation of education and Psychology provides the bricks and mortar for laying the foundation of education on a scientific basis. Without proper analysis of the influences and impacts of other disciplines on education, it is difficult to set its mission for the greater benefit of the human society as a whole.

CHECK YOUR PROGRESS-IV

1. Mention the major areas of educational research identified by l. Koul.

……
……
……

2. Inter-disciplinary means combination of more than two different subjects into one activity. (true/false)

……

1.6 LET US SUM UP:

In this unit, we have discussed scientific thinking, research, educational research and areas of educational research. Here we learnt the sources from which we gates knowledge are of two types

i.e. reliable and unreliable sources. There are five methods of acquiring knowledge. This are- authority, experience, deductive reasoning, inductive reasoning and scientific enquire. We have also leant that there are five steps which are essential in scientific thinking. This are- felt difficulty, Clarification, planning, data collection and hypothesis testing. At the same time, the unit has also helped us to understand the meaning of research. We have also learnt the meaning, nature, scope and needs of educational research. We have also learned that there are several possibilities for categorizing of areas of educational research. Philosophy, sociology, psychology, economics, history etc. are the some of the specifics areas of educational research. We have also learnt about inter-disciplinary research which will ensure that every researcher in social sciences has an overall awareness of the field of social sciences.

1.7 KEY WORDS:

Hypothesis:

A tentative explanation based on theory to predict a casual relationship between variables.

Minor Premise:

A minor premise is a particular case related to the major premise.

Major Premise:

A major premise is a self-evident assumption formally established by metaphysical truth or dogma that concerns a relationship.

Universe:

The universe is commonly defined as the totality of everything that exists.

1.8. SUGGESTED READING :

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2. Koul, Lokesh, "Methodology of Education Research", Vikas Publishing House Pvt. Ltd: New Delhi, 1988.
3. Sidhu, Kulbir Singh "Methodology of Research in Education", Sterling; new Delhi , 1985

POSSIBLE ANSWERS TO CYP :

CYP-I

1. True.
2. True.

CYP-II

1. Etymological meaning of research is the process by which a person observes the phenomena again and again to find out something accordingly.
2. a. Research is a systematic approach.
   b. Research requires expertise.

CYP-III

1. a. Educational research must be related to the study of complex relationships of various facts.
   b. Educational research is based on the subjectivity and intangibility of social phenomena.
2. a. Determination of the past and present status of phenomenon.

b. Ascertaining the nature, composition and processes that characterize selected phenomenon.

3. a. For making education is more and more realistic and scientific.

b. For the development of appropriate tools for making objective measurements of educational research.

CYP-IV

1. a. Problems relating to content of education.

b. Problems relating to the different stages and sectors of education.

c. Problems relating to teaching process.

2. True.

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20. Young, P.V., Scientific Social Surveys and Research, Bombay , Asia, 1961.

MODEL QUESTIONS :

1. Discuss various methods by which man from earlier times sought answers to his problems.
2. What is scientific thinking? Discuss various steps of scientific thinking.
3. What is research? Discuss main characteristics of research.
4. What is educational research? Discuss its scope.
5. Discuss importance of educational research.
6. Discuss nature of educational research.
7. Classified the different field of educational research.
8. Write briefly about interdisciplinary research.

UNIT – II : TYPES OF RESEARCH : FUNDAMENTAL, APPLIED AND ACTION RESEARCH QUANTITATIVE AND QUALITATIVE RESEARCH

STRUCTURE

2.0 : OBJECTIVES :

After going through the texts you should be able to -

- Name the different categories of Research according to purpose.
- Name the different categories of research as per nature of treatment of the subject matter.
- Distinguish different categories of Research.
- Identify the category of a particular research.
- State the utilities of different categories of research.
- Mention the different categories of persons generally involved in different categories of research.
- Critically analyze the advantages and disadvantages of the different categories of research.
- Cite examples of researches of different types.

2.1 : INTRODUCTION :

Friend, by now you learnt about research and its scientific nature. You might have appreciated its necessity in the field of education. As education is becoming largely a public concern it is naturally expanding. At the same time, to make it more utilitarian, educationists have to think of more and more effective and useful means. To do that they have to think and do more and more intensively. Here the necessity of research is coming in.

Basically, education is a behavioral science, dealing with human behavior. Ordinarily study of behaviour comes under the perview of psychology. Accordingly, many a times, findings of psychological studies bears much significance to education. But the psychologists are not directly concerned with education. It is the duty of the educationists to enquire about the findings of psychological studies and see whether they can be profitably utilized for their purpose. Again the educators have to adjust them to fit their need. In

all these steps we need to proceed scientifically and as such these necessities lead to research work. But the research work involved in these different stages are of different nature. Again the data collected for those studies are also, not all alike. That too, make researches different. Accordingly we can classify research into different categories.

The following text is devoted to discuss research according to their category.

2.2 : THE SCHEME OF CATEGORIZATION OF RESEARCH :

Friend, by this time you might have perceived that research is an investigation with scientific procedures. But it is not all about research. There are many things to knew about it. First question arises - whether, are these researches all alike ? No, certainly not. In this unit we shall try to understand research by category. There are different schemes of categorization of research. Here we shall discuss two of them. These two are - (i) According to purpose (ii) According to the nature of treatment of the subject matter.

According to the first categorization they are of three types. They are -

1. Fundamental
2. Applied
3. Action research.

According to the second categorization scheme they are of two types. They are -

1. Quantitative
2. Qualitative

The very nomenclature is indicative. Still then we are elaborating them for clarification of concepts.

2.3 : THE SCHEME OF RESEARCH ACCORDING TO PURPOSE :

As stated above they are three in number. They are namely -- Fundamental or Basic, Applied and Action Research.

In physical sciences the first category of research is a subject matter of the pure scientists. The second category is a subject of the technologists and the third category is usually adopted by the scientifically minded industrialists.

Pure scientists explore the field of knowledge and discover certain universal theories. Technologists try to suggest the utilities of those general theories for human benefit. Following the suggestions of the Technologists industrialists try to adopt them in their industries. In all the three stages research is inevitable.

Similar is the case with the persons directly or indirectly involved with education. Let us examine them one by one.

2.3.1 : Fundamental or Basic research :

We know many basic things of the world. Still then we do not know many of them. For instance we know very little of ourselves, our own behavior. From the psychological view point, education is a behavioural science. For quality education it should be tuned to behaviourial principles. Human behaviour is very complex. Many facts of this area have been explored. Yet many things are yet to be explored. Most of the knowledge about human behaviour attract the educationist. Because they can be utilized beneficially in the field of education. Exploration of this area of knowledge is of emmence help to the educationist. This necessitates research in this field of knowledge. The aim of these researches are to discover rules and theories which remained unnoticed till now. Generally these rules,

laws or theories when discovered are of general nature and broad based. Fundamental or basic researchers intend to explore those broad based theories. Theories are developed on the basis of observation on a limited number of subjects. Subjects selected for such observations are done in such a way that the result obtained is extendible to the entire population of subjects. Subjects selected for such observations or experimentations may be human ones or other animals. They generally studies the behaviours of those organism under certain circumstances. They are just interested in knowing the facts only. They are not interested in their applications. These findings may help workers of different field, but that is not the look-out of the basic researchers.

These researches are conducted in the field of behavioral sciences, which is generally dealt with by psychologists.

These studies are conducted under such conditions that the result obtained may safely be generalized. Physical scientists conduct such experiments in laboratory. But in case of behavioral sciences it may not always be possible to use laboratory. But they contrive the situations in such a way that they become as good as laboratory. Such conditions are known as 'Laboratory like conditions'. As stated above behavioral scientists are known to utilize lower forms of animals like-rat, pigeon, monkey etc. in addition to human being, as their subjects.

In fact basic researches are conducted in different field. But the educationists are interested in the findings of this area because education itself is interested in behavioural changes. As such they take interest in the findings of this area.

Different theories of learning, different theories of human development, theories on personality are contributions of Basic Scientists toward the field of education. For example we can cite the

examples of - Watson's theory of learning, Theory of Operant Conditioning, Piaget's theory of human development. Which have extensive use in education.

For the details of those theories you should consult books on psychology.

Do you think that some part of this area is yet left unattended? If you can find such area that may become an area of research for you. But before sticking to it you should be explicitly sure that, that area is really left unattended. For that you need extensive survey of the findings of this area generated so far.

2.3.2 : Applied Research :

Don't we try to benefit ourselves with the available stock of knowledge ? We certainly do so. Knowledge unutilized is in fact, knowledge useless. In physical sciences, whenever a pure scientists presents a new theory a second category of intellectual takes interest in finding probable area of their application. They are generally known as technologists. We can take the example of Einstein's theory of relativity. Principle of Mass-Energy continuum was a part of that theory. As soon as it was discovered technologists came forward to utilize it to serve their purpose. War technologists utilized it in constructing atom bomb. Its capacity at once drew attention of everybody. Later on peace time scientists came forward to use it in Atomic Power Projects, which supply a huge amount of energy and that can be utilized for constructive works.

Similarly the theory developed by the behavioural scientist draws the attention of a second category of intellectuals. They were mainly animal trainers and educationists. They utilized them beneficially in their own field of activities. This category of intellectuals can be called behavioural technologists. Those, who are

interested in the field of education may be called as educational technologists. They try to utilize the contributions of the Fundamental Scientists to enhance the educational process. Here too, it is not like picking the fundamental theories as it is and throwing them directly to the field of education. They have to experiment to find the probable modes of application and to choose the appropriate one. This itself is a research work and this type of research work is generally called Applied Research. Usually this category of intellectuals too, are not the educators. These intellectuals or the educational technologists device certain ways and means to facilitate the educators. Ultimately they become useful tools that can be handed over safely to the educators.

In the field of education we can cite the example of so called Teaching Machine, which borrows its principle from Tolman's Theory of Operant conditioning. Here Tolman was the Fundamental Scientist and the researchers who developed the Teaching Machine are the applied scientists. Applied Scientists work on improving, both, product and the process.

Like Fundamental scientist the applied scientists, too, take resort to certain techniques, so that the findings of Fundamental scientist may find extension for general use. They, too, adopts techniques like randomization, sampling etc.

It should be kept in mind that the recommendations of the applied scientists are of general nature, not of some particular cases.

2.3.3 : Action Research :

Don’t we feel that the general principle or its general application has little to do anything for us unless it is useful within our own environment that we generally come across. It is certainly

so. Or in other word a generalized psychological theory or the general principle of application bear litter meaning to a teacher, unless he can fit it well to his classroom environment. This process of adopting or adjusting it to the class room requires sufficient try out with scientific approach. This is also a type of research. Research of this type in known as action research. This type of research is useful or infact essential for the teachers and the field workers. For carrying out it effectively and efficiently the teacher may seek help of expert researcher. They work hand in hand in solving the problems of the classroom, met by the teacher. It focuses on immediate application and utility. Such type of try outs sometimes calls for a fresh applied research.

This type of researches are carried on in the field itself, where it is going to be applied. Depending upon the findings future strategies are determined so that it fits to the local need.

Here the educators get their direct involvement. Educators sufficiently well oriented in the scientific methodology can carry on such researches comfortably. Those who are not well oriented, they may have to seek assistance of some others who are specialized in this field. The process, if it is carried out sincerely, certainly helps the educators to acquire a better insight into his business. It also create a scientific outlook and atmosphere in the field. There the educators are less likely to be dragged backward by baseless conventions. Educators working on this line have a farm professional footing. They need not swallow the materials half digested by the so called educationist. They need not blindly carryout the instructions of some outsiders without quarry, who may not have proper idea of the field. Educators, working on scientific line can defend themselves.

In the western world it acquired momentum since 1930. India is yet to acquire it. The new generation is expected to add momentum to the movement as soon as possible.

CHECK YOUR PROGESS (1)

1. Tick the correct words :-
   (a) Pure researches are generally carried out by - (i) Educators, (ii) Psychologists (iii) Education Technologists.
   (b) Piaget's research on stages of human development belonged to the field of (i) Applied research, (ii) Action research, (iii) Basic research.
   (c) Basic researches are known also as (i) action research, (ii) Applied research, (iii) Fundamental research.
   (d) Action research is mainly useful to (i) Education technologists, (ii) Educators, (iii) Psychologists.
   (e) Action researches mainly help in (i) Developing general theory, (ii) To determine general application, (iii) To create scientific atmosphere in the field, (iv) None of the above.
   (f) To solve a local problem faced by you as an educator what type of research will you undertake ? - (i) Fundamental, (ii) Applied, (iii) Action.

2.4 : CLASSIFICATION OF RESEARCH AS PER NATURE OF DATA AND TREATMENT OF THE SUBJECT MATTER :

Research can be classified into two categories depending upon the nature of data and treatment of the subject matter.

In physical sciences data are usually numerical and can be treated mathematically. But in social sciences phenomena can better be judged qualitatively. Can you think of measuring sociability directly ? Achievements, intelligence, creativity, sociability, personality are usually felt qualitatively. Some of them can be functionally defined to measure them. They, too, are also expressible only in interval scale [see the definition given in 2.1.1 (c)]. For many of the phenomena it is not possible to have quantitative measures. They can only be described qualitatively. A few of the types of the data, relevant for analysis can be counted. Accordingly, their treatment are also different. Researches generating numerical data can be treated statistically, which is somewhat akin to mathematics. Those, who generate only qualitative data can only be treated logically.

Accordingly researches are either - QUANTITATIVE or QUALITATIVE.

In the following text we shall attempt to elaborate them.

2.4.1 : Quantitative Studies :

In quantitative studies we deal with data which can be counted, measured indirectly or quantified functionally. Countability or measurability signifies their exactness and increases their reliability. On the other hand commenting on things which cannot be expressed numerically are inexact. Sometimes attempts are made to quantify them by functional definition. Even then they cannot be called exact. It simply facilitate statistical treatment. Hence we see that quantitative studies in social sciences does not mean studies which deal with purely quantitative data.

To make the point more clear it will be better to examine the nature of different types of quantifiable data.

In expressing quantity of things we have to use certain scales which will give its quantitative measure. The data expressible in different scales have different properties. Below we are elaborating them for clarification.

(a) Nominal Scale :- Certain data can be expressed as simple count. Every individual item (person, events etc.) are placed under certain category. Any one of them belong to a certain set and not to other. These data can be arranged in any order. Placing one before the other will cause no harm. For example, the caste wise population of a village is as below.

Castes	Male	Female	Total
Chutia	125	98	223
Kalita	100	79	179
Kachari	98	69	167
Rajbanshi	56	50	106
Total	379	296	675

Here every individual person has been assigned a category. We got different number of cases under different categories. Here 125, 98 etc. are data in numerical form. First row in assigned to Chutia and the last row to the Rajbanshi. Now if this order is altered them there will be no harm. Similarly first column is assigned to male and the second column is assigned to female. If we alter their position then there will be no harm. The scale in which these data are expressed is known as nominal scale. They are not useful for

rigorous statistical treatment, even they do not have the order relationship. Still then these representations are meaningful as well as useful under certain circumstances.

(b) Ordinal Scale :- In certain cases we express certain situations by assigning positions to the individual cases as 1^{st}, 2^{nd}, 3^{rd} etc. Allotment of position depend upon the magnitude of the criteria under consideration. In such cases we say that the data are expressed in ordinal scale. Here the data are expressed as position in the scale that the individual case occupy. Suppose we are to tabulate the weights of seven persons, say A, B, C etc. Their weights are as given below -

A - 68 Kg, B - 57 Kg, C - 50 Kg, D - 64 Kg

E - 58 Kg, F - 60 Kg, G - 59 Kg

On arranging them in descending order of weight they can be arranged as in the table below -

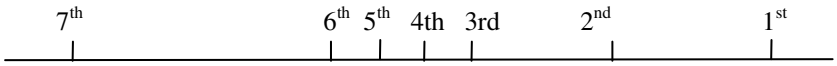
Persons	**Weight (in Kg.)**	**Difference**	**Rank (Data)**
A	68	--	1^{st}
D	64	4	2^{nd}
F	60	4	3^{rd}
G	59	1	4^{th}
E	58	1	5^{th}
B	57	1	6^{th}
C	50	7	7^{th}

Here, in this table, we see a definite order of the data. 'A' weighing 68 Kg. is occupying the first position in the table, 'E' weighing 58 Kg. is occupying the fifth position. We

cannot push down 'A' to the fifth position nor we can lift 'E' to the first position. Their position are not interchangeable. Here, in fact, the data can be expressed numerically, that too, in a definite order. Thus it is better than the nominal scale at least in this aspect.

But the ordinal scale too, has certain inherent draw-backs. Observing carefully we see that they are not equally spaced in the scale of measure of the criteria. They are not equally apart from the predecessor or the successor. Here, for instance, the sixth case is 7 unit apart from the seventh, but only one unit apart from the fifth case.

Accordingly, we see that, here we get a definite order of data but they are spaced unevenly. If the above data are graphically represented over a scale of weight then it will be as shown below.



If we observe carefully, we shall see the following draw-backs of the scale - (i) sometimes we notice that certain phenomena differs by degree or amount. Such that students achievement differs in degree. That type of data cannot be represented by a ordinal scale, (ii) Differences of data are expressed only as ranks they do not have proportionate relationship of its actual measures of the individual cases in the scale of measurement of the phenomenon under consideration, (iii) The ranks have no absolute values.

In spite of these draw-backs data representable by this scale can help the researcher under certain circumstances.

(c) Interval Scale :- Sometimes scales can be devised arbitrarily to indicate the amount of a trait present in a subject. Such

scales help in measuring the quantity of the trait present. Unlike ordinal scale, here the individual scores are equally spaced, i.e. the second differs from the third by one unit, first from the second by one unit. Any two consecutive scores differ by one unit. As such it is one step ahead of the ordinal scale and two steps ahead of the nominal scale.

Assumption of a particular interval scale is a matter of choice. So it has a decided advantage upon the other two scales discussed above, because it has the ability to indicate the relative amount of the trait present in the subject.

Below we are citing an example of a frequency distribution table, which is prepared from data represented through a particular interval scale used by a classroom teacher. The test was of 20 marks.

Scores	**Frequency**	**Scores**	**Frequency**	**Scores**	**Frequency**
0	1	7	6	14	6
1	0	8	8	15	2
2	1	9	10	16	1
3	2	10	15	17	3
4	3	11	9	18	0
5	5	12	8	19	3
6	4	13	6	20	2
Frequency = Number of students scoring that particular mark					N = 95

Though the interval scale is better than the other two scales discussed above, still then it too have certain short-falls. First of all, it has no absolute zero. Since we cannot say that the trait is totally absent at a particular point. Secondly we cannot say that the score numerically double an another has exactly double the amount of the trait than that of the

other. That means we cannot say that a student scoring 50 has exactly double the merit of a student scoring 25 in an achievements test.

However, inspite of these short falls, the data expressed through this scale have the properties that they can be added, subtracted, multiplied and divided like ordinary numbers.

We can demonstrate these properties with the help of the table presented above.

In the above table starting from the first, every alternate column indicates the score values. The columns following them indicate the number of cases getting that score (i.e. frequencies). Now if you are asked to find the number of cases scoring less than 5, then you will certainly add the frequencies scoring less than 5, which comes as 1 + 0 + 1 + 2 + 3 = 7. If we assume the mean score to be equal to ten and you are asked to find whether the above average students of the class out numbers the below average or vice-versa. Then you will certainly find the difference of the sizes of the two groups. i.e.

$(1 + 0 + 1 + 2 + 3 + 5 + 4 + 6 + 8 + 10) – (9 + 8 + 6 + 6 + 2 + 1 + 3 + 0 + 3 + 2)$

$= 40 – 40 = 0$ i.e. the distribution is symmetrical around the assumed mean. Now if you are asked to find the exact mean of the distribution you will find the total score of the distribution and then divide it by the total number of cases. Which is -

$$\frac{(0 \times 1 + 1 \times 0 + 2 \times 1 + 3 \times 2 + 4 \times 3 + 5 \times 5 + 6 \times 4 + 7 \times 6 + 8 \times 8 + 9 \times 10 + 10 \times 15 + 11 \times 9 + 12 \times 8 + 13 \times 6 + 14 \times 6 + 15 \times 2 + 16 \times 1 + 17 \times 3 + 18 \times 0 + 19 \times 3 + 20 \times 2)}{95}$$

$= 10.17$

Here we have multiplied the individual scores by their frequencies and then added together to get the total score of the distribution and then divide it by total number of cases to find the required mean which comes to 10.17.

Thus we have seen that the data expressed through this scale can be added, subtracted, multiplied and divided whenever necessary.

Social scientists often device such scales. But for their arbitrary nature, they are not free from criticism. Their reliability and validity are often put to question.

(d) Ratio Scale : The fourth category of scale is usually beyond the reach of the social scientists. Physical scientists gets its full advantages. As such though this scale has less concern with the social scientists yet its knowledge will definitely be helpful to us, the social scientists.

In comparison to the interval scale this particular scale has two more added advantages. They are as stated below -

(i) Unlike interval scale it has an absolute zero, which represent that point of the scale where the property or trait under consideration is totally absent.

For instance if we say that the pressure is zero cm. then it will indicate the total absence of pressure. In that particular case the pressure concerned will not at all be in a position to lift the mercury column of the pressure gauze from its zero level.

(ii) The second advantage of this scale is that the data bears the same ratio as that would have been done by real

numbers i.e. measure of 10 cm. means just double that of 5 cm.

The data expressible in the ratio scale can be added, subtracted, multiplied and divided just like real numbers.

2.4.2 : Qualitative Research :

Earlier social scientist tried to adhere to the quantitative data, due to the convenience of handling them. But in social sciences there are many circumstances where it is almost impossible to think of quantitative data. In such cases the only alternative is to take resort to qualitative data.

In such researches qualitative data are carefully recorded and sorted out in appropriate manner and are carefully analyzed. Qualitative Researches conducted with proper precautions yield fruitful results and lead to the development of valuable theories.

Sigmund Fred's theory of psychoanalysis, Piaget's theory of stages of development based on generic epistemology are examples of successful qualitative reaches.

2.4.3 : Appraisal of quantitative and qualitative researches :

Earlier researchers and most of the present researchers generally prefer quantitative researches and consider them to be more objective. But the business of quantification itself is not fool's proof. In discussing different scales of measurements we have seen that the only convenient scale available to the social scientists is the interval scale which itself is arbitrary. So we cannot rest assured that the data collected for the study are reliable and valid. Traits can be measured on the basis of manifested outcome of the original phenomenon. For

that we need to define the phenomenon functionally. Accordingly tools for measurement have to be developed by some experts which may not be perfect, as it is thought to be. As such they sometime become useless exercises, inspite of too many statistical sophistications. Quantitative researches are more clear-cut and directed. They have less flexibility. In collecting data they follow a pre-determined scheme.

Qualitative researches on the other hand, are more open. It is subjective in nature. Some times its course may be changed in the middle of the process. In qualitative researches data analysis is a crucial business. It requires a good deal of intuition.

But it is not that the qualitative researches do not have the ability to develop useful results. It too succeed in developing valid, general and universal theories. Piaget's theory cited already is a genuine examples. Qualitative researches can cover a wide range of problem which are not possible to be tackled with quantitative studies. A well planned qualitative study sometimes prove to be more useful.

Thus we see that both the type of studies have their merits and demerits but are equally useful.

There may be problems where a singular approach cannot give fair justice. In such cases it will be wise to make use of both the methods.

In fact studies with simultaneous approach sometimes prove to be most appropriate.

You have learnt something about the types of researches. Now you can take the test below to test your achievement.

CHECK YOU KNOWLEDGE (2)

A. Choose the correct answers -

1. Social scientists prefer quantitative researches for its - (i) accuracy, (ii) its subjectivity, (iii) its openness, (iv) For the simplicity to analyze data.
2. Social scientists consider the following scale most useful and appropriate for their research - (i) ratio scale, (ii) nominal scale, (iii) Interval scale, (iv) ordinal scale.

B. Answer the question -

1. Which of the scale of measurement is most scientific ?
   Ans. :-
2. What are the shortfalls of an interval scale ?
   Ans. :-
3. What are the plus points of an interval scale above the others ?
   Ans. :-

2.5 : LET US SUM UP :

We have discussed about different types of researches according to their purposes and according to the nature of data utilized.

We have seen that, depending up on the purpose of the study, researches are divided into three categories - first one, which intend to explore theories and principles of general nature. They usually have universal validity. Researches intending to have such type of outcomes are usually not concerned with their applicability. Such type of researches are known as Basic or Fundamental Researches.

Second type of researches are carried out by a second category of researchers. They are basically technically oriented. They tries to utilize the theories developed by the Fundamental scientists.

The try to adopt the fundamental theories to practical purposes. They may not be professional educators but take interest in educational development. Such type of researches are said to be Applied Researches.

Then come the educators. Their interest is not the development of fundamental theory or general innovation in application. It is the duty of the educators to improve their own classroom or immediate environment with the help of the available theories and technical knowhow. It is unwise to imitate or accept something blindly. Carrying on the convention without questioning its efficiency is also undesirable. Change is inevitable. Under such circumstances the educators have to find out their own ways and means. But they too, cannot do it whimsically. For that, they, too, are expected to proceed scientifically. For that they have to adopt certain investigative process. They are known as Action Researches. Action researches are inevitable for a progressive educational environment.

Researches are further divided on the basis of nature of data and procedure of data analysis. Researches depending on quantitative or numerical data are called Quantitative Researches and researches, depending on qualitative description of data are known as Qualitative Researches. Both of them have their own merits and demerits.

It is not necessary that a research should follow exclusively one single procedure. Both the procedures can be adopted in a single research project.

This completes the discussion on types of educational researches.

2.6 : KEY WORDS :

Students should note the following key words for comprehending the text. Meaning of these words will help them to do that.

- Absolute :- Actual, exact.
- Action :- (noun) Activity, (adjective) Something which is carried on during actual activity.
- Applied :- Application oriented.
- Educator :- One who is engaged in educating; the teacher.
- Functional :- Reflection of something as function, Appearing as manifested out come.
- Fundamental :- Something upon which many other things may depend.
- Interval :- Space between two consecutive events.
- Interval scale:- Scale where the items are orderly, and equally spaced.
- Nominal :- Particulars which just state the status of thing but have no definite order.
- Ordinal :- Particulars or descriptions which can be arranged in order.
- Population :- Aggregate of events, individuals or such other things which have a common definition and accordingly be placed under a common category.
- Qualitative :- Which cannot be expressed numerically, which can only be understood with literary description, something depending on qualitative descriptions.
- Ratio :- Expressing some thing as a quotient of other.
- Ratio Scale :- A scale where the entries can be expressed as ratio of others.
- Subject :- Some thing or some one who generate data. For instance intelligence is generated by an individual. Here the individual is the subject.

- Technology :- Science of application of some basic principle or theory.
- Trait :- A particular characteristic.

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PROBABLE ANSWER TO CYP'S :

CYP (I) :

Q. (a) Ans (ii)

(b) Ans (iii)

(c) Ans (iii)

(d) Ans (ii)

(e) Ans (iii)

(f) Ans (iii)

CYP (2) :

A. Qn. 1 - Ans - (iv); Qu 2 - Ans (iii)

B. Qn. - 1 - Ans - ratio scale; Qu No. 2 Ans. (i) Don't have an absolute zero (ii) Data not proportional to the actual trait.

Qn. No. 3. Ans. - (i) Data can be orderly arranged (ii) can be subjected to simple mathematical operations (iii) data scores are equally spaced.

MODEL QUESTIONS :

Qn. 1. What are the problems of quantifying the data in social sciences? How the social scientist proceeded to overcome them ?

Qn. 2. What are the different purposes of research in education ? How the different types of researches contribute to it ?

Qn. 3. The educators can commonly take part in what type of research ? How that particular type of research contribute to the educational atmosphere ?

UNIT – I : FORMULATION OF RESRARCH PROBLEM: CRITERIA AND SOURCES FOR IDENTIFYING THE PROBLEM; DEFINING THE PROBLEM

1.0 AIMS AND OBJECTIVES OF THE UNIT :

After going through this unit, you will be able to:

- Describe the research process
- Define a Research Problem
- Describe how to select a Research Problem
- Explain the importance of Formulating Research Problem
- Identify the criteria and Sources of Research Problem
- Describe how to define the Problem
- Evaluating a given research Problem

1.1 INTRODUCTION:

We have already discussed the meaning, nature, scope and need of educational Research in the previous unit. In the same way, we have clearly discussed about the areas of educational research and types of research in the previous unit. From the previous unit we have formed a clear concept about research and research in education.

After knowing the types of research, it is necessary to understand the Research Process. Do you know about research process? Perhaps you have no idea about it! Most probably someone amongst you have some idea regarding the same. The research process is similar to undertaking a journey. Research process consists of series of steps necessary to effectively carry out research and the desired sequencing of these steps. For a research journey there are two important decisions to make (i) what research questions or problems you want to find answers to; (ii) How to go about finding their answers. The way to finding answers to your research questions constitutes research methodology. At each operational step in the research process you are required to select from a multiplicity of methods, procedures and models of research methodology which will help you to best achieve your objectives.

1.2 RESEARCH PROCESS :

Research process consists of series of steps necessary to effectively carry out research. As a first step, the researcher must single out the problem he wants to study, i.e., he must decide the general area of interest of a subject matter that he would like to inquire into. The formulation of a general topic into a specific research problem, thus, constitutes the first step in a scientific inquiry. The review of the literature- the second step may not provide us much information; yet it is necessary to check whether this has been studied by other scholars and what are their findings? One can check from journals, Abstracts and books. This search of literature is extremely important. The third step is to formulate one or more hypotheses. The role of the hypothesis is to guide the researcher by delimiting the area of research and to keep him on the right track. The fourth step is actual collection of data and classifying and processing it. In this age of research, the data are generally made "computer sensible''. The computer gives the desired computations and comparisons including data for statistical tests. The fifth step is to analyze data for finding out contrast between the groups. Are our hypotheses true or false? What further study is suggested by our research? Finally, other researchers will undertake replication studies.

1.2.1 Formulation of the Research Problem :

The formulation of a research problem is the first and utmost important task for a researcher in the process of research. So to say, it just likes an indication of a particular place before undertaking a journey. As in the absence of a particular destination, it is not possible to find out the comfortable route. Likewise, in the absence of a clear research problem, a clear and sound research is not possible. It can be stated that a research problem is just like the

foundation of a building. We know that the type and structure of a building is totally dependent upon the foundation. If the foundation is well-built and strong we can hope the building to be the same. The research problem acts as the foundation of a research study; if it is well formulated, you can expect a good study to follow. According to Kerlinger, "If one wants to solve a problem, one must generally know what the problem is. It can be said that a large part of the problem lies in knowing what one is trying to do (1986:17) you should keep in your mind a clear idea with regard to what it is that you are going to discover about and not what you think you must discover. Any kind of research may be in a number of forms. For example, it may vary from very simple to very complex. The path which you adopt while going to formulate a research problem, determines every step that follows: the type of study design that can be used; the type of sampling strategy that can be employed; the research tools that can be used; and the type of analysis that can be undertaken. The formulation of a problem means the 'input' into a study and the quality of the research report is just like the 'output'.

In the beginning you may be confused but this is normal and an indication of progress. "All progress is born of inquiry. Doubt is often better than overconfidence, for it, leads to inquiry, and inquiry leads to invention'' is a famous Hudson Maxim in context of which the significance of research can well be understood. You should remember that confusion is often but a first step toward clearity.

1.2.2 Review of Related Literature:

The word review comes from the French word 'reveue'. The word review is meant a formal examination of something so as to make change if necessary. In other words it means a critical assessment of a book, play, or other work; a report of an event that has already done. The word related means belonging to the same family, group, or type; connected. On the other hand the word

literature means written tasks that are supposed as having artistic merit. It is meant by the books and writings on a particular discipline. Thus, the term review of related literature from the research point of view, understands the formal examination of the connected written works or other written works on the specific subject undertaken as research problem. In a nutshell, review of related literature means the completed formal examination of all the findings of various research works, research abstracts, informations, articules published in journals, books, periodicals, newspapers and internet etc., which are closely related to the area of investigation and the problem undertaken for research.

1.2.3 Formulation of Hypothesis :

Hypothesis means a proposed explanation based on limited evidence, used as a starting point for further investigation. The formulation of hypothesis is another important task for a researcher in the process of research. After extensive literature survey, researcher should state in clear terms the working hypothesis or hypotheses .Working hypothesis is tentative assumption prepared in order to draw out and test its logical or empirical consequences. The formulation of research hypothesis important because they provide the focal point for research. They also affect the manner in which tests must be conducted in the analysis of data and indirectly the quality of data which is required for the analysis. In most types of research, the formulation of working hypothesis plays an important role. Hypothesis should be very specific and limited to the piece of research in hand because it has to be tested. The role of hypothesis is to guide the researcher by delimiting the area of research and to keep him on the right track. It sharpens the thinking process of researcher and focuses attention on the more important facets of the problem.

1.2.4 Collection of Data:

The work of data collection starts after a research problem has been defined and research plan chalked out. There are two types of data viz., Primary and Secondary. The primary data are those which are collected afresh and for the first time, and thus happen to be original in character. The secondary data are those which have already been collected by someone else and which have already been passed through the statistical process. The researcher should keep in mind which sort of data he would be collecting for his study and accordingly he will have to select one or the other method of data collection. There are several methods of collecting primary data, particularly in surveys and descriptive researches. Important ones are; (i)observation method, (ii) interview method, (iii) through questionnaires,(iv) through schedules, and (v) other methods which include (a)warranty cards; (b) distributor audits; (c) pantry audits; (d) consumer panels(e) using mechanical devices; (f) depth interviews, and (g) content analysis etc. Secondary data may either be published data or unpublished data. Usually published data are available in (a) various publications of the central, state and local governments; (b) various publications of foreign governments (c) technical and trade journals (d) books, magazines and newspapers; (e) reports and publications of various associations with business, banks, stock exchanges etc. (f) reports prepared by research scholars (g) public records and statistics historical documents etc. The unpublished data may be found in diaries, letters, unpublished biographies and autobiographies and also may be available with scholars and research workers public/private individuals and organizations.

1.2.5 Analysis and Interpretation of Data:

Good research is characterized by the care taken in the analysis and interpretation of data. It involves the selection of appropriate statistical and other necessary techniques to be used for processing the data collected for the study. The analysis of data needs a number of closely related operations such as establishment of categories, the application of these categories to raw data through coding, tabulation and the drawing statistical inferences. Analysis does not provide answers to research questions. Interpretation takes the results of analysis; makes inferences and draws conclusions about the relationship. Thus, to interpret is to explain, to find meaning. Researcher must first analyze the data and then interpret the results of the analysis.

1.2.6 Writing Research Report:

This is the last and important step of the research process. Each research has a purpose and each report could be prepared and read by different publics. Therefore, it is characterized by carefully formulated inferences, conclusions, or organizations. For example, it may be made only as an academic exercise to be published in a book form, to be read by college/university students, or it could be submitted to the funding organization which may use it for policy purposes, or it may be used for writing a research paper to be presented at a professional meeting, or it may be published in a newspaper to be read by common people, and so on.

1.3 RESEARCH PROBLEM:

Research Problem means the study of something that is difficult to deal with in other to establish facts and reach new conclusions. Research Problem means the problem of research. The first step in

the research process is the choice of a suitable problem for investigation. It has been felt difficult to formulate a clear, precise and workable problem. It takes place when there is problematic situation and a need to solve the problem. In each field or area of educational research several problems exist which may have reference to the pure, applied, or action research. It is essential to identify such problems, solve them and thereby enrich the corpus of knowledge constituting the science of education.

The identification of a research problem is a difficult but an important phase of the whole research process. It needs a lot of time, energy, and logical thinking on the part of the researcher. It is also one kind of team work. It is not one day's task. A beginning researcher finds the task of identifying a research problem a difficult one. This may be due to his limited knowledge of research process and his lack of preparation for identifying the problem. He/she may be ignorant about the areas in which research is needed and the procedure he/she has to follow while selecting a suitable field for research. For a new comer it might be easy to formulate a problem but it requires a considerable knowledge of both the subject area and research methodology. As a researcher if you examine a question very closely you will realize the complexity of formulating an idea into a problem which is to be undertaken for research. One who goes to research field, he/she has to first identify and then specify a research problem which might seem like tasks that should be easy and rapidly accomplished.

It is very much essential to adopt certain procedures while you

CHECK YOUR PROGRESS 01

Q.a) What are the different steps involved in a research process?

……..……

Q.b) "If one wants to solve a problem, one must generally know what the problem is. It can be said that a large part of the problem lies in knowing what one is trying to do (1986:17)"Who said this statement?

……

Q.c) Why is formulating a Research problem important?

……

formulate a research problem. You must spare a lot of time in thinking the problem as a whole.

1.3.1 Selection of the Problem :

After the selection of the broad area of research, the next task for the researcher is to select a problem that will be suitable for research. This is one of the most difficult phases of the process of research .It is seen from experiences that the beginners face a lot of problems in this phase of research. Those who are not having experiences in the field of research fails to decide immediately which problem will be suitable for his research. Sometimes, researcher blindly struggles to select his/her research problem. This type of selection will mislead the research work which is undertaken by the research scholar. A beginner has to study all the minute aspects of his/her area in selecting a research problem. He/she has to study thoroughly all the available research literatures which are closely related to his/her area. There are, however, some important sources which are helpful to a researcher for selecting a problem. For instance, the M.A., M.ED., M.PHIL., PH.D dissertation that are available in the libraries, research articles, research surveys, research bulletins, research journals, research abstracts and all other research related publications may thoroughly be consulted. As a research scholar, he/she has to sort out the unexplored, relevant and significant problems with the help of experience and insight. It is seen that a lot of problems are lying which are relevant and significant. It is the duty of a beginner researcher to find out a more relevant and significant problem by studying more research literatures as possible. It can be described that experiences in the field of academic and social arena both have very important roles in selecting a research problem. Broader social outlook helps us in understanding the needs of the society. On the other hand, academic experiences of a researcher helps in understanding the academic

needs and values of different problems which are to be undertaken as research problem.

It ought to be noted that research problem should cover a specific part of a problem. The whole area of a problem can't be studied. Because, there is a time limit and the rules and regulations set by the affiliating and sponsoring institution. Despite these, researcher should always remember his/her accountability towards the society. The research has to contribute to the field of knowledge and contribute to human welfare. Thus, at the time of selection of a problem, all the above mentioned factors should be well cared of and a problem should be selected.

1.3.2 Criteria and Sources for Identifying the Problem :

The research problem undertaken for study should be sincerely selected. The task is not easy one, although it may not appear to be so. A problem must come out from the researcher's mind.

Source means a place, a person, or thing from which something is originated. Source of problem, generally means the thing, the place, environment, review of related literatures, experts in the field of research, research supervisor etc. from whom the research problem is to be selected for investigation. As the nature of subjects and the nature of disciplines are different, so the sources of research problems are also different. In educational research most of the problems may be selected from different sources .How do we get the ideas of deciding a topic of research? The ideas are collected from varied sources. The following sources can be used in identifying a research problem by a researcher:

(a) Professional Experience: Professional experience is one of the meaningful sources of problems in selecting a research topic for the beginner. Generally, it is seen that, there is a dynamic interaction between teacher and pupil, between pupil and pupil, and between

pupil and materials. This type of interrelationship serves as a rich source of problems to be solved through educational research. That is why the classroom, school, or community is a logical source. Every teacher is confronted with day to-day problems .He has to make decisions about the probable effects of classroom instruction on pupil behavior so as to establish a relationship between instructional objectives, learning experiences and pupil change. The behavior of students can be analyzed in terms of his family background, intelligence, interest, motivation and other personal matters. Teachers are expected to provide judgments about teaching methods and techniques. Teachers can study the effectiveness of a particular method of teaching. For example, a teacher in a secondary school may want to be investigated whether the discussion method is more effective in the teaching of social sciences to 12^{th}. Grade students in comparison to lecture method which can later be used as a research problem.

(b) Inference from Theory : The important source of research problem can be picked up from the inferences. There are a lot of theories which are drawn from various educational and psychological theory known to the researcher. Popular theories like

Learning theories, personality theories. Theories of intelligence, theories of motivation, sociological theories and many others make an excellent starting point for research in classroom situations.

(c) Professional Literature : Professional Literature is another important source of problems for the researcher. Researcher should be well acquainted with the literature in the field of one's interest. After studying professional literature, a researcher can find the ways in which research related materials will be available him in selecting the problem. Research reports, bibliographies of books and articles, periodicals, research abstracts, yearbooks, dictionaries and research guides suggest areas that are to be investigated. Some specialized sources as the 'Encyclopedia of Educational Research, Dissertation,

Abstracts International, and the Hand-book of Research on Teaching, Psychological Abstracts and similar publications provide rich sources of problems. The publications like Research Needs in the study of Education(1986),surveys of Research in Education up to latest surveys, published by NCERT, University news, and other research related publications are exclusively devoted to identifying and bringing into sharp focus the varied research needs in the different areas and aspects of Indian education.

(d) Technological and Social Changes: Technological changes and social developments are constantly bringing forth new problems and new opportunities for research. A challenge to education has been introduced by the development of commercial and educational television, a field in which much research is needed .Decisions such as whether or not television will significantly alter the role of the classroom teacher must be based on the contributions of careful research.

(e) Consultation with Resource Person: Consultation with the course instructor, advisor, or reputed professor is helpful. Consultation with the more experienced faculty member is a desirable practice. Most students feel insecure as they approach the choice of a research problem. They wonder if the problem they may have in mind is significant enough, feasible, and reasonably free of unknown hazards. One of the most important functions of the research advisor is to help the student clarify his thinking, achieve a sense of focus, and develop a manageable problem from one that may be vague and too complex.

(f) Government priorities: Different government organizations also publicize research topics. e.g., Ministry of welfare and Justice, Government of India circulates a list of various topics in which it feels the necessity of research.

(g) Personal experience: One's own life experiences in professional work or the general life experiences is one of the meaningful sources of selecting a researcher topic for the beginner.

Anyway, at the time of selection of a research problem the researcher must consider and examine the importance of his/her research work. The researcher should keep in mind how the society will be benefited from the research work.

CHECK YOUR PROGRESS-02

Q.a) How do you select a problem?

……..……

Q.b) What do you mean by source of problem?

……..……

Q.c) What are the criteria and sources of problems?

……

1.4. DEFINITION AND STATEMENT OF THE PROBLEM :

After the selection of the problem, the next task is to define it in a form amenable to research. Definition of a problem means separation of the problem from the net of diverse meaning and complexities and separation of the real meaning. According to Whitney(1964), 'to define a problem means to put a fence around it, to separate it by careful distinctions from like questions found in related situations of need''.

The researcher must be certain about the real meaning of his/her problem. He/she should clarify the problem nicely. The detailed view should be expressed in simple words. According to Monroe and Engelhart (1928): "To define a problem means to specify it in detail and with precision. Each question and subordinate

question to be answered is to be specified. The limits of the investigation must be determined. Frequently, it is necessary to review previous studies in order to determine just what is to be done. Sometimes it is necessary to formulate the point of view or educational theory on which the investigation is to be based. If certain assumptions are made, they must be explicitly noted''.

The above definition describes the problem in concrete and specific terms in the form of workable questions.

Hillway (1964) has prescribed some rules which may be placed here as the guiding principles of the process of problem selection.

Hillway's rules are:

(a) Be sure that the topic chosen is neither too vague, nor too broad in scope.

(b) To make the problem clearer and more understandable, state it as question which requires a definite answer?

(c) Carefully state the limits of the problem, eliminating all aspects and factors which will not be considered in the study.

(d) Define any special terms that must be used in the statement of the problem.

Thus, the research problem should be defined very clearly with a boundary for the centralization of interest on the main issue.

Sometimes, the statement of the problem may be different. The statement must clarify the intended solution of the problem that is to be investigated. The whole problem should be defined and brief explanation should also be given here. The problem should be stated in such a way that it indicates a relationship between two or more variables. It should neither involve philosophical issues nor values or judgmental questions that cannot be answered by scientific

investigation. Thus, the statement should be placed in a detailed form with specification of the meaning of the technical terms.

1.4.1. Evaluating the Problem :

After placing a problem which a researcher may undertake for investigation, he is required to ask himself several questions about the problem. These questions will be helpful in evaluating the problem on the basis of personal comfort ability of the researcher. Only when those questions are answered in the affirmative can the problem be considered a good one.

1. **Is the problem Researchable?**

It is seen that a lot of problems lying in front of us cannot be solved through the process of research. For example, “Is it good to provide sex education in the secondary schools” is a question of value and can be answered only on the basis of value judgement. The answer of this question can be provided by the teachers, students, parents, but cannot be answered by scientific investigation because of its philosophical concerns. It can be said that the philosophical and ethical questions are not answered by scientific .Because research problem is closely related to two or more variables that have to be measured.

From the above discussion the main point that is being emphasized here is that the problem must be stated in workable research questions that can be answered empirically. For example, the above question might be reconstructed such as, “What is the impact of sex education in the secondary schools on the attitudes of adolescent girls towards premarital indulgence in sex?” The research can construct a study to obtain information on this type of questions that can be used in forwarding a solution to the ethical question, “Is it good to provide sex education in the secondary school?”

2. Is the Problem New?

It is meaningless to study a problem which had already been investigated by some researchers. Ignorance of prior studies may lead a student to needlessly spend time on a problem already investigated by some other researcher. To avoid such duplication, it is important to examine very carefully the record of previous studies completed in one's field. The researcher should pick up a new problem which has never before been investigated successfully while novelty or originality is an important consideration, the fact that a problem has been investigated in the past does not mean that it is no longer worthy of study. There is constant need for verification of the findings of previous investigations, using newer and better devices and procedures.

3. Is the problem Significant:

The question of the significance of the problem generally concerns with a question, "Is an important principle involved?" what is his purpose in undertaking to solve the particular problem he has chosen?"[1]

What new knowledge does he expect to add to the sum total of what is known? All these questions are directed to the researcher. Unless and until these questions are answered by him, the problem should not be selected to be investigated.

4. Is the problem Feasible for the Particular Researcher?

After a research project has been evaluated, there remains the problem of suitability for a particular researcher. While the problem may be good one, it is a good problem for me? Will I be able to carry it to a successful conclusion? Some of the questions that should be raised are:

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[1] Koul Lokesh-"Methodology of Educational Research Vikash Publishing House Pvt.Ltd. 576Masjid Road,Jangpura, New Delhi 110014.PP.64,65.

(a) The problem should be in an area in which the researcher is qualified and competent. Do I have the necessary competence to plan and carry a study of this type? Do I know enough about this field to understand its significant aspects and to interpret my findings? Am I skillful enough to develop, administer, and interpret the necessary data-gathering devices and procedures? Furthermore, researcher needs to consider whether he has the necessary knowledge of statistical procedures that may be required to carry out through the research till its completion.

(b) Interest and enthusiasm: After selecting the problem the researcher is interested in conducting his research problem and he is truly enthusiastic. If interest and enthusiasm are found about in the case of researcher, then it will not be hoped to complete the research work.

(c) **Financial Considerations:** The problem must be one which is financially feasible. The researcher must ask himself, "Will I have the necessary resources to carry on this study? What will be the expense involved in data-gathering equipment, printing, test materials, travel, and clerical help? If the research project is an expensive one, the researcher may consider the possibility of getting financial assistance from the state and private agencies and other research organizations like the UGC, the NCERT and philanthropic foundation or agency?

(d) Time requirements: The researcher should always keep in mind the time factor which is imposed on him/her by the institution. He/she should ask himself, "Will I have enough time to complete the project? Will there be time to devise the procedures, select the data-gathering devices, gather and analyzed the data, and complete the research project? If the problem is a big one, then it is essential to explore the

possibilities of seeking cooperation from others and taking it is up as a team project.

(e) Administrative considerations: Despite personal, financial and time requirements, the researcher should keep in mind some factors i.e. data, equipment, specialized personal and administrative facilities which are necessary to complete the study successfully. The researcher must confirm whether adequate data are enough and accessible to continue his/her research work. He should be well acquainted with the institutional authorities who permit him/her to contact the students, administer the necessary tools or conduct necessary interactions, interview the teachers, or have access to important schedule of records and documents.[2]

(f) Determination: The researcher should ask himself, "Will I have the courage and determination to purse the study in spite of the difficulties and social hazards that may be involved. "Will I be willing to risk the criticism, suspicion, or even opposition that a delicate or controversial study may raise?

CHECK YOUR PROGRESS-03

Q.a) "To define a problem means to put a fence around it, to separate it by careful distinctions from like questions found in related situations of need" who said this statement?

……

……..…….

Q.b) "Is the problem new one?" How can you check the problem?

……

……

[2] Koul Lokesh-"Methodology of Educational Research Vikash Publishing House Pvt.Ltd. 576Masjid Road,Jangpura, New Delhi 110014.PP.65-66.

1.5. LET US SUM UP:

The research process is similar to undertaking a journey. Research process consists of series of steps necessary to effectively carry out research and the desired sequencing of these steps. For a research journey there are two important decisions to make (i) what research questions or problems you want to find answers to; (ii) How to go about finding their answers. The way to finding answers to your research questions constitutes research methodology. At each operational step in the research process you are required to select from a multiplicity of methods, procedures and models of research methodology which will help you to best achieve your objectives.

The formulation of a research problem is one of the most important tasks in the process of research. It is the foundation on which you can build up the whole study. If there are defects in the formulation of a research problem, it will adversely affect the validity and reliability of the study undertaken by you.

After the selection of the area of research the next problem for the researcher is to select a problem that will be suitable for research. There are some important points in selecting a research problem by a researcher for example, Professional experience. Inference from theory, Professional literature and Technological and Social changes etc. In educational Research most of the problems may be selected from different sources.

The research topic should be defined in a form amendable to research .It means separation of the problem from the net of diverse meaning and complexities of research and its transformation into a simple and easily understandable manner. It is important to articulate the objectives of your study clearly .Objectives should be specific and free from ambiguity, and each one should relate to only one aspect of the study.

Key Words :

Ambiguity- the state of having more than one possible meaning

Articulate- explain your thoughts clearly in words.

Intricacies- the fact of having complicated parts

Hazards- obstacles and barriers faced in approaching a task

Resume: originated from the old French term 'resumed'. It means a summery.

Suggested Readings:

1) Koul Lokesh. Methodology of Educational Research, published by viks publishing House pvt. Ltd. 576 Masijid Road, Jangpura, New Delhi-110014.
2) C.R. Kothari Research Methodology- New Age International (p) Limited, publishers.
3) Ahuja Ram 'Research Methods" Rawat publications, Jawahar Nagar, Jaipur-302004(India).
4) Sidhu, Kulbir Sing(1992)Methodology of Research In Education New Delhi Sterling publishers pvt. Ltd.
5) Best , John w.& Kahn, James v(1999).Research in Education New :Prentice Hall of India Pvt. Ltd.

Answer to check your Progress:01

a) The following steps provide a useful procedural guideline regarding the research process:

i) Formulating the research problem;

ii) Extensive literature survey;

iii) Formulating the hypothesis

iv) Collecting the data;

v) Analysis and interpretation of data;

iv) Writing research report;

b) Kerlinger

c) The formulation of a research problem is the first and utmost important task for a researcher in the process of research. It is just like the identification of a particular place before undertaking a journey.

Answer to check your progress: 02

a) A beginner has to study all the minute aspects of his/her research area in selecting a research problem. He/she has to study thoroughly all the available research literatures which are closely related to his/her area.

b) Source of problem means the thing, the place, environment, review of related literatures, experts in the field of research, research supervisor etc. from whom the research problem is to be selected for investigation.

c) The following criteria and sources can be considered in selecting research problem by a researcher.

a) Professional experience, b) Inference from theory, c) Professional literature, d) Technological and social changes, e) Consultation with research persons. f) Government priorities, g) Personal experience etc.

Answer to check your progress : 03

a) Whitney (1964)

b) There is constant need for verification of the findings of previous investigations, using newer and better devices and procedures.

References :

(1) Asthana Bipin & Agrawal, R.N (1983).Measurement and Evaluation in Psychology and Education. Agra-2: Vinod Pustak Mandir.

(2) Best, John W. & Kahn, James V (1999).Research in Education. New: Prentice Hall of India Pvt. Ltd.

(3) Hillway, Tyrus (1964).Introduction to Research Boston: Houghton Mifflin Company.

(4) Koul LoKesh- 'Methodology of Educational Research"- Vikas Publishing House Pvt. Ltd.

(5) Panda K. Hemanta - "Paradigm Shift in skill Development and the Education Market" New Delhi-110002.

(6) Sarma Mukunda- "Research Methodology' EBH Publishers (India) Guwahati-781001.

(7) Sidhu, Kulbir Sing (1992).Methodology of Research in Education New Delhi: sterling Publishers pvt. Ltd.

Model Question :

1. What are the different steps in a research process?
2. What do you mean by Research Problem?
3. How do you select a Research Problem?
4. What are the sources of Research Problem?
5. What are the Special aspects in evaluating the Research problem?

UNIT - II : REVIEW OF RELATED LITERATURE : PURPOSE, NEED, IDENTIFICATION & ORGANISATION

STRUCTURE

2.0 : OBJECTIVES :

After going through the text discussed in this unit you should be able to -

- State the meaning of review of Literature.
- State the need of Review.
- State the ways and means of identifying related literatures.
- Appreciate the necessities of review of Literature.
- Take notes for a proposed study or a paper.
- Organize notes in a convenient way.

2.1 : INTRODUCTION :

Dear student, I hope that, by this time you have gone through the Block-I - Self learning materials supplied to you. There you have learnt about the need of educational research and you might have appreciated it. Further, attempts were made to familiarize you with various types of research. Assuming that you have gone through that part by heart you have been presumed to be a potent researcher. You might have observed that Block-II material started with that presumption. From the very outset, it is trying to equip you as a potential researcher. You might have scented it in its very first unit. Unit-II materials will lead you one step ahead in this direction. Infact this unit is the crucial part to have a break-through to your real business. Hence you should very critically and carefully go through it.

The unit goes with the running head 'Review of Related Literature'. You should be clear about its meaning, its purpose, need, identification and organization. For verification they are discussed under different heads. You should go through each of them very carefully.

Hope the materials will help you to achieve the stated objectives.

2.2 : MEANING OF REVIEW :

Knowledge has its own continuum. Every individual researcher are expected to maintain this continuity. He should add something which is new and useful. He is not expected to waste time in some useless exercises. But how he will justify his move ? That is possible only through a overall survey of the literature akin to the area from where the researcher choose his problem. This surveying of the problem area through literature is technically known as 'Review of Related Literature'. It has definite purposes and need. There are techniques of locating them. There are techniques of organizing them which should be understood from the following literature arranged under different heads.

2.3 : PURPOSE OF REVIEW :

I think that you won't do something without any purpose. Actually nobody does so. 'Review of Related Literature', too, have certain definite purposes. Can you presume them ? If you can, then before going through the text below. You can record them somewhere and after going through the text you can verity the correctness of your presumption.

Now let us come to the actual subject matter. Purpose of Review of Related literature is two-fold. (1) For the enrichment of the researcher, (2) For its necessity of incorporation in the proposal as well as in the final report. We can discuss them point by point.

Let us first consider from the personal point of view. Searching for a problem area for research project, itself is no less then

a problem. You may somehow concentrate your interest on an area, that too is not but extensive. You cannot cover a huge area within a single research project. More over a large portion of the area might have been covered by your predecessor. You may not find a room for your research project. You are not expected to repeat a work which is once done by some body. If you do that your project will be of no worth. Your personal experience or some other's experience may draw your attention to a certain area. Before proceeding you must know that there is really a gap. But how you will know it ? There the question of review comes in. Further review may help you in determining your strategy. In the next section we shall be discussing them in detail.

The other purpose of review is to convince other that you are going to engage in a worth-while business. You can explore things at your own cost. But usually you cannot or do not. You need some body's sponsorship. The sponsoring authority is going to do it only after knowing that they are doing it for a fruitful thing. They are going to ascertain it from your proposal. Beside others the proposal should have a section on review. The sponsoring authority is going to examine your depth of knowledge in the concerning area. They want to know that you are well informed, you have the ability of correct judgment, you can be expected to proceed scientifically and systematically. That part of your personality is going to be raveled though the section 'Review of Related Literature' of your proposal. If you have really done a worth-while review and if you have presented it in a impressive manner then it is sure that the sponsoring authority will have a positive valuation for you.

We have discussed so far about the importance of the review section in your proposal. But it is not the end of the business. Later

you will see that your final research report should also devote a section toward review. Assuming that you have succeeded in completing your research, then it is natural that you will expect to get recognition of your work. If the learned society recognizes it as a worthy contribution you will get the prize for the pain you have taken in conducting the research. But the learned community will do it only after being convinced that you have done something good. While you were busy with your work they were not with you. They will judge the worthiness of your work from the final report that would be submitted by you. But before actually assessing the work done by yourself they will like to evaluate your range of information and accordingly you must devote a section on review of related literature. They will assess the depth and breadth of your knowledge from that section.

Thus we have seen that the review of literature has two fold purposes. Though the first intention is to acquire knowledge for yourself yet it is not the least that you should let others know about you.

The first aspect needs discussion in depth. For that go to the next section.

2.4 : NEED OF REVIEW :

In the section presented above we have discussed about purposes of Review of Related Literature. But there cannot be any purpose unless there is some necessity. Purposes may sometimes be outwardly. But need arises from inner urge. If you determine to do something then you must internalize the concept that will make feel something necessary. But sometimes it so happen that you may not clearly perceive that what is actually needed and what is not. As

potent researcher review of related literature is your need. You would have done it yourself even it is not discussed here. But in that case due to lack of experience you would have roamed through unnecessary miles. The following discussion will direct you to those points which are your probable destiny. Now let us discuss them point by point.

First of all, to undertake research project you need to locate a problem area. You can do that only after you have a clear overall view of the subject area. You should know which part of the area has already been explored and which part of it is virgin till then. For that the only way is to review the related literature.

Secondly, if you intend to make your research effective then also you should know what has already been explored. The past knowledge is the base from where you can start. For that too, you need review of related literature.

Thirdly, to start with the project you may be searching for a good hypothesis, which is not readily coming to your mind. In that case also, your review work may provide you with a solution.

Critical review will help you in developing your reasoning. In words of Best and Kahn (1989). "Citing studies that show substantial agreement and those that seem to present conflicting conclusion helps to sharpen and define understanding of existing knowledge in the problem area, provides a background for the research project, and make the reader aware of the status of the issue."[1]

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[1] *Best, JW and Kahn J.V., Research in Education, p-38, sixth edition, Prentices Hall of India. Pvt. Ltd. M-97. Connaught circus, New Delhi - 110001)*

Review may also provide you knowledge regarding tools, techniques and procedure.

Thus we see that the need of review of related literature is many fold and we should do it carefully. Best and Kahn are giving some tips for reviews[2] for your convenience I would like to reproduce them as it is.

1. Reports of studies of closely related problems that have been investigated.
2. Design of study, including procedures employed and data gathering instruments used.
3. Populations that were sampled and the sampling methods employed.
4. Variables that were defined.
5. Extraneous variables that could have affected the findings.
6. Faults that could have been avoided.
7. Recommendation for further research.

These tips themselves indicate the necessity too.

Before passing to the next section let us comprehend the things so far discussed and take the small test below.

CHECK YOUR PROGRESS (1)

Qu. 1. State two purposes of review in one or a few words.

(i)

(ii)

Qu. 2. Select the correct statement (tick the correct statements)

(i) Need of review is many fold.

[2] *Ibid*

(ii) Review is necessary to understand what is research.

(iii) Main intension of review of related literature is to give you idea of various types of research.

(iv) Review of related literature helps you to delimit your project area.

(v) Review of related literature provides information regarding your problem.

(vi) Review of related literature helps you in formulating an workable hypothesis.

(vii) Review of related literature helps you mainly to understand scientific process.

(viii) Review of related literature gives you idea of the probable extraneous variables.

2.5 : IDENTIFICATION OF LITERATURE :

Now question arises - how much to read ? What to read ? Answer is very simple - that is, you should read enough but not some unnecessary materials. For a paper you will read those materials only, which are somehow related to your proposed study.

Next the question arises how you will identify them ? First of all you should concentrate on the reviews of the experts and locate the materials apparently useful for your study. Then your duty will be to search them for you.

Some books (e.g. Best & Kahn) provides index of literatures. Best an Kahn are suggesting some sources where you can search literature for your study.[3] They are as below-

1. The educational Index.
2. Research in Education.
3. Current Index to journals in education.
4. Index to doctoral dissertation and dissertations and abstracts International.
5. Other specialized indexes or abstracts indicated by the area of investigation (e.g. Psychological Abstracts).

There are certain organizations like Educational Research Information Centre (ERIC), from where you can get your information.

In India NCERT is regularly publishing an index of educational research at intervals with the name Survey of Education Research. Up till now as many as six volumes of the review have already been published. Students may consult the review materials.

These literatures will simply provide you the information of a certain literature. With that information you have to begin your search for the actual literature in the libraries to which you have access. Some library has the facility of borrowing literatures from some other big libraries. If you are in touch with such a library you can take that advantage also.

Now a day it is becoming easy to get access to any literature through internet, provided the material is loaded in the internet. Present day researcher can depend a lot on internet.

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[3] *Ibid - p - 45*

If you have personal internet connection then you are probably familiar with the process. Even if you do not have, then also you can avail the facility from a nearby internet café. If you can trace the material you can download the same if necessary.

After identifying the material you are to go through it. Again utilization of materials conveniently have certain techniques. In the following section we are going to discuss them.

2.6 : ORGANISATION OF MATERIALS :

While reviewing literatures you are supposed to take note for your proposal as well as your report. They will serve you as guideline for the proposed study. You are to preserve them for your future use, not necessarily for the proposed study only. The same notes may prove to be useful in preparing some other papers also. So if you do the work in a systematic and organized way that will save your time and labour. It may so happen that the material that you have been able to trace today may not be possible to be traced by you on some other day. Even if you can, it will take your extra time. So let us discuss some of the techniques used by earlier researchers. Depending upon them you can develop your own set of techniques. Now let us came to them.

First of all, you should keep a note pad with you all the time. It should be convenient to carry and should be such that a single page of which is roughly sufficient enough for a

single note. If different notes are taken on the same sheet then during editing you have to face trouble. Experienced researchers suggest its convenient sizes as 10cm × 20cm. or 12cm × 25 cm. Choose any one of the sizes.

Notes may be mainly of four different categories. *Quotations* - Lines having special significance can be quoted as it is.

The contents should be correctly and accurately copied and put under quotation mark (ie " ------ "). Sometimes a part of a para in quoted. Then the gaps should be indicated by a set of four dots (ie. -----). Second category is *paraphrase* - Here the content presented by the author is re-stated by the researcher, i.e. by you. Here, the matter is left unquoted. Third category is *summary* - Here, you are to write the content of a text in compact form with your own words. Care should be taken to touch all the points that the text contains. Language of summery should be simple and self explanatory. Fourth category of note is known as *evaluation.* - After going through the text of the original author you will record your own judgments or reaction. You will state your opinion, why you agree or disagree to the idea or opinion of the author.

In preparing note sheets you should not forget to record the necessary references, preferably in one of the corner toward the top. The reference should contain the name or names of the author or authors, with last name first, year of publication, name and address of the publishing agency, and page number of the original literature. Figure indicating the page number should be preceded by a single 'P' if the content of your note is taken from a single page. If your note is taken from several pages then that should be indicated by first and the last page number separated by a hyphen and preceded by two p's i.e. 'pp'. You should put a heading at the top of the card, preferably indicating the title of the section under which it is going to be incorporated. A note sheet has its content as shown in the figure below. Some researchers prefer to record the bibliographic citation at the bottom of the sheet.

There are certain conventions of recording the references of different categories of literatures. A category wise list of references, given below will help you to understand the convention.[4]

1. **Book :**
   Ghosh B. N. (1986) *Scientific Method and Social Research.* India, Sterling publication Pvt. Ltd.
2. **Books with Multiple authors :**
   Best J.W. and Kahn J.V. (1989), *Research in Education*, New Delhi, Prentice Hall.
3. **Books in Subsequent edition :**
   Hallaban, D.P. & Kauffman J.M. (1982)
   Exceptional Children (2nd ede), Englewood cliffs, N.J. Prentice Hall.
4. **Editor as Author :**
   Michel J.V. Jr. (Ed) (1985), *Mental Measurements Year Book* (9th ed) Highland Park. NJ Gryphen Press.
5. **No author given :**
   Prentice-Hall Author's Guide (1978), Englewood clifts, N.J : Prentice - Hall.
6. **Association Author :**
   American Psychological Association (1983) *Publication Manual* (3rd ed.) Washington DC : Author.
7. **Part of a Series of books :**
   Jerman, L.M., Koden, M.H. (1947), *Generic Studies of Genius Series : Vol. 4 : The Gifted Child Grows up*. Stanfend, CA : Standford university press.

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[4] *Ibid - p - 45*

8. Chapter in an edited book :

Kahn, J.V. (1984), Cognitive Training and Its Relationship to the Language of Profoundly Retarded Children. In J.M. Barg (Ed), *Perspectives and Progress in Mental Retardation.* Bultimore : University perk, 211-219.

9. Journal Article :

Seltzer, M.M. (1984). correlates of community opposition to community residences for mentally retarded persons. *American Journal of Mental Deficiency*.

10. Magazine articles :

Meer, J. (1984, August), Pet Theories. *Psychology Today*, pp. 60-67.

11. Un published paper presented in a meeting :

Schmidt, M., Kahn, J.V., K Nucci, L., (1984, May) *Moral and Social Conventional Reasoning of Trainable Mentally Retarded Adolescents,* presented at the annual meeting of the American Association of Mental Deficiency, Minneapolis, MN.

12. Thesis or dissertation unpublished :

Best, J.W. (1948) *An Analysis of Certain Selected Factors Underlying the Choice of Teaching as a Profession*. Unpublished doctoral dissertation university of Wisconsin, Madison.

13. Unpublished Manuscript :

Kahn, J.V., John, C. K., Schmidt, M. (1984) *Effect of Object Preference on Sign Learn Ability by Severely and Profoundly Retarded Children : A pilot study*. Unpublished manuscript, University of Illinois at Chicags.

Kahn, J. V. (1984) *Cognitive Training and Language Learning*. Manuscript submitted for publication.

14. Chapter accepted for publication :

Kahn, J.V. (in press) cognitive assessment with mentally retarded infants and pre scholars. In T.D. Wachs K.R. Schechan (Ed), *Assessment of Developmentally Delayed Infants and Pre-scholars : A Trans-disciplinary Approach*. New York : plenum.

15. Technical report :

Kahn, J.V. (1981) *Training Sensory Motor Period and Language Skills with Severely Retarded Students*. Chicag (ERIC Document Reproduction service, No. ED204941) Ordering of the categories of literature is clone according to best and Kahn.

After taking notes, file the cards according to the topic. This will facilitate you when preparing your report.

Some times notes are collected by getting xerox copy of the original or are downloaded from the internet. In that case also the appropriate references should be recorded and should be filed like other note sheets. Sometimes such materials many contain only a little useful part. In such cases it will be convenient to record them in a note sheet and to preserved with others. The original copy may be discarded to minimize the load of unnecessary papers.

Friend, we have discussed so far about the identification and organization of related literature. Shortly we are going to sum up the entire unit. Before that, take a small test to get your achievement assessed.

CHECK YOUR PROGRESS (2)

Fill in the gaps with appropriate works.

1. First source of information about related literature is ----------.
2. When an idea expressed by an author in a small part of his writing is restated by the researcher in his own word is known as ----------.
3. Easiest way of locating a literature is through ----------, now a day.
4. For the convenience of preparing the final report, ---------- arrangement of the notes are necessary.

2.7 : LETS SUM UP :

We have discussed so far, about the review of literature. A section in the report is devoted to review. By reviewing the earlier relevant literatures the researcher can locate a problem area for study, get idea to frame a good hypothesis, gets valuable idea of the variables, techniques, procedure etc.

A well presented review creates a good image of the researcher in the mind of his valuer. They guess the depth of the researchers concept from it.

Any literature available to the researcher may not be useful to him. He should carefully select them. It may not be readily available also. He has to search them through various sources. Now a day internet is becoming a handy device in this matter.

A researcher may refer many literatures and note down the valuable things from there. Haphazardly maintained records often

spoil time and energy. Hence the researcher should follow certain procedures in arranging and storing them.

'Review of Literature' comes in the report after a few section, but the actual research work starts with review of literature. So any potent researcher should be well conversant with the concept.

2.8 : KEY WORDS :

Reference :- References are those documents which are referred (mentioned) in a report. The author's name, Title of the literature are their identification. Here those identifications are termed as reference.

Organization :- Sorting and keeping the notes in order for future utility.

Index :- Index is a list. Here index indicates lists of Books, journals, papers etc.

Specialized index :- Index of certain things with special identification.

2.9 : SUGGESTION FOR FURTHER STUDY :

Best, J.W. and Kahn J. V. *'Research in Education'*, sixth edition, 1989. Prendice - Hall of India, Private Limited. M-97, Connaught circus, New Delhi - 110001.

Purohit, P.N. (2003) *Methodology of Educational research : Tools and techniques*, Mangal Deep Publication, Jaypur (India)

Pall, Dr. S. K. and Saxana, P.C. (ed) (1985) *Quality Control in Educational Research*, Jadav, Dr. N.J. etc., Quantities and Qualitative Research and Education, Metropolitan book company New Delhi.

Goyal, J.C., Duggal, J.(ed) *Research in Classroom*, NCERT Publication (Several volumes)

Probable answer to the questions of CYP's :

CYP (1)

Qn. No. 1. (i) To get acquainted with problem area yourself (ii) To let your evaluator know that you are well acquainted with the problem area.

Qn. No. 2. (i), (v), (vi), (viii)

CYP (2)

Qn. No. 1 : Experts review
2 : Paraphrase
3 : Internet
4: Head wise.

References :

Best J.W. and Kahn J.V. : *Research in Education* (1985) Prentice Hall of India, M-97, Connaught circus New Delhi.

Model Questions :

Qn. 1: What is the value of review of literature for the researcher and the research ?

Qn. 2: How a literature relevant to a study can be located ?

Qn. 3: What techniques should be adopted in recording the notes during review ?

Qn. 4: What is the importance of organization of notes, for a researcher ?

BLOCK-II

METHODOLOGY OF EDUCATIONAL RESEARCH

Unit-III

1.0 OBJECTIVES :

After going through this unit you will be able to

1. Explain meaning and importance of hypothesis in educational research.
2. Distinguish between different types and forms of hypothesis.
3. Formulate hypothesis.
4. Use the techniques involved in collection and analysis of data
5. Write research proposal.
6. Write research report.

1.1 INTRODUCTION :

In the field of education, there are many situations arise where different facts and phenomena are necessary to investigate scientifically. To do this the researcher must possess knowledge of research methodology. As a student of education you might be interested how to solve problems pertaining to the field of education. The researcher needs to follow certain distinctive steps to arrive at valid and acceptable conclusion. The steps are in brief are-

1. Identification of the problem.
2. Defining the problem in simple language.
3. Stating objectives of the study.
4. Formulation of Hypothesis.
5. Collection and analysis of data.
6. Drawing generalizations and conclusions.
7. Chapterization Scheme.

These seven steps are basics of any educational research. Besides this after competition of his/her studies, it is necessary to write the report by using a commonly accepted format. If you want to be a researcher in this field, you should try to derive pleasure form learning such important activities. This unit is being organized in to seven sections all of which are very important for you. I hope you will be able to follow the all these without any difficulty.

1.2 HYPOTHESIS :

In day to life, in usual conservation you have used term ' hypothesis' in one form another. Here we should try to know its meaning with a greater precision. In this section an effort has been made to more clear of this term. Etymologically, 'hypothesis' is made up two words. They are 'hypo' and 'thesis' where 'hypo' means- less than and 'thesis' means- certainty or truth. Thus, general meaning of the term 'hypothesis' means some assumptions which may or may not be true. The statements or predictions are tentative in nature where there exists sufficient scope for verification. Through scientific investigation the hypothesis can be proved. As a result of this a hypothesis is rejected or retained. 'Hypothesis' is a singular tem where as 'Hypotheses' is a plural term. In research studies after stating the problem of the task of the researcher is to guess all the possible causes based on available evidence. This opens the doors of solution of the problem chosen by the researcher. The simplified, meaning of term hypothesis is a tentative or working proposition suggested as a solution of the problem that a researcher identified. Therefore, it should it should based on certain evidence which needs to be tested for confirmation of the causes relating to the problem. From this point of view knowledge about types and ways of formulating hypothesis is very important in educational research.

1.2.1 Importance of Hypothesis :

The importances of hypotheses are significant in the studies which aim to make predictions about some outcome. If you choose a research problem belonging to 'experimental type' then you will be interested in making predictions about possible outcome of your experiment. In this case you expect what may occur in future. Therefore, the role of hypothesis is considered to be of utmost importance. If you select a research topic belonging to historical or descriptive research you may investigate the history of a city or a nation, the life of a man, the happening of an event or seeking facts to determine the status quo of some situation and thus may not have a basis for making a prediction of results. In this situation there is no need for thinking about hypothesis. A hypothesis, therefore, may not be required in such fact finding studies.

Most historical or descriptive studies, however, not only fact finding but interpretation of facts to draw generalizations. If as a researcher you want to trace the history of a school or making a study about the results of a coming assembly poll, the facts or data that you able to draw generalizations from them. Whenever possible, a hypothesis is recommended for all major studies to explain observed facts, conditions, or behavior and to serve as a guide in the research process. In this case, if you don't construct hypothesis, you may waste time and energy in gathering empirical data, cannot state facts clearly and detect relevant relationships between different variables.

1.2.2 Characteristics of a good Hypothesis:

1. The hypothesis should be conceptually clear. It means, a good research hypothesis is one which is based upon operationally defined concepts. For example, the term achievement may be defined by different authors giving focus on different aspects. The definition which is most suited to your study is your operational definition. Not

only this, the definitions must be given in commonly accepted and communicable words so that the complete hypothesis is clear to any reader.

2. The hypothesis must be testable. It should be formulated in such a way that can be tested directly and found to be probably true or false. A hypothesis like 'Democratic atmosphere in educational institution improves the creative thinking of the pupils' is apparently seems to be true hypothesis but due to too broad in nature it is difficult to test.
3. The hypothesis should be related to the existing body of theory and facts. If the investigator forwards a hypothesis, which seems to him of interest but which is not related to the existing body of facts, definitely it will not be a good research hypothesis.
4. The hypothesis should have logical unity and comprehensiveness: Sometimes several hypotheses can be formulated regarding the same research problem; the most logical comprehensive one should be preferred.
5. The hypothesis should be specific in scope: A general hypothesis permits several deductions and thus explains several facts at a time. Therefore, very broad or very general hypothesis cannot be good research hypothesis because such hypotheses are usually vague and cannot be tested.
6. The hypothesis should be related to available scientific tools and techniques: There are hypotheses about which data cannot be collected because of unavailability of scientific tools or techniques. In such cases by framing very good hypothesis will not serve our purpose.
7. The hypothesis should be in accordance with other hypothesis of the same field. Usually this is an accepted criterion of a good research hypothesis. But this condition

is not must. A hypothesis that contradicts other hypothesis of the same field can also be regarded as good hypothesis if there is scientific rationale, which in turn, has experimental support.

1.2.3 Types of Hypothesis :

A research or substantive hypothesis must be stated in a testable form for its proper evaluation. There are research hypotheses which give directions what may occur or which are expected to occur. For example, “achievement of the intelligent learners is better than slow learners.” is a hypothesis which shows direction. This type of hypothesis is called directional hypothesis. Similarly, the hypothesis “Adolescent boys with high I.Q. will exhibit low anxiety than adolescent boys with low I.Q. is a directional research hypothesis because it stipulates the direction of difference between two groups.

There are research hypothesis which doesn’t specify the direction of difference. For example “There is a difference between the boys and girls so far achievement is concerned”. and there is a difference in the anxiety level of adolescent girls of high IQ and low IQ” are examples non-directional research hypotheses. In the first example whether boys are better over girls or girls are better over boys is not mentioned. In the second example, whether anxiety level of girls of high IQ is higher than girls of low IQ or anxiety level of girls of low IQ is higher than girls of high IQ is not given. Therefore, this type of hypothesis, where the direction of difference is not given, simply the existence of difference is mentioned is termed as non-directional hypothesis.

1.2.4 Forms of Hypothesis :

Forms of hypothesis is cited with the help of certain examples. “The academic achievement of extroverts is significantly higher than that of the introverts,” is stated in the declarative form. In such a statement of hypothesis, the researcher makes a prediction based on his theoretical formulations of what should happen if the explanations of the behavior he has given in his theory are correct. Another hypothesis, “There is no significant difference between academic achievement of athletes and that of non-athletes” is stated in the null form. Such null hypothesis can be tested statistically, so they are often termed as statistical hypotheses. They are also called the testing hypothesis when declarative hypotheses are tested statistically by converting them in to null form. This frequently happens in educational research

A null hypothesis challenges the assertion of a declarative hypothesis and denies it altogether. It says that even where it seems to hold good it is mainly due to mere chance. It is the task of the researcher to reject the null hypothesis by showing that the outcome mentioned in the declarative form does occur and the quantum of it is so much that it cannot be easily said to have occurred due to chance only. The criteria for rejecting the null hypothesis may differ. Sometimes the null hypothesis is rejected on the ground that the quantity of occurrence of the outcome so large that the probability of its occurrence is 1 time out of 100 or .01 time out of 1. We consider the probability of its occurrence by chance is too little and we reject the chance theory of the null hypothesis and take the occurrence is due to a genuine cause. On other occasions, we may be bolder and reject the null hypothesis even when the quantity of the reported

outcome is likely to occur by chance 5 times out of 100 or .05 time out of 1. Statistically the former is called as the rejection of the null hypothesis at .01 level of significance and the latter as the rejection of the null hypothesis at .05 level of significance.

It is another interesting fact to be noticed that as researcher you may be able to reject the null hypothesis, but you cannot directly uphold the declarative hypothesis. If an occurrence is not held to be due to chance, it doesn't mean that it is due to the very cause or effect relationship asserted in the particular declarative form. It may be due to something else which the researcher may have failed to control. However, inferentially the cause of the declarative hypothesis becomes strong. The less plausible the null hypothesis, the more plausible the declarative one. It the general agreement amongst the researchers that null hypothesis should not be used as an alternative to the declarative hypothesis nut should be used in combination with it for statistical purposes.

Hypothesis may be stated in question form. In this form a question is asked as to what the outcome will be instead of stating what is expected to occur. For example a researcher is interested in knowing whether the programmed instruction has any relationship to test anxiety of children. The declarative form of the hypothesis might be : "Teaching children through the programmed instruction material will decrease their test anxiety." The null form would be: "Teaching children through programmed instruction material will have no effect on their test anxiety." This statement shows that no relationship exists between programmed instruction and the test anxiety. The question form puts the statement in the form: "will teaching children through programmed instruction decrease their test anxiety?"

Check your progress :

(a) Discuss the meaning of the term hypothesis.

……

(b) Enumerate the characteristics of a good hypothesis.

……

(c) What are the types and forms of research hypotheses?

……

(d) Frame at least two directional hypothesis and two non-directional hypotheses.

……

(e) What is meant by level of significance to retain or to reject a null hypothesis?

……

(f) Frame at least three examples of null hypotheses and three examples of question form hypotheses.

……

1.3 PREPARING A RESEARCH PROPOSAL :

The writing of a research proposal is an important aspect of the research process. Before we elucidate the steps involved in preparing a research proposal, it is essential to throw light upon the nature and need for a research proposal.

A research proposal is a detailed plan of the research to be conducted. The research proposal is comparable to the blueprint which the architect prepares before the construction of a building. The research proposal provides the basis for evaluation of the submitted project. Many institutions require that a proposal must be submitted before it is finally approved. The major purpose of a research proposal is to ensure a workable experimental design which,

when implemented, may result in to analyzable piece of research of finding of significant scientific document.

The initial draft of the proposal is subject to modification in the light of constructive criticism, comments and suggestions of the experts in the field. These experts include researcher's supervisor, colleagues, research and statistical specialists or other experienced researchers who act as members of the research committee of an institution or organization. The research proposal always goes through the developmental phases and therefore, deficiencies, if any may be corrected by discussing the same with the experts.

1.3.1 Preparation of the Research Proposal:

There are certain specifications that are essential to good research and, therefore, all such specifications should appear in each plan. A worthwhile research study is likely to result only from a carefully planned and well-designed proposal. The following are the important parts of a research proposal.

Introduction: The introductory part of the proposal should include the following information:

1. The Title: The title of the research proposal should contain only the name of the topic. It should be so worded that it suggests the theme of the study. In selecting the topic, the researcher should consider two things:
   (a) The title should not be burdened by pompous words and should not include terms of unscientific, rhetorical, argumentative, emotional or biased nature. The language of the topic should be easily understandable by the readers.
   (b) The title should not be too lengthy unnecessarily. It should be specific to the area of study. An adequate title for a study is one which represents a reasonable

restriction and implies an objective approach. It must be noted that the proposed study cannot completely be represented in the title; but it should be so worded that it would give sufficient information about the nature of the study.

2. Statement of the Problem: Statement of the problem is not exactly same as the title of the thesis. It has a definite place in the introductory chapter and is an attempt to focus on a clear goal. Statement of the problem should primarily be an expansion of the title. It should be either in question form or declarative statement. The major question or statement may be followed by several minor questions or statements.

3. Review of Related Literature: The theoretical and empirical framework from which the problem arises must be briefly described. Both conceptual and research literature are to be reviewed for this purpose. The latest research trends pertinent to the problem should also be mentioned in this section.

   The researcher has to make it clear that his problem has roots in the existing literature but it needs further research and exploration. A brief resume of related studies found in journals, magazines, abstracts and reports should be made. This provides evidence that he researcher is familiar with what is already known and also with what is unknown and unproved. An analysis of the previous research eliminated the risk of unnecessary duplication of what has been done, and provides bases for formulating hypotheses.

4. The Hypotheses: Questions that the research is designed to answer are usually framed as hypotheses to be tested as the basis of evidence. This step establishes the problem and the logic underlying the research study. It gives direction to the data gathering procedure. It is in the light of the hypotheses

that the relevance of dada to be collected is judged. The formulation of the research hypotheses is determined by the implications of the related literature and deductive logic of the problem under investigation.

5. Significance of the Study: A research proposal should justify the worthwhileness and urgency of the research study. It should indicate clearly how the results of the study can influence educational theory and practice. The need for undertaking a research study can be shown in several ways.

   One way of establishing a need for a research study is to show the time lapse between the earlier study and the present one; and therefore the new knowledge, techniques, or conditions indicate a need to replicate the study. A second way of showing the need for a study is to divulge that there are gaps in the knowledge provided by previous research studies and how the present study will help to fill in these gaps and to the quantum of existing knowledge. A third and final way is to show the lack of information about a problem by prescribing the supporting statements of other research studies.

6. Definition of Terms and Concepts: It is necessary to define all unusual terms or words and phrases having special meanings need to be defined operationally. We seldom come across unanimous definition or modes of measurement for certain concepts and terms, such as intelligence, motivation, achievement, etc. and in such situations it becomes obligatory on the part of the researcher to provide an operational definition of such terms or concepts by stating how the variable will be measured and interpreted. The Dictionary of Education, Edited by Carter V. Good; the Comprehensive

Dictionary of Psychological and Psychoanalytical terms, edited by Horne B. English and Eva C. English; and the Dictionary of Sociology; edited by H.P. Fairchild are valuable sources for definitions of technical terms.

7. Delimitation of the Study: Boundaries of the study should be made clear with reference to (a) the scope of the study by specifying the areas to which the conclusions will be confirmed, and (b) the procedural treatment including the sampling procedures, the techniques of data collection and analysis, the development of measuring tools and their use in the study.
8. Methods and procedures: The detailed plan of population, sampling, construction of tools and plan of analysis needs to given clearly.

Check your progress:

(a) What is a research proposal ?

……

(b) How many steps are involved in preparation of a research proposal and what are they?

……

1.3.2 Procedures for collection of data:

In this section the details about sampling procedures and the data collecting tools are described. It may be noted that in historical and philosophical researches the nature of the data and their treatment is different from other types of researches.

1. Sampling : In research situations, sometimes come large populations which needs to be managed scientifically. In such situations, the researcher may use different sampling methods, such as random, systematic, multistage,

stratified, cluster, judgment or Quota sampling depending upon his requirement. The researcher should be well informed about the scope and limitations of each of these sampling methods before he thinks of his own sample in the research. A research proposal should clearly define the population from which the researcher will draw his sample, and describe the procedure he will use to select the sample.

2. Tools: In order to collect evidence or data for a study, the researcher has to make use of certain

   Testing and non-testing tools such as intelligence tests, aptitude tests, personality inventories, observation, interview, questionnaire, rating scale, etc. The researcher must be well familiar and competent enough in the use of these tools and fully aware of their merits and demerits.

   The research proposal should explain the reasons for selecting a particular tool or tools for collecting data. The proposal should include the reported evidence of reliability and validity of the standardized tools for the purpose of the study. The researcher should take help of Mental Measurement Year Books (Buros), Indian Mental Measurement Year Book (NCERT) and other similar literature on test development for the selection of appropriate standardized tools. If he is developing his own tools, he should outline the procedure to be followed in their development.

1.3.3 Procedures for treating data:

In this section, the researcher describes how to organize, analyze and interpret data. The details of the statistical techniques and the rationale for using such techniques should be described in the research proposal. In case of historical research, it is necessary to

throw light on the methods of internal and external criticism that are to be adhered to in the analysis of data. In documentary studies, mode of content analysis should be explained in the proposal.

1.3.4 Bibliography :

In each research proposal, the researcher should give a list of books, journals, and other documents that he has used in selecting the problem and which he may use during the conduct of study.

Check your progress:

(a) Why sampling is necessary in educational research?

……..……

(b) What are the different sampling techniques used in educational research?

……..……

(c) How the collected is analyzed to draw conclusion?

……..……

(d) What are the different elements of Bibliography?

……..……

1.4 WRITING RESEARCH REPORT:

For the purposes of presentation of a research report, several style manuals are available which provide guidance to researcher as to the specific rules on style and format to be followed in reporting findings of his research. Some universities, research organizations or journal boards have established their own formation which their theses, dissertations or research must conform, but all formats are somewhat similar to the following outline which comprises of three main sections: (1) the preliminary section; (2) the body of the report to text and (3) the reference section. Each main section comprises of several sub-sections.

1.4.1 Preliminary Section :

1. Title page
2. Preface, including acknowledgements (if necessary)
3. Table of Contents
4. List of Tables (if any)
5. List of figures, maps or illustrations (if any)

1.4.2 Body of the Report or Text :

(a) Introduction

1. Statement of the problem
2. Analysis of previous research
3. Relation of present problem to theoretical position of the previous research
4. Significance of the problem
5. Delimitations of the study
6. Assumptions underlying hypotheses
7. Statement of hypotheses
8. Definition of important terms.

(b) Design of the study

1. Procedures employed
2. Sources of data
3. Data gathering instruments
4. Sampling and methods of gathering data.

1.4.3 Analysis and interpretation of the data :

1. Text
2. Tables (if any, are usually included in to the text)
3. Figures (if any, are usually included in to the text).

1.4.4 Summary and conclusions :

1. Brief restatement of problem and procedures.

2. Principal findings and conclusions with their practical implications (if any)

3. Suggestions for further research.

1.4.5 Reference Section :

1. Bibliography
2. Appendix
3. Index (if any)

Preliminary Section

1. Title Page. Several pages of preliminary material are presented prior to the body of a research report. Generally it contains the following information:

(i) Title of the study

(ii) Name of the institution to which the report is submitted.

(iii) Degree for which the report is submitted.

(iv) Name of the candidate (if desired, previous academic degrees may be listed after name)

(v) Date of submission of the report.

2. Preface. The preface usually include a brief statement of the purpose and scope of the report. A preface should also include thanks for those who gave the researcher substantial guidance or assistance in the conduct of the study. If the researcher has little to say about the contribution of his work, the preface can easily be omitted. In such a situation, the page should be labeled ‘acknowledgements’ rather than ‘Preface’. Acknowledgements should be brief and simple. A long list of effusive acknowledgements full of flattery is not good taste. The

brief statements of acknowledgement should sincerely recognize the persons and institutions to which the researcher is indebted for providing academic guidance, administrative facilities and financial assistance.

3. Table of Contents. The table of contents includes the major divisions of the report; the introduction, the chapters with their sub-sections, the bibliography and the appendix. Page numbers for each of these divisions and sub-divisions are given. The titles of chapters for and sub-divisions within chapters should correspond exactly with those included in the body of the report with correct page citation. The preface or acknowledgements, list of tables and list of figures are also entered in the table of contents. The table of contents provides reader a birds' eye view of the report and enables him to locate quickly each section of it.

4. List of tables and figures. If tables and figures are presented in the research report, a separate page is included for each list. These lists include full titles of tables and figures with their corresponding numbers and page citation.

Body of the report: The main body of the research report usually contains four logical divisions; (1) an introduction; (2) design of the study, (3) analysis and interpretation of data; and summary and conclusions. In a thesis or in dissertation, these divisions comprise chapters, while in a research paper they may consist of sections with suitable headings.

1. Introduction. The introduction of a research report should be lucid, complete and concise. It should introduce the research problem in a proper context, and arouse and stimulate the reader's interest. If introductions are dull, confused, and lacking in precision, direction and specificity, there is little incentive for the reader to continue reading the research report.

In the introduction, the researcher defines, analyses and states the nature of the problem. He also reviews the related studies so as to lay a foundation for research. The review of the results of previous workers brings out areas of agreement and disagreement, and shows how the present study arose from contradictions or inadequacies of earlier investigations. The introduction also includes the significance of the problem and the need for conducting the work undertaken. After reviewing the background of the problem, its scope and delimitations, the researcher presents his hypotheses and the assumptions on which the hypotheses are based. He then defines the terms used in the study that have a special meaning or significance for the investigation.

2. Design of the study. This section explains the design of the study in detail. It includes a detailed description of the manner in which decisions have been made about the type of data needed for the study , the tools and devices and devices used for collection of data and the method by which they have been collected. A researcher may present the structure of population; the size of the sample and the logic for the size; the method of sampling; the number of individuals who declined to participate in different phases of study and why, where, when and what types of data are being collected; the process of constructing data collecting tools along with their reliability and validity; the design and method of conducting the experiment full about the assumptions, classification and manipulation of variables, and nature of treatments; directions given to the individuals from whom information are sought ; characteristics of interviewers or observers and the type of

training provided to them; the type of data analysis made; the statistical formulae used and the reasons for their selection and application ; and how the data will be organized and presented for analysis and interpretation.

3. Analysis and interpretation of the data. This section is the heart of the research report. The data analysis and interpretation may either be in separate chapters or may be integrated and presented in one chapter. This is presented in tables and figures accompanied by textual discussion. The tables and figures should be constructed and listed in such a way that they clarify significant relationships and become self-explanatory. Tables which are complex and lengthy should be placed in appendix, otherwise the continuity of the textual discussion gets broken. In the textual discussion of the data, the report should not repeat all the detailed information that is provided in the tables and figures. He should only point out important facts and relationships to give meaning to the data and make certain generalizations about the data.

The formulae and statistical procedures which were used in the analysis of the data should be clearly specified and explained in detail. Statistical information may be presented in the form of sums, ratios, proportions or percentages; frequency distributions; means and variance, significance of difference between means, measures of variability, coefficients of correlation, regression analysis, analysis of variance etc. The reasons for selecting a particular test of significance, the assumptions underlying their use and the confidence levels chosen in arriving at the results must be presented carefully. All the unexpected developments in the

form of unanticipated relations or unforeseen trends should be reported fully. Any weakness in the research design, tools, techniques, or population that have come to light during the conduct of study should be discussed frankly along with the manner in which factors may have affected the findings of the study.

4. Summary and conclusions. This section includes a brief re-statement of the problem, a description of the procedures used, and discussion of findings and conclusions of the study. The conclusions are presented concisely and related directly to the hypotheses that were tested. They announce whether the findings of the study accept or reject the hypotheses. Conclusions are answers to the questions raises and suggest modification in the existing theory. In addition, the researcher may list unanswered questions that have occurred in the process of study and which require further research beyond the scope of the problem investigated. If no further research would appear to be advantageous in the area investigated and a new approach to the problem is needed, the researcher should make suggestions. In short, the discussion and presentation of conclusions should leave the reader with the impression of completeness and of positive gain.

The summary and conclusion section is the most widely used part of the research report because it reviews all the information that has been presented in its previous sections. Most readers scan this section of the report first to get an overview of the study and to determine its utility to them; they go through the remaining chapters also.

In addition to summary, some institutions and research journals require a researcher to submit an abstract of study. This abstract serves as a synopsis that gives relevant information to a reader to judge whether he wishes to read the complete research report.

Reference Section: The reference section includes bibliography and appendix. In a research article, the heading article, the heading 'references' is used in place of bibliography. The bibliography is a record of those sources and materials that have been used for the study. If the number of references is large, the researcher may divide the bibliography in to various sections, one for books, one periodicals and journals and possibly one for reports and special documents.

An appendix follows the bibliography. All the relevant supporting unwieldy materials, that are important but not essential to the understanding of the report, are presented in the appendix. These materials include questionnaires, copies of covering letters used, evaluation sheets, checklists, courses of study, long quotations, documents, tests, interview forms, and raw data.

If a study is of major importance and is to be published in book or monograph form, the researcher also prepares an index in alphabetical order which follows the appendix.

Check your progress:

(a) How many main divisions of a research report and what are they?

…….

(b) Discuss in detail the qualities need to be reflected in the main body of the research report.

…….

(c) Mention the qualities need to be reflected in the reference section of a research report.

…….

1.5 STYLE AND FORMAT OF REPORT WRITING :

Language: An outstanding scientific investigation is of little value if its process and findings are not communicated effectively to others. Compbell (1969), Dugdale (1967) and Turabian (1967) have provided several style manuals. After adopting any of the style manuals, the researcher must adhere to it throughout the report. A clear statement of the hypotheses, and logical and objective presentation of the procedure rather than emotionalized discriptions are required in a scientific report. A research report is usually read by well informed readers who always search for flaws in the process of reasoning. It is possible that the readers may check the results by repeating experiment or computations. To meet this eventuality, a

research report must be presented so carefully that it can stand the test of critical scholarship of other readers.

The presentation of the research report should be creative, logical and concise making use of simple common words and sentence structure whenever possible. Its language should be formal and straight forward avoiding proverbial or discourteous phrases. The personal pronouns like I, we, you, my, our, and us should be used. For example, instead of saying, " I administered an attitude test to test students' attitude towards democracy", the passive voice construction. "Attitude of students' towards democracy was administered by the researcher/ investigator", would be more preferable. The personal pronouns may be avoided by the use of such expressions as the "the investigator" or "the researcher".

The use of abbreviations, except some universally acceptable such as IQ, M.A., M.Sc., etc. should be avoided in the main text of the research report. In the footnotes, the tables and the bibliography, some standard abbreviations are used to conserve space. A researcher should be familiar and should master the following standard abbreviations;

bk., bks.	book, books
chap,. chaps	chapter, chapters
p,. pp.	page, pages
anon,	anonymous
col,. cols.	column, column
e,g.	for example
edn., edns.	edition, editions
et al.	and others

Ibid	same reference
Op. cit	previously cited
Loc. Cit	the same place cited
fig., figs	figure, figures
Idem	same person
Illus.	illustrated
I., II	line, lines
f., ff,	and the following page(s) (pp. 5ff., Page 5 and the following pages)
mimeo	mimeographed
MS, MSS	manuscript, manuscripts
n., nn.	Note, notes
N.B.	please note
n.d.	no name
n,p.	place
N.S.	new series, new style
no., nos.	number, numbers
trans.	Translator, or translated by
viz.	namely
vol. ols.	Volume, volumes
vs. vss.	Verse, verses
rev.	revised or revision
sic.	thus
vide.	See

Numbers of less than three figures, round numbers and numbers that begin sentences are spelled out, in statistical discussions in which they are used frequently. Fractions are also spelled out

unless they are part of longer numbers. Figures are used for all the small and large numbers which appear in a series. In numbers with more than three digits, commas are usually used to point off thousands or millions, use either letters or numbers in parentheses to enumerate items in a paragraph. Both forms of letters and numbers in parentheses are not used in the same report. All numbers beginning sentences are spelled out. Figures are used for decimals and percentages, but the word 'percent' is spelled out. e.g, 15 per cent.

Check your progress :

(a) Mention with examples the precautions need to be taken in writing a research report.

……

(b) Cite examples of ten abbreviations used in writing research report.

……

1.6 LET US SUM UP :

In this unit you have leant some of very important concepts relating with educational research. These are- How to write a research report, meaning and importance of hypothesis, types of hypothesis, preparation of research report and style and format of report writing.

If you clearly acquire the ideas, it can be expected that you will be largely benefitted from it.

***Key words:**

Hypothesis, Hypotheses, Level of significance and the different common abbreviations used in writing the report.

- **Possible Answers to CYP :**
- What is a research proposal?

How many steps are involved in preparation of a research proposal and what are they?

Ans.: There are usually seven steps involved in preparing a research proposal. They are- Identification of the problem.

1. Identification of the problem.
2. Defining the problem in simple language.
3. Stating objectives of the study.
4. Formulation of Hypothesis.
5. Collection and analysis of data.
6. Drawing generalizations and conclusions.
7. Chapterization Scheme.

Discuss the meaning of the term hypothesis.

Ans.: Etymologically, 'hypothesis' is made up two words. They are 'hypo' and 'thesis' where 'hypo' means- less than and 'thesis' means- certainty or truth. Thus, general meaning of the term 'hypothesis' means some assumptions which may or may not be true. The statements or predictions are tentative in nature where there exists sufficient scope for verification.

Enumerate the characteristics of a good hypothesis.

Ans. The important characters of a good hypothesis are - The hypothesis should be conceptually clear.

- The hypothesis must be testable.
- The hypothesis should be related to the existing body of theory and facts.
- The hypothesis should have logical unity and comprehensiveness.
- The hypothesis should be specific in scope.
- The hypothesis should be related to available scientific tools and techniques.
- The hypothesis should be in accordance with other hypothesis of the same field.

What are the types and forms of research hypotheses?

Ans.: There are two main types of research hypotheses. They are – Directional and Non-directional. Hypothesis is of main two types. They are- Declarative form and question form.

Frame at least two directional hypothesis and two non-directional hypotheses. (try yourself)

What is meant by level of significance to retain or to reject a null hypothesis?

Ans.: The criteria for rejecting the null hypothesis may differ. Sometimes the null hypothesis is rejected on the ground that the quantity of occurrence of the outcome so large that the probability of its occurrence is 1 time out of 100 or .01 time out of 1. We consider the probability of its occurrence by chance is too little and we reject the chance theory of the null hypothesis and take the occurrence is due to a genuine cause. On other occasions, we may be bolder and reject the null hypothesis even when the quantity of the reported outcome is likely to occur by chance 5 times out of 100 or .05 time out of 1. Statistically the former is called as the rejection of the null hypothesis at .01 level of significance and the latter as the rejection of the null hypothesis at .05 level of significance.

Frame at least three examples of null hypotheses and three examples of question form hypotheses. (try yourself)

How many main divisions of a research report and what are they?

Ans.: There are ten main divisions of a research report. They are- Introduction, Statement of the problem, Review of related literature, The hypotheses, Significance of the study, Definition of terms and concepts, Delimitations of terms and concepts, Methods and procedures to be followed, Analysis and Interpretation of data, Summary &Conclusion.

Discuss in detail the qualities need to be reflected in the main body of the research report.

(c) Ans.: The main qualities to be reflected in the research report are- Introduction

9. Statement of the problem
10. Analysis of previous research
11. Relation of present problem to theoretical position of the previous research
12. Significance of the problem
13. Delimitations of the study
14. Assumptions underlying hypotheses
15. Statement of hypotheses
16. Definition of important terms.

(d) Design of the study

1. Procedures employed
2. Sources of data
3. Data gathering instruments
4. Sampling and methods of gathering data.

1.4.3 Analysis and interpretation of the data

1. Text
2. Tables (if any, are usually included in to the text)
3. Figures (if any, are usually included in to the text).

1.4.4 Summary and conclusions

1. Brief restatement of problem and procedures.
2. Principal findings and conclusions with their practical implications (if any)
3. Suggestions for further research.

1.4.5 Reference Section

4. Bibliography
5. Appendix
6. Index (if any)

Mention with examples the precautions need to be taken in writing a research report.

Ans.: The language should be simple, understandable, clear, free from ambiguity, interesting to the readers. Besides, the report should be free from grammatical and spelling mistakes.

Cite examples of ten abbreviations used in writing research report.

Ans.: The commonly used abbreviations in a research report are-

bk., bks.	book, books
chap,. chaps	chapter, chapters
p,. pp.	page, pages
anon,	anonymous
col,. cols.	column, column
e,g.	for example
edn., edns.	edition, editions

et al.	and others
Ibid	same reference
Op. cit	previously cited
Loc. Cit	the same place cited
fig., figs	figure, figures
Idem	same person
Illus.	illustrated

References :

(a) John W.Best, James V. Kahn; Research in Education; Printice Hall of India Limited, New Delhi-110001

(b) Koal.L.; Methodology of Educational Research, Vikas Publishing House Pvt. Lt, New Delhi-110001

(c) Michell, (i998) Measurement in Psychology : Critical history of methodological concept.; New York: Cambrige University Press.

(d) Singh, A.K & Singh, AK (2002) Manual for Different Personality Inventory, Agra: National Psychological Corporation.

(e) Singh, A.K ; Tests, Measurements and Research Methods in Behavioural Sciences; Bharati Bhawan Publishers & Distributors.

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METHODS OF EDUCATIONAL RESEARCH

INTRODUCTION :

Dear student by this time you might have learnt terms like research, science, scientific method of thinking and inquiry. Do you remember them ? Try to recall them. If you have forgotten consult the relevant materials once again.

Friend, you are probably conscious about the fact that mankind claims its superiority over other beings for the vast stock of knowledge it possesses and boasts of. Probably as one from the same species you too boast of the same. But friend, mankind was not born with the huge stock of knowledge it has at its disposal. It was accumulated bit by bit, and innumerable persons contributed to it. Unluckily we even cannot remember most of them. Only a few of them could draw our attention. We remember them ; we are thankful to them. Surely, we cannot forget, Newton, Einstein, John Dewey, Pestalozzi, B.S. Bloom etc. Don't you aspire to join their group ?

To do that you will have to throw light on a bit of unexplored knowledge. But at present, it is not easy to hit with a bit of unexplored knowledge. Unless you proceed methodically, you cannot do it. The content of this block will help you to know something in this regard. Enriched with the knowledge you attain here, with further studies, you will be qualified to enter into the field of inquiry. If you are sincere you would be lucky to enlist yourself as a contributor of knowledge. We expect that from you as well.

The entire block is divided into three units. Each of the unit deals with one method each. At the outset of each units, the objectives are stated. After completing the study of the unit, you are expected to attain them. At the end check yourself whether you have attained them. Within the text, some objective tests, under the head CHECK YOUR PROGRESS, are provided at intervals. The teacher is not with you. So you shall have to be your own teacher. You should learn yourself and test yourself too. SO DONOT SKIP THAT PART.

Do you have the habit of reading a book from A to Z ? For a good reader, it is desirable. A good literature have valuable things from its top to bottom. Some times in some cases the preface contains more valuable things than the text. So go through the content from the beginning to the end. The later part will help you in gaining your proficiency.

UNIT - I

HISTORICAL METHOD

STRUCTURE

1.0 : OBJECTIVES :

After going through this unit you are expected to -

- state the meaning of Historical Research.
- state the main objectives of Historical Studies.
- discriminate between Historical Readings and Historical Studies.
- recall the steps followed in Historical method.
- be able to explain its salient features.
- be able to justify it as a scientific method.
- be able to outline its scope.
- judge he strengths and weaknesses of this method.
- be able to undertake a small study project yourself where historical method will be applied.

1.1: INTRODUCTION :

Dear student, in this particular unit, we are going to discuss a particular type of method commonly known as historical method. Studies following this method often do not lead to a generalized conclusion. As such, such studies generally do not come under research category. Here we are going to discuss its meaning, nature and steps.

In Block : I, unit - I : You have come across the concept of scientific thinking and research. So you are expected to judge its scientific elements and understand - how far scientific it is. In the following two units, we shall be discussing two other methods. By then, you will be able to compare this method with them too.

The content of this unit is not very difficult. So you are expected to comprehend them easily. On the other hand it is the

stepping stone to the comparatively tough portion of the block. So you are expected to comprehend it properly.

At the end you should get inspired to undertake a small study programme with this method.

Please go through this matter thoroughly.

1.2 : MEANING :

1.2.1 : Meaning of History :

To understand the meaning of the historical method, we should first understand the meaning of history.

By history we ordinarily mean some facts and events arranged in a chronological order. Do you observe any other features apart from the chronology ? In fact, the historical events have an order of its own. The event that is taking place now could not have taken place at an earlier date. Now a days you communicate through the internet. But our grandfathers eagerly waited for the postman. You are wearing a piece of dress that your forefathers could have never thought of. Don't you sometimes ponder over it and ask why? If you observe it keenly, then you will realize that interwoven forces of society, culture, economy, politics and some other factors are blending the events. Some events might not have happened in the field of economics if certain events had not taken place in the field of politics.

Hence, we say that History is an 'integrated account of social, cultural, economic and political forces'[1]. It is an organized and meaningful record of past events. Best and Kahn said, "It is not merely a list of chronological events but a truthful integrated account of the relationship between person, events, times and place."[2]

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[1] Lokesh Kaul, *Methodology of Educational Research,* p. 387

[2] Best and Kahn, *Research in Education*, p.57

1.2.2 : Meaning of Historical Research and Method :

Don't you have the inquisitiveness to know about various blending of events ? Their occurrence often arouse inquisitiveness. Their knowledge often become necessary. Many a times history provides insight into the process of blending. Investigating historical events systematically, social scientists are trying to find solution to many a things. Some times its solution may be extended to make it a generalized one. Historical method means the method of investigation that facilitates the investigation of historical events. The research work adopting this method of investigation is known as Historical Research. Some of the social sciences inquire about the web of different forces which have blended the events of history to formulate a general principle. These investigations are historical researches. The scientific course of action it follows is the historical method. As such, we can say that the historical method is the systematic method of investigating about past events or history.

All historical enquiries do not lead to generalization, so they are not researches but mere historical studies. But even then, they too follow the same method as that of historical research.

1.3 : NATURE OF HISTORICAL RESEARCH :

You have seen that the historical method is a method of looking back. So its area of action is the past events. Or, in other words, it is all about investigation of past events. As such, it has some inherent drawbacks. We can sort them as follows :

(i) We cannot experience them personally.

(ii) In case of collecting data, we have to depend upon other person's experience or on other sources like documents, relics etc.

(iii) Sources of data are in many cases less dependable; in some cases, of no use.

(iv) As the observation is not within the control of the investigator, he/she may not be able to get data or informations as per his/her requirements. Accordingly, these inadequasies may lead to some "missing links".

(v) Inadequacies and unreliability of data makes the finding unfit for generalization.

(vi) It follows the analytic-synthetic logic in inferencing.

(vii) It has least control over the variables and as such is least scientific.

For the inherent shortfalls of this method it was not accepted as a method of research. But with certain precautions, social scientists initiated it as a method of social science.

1.3.1 : Contention of Social Scientists :

Some of the social scientists contended that with certain modification, historical method can be effectively utilized as research methodology and it has great value in certain aspects. According to Best and Kahn they can be listed as follows :-

1. The historians delimits a problem, formulate hypothesis, gathers and analyses primary data. Test the hypotheses as consistent or inconsistent with the evidence, and formulates generalizations or conclusions.
2. Although the historian may not have witnessed an event or gathered data directly, he or she may have the testimony of a number of witnesses who have observed the event from different vantage points. It is possible that subsequent events

have provided additional information not available to contemporary observers. The historian rigorously subjects the evidence to critical analysis in order to establish its authenticity, truthfulness, and accuracy.

3. In reaching conclusions, the historian employs principle of probability similar to those used by physical scientists.
4. Although it is true that the historian cannot control the variables directly, this limitation also characterizes most behavioral research, particularly nonlaboratory investigations in sociology, social psychology and economics.
5. The observations of historians may be described in qualitative or quantitative terms depending on the subject matter and the approach of the historian. In general, the traditional approach is qualitative. While the revisionists use quantitative analyses. The traditional qualitative approach in many historical studies does not preclude the application of scientific methodology. As Brickman (1982) points out, it simply required "the synthesis and presentation of the facts in a logically organized form."[3] Gottschalk, Finley and Aydelotte argued in favour of the method.

Which of the above arguments have impressed you more ? Probably you are still in a dilemma to take sides with a particular group. Now if you can identify the scientific characteristics that the method possesses with the characteristics it does not, you will be able to get the answer yourself. Compare your total list with that you found in BLOCK : I, Unit - I, You will be able to ascertain the validity of your argument.

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[3] Best and Kahn, *Research in Education,* pp-61-62

As quoted by R. Kand, Knight (1934), Barr and Scates (1941) stated its value as follows :-[4]

1. Acknowledgement of the history of schools and other educational agencies is an important part of the professional training of the teacher or the school administrator.
2. Much of the work of the school is traditional. The nature of the work of the teacher and the school administrator is restrictive and tends to foster prejudices in favour of familiar method. The history of education is the "Sovereign Solvent" of educational prejudices.
3. The history of education enables the educational worker to detect Fred and Frills in whatever form they may appear, and it serves as necessary preliminary to educational reform.
4. Only in the light of their origin and growth can the numerous educational problems of the present be viewed sympathetically and without bias by the teacher, the school administrator, or the public.
5. The history of education shows how the functions of social institution shifts and how the support and control of education have changed from very simple and local arrangements to those that are now somewhat centralized and complex.
6. History of education is an ally in the scientific study of education rather than a competition. It serves to present the educational ideals and standard's of other times, and it enables social workers to avoid mistakes of the past.
7. It inspires respect for sound scholarship and reverence for great teacher.

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[4] Kaul, L. *Methodology of Educational Research* pp-388-389

Do you agree to the arguments given above ? Analyze them and give your point-of-view.

1.3.2 : Its coverage : Types of Historical Research :

Have you observed any significance of the section title ? Have you noticed the significances if any ? If you can guess something then record (write) it somewhere and proceed to the discussion below :-

We are now going to discuss probable areas of the problems of the field of education, that can be investigated following this method.

(1) **Bibliographic research :-** The contribution of Gandhiji, R.N. Tagor, Dr. Md. A.K. Azad etc. are usually acknowledged widely throughout the country. Their bibliography as educator may be quite interesting for educational research.

Here, in the context of N.E. India, one can study the life and contribution of Suresh Rajkhowa (he surveyed the problem of computational proficiency of the students of elementary level and published his findings with the title 'DIOGNISTIC TEST IN MATHEMATICS' which once got wide spread publicity amongst the teaching community of the regions), Mrs. I. Miri (She contributed towards popularizing education amongst backward communities and teachers' education of the state of Assam) etc. can be chosen as cases of bibliographical research.

At the local context bibliography of a reputed teacher, eminent educationist can be chosen as a subject of educational study with this method.

(2) Legal Research :- Every unit of the society within a state falls within the jurisdiction of Law. For instance, constitutional right to education, legal jurisdiction of institutions run by different agencies, responsibilities of the

government, rights and responsibilities of the teachers and other employees have certain legal implications. Matters relating to them may be problem for a study which can be dealt with this method. Can you think of an example ? Think of it. At present I can cite the case of the education of the minority community. You try to find other examples. Newspaper headings may help you in this regard.

(3) Studying History of Ideas :- Ideas of child-centered education, craft centered education, providing mid-day meal programme have a certain history. So they may constitute the subject for study with the help of this method.

(4) Studying the History of Institutions and Organization :- Growth and development of institutions have their own history. Their success and failure may help the organizations of today in taking decision for their own. They may be dealt judiciously with this method. Role of Cotton College in the development of Higher Education in Assam may be an example of this type of studies.

The categories stated above are the common categories only. We may have categories bases on period, geographical region, methodology, curriculum etc.

Up till now you should have acquired some concept. Alright, let us have a small test.

CHECK YOUR PROGRESS (1)

Fill in the blanks with the suitable words provided within bracket (Qn. 1(a) & 1(b)

1.(a) Historical method is …….. in nature (longitudinal / cross-sectional)

1. (b) Types of data usually available for historical research are …….

(qualitative / quantitative)

2. State the different categories of Historical research.
3. Whether Historical method is suitable to investigate a problem relating to – (Tick the right answer)
   (i) The infrastructural facilities available in educational institutions. (yes/no)
   (ii) Effectiveness of structural method in teaching English. (yes/no)
   (iii) Project method in teaching mathematics. (yes/no)
4. Historical reading is akin to / identical with / different from, historical studies.
   (Strike off the irrelevant portion)

1.4 : STEPS TO HISTORICAL RESEARCH :

We generally start a work and attain the end. This is only true for works which are very tiny and are of insignificant consequences. But which are of significant consequences can only be done step-by-step. Any scientific study is a significant piece of work. So you are expected to proceed cautiously through different steps. Can you presume the steps in historical research ? Think of the steps and compare your presumption with the list given below.

As per social scientists, the steps are as given below :-

Step 1. Selection of the problem.

Step 2. Formulation of hypothesis.

Step 3. Collection of data.

Step 4. Criticism of data.

Step 5. Interpretation and reporting of findings.

In the next two units, two more methods are going to be discussed. Go through the lists given there, compare them with this and try to comment upon them. Now let us return to our discussion.

Mere statement of the names of the steps can convey very little meaning. So let us discuss them to some extent elaborately.

1.4.1 : Selection of the problem :

The concept literally sounds very simple. You may think that it is just like selecting a present from a shop for your friend's wedding. But it is not so simple. The investigator in real practice does it very cautiously. You can choose a problem from any of the areas discussed above-say a person, institution, policy and so on. But you should be sure that the solution of the problem is going to prove beneficial to the society. Being sure of its utility, you have to consider the size of work that you have to undertake to derive a solution of the problem. If after proper consideration, it appears to be very big then you can restrict your study by minimizing its geographical boundary, by curtailing certain concept or by restricting the span of time under investigation. There by, the researcher sets limit to his problem. This process is technically known as delimitation. Last but not the least important consideration is its feasibility and the ability of the researcher. If data is available only scantily, then it will be unwise to undertake the project. If there are financial constraints or constraints of time, the project needs to be abandoned.

1.4.2 : Formulation of hypothesis :

First of all you should know that you should have a hypothesis to undertake a research. A good hypothesis to a researcher is like a lighthouse to a navigator. If it is steady and clear, it will help the researcher safely and correctly. If it is erroneous, then you may have to stagger here and there. Van Dalen states that the quality of a good hypothesis is - "An explicit statement or a systematic awareness of the hypotheses used in determining what facts were significant, clarifies the relationship between the investigators ideas and the facts

he reports, and it minimizes the possibility of employing trivial, biased, conflicting, faulty, or archaic hypotheses."[5]

A good hypothesis is a good speculation, where the researcher intends to arrive at the end.

Some investigators do not believe the necessity of hypothesis in historical research. They simply like to record facts in a chronological order. If the study is merely an exploratory study, it is not always necessary to have a hypothesis.

1.4.3 : Collection of data :

Dear student, by now, you have crossed the planning part of your work. From here the real part of work is about to start. Going through the title you may think that it is something like collecting some colourful pebbles from the shallow riverbed. But it is not so easy. So it has been broken into subsections and topics. Carefully go through them and try to appreciate them. First question that may come to your mind is about the source. You may ask from where you have to accumulate the data. It is mentioned elsewhere that, in historical research your main source of data will be documentary - they may be news papers, journals, booklets, office documents, court releases and even letters. Relics, mementos etc. come under the second category. They are of nondocumentary nature. Verbal information may constitute the third category of data source. These data sources are again categorized according to the nature of their sources from where they get the data materials. The following sub-section titled 'Classification of Source's will help you in understanding the subject-matter.

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[5] Van Delen (1973), *Understanding Educational Research,* p177

1.4.3.1: Classification of sources of Data :

a) **Primary Sources :-** These are the sources which acquire the data directly from the object or the events. They are the eye-witnesses or direct records done by eye-witnesses. A categorical list is provided below:

   (i) **Personal records :-** Certificates, diaries, letter, wills, deeds etc. comes under this category.

   (ii) **Official records :-** Social organizations both government and non government preserve their records of activities. Those documents come under this category.

   (iii) **Oral testimony :-** One type of it may be derived out of myth, folk lores, folk tales etc. Statement given by persons who witnessed the event constitute the second type.

   (iv) **Audio visual records :-** They may be either audio or visual or both at a time. Photographs, films, audio and video C.Ds. tapes etc. fall under this category.

   (v) **Relics and remains :-** Fossils, weapons, garments, coins, memorial erections etc. come under this category.

This list is only exemplary. With your intuition, you should try to develop it. You may consult some standard books too.

b) **Secondary sources :-** The data stored in them are not directly collected from the sources or events. The persons supplying them does not have firsthand experience of the event. They may be **(a) Documentary :-** For instance some journal reporting something about a past event. The reporter did not have to experience it himself. He collected the data from somewhere else. **(b) Personal source :-** Some persons may report something which he did not experience himself. He

may say, "I heard it from my father" or may say, "I remember reading this in the paper" etc.

The above classification of data helps the researcher in determing its value. Ofcourse something of less importance somewhere may be more important somewhere else. Here, you can have some scope for mental exercise. The secondary data may sometimes be of immense help in locating a hypothesis or in formulating a hypothesis.

After collecting the data, it is the duty of the researcher to check his/ her data very carefully. He should sort them - may be chronologically or otherwise, as per his convenience.

1.4.3.2. : Criticism of Data :

After collection of data, the researcher should check them very carefully to ascertain that they will provide him the informations as par his needs. This process is known as criticism of data. It is done in two ways - (a) External criticism (b) Internal criticism. They are important concepts. So we are discussing them below somewhat elaborately.

(a) **External criticism :-** It is mainly aimed at authenticating the document. Genuineness of the available source of data is checked. To establish the genuineness of source of data, which is usually in the form of document, we should verify the signature of the signatory, hand writing, scripts, the language, the usage, documentation etc. Sometimes physical and chemical tests of the materials used (such as - ink, paints, paper, parchment etc.) may have to be done. Through carbon dating, the precise era of the document may be ascertained.

(b) **Internal criticism :-** It is aimed at evaluating the accuracy of the documents collected. Sometimes it may so happen that the document collected is authentic but not reliable. It may be

reliable in case of the authorship but may not be able to reveal anything that we intend to underline. The source of data may be unreliable for various reasons. They may be produced to distort a fact, or might be produced under pressure or fear. The recording may be after a long lapse of time during which the reorder may have forgotten some important aspacts. The recorder may not have the general and technical knowledge of acquiring information in their right perspective. Consideration of the following points about the recorder will prove helpful - (i) General information of the recorder, such as his position, his personality, his character etc. (ii) His qualification as reporter - alertness, biasness, character etc. (iii) His qualification specific to the events he is reporting (a)His interest while reporting the event (b) His closeness with the event i.e. was he present there personally or is reporting it by knowing it from others ? (c) Had he the general and technical knowledge of acquiring knowledge and of reporting ? (iv) What was the time interval between the occurrence of the event and reporting ? (v) How was the document written - from memory, in consultation with others, after checking the facts or by combining earlier documents ? (vi) Its relationship with other documents - If the document is not wholly original. If a part of the document is original then that should be tested for its credibility. In the case of borrowed documents - we should identify the borrowed parts. Then we should ascertain the time of borrowing, whether it was borrowed perfectly. If the borrowed material is changed then we should be careful in ascertaining the perfectness of reproduction of ideas borrowed.

Example of External and Internal Validity :

In a particular school the experimenter is trying to trace the growth of enrolment. Institutions have to report the

various particulars to the department, annually, which is known as school Annual Report or A.R. Along with other particulars they have to report the enrolment of the concerning year. On verification it is found that the institution is regularly submitting the AR's. It is maintaining an AR file neatly. They are duely signed by the school authority. As such these documents are valid. This is an example of external validity. If they would have not been properly signed or the experimenter traces any sign of forgery, then they would have been externally faulty i.e. it does not have external validity.

On varification of other relevant record he found that the enrolment records of AR reports tally with the attendance register. As such its seems to be internally valid too. That means, its data are also true. But on further enquiry the researcher found that the enronment figures do not tally with the admission register. Hence we cannot regard it as internally valid.

1.4.4 : Interpretation and Reporting of findings :

We can call this part as table work. The title indicates that there are two processes. But they go hand-in-hand in a study. Of course after interpreting, the researcher may find that there is nothing substantial to be reported. Then he may have to abandon the idea of reporting it. Anyhow, I am elaborating the concepts separately for better comprehension.

a) ***Interpretation of data :-*** Data themselves say nothing. It is the duty of the researcher to state what the data is going to reveal. The data generally reveal some relationship between certain variables. Sometimes we see that certain variables changes with the variation of some other variables. For instance, when there is a change in rainfall pattern, we see changes in the production of paddy. Mechanization of

cultivation is gaining popularity with time. These are interpretations of our commonsense observation of facts. The first example in an example of causal relationship. Actually, rainfall causes high yield. Here the relationship is not reversible. That means, we cannot say that if one produces more rice, there will be more rainfall. In the second case mechanical cultivation is increasing with time. But time is not causing mechanical cultivation. In the same way you should interpret your observation. There may be covariation type relationship, correlated type relationship, causal relationship etc. If we observe such relationships we should record it. Finding out such relationship is known as analysis of data. Here we can see that the analysis of data leads you to interpret your data. In interpretation process, the researcher should be very careful. Slight carelessness may lead him to an utterly wrong interpretation. A researchers wrong interpretation bears a big consequence upon the society. Especially, the historical researcher should be more careful in the process of interpretation, because he does his work with inadequate and unstructured data. While interpreting causal relationship, he should be far more careful. Because historical study is a longitudinal study spreading along the time coordinate, there may be change in the condition of the phenomena. Some variables may enter the phenomenon at some moment and disappear at some other time, leaving some amount of effect on the phenomenon. Such factors may remain unnoticed. This will certainly affect the inference. Mouly, commenting on causal interpretation said - "Causation is a troublesome concept in science ; it is doubly so in historical research

where 'causes' are in the nature of antecedents, or precipitating factor, rather then 'causes' in restricted scientific sense."[6]

Actually interpretation process does not end here. From his study he is expected to indicate the trends in various direction. His attempt should be to synthesize facts not heaping up of facts.

When the researcher is contented with his interpretation and feel that it is useful to the society, then he will proceed to report it. That step (substep in this case) is discussed below.

b) **Writing of the Research Report :-** For that the researcher shall have to organize everything. The subject matter is discussed in block-II unit-III. Here we shall discuss those features which are specific to the historical method alone.

It must be mentioned that historical report writing requires mastery both in reasoning and writing. He must have creativity and objectivity.

Authorities like Good, Barr etc are recommending chronological organization of data in writing historical report. The report is to some extent intuitive creation. So it may sometimes become superfluous. So different authors suggest that it should not become "Flowery" at the same time they suggest the researcher to avoid dull reporting.

This completes the discussion on Historical method. Probably you have been able to comprehend the subject matter. Before recapitulation, let us have a small test.

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[6] Mouly, G. J. (1963) *Educational Research*, Longman p-214.

CHECK YOUR PROGRESS (2)

Choose the right answer :-

1. Which one of the following steps is the most important step in historical studies ?
   (i) Selection of the problem.
   (ii) Formulation of hypothesis.
   (iii) Interpretation and reporting the findings.
2. Which one of the following causes is the major hurdle in satisfactory completion of a Historical Study ?
   (i) Lack of appropriate hypothesis.
   (ii) Difficulty in interpreting data.
   (iii) Dearth of data
3. External criticism is intended mainly to verify -
   (i) its authenticity.
   (ii) accuracy of the statement of the data source.
   (iii) its relationship with other documents.
4. Which of the following category of data source is not likely to be data source in historical research ?
   (i) Documents.
   (ii) Personal experience of the researcher.
   (iii) Official records.

1.5 LET US SUM UP :

In this particular unit we have discussed a particular method of investigation, which is Historical Method. We discussed the importance of history. They may be about individual, idea, legal issue, organization, institution etc. We have also discussed their implications.

We have also discussed its meaning and nature. We have also discussed its values. It should be marked that these values are directly related to the implication of this method. There we have discussed its types too. Types are related to the subject areas like individual, organization etc.

Then we discussed its steps. Steps are related to the actual plan of action. The activities to be performed are divided on priority basis and arranged in steps. You may imagine the entire work as a staircase leading to a destination and the steps constitute the staircase. This stair case will lead you to the preparation of study report. We should climb it by covering the steps in order. They are selection of the problem, formulation of hypothesis, collection of data, criticism of data, interpretation of data and writing of the report. You cannot arrive at the last step unless you start with the first and cross the rest one by one in order.

The third, along with the fourth steps are considered to be the most crucial part of the study. Unless you succeed in collecting data, you cannot think of a study. Collection is accompanied with their sorting and organizing. The fourth step comprises of checking the usability of the data.

The fifth step is about inferencing. Here the investigator applies his own ingenuity. The quality of the report rests on it. It actually puts the authority of the investigator to test.

Comprehending this properly you can aspire to be a good historical researcher.

During our discussion you have come across with some new terms. You will get a small list of terms, may be new for you, with meanings. You can extend it. Hope it will help you.

1.6 KEY WORDS :

- Analytical :-Something where the process of analysis comes in.

- Analysis :-The process where the object (say phenomena) is broken into components to have a clear conception.
- Causation:- The process of affecting in a manner to cause occurrence of something.
- Deduction :- The process of deriving a concept from many other established concepts.
- Deductive :- The process of reasoning that utilizes the process of deduction.
- Delimitation :- Setting boundary to minimize the span or coverage.
- Hypotheses :- See it in Block - II. In simple language it is a hunch or assumption.
- Induction :- Coming to general conclusion form concrete observation.
- Inductive :- Some thing involving the process of Induction.
- Synthesis :- Blending together to get a new thing.
- Synthetic :- That results from Synthesis.
- Variable :- Something that assumes different values or form is called Variable.

1.7 SUGGESTED READING :

- Best J.W. and Kahn J.V., *Research in Education* 6th. Edition, Prentica Hall, 1968.
- Kaul L., (1988) *Methodology of Educational Research*, second edition, New Delhi, Bikas Publishing house Pvt. Ltd.
- Mouly, G.J. (1963) *Educational Research*, Longman.

Possible answer to CYPS :

CYP (1) : Qn. 1 (a) Ans. Cross sectional.

Qn. 1 (b) Ans. Qualitative.

Qn. 2 Ans. Bibliographic, Legal research, History of Idea, History of institution.

Qn. 3 Ans. (i) no (ii) no (iii) no

Qn. 4 Ans. Different from

CYP (2) : Qn. 1 Ans. (iii)

Qn. 2 Ans. (iii)

Qn. 3 Ans. (i)

Qn. 4 Ans. (ii)

References :

Best J.W. and Kahn J.V., *Research in Education*, 6th. Edition, Prentice Hall, 1968.

Kaul Lokesh, *Methodology of Educational Research*, second edition, New Delhi, Bikas Publishing house Pvt. Ltd.

Van Dalen, D.V. (1979) *Understanding Educational Research*, Mcgrow Hill

Model Questions :

1. Historical method is very beneficial in locating problems and determining the course of action. Discus.
2. Give a detailed plan for a study that you would like to undertake adopting historical method, with a special mention of the area where you fear to face difficulty.

UNIT - II

DESCRIPTIVE METHOD

STRUCTURE

2.0 : OBJECTIVES

2.1 : INTRODUCTION

2.2 : MEANING OF DESCRIPTIVE RESEARCH

2.3 : NATURE OF DESCRIPTIVE METHOD

- 2.3.1 : TYPES OF DESCRIPTIVE STUDIES.
  - (a) : ASSESSMENT STUDIES
  - (b) : EVALUATIVE STUDIES
  - (c) : DESCRIPTIVE RESEARCH
- 2.3.2 : ANOTHER TYPE O DESCRIPTIVE STUDIES
  - (a) : SURVEY STUDIES
  - (b) : INTER RELATIONSHIP STUDIES
  - (c) : DEVELOPMENTAL STUDIES

* CHECK YOUR PROGRESS (I)

2.4 : STEPS OF DESCRIPTIVE STUDIES

- 2.4.1 : SETTING OF OBJECTIVES.
- 2.4.2 : FORMULATING THE HYPOTHESIS
- 2.4.3 : COLLECTION AND PROCESSING OF DATA.
  - 2.4.3.1 (i) : TYPES, NATURE AND SOURCES.
  - 2.4.3.1 (ii) : SORTING AND EDITING.
  - 2.4.3.1 (iii) : RECORDING OF DATA.
- 2.4.4 : ANALYSIS AND TESTING THE HYPOTHESIS
- 2.4.5 : INFERENCING AND REPORTING.

* CHECK YOUR PROGRESS (2)

2.0 : OBJECTIVES :

After going through this unit you will be able to -

- define descriptive method.
- distinguish it from Historical Method.
- state different categories of studies adopting this method.
- state the steps and describe them.
- justify its extensive use in practice.
- appreciate its adoption.
- examine it as a scientific method.
- give examples of Longitudinal and cross-sectional studies.
- propose a study where this method can be used.

2.1 : INTRODUCTION :

Descriptive Method is a method of enquiry adopted in a wide range of studies in social science. It investigates facts about things in its natural setting. It is mostly for events of the contemporary period extending to the past only in selective cases. These studies are roughly categorized under three heads - Assessments, Evaluations and Descriptive Research. According to an alternative classification it can be categorised an survey studies, inter-relationship studies and developmental studies. All of them roughly follow the same methodology, so they are more or less alike. These studies differ mainly in the intention or motive of the investigator. Only because of this reason some deviations appear in the treatment of data, nature of the possible conclusions and the use of the findings. It is possible to convert one type of study into another, simply by making some minor alterations.

It should be noted that all them are not research studies.

Most of the studies in social sciences adopt this methodology. This is mainly due to the fact that most of the social events cannot be contrived due to ethical, social or some other reasons. The only

alternative of which is to study them in natural setting or in the position how and where it is.

One should not think that the method is applied only in social sciences which is characterized as a less exact science. Instead it proves to be a good tool of investigation in many of the exact sciences. Cases from astrophysics or astronomy can be cited as substantial examples. Sciences like geology, chemistry, Life-Sciences and medicine often take recourse to it.

2.2 : MEANING :

Meaning of Descriptive Method is evident from the verbal term descriptive, which indicates that it describes something as it exists. One may observe some object and states what he has observed. For instance, someone observes a tree and states that the tree is a mango tree, it is mature, the girth of its trunk is about one meter, some of the branches are bearing fruits, some of them are dry and so on. Thus the observer describes the tree. But the observation may not be without motive. Accordingly, depending on his motive he may further state that the tree is productive, that will provide enough fire wood or enough timber can be procured by milling it. In this stage it enters into one particular category. Accordingly, the meaning will also differ. For that, we shall have to discuss them differently. As for the method in general we can say that, "It is a fact-finding approach related mainly to the present, and abstracting generalizations through the cross-sectional study of the present situation."[1] Explaining it, we can say that it describes facts about opinions that are held, processes that are going on, effects that are evident, or trends that are developing. Evidences for stating or

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[1] M.H. Gopal, *An Introduction to Research Procedure in Social Science,* p.74

describing the situation will be collected from the existing state of the same, i.e. it is already there ; we are simply comprehending and stating them in verbal terms. For the necessary comprehension, we survey a cross-section of the situation and from that we infer about the situation as a whole.

2.3 : NATURE :

The nature or characteristics of a descriptive method can be presumed to some extent from its meaning. In precise terms, we can say that it is a scientific method with a lesser degree of sophistication. It has the capacity to deal with problems which are capable of being described, not a subject merely to be argued about. We can see the following features in a descriptive study.

1) They use the logical methods of reasoning to arrive at a conclusion.
2) They often employ methods of randomization so it is a cross-sectional study. This helps the investigator to estimate error in inferring about population characteristics from observation of a sample.
3) They are non experimental, for they deal with the relationships between nonmanipulated variables in a natural rather than artificial setting. Since the events or conditions have already occurred or existed the investigator selects the relevant variables for an analysis of their relationship.

These are the features common to all types of descriptive studies and slight modification or minor additions makes it a social research. They are as follows -

(i) It involves formulation of hypothesis and testing of the same.
(ii) The variables and procedures are described accurately so that the result can be verified by some other researchers by replicating the same.

This method is mainly concerned with the collection of data. But mere collection of data seldom serves any purpose. So this method intends to interpret them properly to throw light on the causal connections to the extent possible.

2.3.1: Types of Descriptive Studies :

Studies adopting descriptive method have different types of objectives. According to the type of objectives, they can be divided into three major categories. They are as follows.

(a) Assessment Studies :-

Assessment describes the status of a phenomenon at a particular time.[2] Here we describe the phenomenon without giving any value judgment. It does not attempt to find out the reason responsible to the phenomenon. It does not recommend any course of action to attain a particular goal. It deals with prevailing opinion, knowledge, practice, or conditions. As instances we can cite that through some planned programme we can describe the infrastructural facilities in schools of upper Assam during a particular period of time. Say, first decade of twenty first century. Taking different span of time we can state the trend of its progress. We can assess the general achievement of the female students of a region, say Assam in the contemporary period. We can do the same for the male counterpart too and by combining both the result we can describe the achievement of a particular sex in comparative term. We can assess the preference of the students or guardian toward a particular category of school or college. We can assess the job satisfaction of the school or college teachers. This is what the assessment study is meant for.

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[2] Best and Kahn, *Research in Education.* p.76

Some social scientists follow a different scheme of categorizing the studies, where Exploratory or Formulative study precedes descriptive studies. Here in this case, Assessment studies serves best for Exploration or formulation. As such assessment studies can be regarded both as exploratory or formulative studies. But considering the methodology aspect, there is justification in inclusion of the same in the single general category of descriptive studies.

(b) Evaluative Studies :

Evaluation is a process used to determine the effect of a particular programme or institution in certain aspect of human behaviour or in the system setup. It is one step ahead of the assessment studies. That is in its value aspect. In the words of Best and Kahn - 'to assessment, evaluation adds the value judgment of the social utility, desirability, or effectiveness of a programme and it sometimes includes a recommendation for some course of action.'[3]

Accordingly, a study leading to the description of the development of infrastructural facilities under the 'Sarva Sikha Abhijan' may be an example of evaluative study. Enhancement of achievement of the students in learning English after introducing the subject in the lower primary level in the state of Assam; Increasing dropout problem in schools of the region due to job reduction policy of the government, Increasing enrolment in the schools due to the introduction of the mid-day meal programme etc. may conveniently be under taken as subjects for an evaluative study.

As such we can say that it is not different from the category of assessment studies except the addition of value aspect which states

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[3] Ibid. p.77

the desirability or undesirability of a phenomenon from the social view-point.

(c) Descriptive Research :

There is a wrong notion in our mind that any investigative studies conducted by a scholar or group of workers is a research. But that is not true. We can cite the examples of the assessment and evaluative studies described above as non-research studies. We should remember that in research we advance through systematic procedures to arrive at some principles or theories which have universal validity, with the idea of which we can predict the occurrence of certain phenomenon in the future, or we can suggest that manipulation of certain factor or factors involved in the phenomenon is likely to produce certain results. Barred from these qualities a study fails to occupy the status of research. In the words of P.V. Young, a social research is "the systematic method of discovering new facts or verifying old facts, their sequences, interrelationships, causal explanations and the natural laws which govern them."[4]

In certain respect, it is not different from any scientific methods. Like the latter it systematically investigates the interactions of the factors involved in the phenomenon, finds their correlations, inter dependence etc. It intends to acquire new knowledge, new facts. It tries to find out causal relationships between factors. It is intended to formulate new laws and principles and with more generalization, a universal theory. Up to this it is no different from a pure scientific research.

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[4] Young, B.V. (1975) *Scientific Social Survey and Research,* Prentice Hall of India, New Delhi, pp 30-33.

It is different from the experimental method in that it does not attempt to manipulate the factors or variables involved in producing the phenomenon. It studies the phenomenon without inflicting any manipulation to the factors involved. It studies them in their natural settings.

2.3.2 Another Types of Descriptive Studies :

The above classification is based on the objective of the study. Some authors like to categorise them on the basis of the nature of the procedure. One of them is as follows (Lohesh Kaul, Methodology of Educational Research, PP 400-437). Acording to them it can be broadly divided into the following three categories – (i) Survey Studies, (ii) Inter-relationship Studies and (iii) Developmental Studies. A detail description is given below :-

(a) Survey Studies :

Survey studies are mainly intended to comprehend the existing state of a certain phenomenon in order to justify current condition or practices or to make more intelligent plan for improving them. (L. Kaul, P-405). It rarely leads to a pure research, i.e. it often does not yield theories of longlasting consequences. This major category is sub-divided into five sub-categories.

(i) School Survey
(ii) Job analysis
(iii) Content analysis
(iv) Public opinion survey
(v) Social survey

(i) School Survey : This type of studies are conducted very commonly and it covers a wide range of subject. Accordingly specific names are assigned to them. It usually covers areas like – adequeacy of schooling facilities within a particular geographical boundary;

infrastructural facilities available in the schools; enrolment trend; non-starter and drop-out patern; government sponsorship and public participation in financial and other management; public and private endeavours in school organization in a particular area; staffing pattern and so on.

Relevant information are collected through information schedules. Inforamtions thus collected are analysed to arrive at a conclusion. These information help in the improvement of the system and in effective planning for the future.

These surveys are often conducted to cover a huge area and as such it suffers from lack of sufficient skilled personnels. Lack of proper attitude of the persons involved in this process frustrates the cause of the study.

For better result personnels involved in the process must be properly oriented.

(ii) Job-analysis : It is type of distinctive study intended to gather information about the personnels engaged under various status to run a system. In education there are personnels right from fourth grade employees to the state level commissioner. In between these levels there are office staff, teachers, inspecting officers, directors etc. Job analysis provides information regarding adequacy of personnels in various level, reveals information regarding appointment of right persons in right job, provides information regarding appropriateness of their educational and training back-ground necessary for rendering the job entrusted to them in an efficient manner.

Information are collected through interview and questionnaire schedules. Data are conveniently tabulated and analysed to get the desired result.

(iii) Content analysis : Though catagorised as survey study, content analysis are of different nature in certain aspects. It is conducted to justify the content materials of a course of study. It may concern with externally distinguishable elements like words, sentences, phrases, chapters etc. Some times it may concern with items related with meaning such as concept. Each of the above items are considered as an unit of study. The unit or units are identified and defined properly. Then every individual items under the category is identified and listed. Then they are assigned ranks according to their appropriateness in the context of the set objectives, according to clarity of subject-matter, and according to the relevancy of context etc. And from the analysis of the recorded data their relevancy or appropriataness are justified.

(iv) Public Opinion Survey : In some circumstances it becomes desirable to know public view. Usually to know the public acceptance of programme surveying the public opinion becomes necessary.

But it can very well be perceived that the public opinion is rarely annonymerous, moreover it is difficult to reach each and every individual of the society. As such sampling becomes necessary. Accordingly stratified sample is selected to get a dependable result.

(v) Social Survey: It is generally conducted to assess the role of school in the social perspective. Interrelationship of school and the society is the major concern of this type of study. This type of study is also known as **community survey**.

Various local customs and different practices of the community has direct bearing on the educational atmosphere of the school. For instance child rearing practices of the community, festivals and rituals have impact on the school atmosphere. On the otherhand education plays a major role in social transformation. These types of issues are targeted in these studies.

(b) Inter relationship studies :

This type of studies are sub-divided into four sub-categories –

(i) Case study

(ii) Casual Comparative Studies.

(iii) Correlation and predictive studies

(iv) Cross-Cultural and Comparative studies

Out of these Case Study will be dealt separately, elsewhere, here we shall discuss the other three.

(ii) Casual Comparative Studies. These type of study bases upon John Stuart Mills two postulate for discovering casual relationship between two phenomenon. They are namely –

(1) "If two or more instances phanomenon under investigation have only one circumstances in common, the circumstance in which all the instances agree, is the cause (or effect) of the given phenomenon." (Mil 1846, P.224).

(2) "If two or more instances in which the phenomenon occurs have only one circumstances in common, while two or more instances in which it does not occur have nothing in common save the absence of that circumstance in which the two sets of instances differ, is the effect, or cause or the necessary part of the cause, of the phenomenon". (Mill. 1846, P-229).

The first postulate is known as method of agreement and the second one is known as the joint method of agreement and difference.

The method can be illustrated with the following example. Suppose in an school six students scored differently in the language test. Accordingly they have been given grades as above average (M^+) or below average (M^-). The teacher presumed that the factors likely to affect their performances are IQ of the individual (U), economic status of the family (V), educational status of the parents (W),

attendance of the pupil (x), individuals participation in co-curriculum activities (y), their sociability (2). The are also graded as '+' or '-' according to the trait or circumstances for the individual is above average or below average. The students are designated as A, B, C, D, E, F and the data have been tabulated as below –

Subjects	**Phenomenon observed i.e. Language score (M)**	**Circumstances**					
		IQ of the student (U)	**Economic status of the family (V)**	**Educational Status of Parents (W)**	**Class attendance (X)**	**Participation in co-curricular activities (Y)**	**Sociability (Z)**
A	M+	U+	V-	W+	X-	Y+	Z+
B	M+	U-	V+	W+	X+	Y-	Z+
C	M-	U-	V-	W-	X+	Y+	Z-
D	M+	U+	V-	W+	X-	Y-	Z+
E	M-	U+	V+	W-	X+	Y+	Z+
F	M-	U-	V-	W-	X-	Y-	Z-

The table shows that three of the students A, B & D performed well in language. Tabulating different circumstances for them we get –

Subjects	**Circumstances**					
	U	B	W	X	Y	Z
A(M+)	U+	V-	W+	X-	Y+	Z+
B(M+)	U-	V+	W+	X+	Y-	Z+
D(M+)	U+	V-	W+	X-	Y-	Z+

The table shows that, when M is (+) then W and Z are seen to have same sign '+'. So the may be the probable cause of good

performance in language. Now Coming to the poor performer we see the following picture.

Subjects	**Circumstances**					
	U	B	W	X	Y	Z
C(M+)	U-	V-	W-	X+	Y+	Z-
E(M+)	U+	V+	W-	X+	Y+	Z+
F(M+)	U-	V-	W-	X-	Y-	Z-

Here we see that absence of M agrees completely with absence of W, all the other including Z donot agree with it. Thus W i.e. parental educational status is the causal factors in pupils performance in language.

(iii) Correlation and Predictive Studies : This type of studies attempt to establish relationship between two sets of variables, with the help of statistics. The statistical method is choosen according to the nature of the variables. If one or both sets of variables can only be expressed in nominal scale the only available method will be diagrammatic representation. Suppose one set of variable is expressed as attributes like sex, caste, race etc. Then the relationship can be visualized with diagrams like pie-diagram, bar diagram, divided bar-diagrams etc. If one or both the sets of variables are expressible in interval scales than the relationships can be represented with the help of scattergram or regression equation. Of course certain statistical methods are there with which we can express the measure of correlation numerically. You should better consult text on statistics to comprehend the subject.

Knowledge of degree of correlation one can predict the probable value of a variable for a given value of the other. So this type of studying is also know as predictive studies.

(iv) Cross Cultural and Comparative Studies: Cultural phenomenon of the society often seen to influence the personal traits of a growing individual. It influences the educational achievements too. Again various government agendas of a state have definite impact on personality development and education. These conditions varies from community to community and even between the sections of the community. Cross cultural studies investigates the influences of these factors in different societies and compares them. This may help in constructing a suitable model for a society.

Cross cultural studies are extensive as well as expensive too. Inclusion of unappropriate person as investigator often frustrate the very objective of the study. It being expensive requires the sponsorship of some big organizations.

UNESCO is sponsoring some valuable cross-cultural studies.

(c) Developmental Studies :

The mental ability, learning skills and other personal traits changes[5] development. For an efficient education system the educational planners and the educators should have a sound knowledge of this process of development. Study materials and teaching method should be at per with the process of development. These studies or intended study such phenomena. They are also known as **Genetic Studies**.

This type of studies are subdivided into three sub-categories. (i) Growth studies (ii) Follow up studies (iii) Trend studies.

(i) Growth Studies : Growth studies are intended to investigate the changes of the human organism along with age. Good knowledge of these changes helps the teachers to adjust his teaching procedure; a curriculum planner can prescribe study materials appropriate for

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[5] Along with age, This process is known as

different age group. This type of study adopts both **longitudinal** and **cross sectional** procedures. In the first procedure a single unit is studied along with progress of time. Accordingly it is time consuming, In the cross sectional procedure different units are selected to represent various age level. This approach curtails the duration of study, no doubt but the different units representing different age groups may not be comparable in other aspects.

(ii) Follow up Studies : Follow up studies investigates actually follow up a case to observe the effect of a certain treatment. It is longitudinal in nature. It may sometime follow up a group of cases with certain characteristics. Terman and associates studied the development of gifted children extending for a period of 24 year and concluded that gifted children enjoyed better physical and mental conditions as adults.

(iii) Trend Studies : This type of study the trends of development of certain phenomenon with the help of relevant records. For instance trend of urban population pattern, population growth, increasing demand for educational facilities, increasing need for human resources can be studied. It is needless to mention that all these phenomena calls for an appropriate educational planning.

CHECK YOUR PROGRESS (1)

1. Select the right statements from the following statements :-
   (a) Descriptive method is indistinguishable with historical method.
   (b) Descriptive study is cross sectional in nature.
   (c) Data for descriptive studies are mainly qualitative.
   (d) A descriptive study studies phenomena of contemporary period.
   (e) It is a type of census.
   (f) Descriptive studies are social research.

2. State the three major categories of descriptive method.

   ……..….

   ……..….

3. Studies intended for finding new areas of research are commonly known as……..…

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   ……..….

4. Studies intended to know the effectiveness of a programme which has already been launched, in known as…….…..……

   ……

5. Studies intended to enquire the existing status of a phenomenon is known as ……...……..

   ……

2.4 STEPS : The following are the steps involved in descriptive method of educational research:

2.4.1: Setting of Objectives :

Any activating undertaken by human beings must have some specific objectives to be achieved. Without objectives, it is like a journey having no idea of the direction toward which you are to move. In the same way an investigator must have the idea of his target. Or in other words, he must set his objectives first. Eventually, descriptive method is no exception to it. So we can precisely say that setting of objectives is the first step in descriptive method. The objectives will throw light on the factors or data that you will go on to investigate.

2.4.2 : Formulating the Hypothesis or Hypotheses :

You have already studied about hypothesis in detail in Block-II, Unit-III.

This step is not essential in all cases of descriptive studies except in case of the descriptive research. But descriptive research must formulate the hypothesis or hypotheses before starting the investigation. Hypothesis is a speculation or a hunch about the fact or principle that you are going to establish. Suppose you are speculating that event 'A' causes the occurrence of event 'B'. Then that assumption is the hypothesis of your study. You may assume that Factor 'A' enhances the occurrence of event 'B', or you may assume that factor 'A' hinders the occurrence of event 'B'. These are all hypotheses. Coming to a concrete example, we may assume that 'Incentive programmes enhances the achievement level of the students' or 'Inspection helps the teachers in developing their professional ability' or we may assume that 'medium of instruction is not a barrier to students' achievement'. These are some real hypotheses. In formulating hypothesis, one should be sure that the hypothesis does not target at a fact or a principle which is already established. The hypothesis a plays the same role to researcher that a radar plays to the navigator.

Of course, in this regard one must realize that even though hypothesis plays an important role in research, it is merely a steering arrangement and the tools must function smoothly. Steering should be done properly by looking at the road ahead. We describe something depending upon the prevalent situation. At some point of your research work, you may realize that your prior assumption is not correct. In such cases, you should reject it and assume a new one. Else the condition may become like a running vehicle getting its steering locked.

Further, it should be noted that a researcher may formulate several hypotheses for a single study instead of one single hypothesis.

One more probability is the formulation of a null hypothesis. In this case, we postulate a hypothesis which is just reverse in sense of the fact to be studied, nullifying which we arrive at the desired result. Suppose we want to establish that 'incentives enhance, the achievement of the student'. In that case our null hypothesis will be, 'incentives do not enhance achievement'. Now, by analyzing our data, if we can nullify the second hypothesis, we can say that the alternative possibility is established.

2.4.3 : Collection of Data :

Collection of data is not just like picking up of an object from a stock at your will. There are several points to be considered and several sub-steps to be followed. It is a collective name for several sub-steps. It is the name for the entire work that has to be done before analyzing the same.

We shall consider the sub-steps of data collection, one by one.

A) Determination of Type, Nature and Source of Data :

Depending upon the problem, types of data varies. In some cases, it may be convenient to collect data in numerical terms. They are known as quantitative data. But in some cases, it may not be possible to get data in numerical form. The only available data are simply in descriptive form. They are known as qualitative data. For example let us assume that a particular study requires the achievement level. Achievements are expressed in terms of students' score which are numerical in nature. But in some cases, we may have to resort to the use of none numerical data which are constituted of different types of documents, such as - books, journals, news paper, records, circulars, letters etc. As for instance, we intend to analyze the criteria of evaluation of a particular level and of a particular region as per students' progress cards. Here we suppose that the term evaluation is not synonymous with examination. Here the criteria as shown in the progress card will be in descriptive terms. These data

are not quantitative but qualitative. Sometimes, data may be obtained from readymade sources viz - achievement records of students, institutional records, correspondence letters etc. Sometimes, data have to be collected through some tools prepared by the investigating agency, such as a questionnaire. It is devised to collect public opinion or information from the subject on different facts or events. Now a days, the electronic media is giving us a lot of facilities. It is now possible to receive and record information from a huge number of sources within a very short span of time. Then comes the decision from where you to collect the data, whether you are going to collect it from an extensive population or from a sample. If it is a sample, then comes the question of the procedure of sampling. If you are not sufficiently careful in this stage, then you may face a lot of difficulties in the later phases of your study. It may so happen that you may be able to collect only a scanty data or you may succeed in colleting a large bulk of data which you cannot analyze justly. If your source is not readymade, then you may have to design the device you presumed. If any error creeps into it then you may collect a scanty amount of data which can not be successfully utilized to yield any fruitful result.

Then comes the aspect of financial planning, which is very important. Then the next phase of the step will be to determine the agencies through which the process of collection will be performed. It may not always be possible for the researcher to collect data by himself/ herself. If you can design your study properly, then you can use the electronic network fruitfully. For that, it should be possible on your part to manage the electronic networks. In ordinary circumstances and prior to the easy availability to the network system, it was customary to engage a team of workers. It is the responsibility of the investigator to train the workers engaged in the collection of data. If that is not upto the mark then you may not be able to get quality material for your work.

Suppose you have done these things desirably and materials bearing your data reached your hand, then your duty will be to think of utilizing them properly. You should mind that raw data will not yield you anything. You will have to analyze them but before that you will have to make them usable for your analysis. Thus, the next phase of this step is to sort out and to edit them. Then you will arrange then in an orderly manner which will make your work easy and convenient.

B) Sorting, Editing and Arranging or Cataloging :

Looking into the collected data materials, you will see that many of the data materials are useless, some of them may be incomplete. Some may be erroneously supplied. You will have to sort them out and reject them. You will have to get your task done with the remaining lot of data material. Sometimes especially when the agency used by you to collect the data is not properly trained or motivated, you may find that the useful materials you get through this tedious and toilsome process is very scanty. If you are lucky enough, then a substantial quantity of data materials may remain at your disposal which can be utilized for the later part of your work. After doing this, you check them and edit. The data materials sorted out for your use may also have some minor omission and commission which needs certain rectification. Then you can think that your data material can be used for further treatment. After that you will have to arrange them in order. Otherwise while proceeding your work may be distracted or delayed by the task of searching the appropriate material. Cataloging or arranging should be done by keeping in mind the future course of action.

The next phase of the action will be to record them.

C) **Recording of data :**

Recording procedure will vary according to the necessity of the procedure of analysis. Sometimes, you may have to record them in tables. They may also be different. Mainly they will be either primary or secondary. Primary tables are those which are used for recording the first-hand data. You may utilize them to derive some secondary data which also may not reveal anything substantial. They may have to be treated further for finding the final outcome. The table or charts used for recording the firsthand data are called primary tables and the tables used for recording the data of secondary nature are called secondary tables. The secondary tables should be such that they facilitate the process of analysis to the optimum level. Preparation of tables and charts is technical as well as aesthetic. Experts only can design a good table. A good table enhances the task whereas a bad table make the work clumsy.

This phase is the last phase of the step of data collection. It is last but not the least. So care should be taken to perform this task carefully.

2.4.4 : Analysis and Testing the Hypothesis :

This step is the crucial step of the method. The question of hypothesis does not come into all types of studies. Only those which are intended to be a research activity will require it. But analysis is inevitable whether it be a simple assessment or a research activity.

Analysis of data may vary from being simple inspection to critical statistical analysis. This will vary from problem to problem. Somewhere some procedures are necessary and useful but the same may be unnecessary and inconvenient else where. Somewhere, analysis can be done through simple inspection and somewhere else some rigorous statistical treatment will be required to yield better results. It is presumed that statistical procedures sophisticates results. But it is not to be presumed that results extracted through simple inspection is of no worth. Max Weber's research relating to the

catholicity and financial backwardness did not use any sophisticated statistics. Many of the investigators entering into the field of research are not well-conversant in statistical methods. Such investigators cannot afford to use this tool and take a short-cut route. There are some who are well conversant with this tool. They find pleasure in using it here and there. They venture to use highly technical statistical methods in analyzing these results because they are conversant with it, otherwise it has no use. Sometimes, data quality do not call for a sophisticated technique. It may so happen that there is scope for using sophisticated technique of statistics but the data at your disposal is not much sophisticated. Then whatever technique you use, the data is destined to yield poor quality result with inherent errors. After analyzing the data, the duty of the researcher will be attempting to fit it to the hypothesis or hypotheses already laid. If the researcher finds that the analysis of data conforms to his hypothesis then it is well and good. Or he may find that it conforms only partially. In both the cases their inferences will be different. It may also happen that the result totally fails to conform to his hypothesis. Then he will have to abandon his hypothesis.

2.4.5 : Inferencing and Conclusion :

This is the final step of the descriptive method. After a long toiling process, the investigator arrives at the final stage. Here the work will be different for different categories of studies. In case of assessment studies, the investigator has to translate the findings from its technical form to understandable common man language. In the previous step, he gets the description the phenomena investigated by him in numerical or other technical form. The only task will be to express it in simple language. But, in doing that he may himself fail to understand the significance of the result which he had worked out by that time or he may be able to appreciate it partially. Then in such cases, the study will be less fruitful than it should be. the same is the case with evaluative studies. Of course it is associated with value judgments. So the inferencing should be in conformity with the target already set.

In case of a research study, the investigator should go through this stage cautiously. Because he is going to contribute a piece of abstract knowledge, however small it may be. He should be utterly unbiased and unprejudiced. This is because the bit of fact or principle he puts forward through his research is going to be utilized by his successors. If he does not do so, then all studies using his findings will be malignant with inherent error. It may so happen that the researcher may have to abandon an idea long cherished by him personally.

Investigators know or should know that the field of knowledge have a continuum. A bit of knowledge newly acquired has its relation with the bulk of knowledge already in stock. This will also go into it and will make it bigger in size. But still then it is not complete. We expect more knowledge than the prevailing stock. So it must be the duty of each and every body to encourage the inflow of knowledge. The investigator may feel that it is possible to acquire knowledge from a different enquiry. If the investigator feels its necessity, then he should incorporate his suggestion at this stage of his study. This is true for all types of studies, whether it be assessment, evaluation or a research work.

This completes the steps. But the learners are advised to use it cautiously. In this respect, a passage from Best and Kahn is quoted below.

"Glass (1968) cautions the educators of the need for critical analysis of reported research. He cites a number of interesting examples of carelessly conducted studies that resulted in completely false conclusions."[6]

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[6] Best and Kahn, *Educational Research,* p.165.

So far we have discussed the studies that can be tackled with this method in a broad frame. For better understanding, we shall discuss two particular types of studies in detail as far as possible.

CHECK YOUR PROGRESS (2)

1. Which one of the steps in descriptive method is most challenging ?

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2. The following list provides the name of a few steps of the descriptive studies. Arrange them in an orderly manner. Is it a complete list of the steps ?

   (Inferencing, Formulation of hypothesis, Data collection, Setting the objectives)

   ---

3. What are the steps to be under taken to make the data useful for fruitful analysis ?

2.5: Two Important Types of Descriptive Method

2.5.1 : Survey Studies :

Survey covers a wide range of studies both from assessment and evaluation categories. The word 'survey' came from two words 'sur' and 'vor' meaning to see a particular thing from a high place. In other words, we say it means having a bird's eye view. In fact its concern is for a huge population but the study is conducted by taking a limited section of it. It is not concerned with individual as individuals. All the individual characteristics will be polled to

produce a group characteristic. We do not say that Mr. X is having such and such characteristics but we say that this particular population has the following characteristics. Mr. X is a member of this population whom we can forget by name. We shall collect information from a number of individuals but our concern will be with the generalized statistics.

Information may be collected from a reasonable number of individual cases but not necessarily from all members of the whole population. As such it is a cross sectional study.

P.V. Young states its prospects as follows "Social Surveys are Concerned with (i) the formulation of a constructive programme of social reform and (ii) amelioration of current conditions of a social pathological nature, which have geographic limits and definite social implication and significance, (iii) these conditions can be measured and compared with situation which can be accepted as models". Best and Kahn cites a wide range of studies conducted abroad.

As regard its methodology, we should mention that it selects a section of the population through sampling. This is done because of the fact that we intend to comprehend some aspect or aspects of a population which is too big in size to handle it as a whole. The sampling is an important step in a survey study. If the sampling is not appropriate then the analysis of data yields incorrect result. Data drawn from a small sample may yield good result if the sample is a good representative of the population.

Though the use of sample is customary in survey studies, yet there are certain studies where data are collected from the entire population. Again there are certain survey studies which describes a limited population, which is the only group under consideration.

- **Categorisation :**

Different authors categorizes survey studies in different manners. Best and Kahn's classification[7] is based mainly on different

[7] Best & Kahn, Educational research, pp. 78-8

natures of the study. The categories mentioned by them can be listed as below -

1. Social survey.
2. Public opinion survey.
3. National survey.
4. International assessment.
5. Activity analysis.
6. Trend studies etc.

This categorization scheme does not follow the principle of differentiating criteria. B.N. Ghosh gives a different scheme of classification.[8] According to him social surveys can be categorized according to their subject matter, scope and some other factors. In a broad sense, there are two types of surveys, i.e. general survey and specialized survey. General survey involves the study of the entire community in a general way. National surveys conducted by the government covering various aspects of the nation as a whole can be cited as example of general survey. On the other hand, specialized survey studies some of the particular aspects of the community surveyed. National handloom survey, literacy survey can be cited as example of the second type. Besides these two categories, the social survey can be classified in the following ways :-

(1) Regular and Ad Hoc Survey :- Regular survey is conducted after regular intervals. Generally this survey is undertaken by the Government for obtaining certain facts and data about socio-economic problems.

Ad Hoc surveys are conducted for certain purposes and, are undertaken once and for all. National Hand-loom

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[8] B.N. Ghosh, *Scientific Method & Social Research,* p. 193

survey is an example of this category. Mostly, these surveys are conducted for testing hypothesis or getting missing or new information.

(2) Census and Sample Survey :- In a census survey, the entire population is studied. It is a time consuming and expensive method of survey. On the other hand, in a sample survey, a part of the population or unit is studied. It is less expensive and less time consuming. But the validity of this survey is not always universally true and up to the mark.

(3) Primary and secondary survey :- The primary survey is conducted in order to acquire directly the relevant facts. This survey is more reliable than the secondary survey. Secondary survey is conducted after the primary survey has been completed.

- **Merits and Demerits:**

According to the social scientists, survey method is the most reliable method. It has the following Merits :-

i) A social survey throws useful light on various aspects of a social problem. On the basis of this survey, a constructive plan can be prepared to improve the situation.

ii) Survey helps to build the formulation for a research programme.

iii) Social Survey helps to gather well-organized information on a particular problem.

iv) Survey is more reliable because of the fact that it is quantitative.

Its Demerits are as follows :-

1) It is expensive.
2) Time consuming.
3) Data collected may not be reliable.

4) Result obtained through survey is more general.
5) It does not consider the historical aspect.
6) It might have sampling error.
7) It emphasizes only the immediate problem.

For heavy financial involvement, individual researcher cannot afford to choose this method for his study. On the other hand, agencies conducting studies with this method often fail to arrive at fruitful results due to involvement of untrained and poorly motivated workers. On the other hand, planning based on these results are destined to meet with failure. Such things are happening in the developing countries like ours. Advanced countries like USA has some agencies who engage themselves in studies with this method.

The following list has some examples of problem areas which can be tackled with **survey method**.

The list is not exhaustive.

1. Educational facilities available in this region in comparison to its necessity.
2. Assessment of Educational achievement in the light of available facilities.
3. Infrastructural facilities available in the Educational Institutions of this region.
4. Growing tendency of Privatization of Education.
5. Education as facilitator of Earning Livelihood.

Students may extend the list applying their own intuition.

2.5.2. Case Studies :

It is a type of intensive study. Unlike survey, it deals with a particular subject which is a social unit. It investigates the various aspects of the unit exhaustively. The unit or the subject selected for the study may be an individual, a family, an ethnic group or a group with specific features. According to P.V. Young. "Case study is a

method of exploring and analyzing the life of a social unit, be it that of a person, a family, an institution, cultural group or even an entire community." An individual of interest, a school say Balya Bhawan of Jorhat. Salt Brook Academy of Dibrugarh, Sishu Sikha Samity Assam, Jatiya Vidyalaoy Assam, drug addict group of school going students of Birubari area, Sonowal Kacharis of Chapakhowa, etc. may easily be taken as subject for such a study. It is categorically a longitudinal study in contrast with the descriptive study which is essentially a cross sectional one. As Bromley (1986) notes, "A 'case' is not only about a 'person' but also about that 'kind of persons'. A case is an exemplar of, perhaps even a prototype for, a category of individuals".[9] Accordingly, you can choose an individual drug addict student. Then the case comprises of a single individual. On the other hand, the drug addict students of Birubari may comprise of several individuals having the common criterion of drug addiction. Similarly, the Sonowal Kacharis of Chapakhowa comprises of the entire community residing in that area. The Missing community of Dihingmukh locality may be regarded as a case for a study with this method. In selecting a case, care should be taken that it has an uniqueness and the individual elements comprising the group, more or less, conform to the group in the distinguishing feature.

Like all other studies, it too proceeds with data collection. But unlike other studies you cannot think of a data collection schedule well ahead of time. It will follow the course of your investigation. You shall have to adjust your data colleting and recording schedule as per the demand of your investigation.

For collection of data, various procedures are adopted. Some of them, according to Best and Kahn[10] are as follows :-

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[9] Bromley, D.B. (1986) *The Case Study Method in Psychology and Related Disciplines,* Newyork John Wiley. p. 295.

[10] Best & Kahn*, Educational research*

1. Observation by the researcher or his or her informants of physical characteristics social qualities or behavior.
2. Interviews with the subject(s), relatives, friends, teachers, counselors and others.
3. Questionnaires, psychological tests and inventories.
4. Recorded data from newspapers, schools, courts, clinics, government agencies or other sources.

It is a study in depth. It is a time-honored procedure in many social problems and in various disciplines. Theories of Sigmund Freud and Piagio where case history method was adopted, were the results of, keen and long term toiling effort.

Case studies pertaining to a community are conducted for the purpose of understanding the culture, development of various relationships, development of a particular attitude and so on and so forth. Earlier, researchers conducted these studies as outsiders of the community. But at present, researchers feel that if they keep themselves aloof from the community, then they may miss many of the information useful for their analysis. If the language code of the researcher is different from that of the case (say, a tribal group) under study, then he will face communication barrier. If he uses an interpreter, then also he is not in a position to get information to the minute details. So the present researcher makes himself well-acquainted with the language code of the group under his study. Adopting all these measures, he merges himself with the group and hides his identity as researcher. If the group knows his motive, then they may, hide themselves from him as a respondent. Their behavior may become artificial resulting in errors in his inferences.

For collecting data for an individual case or an organization, records are usually regarded as good sources. For instance if your case is an institution then you need information of the starting, functioning, changing trends etc. You will next have to resort to the records maintained by the institution. They are most helpful sources

of your data. Other records like news paper reports, articles published by some individual etc. may also serve as data source. But in using them, necessary precaution should always be taken. Because they may be motivated and distorted, which in turn will distort your result. In case of study of a group, the procedure of data collection may be participatory or non-participatory as mentioned above. Regarding this, we should remember that, if the researcher do not hide his identity then it is a non participatory method of data collection and if the researcher hides his identity as researcher by mingling himself with the target group he intends to study, then the process in said to be participatory procedure of data collection. Once a reputed writer intended to study the behaviors of a group of country liquor consumers. For that he visited their den several times and participated them. Of course he utilized his findings in his literary work.

If the case be an individual, then family album, diaries of the individual and his relatives. His certificates and other testimonials, opinions of the persons coming into his contact may serve as sources of data. If the person is a man of repute, then articles or newspaper commentary may also be helpful.

Case history as a method of research is not acquiring momentum in The North-East India. Of course it has tremendous prospect for a researcher.

CHECK YOUR PROGRESS (3)

1. Which of the two types of studies (survey and case study) essentially, use sampling as a necessary measure ?

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   ……

2. What are the social units that can be studied adopting case study method ?

……

……

……

3. You are to study the causes of behavioral pattern shown by a group of delinquents. Which method of investigation will you choose ?

……

……

……

2.6 LET US SUM UP :

In this particular unit, we have discussed the descriptive method of investigation. As a student of education you will observe that the descriptive method of education is playing a remarkable role in educational research and in all the other aspects of education. It is useful both to theory and practice. So, if you are intending to work in the field of education, you should know it by heart.

Now, coming to the meaning of the method we can say it in a single sentence - 'The method that helps the investigator describe something is the descriptive method'. Here you should note that this 'something' is not some ordinary thing like a cow, a flower etc. This something stands for a social phenomenon in social science. Here, in education, it is about some phenomenon relating to education.

Then we came to the nature of this method. Regarding its nature we can say that it is scientific to a large extent ; though not as much as the experimental method. With reference to nature, the different types of studies or research that can be handled with this method is also discussed. Depending on their main objectives, they

are placed under three categories - Assessment, Evaluation and Descriptive Research.

Finally we came to the steps of the actual process. There are many a steps common to all the methods. Here data collection and processing is a vital step. There, we have different related concepts under different heads.

Toward the end of the discussion, we are discussing two special types of studies viz. Survey and Case Studies to some extent elaborately.

After this section, some words with their meaning is given in the section 'key words'. Go through it whenever you find necessity.

2.7. KEY WORDS :

Assessment :- The process of knowing status of something.

Census :- Collect informations excluding none of the units of the population.

Correlation :- Inter relationship between two things such that any change in one causes change in the other.

Manipulation :- Changing something at some body's will.

Numerical Data :- Information that is expressed in number.

Randomization : - Picking up of a small section of a group in such a way that every individual member gets equal chances of getting selected and selection of one do not affect the selection of any other.

Replication :- Reproducing or regenerating something in a way similar to something that had occurred once before.

Sorting :- Arranging things following certain order or principle.

2.8 SUGGESTED READINGS :

Best. J.W. and Kahn I.V.,(1968) *Research in Education, 6th Edition*, Prentice Hall.

Ghosh. B.N. (1985) *Scientific Method and Social Research,* Sterling Publication.

Bromley, D.B. (1986) *The Case Study Method in Psychology and Related Disciplines,* Newyork John Wiley.

Possible answers to CYP :

CYP (1) Qn. 1. (b), (d)

Qn. 2. Assessment, Evaluative, Research.

Qn. 3. Exploratory or formulative.

Qn. 4. Evaluative.

CYP (2) Qn. 1. Data collection.

Qn. 2. Consult the text of this study material.

Qn. 3. Go through the step 'collection of data' in the foregoing text.

CYP (3) Qn. 1. survey.

Qn. 2. Consult the part of case study method in the foregoing text.

Qn. 3. Case history.

Qn. 4. Freud.

References :

Gopal. M. H., *Introduction to Research procedure in social Sciences*, Allied Publisher.

Best J. W. and Kahn J.V.,(1968) *'Research in Education*.' 6th. Edition, Prentice Hall.

Ghosh. B.N.(1985) *'Scientific Method and Social Research'*. Sterling Publication.

Bromley D.B. (1986) *The Case Study Method in Psychology and Related Discipline*, Newyork, John Wiley.

Model Questions :

Qn. 1. Descriptive method is very helpful for the educational administrators. Justify the statement indicating the various aspects of this process.

Qn. 2. What are the importance of the following activities in descriptive studies? Training of the enumerator, collection and processing of data, statistical analysis.

UNIT - III
EXPERIMENTAL METHOD

STRUCTURE

3.0 : OBJECTIVES :

After going through this unit you will be able to -

- define experiment.
- state the characteristics of experiment.
- compare experimental method of physical science with that of social science.
- compare experimental method with the other two methods.
- state, why control of extraneous variables are necessary ?
- Say how intervening variables differ from extraneous variable.
- give examples of intervening and extraneous variable, with reference to a particular study.
- state various methods adopted to control the extraneous variables in studies of social science.
- appreciate the method.
- prepare a project proposal of a study where experimental method can be adopted.

3.1 : INTRODUCTION :

It is a method of study adopting concepts parallel to the studies conducted by the scientists for investigating problems pertaining to the area of exact sciences. Physical scientists create a situation where the phenomenon to be studied does occur. The situation is created so it is artificial but similar to that situation where it might have accrued in a natural setting. Though it is artificial it is similar to the natural situation. Since the situation is created it can be so designed that it provides scope for close and minute observation. We may cite the example of the experiment devised for measuring

the gravitational forces. Ordinarily, all the physical objects in nature are exerting forces of attraction on the other objects surrounding it but it is difficult to measure the magnitude of the interacting forces. To avoid this difficulty, scientists developed a device, fitted with two metallic spheres which can be brought closer and the interacting forces can be measured with sufficient accuracy. Thus, a situation is contrived making it convenient to observe the phenomenon closely and minutely. Thus in this type of study, it should be possible to create the situation artificially. So in other words, we contrive a situation in an artificial setting, where as we are in a convenient position to observe the phenomena, and we do experience it and gather informations necessary for us to draw a substantial inference and accordingly the type of study in known by the name 'experiment'.

In social sciences, we have so far discussed certain methods and procedures where we go to the subject to be studied. We observe it carefully without disturbing it, in its natural setting. But the method that we are going to discuss is a method where we shall try to contrive a situation as it is done by physical scientists. Here we shall be in an advantageous position to observe it from closer vicinity. We shall take measurement wherever necessary, that too experiencing it personally. By doing this, social scientists are trying to become more scientific. Physical scientists contrive the situation in a laboratory. The social scientists do not have so called laboratories. Still then, where they contrive the situation becomes their laboratory. Accordingly, it is also known as the laboratory method.

By being well conversant with this method, students will develop ideas about the scientific method of approach to a subject area.

3.2 MEANING OF EXPERIMENTAL RESEARCH :

Experimental method means a method where knowledge is gathered through experiment. It is similar to the laboratory method of

the physical scientists. Laboratory situations are contrived and the study conducted in such an environment is generally called experiments. Studies of social sciences which are conducted under controlled situation just like experiments of the physical sciences are known as experimental studies, and the method involved in such studies are known as experimental method.

Though the method is known as the 'experimental method', it should be remembered that the so-called experiments in social sciences are not the same with the experiments of the physical sciences. This is because the physical sciences deals with innate objects which do not react to a stimulus. But the social sciences work with organisms, that too the most sensitive organisms, i.e. human being. They react to all sorts of stimuli readily. So these experiments are not experiments as can be perceived by a physical scientist.

As such, experimental method in social sciences mean a method of investigation which in certain aspects bear the similarity with experimentation.

Suppose we intend to test the hypothesis - 'environmental background have a bearing on intelligence'. We can test it through observation in different environmental background and can infer positively in favour of the hypothesis. But we may have the feeling that the environment is not a factor influencing intelligence. Because there are many factors interacting with the subject. So any one of them may have the influence on intelligence. In such cases, we feel the necessity of a method in which that problem (i.e. the influence of other factors) can be eliminated or at least an ideal situation is created as close as possible.

We can say that experimental method in social sciences (including education) is a method which bears similarity with experimentation in physical sciences. According to Cohen and Nagel. "A scientific method is the way in which one can test opinions, impressions and guesses by examining the available both for and

against them. It is simply the pursuit of truth which is determined by logical considerations. Scientific method is the most assured technique for controlling a host of things and establishing stable belief."[1]

CHECK YOUR PROGRESS (1)

1. Experimental study is a longitudinal study. Comment.

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2. In what aspect does it differ from the other two types of studies ?

…….

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3. Experimental method studies about phenomena in its natural settings, Comment.

…….

…….

4. Experimental method is more scientific then the other two types of studies. Mention the reasons.

…….

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…….

[1] Cohen and Nagel, (1968) *An Introduction to Logic and Scientific Method,* Allied Publisher,.

3.3 NATURE OF EXPERIMENTAL RESEARCH :

This method is scientific in nature, of course, within the limitation of non-exact sciences. It provides opportunities to contrive the situation in its own way. It observes and takes reading of the findings. It measures the variables and expresses them in quantitative terms. The variables which needs measurement are not measurable in true physical terms. But the social scientists are devising their own scale which can be used to measure the variables in their experiments. Of course, the measuring tools vary from experiment to experiment, and from investigator to investigator. Accordingly, the measure of variables taken by different investigators may vary from each other. Unlike physical sciences, these quantities cannot be treated mathematically. But they are best analyzed with the help of statistics. After the statistical treatment, apparently divergent results prove to be consistent, provided the investigator succeeds in contriving the situation to near perfection.

In deriving the result, it takes recourse to analytic synthetic method and in reasoning, it follows the logic of induction and deduction.

The experiment can be repeated time and again. i.e. it is replicable. That too reveals its similarity with scientific method.

Like descriptive method, this too is cross sectional. It draws inferences from the study of small group and extends its findings to the entire population.

In comparison to descriptive methods it is economic both in finance and time. Man power requirement is also lesser in comparison to that of the descriptive method.

According to Best and Kahn, - "Experimental research provides a systematic and logical method for answering the question, 'If this is done under carefully controlled conditions, what will happen?' Experimenters manipulate certain stimuli, treatments or

environmental conditions and observe how the condition or behavior of the subject is affected or changed."[2] This is what we have already explained in our discussion above. According to Northrop, scientific methods are relative to the stage of enquiry and type of problem.[3] Different disciplines of studies are in different stages of enquiries, Accordingly what is scientific for social sciences are not the same with that of the physical sciences.

In science, broadly there are two types of methods - (i) Technical (Technological) and (ii) Logical. Technical method depends upon observation of facts which the investigator contrives. But sciences, however sophisticated it may be, are likely to develop theories without any observation to test its hypothesis. Rather, it draws inferences from existing premise or premises which are already there. It does not use any laboratory. Einstein's theory of relativity was established without using any laboratory. Here we are speaking of Technical method, i.e. the experimental method of social sciences belong to the technical category of scientific method.

- **The Concept of Variables :**

Sociological phenomena are the consequences of a very complex system. A host of factors play together to produce, a single effect. So it is difficult to say with certainty that this factor caused the occurrence of that factor, or occurrence of this phenomena is tied with the occurrence of this phenomena or is tied with the occurrence of that phenomenon. Suppose, you see a man is sad. You may presume that he had a quarrel with his spouse and he is sad because of that. But there may be other reasons of his sadness. Say he is a pessimist, he is poor, he may be faced with a failure. So he may be

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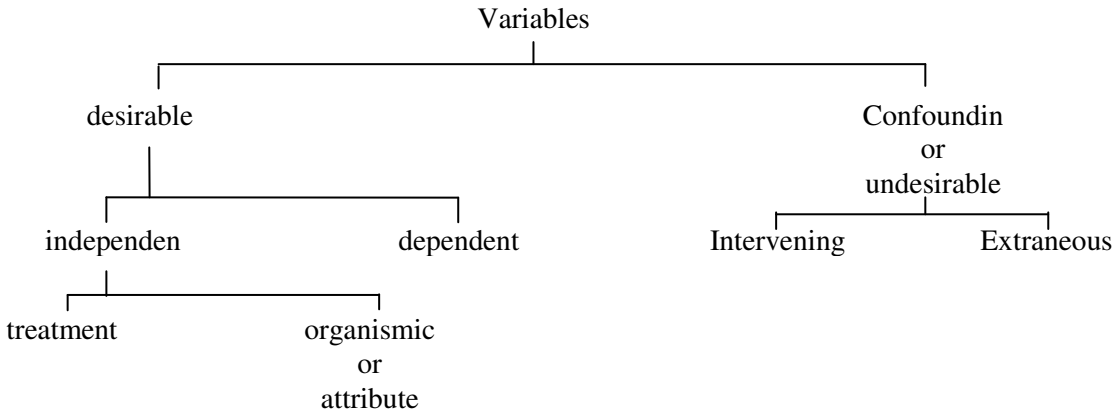
[2] Best and Kahn*, Research in Education,* p-110

[3] Northrop, F S G *The Logic of the Sciences and Humanities,* p-19

sad due to one or more of the factors. Coming to a pupil's achievement, we can attribute it to his intelligence, to the family environment, to the schooling facility, so on and so forth. All of them are factors which influences the phenomenon. Now, suppose, you postulated the hypothesis that 'family environment influences pupils' achievement". We can correlate the two factors and infer in favour of the hypothesis. But how can you be sure about your result without paying heed to the other variables ? One of them may be the real influencing variable. So in testing your hypothesis, you must take account of them too. For that reason, we must identify the probable factors influencing the phenomenon. They play different roles in the overall environment. These factors are often termed as variables because their magnitudes go on changing with time. They are classified according to the role they play. The experimenter is interested in certain categories of the variables. They are mainly of two types - independent and dependent variables. Independent variables are the conditions or characteristics that the experimenter manipulates or controls in his or her experiment to ascertain their relationship to the observed phenomena. The dependent variables are those conditions or characteristics which are changing in their magnitude or even appear or disappear along with the introduction, withdrawal or change of intensity of the independent variable. Independent variables are of two types - treatment and organismic or attribute variables. Treatment variables are those factors which the experimenter manipulates and to which he or she assigns subjects. Attribute variables are those characteristics that cannot be altered but the experimenter can decide to include or exclude them. They are naturally attributed to the subjects. The second broad category of variables can be termed as confounding variables. Confounding variables are those variables whose effects may be confused by the experimenter to be the effect of the independent variable. They can again be subdivided into two types; intervening and extraneous variables. There are certain types of variables which can neither be

measured nor eliminated. They, on the other hand, influence the dependent variable. On the other hand, the variables which are likely to influence experimental condition, whose effect may either be incorporated in the result or may be controlled to some extent to have minimum effect.

The experimenter should clearly identify them and proceed accordingly. The following graphical representation of the classification may help the reader to comprehend the subject matter.



• **Examples of different types of variables :**

Independent variables :- Suppose the experimenter is presuming that a particular method of teaching mathematics may be beneficial to the subject. He is intending to test his hypothesis. Then the method is the condition which according to him will influence the subject in learning mathematics. Here, the investigator may introduce the method or withdraw the same to produce an effect, in learning. He may further presume that the method is effective especially in the lower age group. He can choose subjects of various age groups and may be exposed to the same. Here, presumption is that the method and the age group affects the learning process. But they are not going to be affected in the reverse way. The method of teaching or the age of the subject is not going to be changed along with the learning

outcome. Age will not be altered by the learning out-come. So the learning method and the age group are independent in the process. Accordingly they are known as independent variable. Here the experimenter can change the method while treating. So it is treatment variable. On the other hand the experimenter can choose the age group but cannot change it. It is already attributed to the subject accordingly it is known as organismic or attribute variable.

Depended Variable :- The event or the characteristic that changes or vary with the variation of the independent variable is known to be dependent variable. The experimenter intends to measure the magnitude of variation of this variable which might occur due to the manipulation of the independent variable. In the above mentioned example, the experimenter intends to measure the difference produced in the learning outcome in a subject of a particular age group. It is presumed that the level of learning outcome is dependent on the method he applied on the age group of the students. Accordingly, the learning outcome is the dependent variable in this experiment.

Intervening variable :- In social research, we often come across certain variables, which can neither be controlled nor be measured. In the above example, learning outcome is likely to be affected by fatigue, anxiety, motivation etc. They definitely influence the learning outcome. But you cannot avoid, eliminate or measure them. They enter the experiment and interfere or intervene in the experimentation process. This type of variables are known as intervening variables.

Extraneous Variable :- This type of variables are uncontrolled i.e. not manipulated. Their influences are unwanted and may tarnish the finding. But planned experimental design enables the experimenter to neutralize their influence.

For instance, in the above mentioned experiment the teacher's competence and enthusiasm, age, sociometric level or the academic ability of the student subjects are examples of such a variable.

3.4 CHARACTERISTICS OF EXPERIMENTAL METHOD :

3.4.1 Control :

In an experiment the control is one of the important criterion. In all sorts of experiment either of social sciences or of physical sciences control is essential. By the term 'control' we mean control of the extraneous variables as discussed in section 3.3 of this chapter. In an experiment of physical sciences undesirable factors are eliminated through special arrangements or some convenient or pre-assigned values are assigned to them. But in social sciences the case is something different. In a social situation different factors are so interwoven that one cannot be imagined without the other. For instance the students cannot be imagined without his family-background or the influence of his pear group or his fatigue or emotion. But the experimenter is not concerned with all these factors. Except in factional conned with all these factors. Except in factional design the experimenter is concerned only with two types of variables the independent and the dependent variables. All the other variables need to be controlled. Here in social science, by control, we mean neutralizing or minimizing the effect of the extraneous variables. Here these extraneous variables come from two sources. First type comes from the subject themselves. If an experiment is conducted on the students, then the students are the subjects of the experiment. Every individual student differs from the rest in various aspects. They constitute an array of extraneous variables. This category of variables are known as '*intersubject differences'*. The other category comes from the condition under which the experiment is conducted. This category is know as *situational variables'*. There are different

methods of controlling them. Category wise they can be described as below.

Let us first discuss about the *inter subject differences.* This category of extraneous variables can be controlled through five different ways.

(a) Random assignment of subjects to groups.

(b) Matching subject with random assignment.

(c) Random assignment on homogenous relation.

(d) Using subjects as their own control.

(e) Using the technique of analyzing covariance.

Details of them are as follows.

(a) Random Assignment of subjects to groups :

Randomization is a statistical method based on probability principle. It restricts the experimenter in exercising his discrition in assigning groups to his subjects. It minimizes the effect of the undesirable factors which may interact with the experimental treatment.

Randomization is done with the help of random tables, or with the help of random methods as throwing of dices or tossing of coins.

Randomization counter balances the effect of inter subject differences through chance factor. Even then it cannot be totally neutralized. But the experimenter can estimate the magnitude of the error due to chance, with the help of statistical method. This is known as the '*sampling error' or error variance.* If the difference of the magnitude of the change of the dependent variable between the experimental and the controlled group exceeds the magnitude of the sampling error then the experimenter can claim a positive effect of the independent variable on the dependent variable.

In this way, randomization helps in controlling the extraneous variables that may occur due to inter-subject differences.

(b) Matching subjects with Random Assignment :

In this method the subjects assigned to different groups are matched on the basis of an extraneous variable, which the experimenter deems to be the most powerful influencing factor. Depending upon the procedure of matching, the method is divided further into three sub-categories. The are –

(i) Subject to subject matching or matching by pairs.

(ii) Matching for mean and variance.

(iii) From rank orders of the subject on the matching variable.

(i) Subject to subject matching or matching by pairs : In this procedure the subjects are arranged in pairs who are identical or comparable in respect of the most influancial extraneous variable. Then one of the members of one pair is assigned to one group through random procedure and other to the other group. The same process is followed for all the pairs.

There may be one problem. Some one of the subject may not have any match within the available group of subject. Than he may have to be eliminated from the experiment.

(ii) Matching for mean and variance : This procedure is also known as *balancing cases* or *group matching.* Matching by mean and variance is done by dividing the subjects into two groups in such a way that the two groups become comparable i.e. their means and variances become almost equal.

(iii) Grouping of subjects from the rank order of the subjects in the most influencial extraneous variable : In this procedure a rank order list of the subjects are prepared on the basis of the variable basis of the variable on the basis of the variable in which the experimenter decides to match them. Then the first one of the list is

assigned to a group through random procedure and the next one to the other group. The process is repeated for every alternate subjects of the rank-order list until it is exhausted.

(c) Random assignment on the basis of homogenous relation : If the experimenter feels that the independent variable is not equally effective to the different categories of the subjects to which they can be subdivided. For instance the experimenter may feel that a certain treatment apparently influences the girls more then the boys. Then he may eliminate the boys from his experiment and can divided the girls into two groups for his experiment following any one of the procedure discussed above.

This procedure has one draw-back. In this process the experimenter cannot generalize his finding, it is valid only for the category of subject with whome he conducted his experiment. For generalisation he shall have to repeat the experiment for the remaining category or categories of subjects.

Using subjects as their own control : In this procedure the same group is given both the treatments alternately. For clarity reader can consult section 3.5.3 of this unit.

Using technique of analysis of covariance : This method enables the experimenter to eliminate the influences of one or more variable between the experimental and the controlled group by applying statistical method. The use of pretest mean score, as covariants, is preferable to the conventional methods of matching the groups. (For covariance reader is adviced to consult text on statistics).

Let us now discuss the control of **situational variables**. During an educational experiment the subjects are exposed to the situation, which may not be constant for both the groups and through out the entire span of time which is necessary for conducting the experiment. The teacher, the class room, class room accessories, weather condition etc. are some of the situational variables.

Attempts is made to control these variable through the following methods.

(i) Method of holding the situational variable constant.

(ii) Method of Randomization.

(iii) Method of manipulating situational variable.

Let us elaborate them.

(i) Method of holding the situational variable constant : In this method both experimental and controlled groups will be taught or dealt with by the same teacher, in the same class room, with the same class room accessories, under same condition of temperature and pressure etc. Treatment will be the only difference between them.

But inspite of all the attempt it is not possible to keep all the variables constant. For instance the mental and emotional state of the teacher cannot be expected to remain same.

(ii) Method of Randomization : In this method all the situational variables, such as – the class room, teacher, period etc will be allotted trough random procedure.

(iii) Method of manipulating situational variable : In this method the experimental and control conditions are applied in a sequence. The two groups are further sub-divided into two subgroups each and the sub-groups are subjected to the two treatments in alternate order. If X_1 and X_2 are the two treatments then one half of the subjects may have X_1-X_2 treatment. By doing this, attempt is made to counter balance the effect of the variables.

3.4.2 Manipulation :

Through experiment, we want to estimate the change in the dependent variable due to the application of the independent variable. For that, the independent variable is changed by the experimenter. He changes the variable by degree, or introduces it or withdraws it and

thereby causing change in the dependent variable. This is known as the manipulation or the treatment of independent variable.

3.4.3 Observation :

Estimation of variation in the dependent variable due to the application of the independent variable is known as observation. The quantities to be measured in these cases are not externally manifested. Their measurements cannot be taken with ordinary measuring devices. Specially designed tools are necessary for their measurement. These measuring tools are usually some test batteries which are standardized by experts. Measurements or observations are usually some test scores.

There are certain test batteries that are available in the market.

But all the test batteries are not useful to all subjects of all geographical regions. The experimenters have to adapt it for using it in the experimental environment.

3.4.4 Replication :

The word replicate is a combination of the words *'repeat'* and '*duplicate*'. It is a process in social research where previous experiments are repeated. By doing this, researchers refute or reassert a hypothesis tested by his predecessor. This often helps to strengthen or reject a theory. The experiments are characterized by the replication property. There, it is assumed that the experiment performed somewhere by some person at a particular time can be replicated by some other experimenter of some other place at a different time. Theories in social sciences are often loosely founded or of temporal nature. So replication is often necessary in order to test the correctness of the theory or to adjust it for particular time period or some other conditions.

Like replication, there are two other procedures which take interest in the past studies. But they differ from replication on the fact that they do not repeat the experiment but reanalyze previous data or findings. The first one is known as *secondary analysis*. Here the researcher uses data that were collected and used by some previous researcher. The only thing he does is to follow a different method of analysis. Which may refute or reassertain the findings of his predecessor.

The second one tries to combine facts of several predecessors working with the same hypothesis to confirm a theory. Such activities are known as *meta analysis*. Now a days there are statistical methods which facilitate a researcher in combining results of several studies. This types of studies are helpful in social sciences.

3.5: MAIN TANETS OF EXPERIMENT AND EXPERIMENTAL DESIGNS :

Main Tanets of Experiment :

There are certain salient features of the experimental method, which distinguishes it from the other methods used in social researches. The first feature which is characteristic to this method is the situation where the study is conducted i.e. t is conducted in a contrived situation or setting. Other methods, on the other hand are conducted in natural settings. The most primitive studies conducted in artificial or contrived setting lacked certain features of the experimental method and accordingly they were placed under a separate category known as pre-experimental study.

We would like to introduce the symbol scheme followed by the social scientists to indicate the characteristics of various experimental designs. This scheme is credited to Campbell and Stanley. According to them the symbols used to different feature are

R - Random assignment of subjects to group or treatments.

X - Exposure of a group to an experimental variable.

C - Exposure of a group to the control or placebo condition.

O - Observation of test administered.

Accordingly experimental designs can broadly be divided into three categories.

Experimental Design : Experimental design is the blue-print of the procedure which the experimenter adopt to test his hypothesis. It depends upon the practical aspects of the experiment. The design has to be chosen according to the condition under which the experiment has to be conducted - such as the purpose of the experiment, the variable that has to be controlled, facilities available for the experiment etc. This suggests the practical aspects of the experiment – such as, how the subjects will be assigned to the experimental or to the controlled group, what measures will be adopted to control the extraneous variables, in what order the treatments will be given and such other things.

Many designs have been developed by the researchers. According to the nature of the experiment and the extent to which the experimental conditions are achieved, they can be broadly divided into four categories –

1. Pre-experimental Design.
2. True-experimental Design.
3. Quasi-experimental Design.
4. Factorial Design.

A brief category wise description is given below -

3.5.1 Pre-Experimental Designs :

These designs lack provisions for comparision and of taking measures for the control of the extraneous variables. Three types of such designs can be mentioned. They are (i) One shot case study. (ii) On group pre-test-posttest design. (iii) Two groups static design. They can be elaborated as below –

(i) One shot case study : The design can be represented symbolically as XO

In this design the experimental condition is applied to a group and then observed. If the score is high in the trait to which the experimental treatment is applied then the experimenter infers that the high score is due to the treatment applied.

Suppose, a teacher assumed that a particular method of teaching mathematics is effective. Then he applies it to a particular group of students and if he finds that the group scored high in the subject then he may incline to infer that his method is good. But he cannot claim that the apparent high score is due to the method he applied. It may be due to the fact that the content is easy to learn or the group he selected is brilliant inherently.

(ii) The one group pre-test-posttest method : Symbolically it is as indicated below –

$$O_1 \; X \; O_2$$

O_1 –Pre-test O_2-Post-test

In this method also the experimenter selects a single group. Before administering the treatment he perform a test. Then he administer the treatment and after the treatment is over he again conduct a test. If the post test score is higher than the pre-test score then he claim his treatment to be effective.

We can take the example of the previous design. Here the only additional thing he has to do is to admister a test before he tryout his method. Suppose in that test the students scored 50 on average and after the treatment i.e. the application of the new method their average score become 60. Then there is a gain of (60-50=) 10 points. He, than, claims it to be the effect of his method.

Here also there is no scope of comparing the performance with some other. We can say it to be effective but we cannot call it to be better. Further, the pre-test may make the students sensitive or aware to certain points which may lead them to score high in the second test.

(iii) Two groups static design : Here the experimenter selects two groups. One group is treated with conventional method and the other group with the experimental method. Symbolically the scheme is as follows -

CO

XO

Here C-stands for conventional method, X-stands for experimental method and o-stands for observation or test.

Coming to the example given above we see that the experimenter shall have to take an additional group. Suppose the first group is taught a topic on mathematics with experimental method and the same topic was taught to the second group with the conventional method. If their average scores in the test are 60 and 40 respectively, then the apparent gain of the experimental group is (60-40=) 20 point. Then the experimenter will claim his method to be better than the conventional method. His claim is apparently true but the inter subject and the situational differences were not taken into account. Thus this method lack the control over extraneous variables.

3.5.2 True Experimental designs :

In this category of designs utmost care is taken to control the extraneous variable. There are many designs covered under this category. A few of them are discussed below –

(i) Two groups, randomized subject, post-test only design : It is a slight modification of the two groups static design discussed under section 3.5.1 above. The only difference is the randomization of the subjects into the groups. Randomization makes the groups comparable, Effect of inter-subject difference is reduced through it. Symbolic representation of the process is as follows -

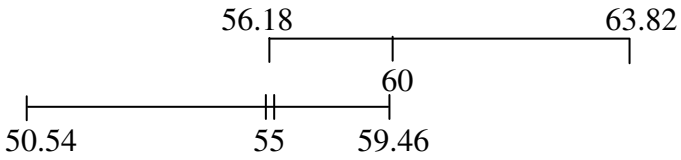
R X O

RCO

Here, R-stands for randomization.

Suppose the same teacher mentioned in the previous design intend to tryout the same method. Then he first takes the entire group of subjects and he assigns them to two equal groups through random procedure. Suppose he intend to try-out his experiment with a group of 100 students of class VIII standard. Then through random procedure he assigned 50 students to one group and 50 students to an other. He then gives experimental treatment to one of the groups and conventional treatment to the other group. After the treatment the groups will be tested. Suppose the score for the experimental group the average score is 60 and that for the controlled group, which received conventional treatment came as 55. Then the apparent gain is 60-55 = 5. But the entire credit cannot be given to the method. Before drawing any conclusion we should consider the possible sampling error. To compute the sampling error. To compute the sampling error he shall have to compute the sampling error he shall have to compute its SD's (i.e. standard deviation). Suppose they are 10.5 and 12.25 respectively. Using the formula $SE_M = \frac{SD}{\sqrt{N}}$ he gets

the standard error for the mean of the experimental group to be $= \frac{12.25}{\sqrt{50}} = 1.73$. For 0.99 level of confidence. The first mean is likely to assume values between 60-2.58 × 1.73 = 50.54 and 55 + 2.58 × 1.73 = 63.82. Similarly the mean of the controlled group is likely to assume values within the range 55-2.58 × 1.73 = 50.54 and 55 + 2.58 × 1.73 = 59.46. Diagrammatically it can be roughly shown as follows



This shows that the probable values of the means has a common range i.e. from 56.18 to 59.46 within that they do not represent two different population. That means the means have no real difference. Even at 0.95 level of confidence he will find a common range (from 57.09 to 58.35). So though there is an apparent gain through the experimental method yet it cannot support the hypothesis genuinely.

(ii) Randomized groups, Pre-test post test design : It is also known as *equivalent group pre-test post test design.* Symbolically the design can be represented as follows.

RO_1 X O_2 $\quad$ O_1, O_3 – Pre-tests

RO_3CO_4 $\quad$ O_2,O_4 – Post tests.

Gain due to X treatment (Say X_{gain}) = O_2-O_1

Similarly C_{gain} = O_4-O_3

This design is, to some extent similar to the previous design, except the groups will receive a pre-test. The groups are constituted through random procedure. Accordingly they are comparable. To make it more comparable randomization can be done after a matching procedure is followed. Here the experimenter will compute the means

and standard deviations of each group separately for both the tests. The he will compare X_{gain} with C_{gain} and will compute X_{gain}- C_{gain} and will test for its significance. In this design pre-test scores can be utilized to rectify the final scores using analysis of covariance utilizing the pre-test scores. This is helpful where elimination of personal difference cannot be neutralized properly through any pre-experimental arrangements. Analysis of covariance involve a lot of numerical computation, which increases with the number of subject. So in this type of design small groups are usually preferred.

Suppose a group of students were assigned to two sub-groups. Each of them were tested (Pre-test) and then one of the group is exposed to an experimental treatment and other is exposed to the conventional method of treatment. After a stipulated period both the groups will again be tested. The test scores are recorded categorically. From the tabulated scores we can compute four means (M) and 4 standard deviations (S.D's). Variances are calculated from the same tabulated data. Correlation between the sets of scores can also be computed. From these data variance can be analysed to detect the significance of differences between means, if any 'F' test and 't' test is used to determine the level of significance. If significant difference is observed then the means will be adjusted by allowing for initial difference. Then the difference between final adjusted means will be tested for significance and inference will be drawn accordingly.

(iii) Randomized Solomon 3 groups design : In this type of designs instead of single independent variable two independent variables can be put into action. Or if the experimenter feels that other than the independent variable some other prominent factor is likely to influence the dependent variable then the effect of the undesired factor can be eliminated through statistical procedures. In the Solomon 3 groups design pre-test is presumed as an interacting factor. So measures are taken to eliminate its effect.

Symbolic expression of its scheme of action is as follows –

RO_1 X O_2 O_1, O_3 - Pretests

RO_3CO_4 O_2,O_4,O_5 – Post tests.

R CO_5

Suppose that in a class there are 60 students. They are randomly assigned to three groups of 20 each. First two groups receive a pre-test (O_1 and O_3) and third does not. Then the first group is exposed to the experimental treatment, while the second and the third group will receive conventional treatment. After the stipulated all the groups will receive a post test (O_2, O_4, O_5). From the tests we shall have five sets of data (O_1, O_2, O_3, O_4 and O_5). By comparing O_2-O_1 with O_4-O_3 the experimenter can test his hypothesis. Using all the five sets of data variance and covariance can be analysed and the significance of the differences between means are determined and the inference is drawn accordingly.

(iv) Randomized Solomon 4 groups design : Randomized Solomon 4 groups design is almost similar to the previous design, except one additional group which does not receive the pre-test but the experimental treatment. Symbolic representation the procedure of the design is as follows.

RO_1 X O_2 O_1, O_3 - Pretests

RO_3CO_4 O_2,O_4,O_5, O_6 – Post tests.

R XCO_5

R CO_6

Here the subjects will be assigned to 4 groups. First two groups will receive a pre-test (O_1, O_3). Then the first and the third groups will be given the experimental treatment, second and the fourth groups will receive conventional treatment. After a stipulated period of exposure all the four groups will receive a post test (O_2 O_4 O_5 O_6). Analysing the data, it is possible to evaluate the effect of

history, test and maturation. Anlysis of variance is used to compare the four post test scores and analysis of covariance is used to compare gain in O_2 and O_4 (O_2-O_1, O_4-O_3).

Here there is a difficulty of getting enough subjects to randomly assigned to four groups.

3.5.3 Quasi-Experimental Designs :

Quasi-experimental designs donot exercise the conventional methods to control the extraneous variable. This is actually a consequential development of the situational constrains. In certain situation we do not find enough subjects for random arrangement. It is difficult to match subject. Again randomization breaks the natural set-up of the subject, which may have adverse effect. These designs permits experimentation in the existing set-up itself. These designs are usually of two types-first one utilizes more than one group and provide scope for intergroup comparision. Second one utilizes the same group but introduces different treatment as the time progresses. Accordingly the second type is usually known distinctively as time. Series design and some authors prefer to put them under a different category. But as they bear the same basic characteristics of quasi-experimental designs, here they placed under the category of quasi-experimental design.

There are many designs of this category. A few of them are discussed below.

(i) The Pre-test-Post test non equivalent groups Design :

This is a two groups design, where the groups are picked up from the natural setting. Multi section classes are available in the schools. So for teaching experiments two sections can be selected as groups of subjects. They are readily available and in many institutions they are almost equivalent.

Procedure can be represented diagrammatically as follows –

O_1 XO_2 O_1, O_3 - Pre tests

O_3CO_4 O_2 O_4 – Post tests.

Here one pre-test will be administered to both the groups. Then one group will be exposed to the experimental condition (X) and the other will be exposed to the conventional treatment(C). After the stipulated period is over both the groups will receive a post test. Analysis of covariance will be used to make allowances for the pre-experimental condition, which will compansate the shortfall due to non-randomization, or not matching, then method of analysis of variance will be done to compare the gain in the post-test gains. The significance of gain will be tested through 'F' and 't' tests and inferences will be done accordingly.

(ii) Counter Balanced Design : As other quari-experimental designs, it to take the advantage of natural setting. To some extent it is improved in the sense that the design permits control over the inter-subject differences to some extent through its special course of action. The experiment is completed in two round, each time interchanging the groups receiving different treatments. The scheme of work of the design can be represented symbolically as below –

First round		**2nd round**	
Unit – 1	Sec A – X_1O_1 Sec B – X_2O_2	Unit – 2	Sec B – X_1O_3 Sec R – X_2O_4

Here both the groups are getting both the treatments, so inter-subject difference effect will be counter balanced. In different session teachers will also be changed. So the interaction effect due to the teacher can also be controlled.

For detail arrangement please go through the example given under section 3.6.

The advantages of this method are as follows –

(i) The experimenter does not require to take the pain of grouping (ii) The entire process of experiment can be concealed within the usual school routine (iii) The cost of the experiment reduces to a minimum (iv) Sufficient control over the extraneous variable can be exercised upon the extraneous variables through special arrangements or through statistical procedures.

(iii) The Simple Time-Series Design : This design is convenient where there are scanty of subjects to assign to several groups. Moreover it is convenient in case of study on social behaviours in which the teacher need not take regular class, symbolically the procedure is as follows –

$O_1\ O_2\ O_3\ O_4\ X\ O_5\ O_7\ O_8\ O_9$

Here X is a treatment and O's are observation.

Suppose there are some nursery students who do not like to share their toys with fellow students. The teacher presumed that an instruction treatment along with an announcement of some token rewards may work well to make them friendly with their friends. For that the teacher will prepare the list of the target groups and will observe their behaviour at a regular interval of time. O_1 to O_4 are such observation. Then he will administer the treatment X then he will continue observing. O_5 to O_8 are such observations. Now if his counseling worked positively then O_5 score will exceed O_4 score. Than O_5 O_4 will give the measure of the effect of his counseling. Successive observations will indicate the permanency of the effect.

There are other designs, which also come under this category. You are adviced to consult books on research and research reports to become familiar with different designs.

3.5.4 Factorial Designs :

These designs do not care much about the influencing factors other than the independent variable. Some of such factors are allowed

to interact rather than trying to control them. Such factors may be kept aside through statistical method to study the effect of the independent variable. If the experimenter desire then he may even estimate the effect of the other factors one by one.

As example we can think of situation where learning outcome cannot entirely be attributed to the teaching method, contrarily it depends upon the IQ of the students, regularity of the students, their social and economic back-ground etc. Then the experimenter will collect data pertaining to the other variables also by developing appropriate scales to measure them. The rest of the work will depend upon statistical computation. To know further about this you will have to go through some standard books on statistics.

CHECK YOUR PROGRESS (2)

1. Mention three types of variables commonly faced by the social scientists.

   ……
   ……

2. State the two major categories of confounding variable.

   ……
   ……

3. Manipulation helps us to control the confounding variable. Comment.

   ……
   ……

4. Which category of the variables are controlled in an Experiment ?

   ……
   ……..

5. Can elimination be adopted as a measure of control in social experiment ?

   ……

   ……

6. In earliest methods of experiment which technique was adopted as the measure of control ?

   …….

   ……..……

3.6 STEPS OF EXPERIMENTAL RESEARCH :

You have already come across the general steps of a research study. Here it will be discussed with the help of a concrete example for an experimental study.

3.6.1 Identification and definition of the problem :

As stated earlier a research starts from the identification and definition of a problem. That should come from your personal experience and review of literature. Here a problem experienced by a teacher of Bodoland is taken as an example. The research described here is hypothetical. For convenience of discussion it is assumed that it was really felt and he actually conducted the study.

The mother tongue of his students was Bodo. But as Bodoland is a part of Assam, he expected that his students should know Assamese properly which is the link language of the region. As such it paused as his problem that there should be an appropriate method for teaching Assamese to the students who speaks in Bodo of course there might be a chance of extending it to all the learner whose mother tongue is not Assamese. So he selected the problem of 'teaching Assamese to non-Assamese speaking students effectively' for his study. He reviewed literature on teaching of languages and

came to know that foreign languages like English can be thought affectively through structural method. In a sense Assamese can be regarded as foreign language to the non-Assamese speaking students. So he assumed that the same method could be adopted in this case too. Then his problem was to asserts it scientifically. Accordingly he defined his problem as '*Effectiveness of Teaching Assamese to Non-Assamese Speaking Students Through Structural Method ; Specially to the Bodo Speaking Students.'*

3.6.2 Formulation of hypothesis :

Next step was to state his hypothesis. He assumed that the structural method would be effective in teaching Assamese to the Bodo speaking students. So he stated his hypothesis as – '*Assamese can be taught effectively to the Bodo Speaking students through structural method'*.

3.6.3 Identification of the variables :

The teacher determined to teach Assamese to a group of students with structural method and to ascertain their progress in learning the language. So he was interested in two things first his method and the second one achievements of the students. The method he would apply and the achievement would be its out-come. So the method i.e. 'Structural method of teaching' was the independent variable and 'learning outcome' was the dependent variable. He was not interested in any other variables. So he will perform an experiment where he desired to avoid other variables which might influence the process. He decided to perform the experiment with two groups of student one, experimental and the other controlled. Here subjects were his students who might have differences in various aspects. He would have to conduct the experiment under certain circumstances or situations. They might influence his experiment. So

they were also variables but unwanted. So he had to take some measure to have control over them.

3.6.4 Planning the Experiment :

First of all he thought of the feasibility and next a suitable design. As regard feasibility he perceived that the experiment could be conducted in his own school with his own students. He might have to take help of one or two of his colleagues, whom he could convince. He would have to conduct a few tests, which he could manage from the school fund. Next he required some literatures prepared on the line of the method, which might cost something. So he considered the project to be feasible. Then he had to think of his design.

He thought of a two-groups design. Which particular design he would choose, that he required to finalise. He did not go for the pre-experimental designs, as they are not suitable to control the extraneous varbles. He did not preferred those designs where randmozations of the subjects was necessary. Finally he decided to adopt the *counter balanced* design of quasi experimental catagory, where the effects of the extraneous variables would be counter balanced. To have added advantage he decided to postpond the experiment to the new session, when he would be able to assign sections to the newcomers depending on the scores in the admission test. That would make the sections comparable to same extent.

3.6.5 Experimentation :

As per decision the teacher proceeded to conduct his experiment in the next session. He decided to take the experimental group himself and allotted the controlled group to one of his colleague who was comparable to him to a great extent. The experiment was conducted in two phases. In the first phase one lesson was taken. In one section he took the lesson with structural method

and that section served as the experimental group. The other section was taken by his colleague and taught with conventional method and that was the controlled group of that phase. In the next phase some other lesion with almost difficulty level with that of lesson of the first phase was taken. Teachers were also interchanged. That time the section receiving the experimental treatment earlier got conventional treatment. This design prescribes two tests only-one after the end of the first phase and the other at the end of the 2nd phase. He had done accordingly. The results were as follows –

Phases	**Groups**	**Method (treatment)**	**Scores (average)**
Phase one	Sec A	Experimental	35
	Sec B	Conventional	25
Phase two	Sec A	Conventional	31
	Sec B	Experimental	40

3.6.6 Statistical Analysis and Inferences :

This design does not require much statistical analysis. Here the scores after receiving the conventional treatment of both the sections were added to get the achievement through conventional method and that was = 31 + 25. Again to get the achievement through the experimental method, the average scores of both the groups after receiving experimental treatment were added and that came as 35 + 40. Thus gain of the experimental method over the conventional method was

$$= (35 + 40) – (31 + 25)$$

$$= 19$$

Hence the teacher inferred infavour of his treatment and concluded that his hypothesis was established, which means that

teaching of Assamese through structural method to non-Assamese speaking students is better than the conventional method of teaching Assamese.

CHECK YOUR PROGRESS (3)

1. What are the major steps in an experiment ?

   …….

   …….

2. Which one of the step is most imported according to you ?

   …….

   …….

3. State two uses of statistics in experiment.

   …….

   …….

4. What are the measures adopted to control the extraneous variable that has already entered into the experiment ?

   …….

   …….

3.7 LET US SUM UP :

Dear reader in this particular chapter we have discussed about experimental method of research. In previous two chapters we have discussed about two other methods other than this. In comparision to those the method discussed here is more rigorous and scientific too. Specially studies conducted with other methods cannot be replicated at will, which is a basic characteristics of scientific method. It is

possible only with this method. You are to note it. You can comprehend this from sections 3.2, 3.3, 3.4, where you will get its *meaning, nature* and its *characteristics.*

Before venturing into the field of research the experimenter must be acquainted with the concept of *variable.* You are deemed as a potential researcher. So you should have proper concept of them. You will get it at the end of section 3.3.

For a research to be an experiment it must possess certain characteristics. They are namely CONTROL, MANIPULATION, OBSERVATION, REPLICATION. You have gone through them in various sub-sections of section 3.4.

To proceed with an experimentation, the experimenter must follow an well laid strategy. This course of action is known as *experimental designs.* They have been discussed in 3.5.

Lastly comes the question of actual action. For completing a work successfully one must proceed step by step. Certain specific activities are designated as *steps* in experimental research. As the stairs or steps of a flight they are arranged in order. A researcher has to follow these steps in prescribed order. You found them in section 3.6.

If you go through this chapter properly you are expected not to know the content of this chapter alone but expected to acquire the enthusiasm to conduct experimental research yourself.

Key Words :

Attribute :- Innate, which cannot be altered afterward.

Contrived :- Artificially arranged or organized.

Covariance :- Consult Block IV.

Exact science :- The sciences whose laws and theories can be expressed in mathematical terms exactly.

Extraneous :- Variables which are unwanted and cannot be avoided. But their effect can be eliminated or minimized by arrangements or with the help of statistics.

Intervening :- The variable that cannot be avoided and difficult to control.

Organismic :- Specific to organism.

Placebo :- Comfortable

Treatment :- Applying something in order to get some effect.

Suggested Readings :

Cohen and Nagel, (1968) *An Introduction to Logic and Scientific Method*, Allied publisher.

Best J.W. and Kahn J.V. (1989) *Research in Education*, Prantic Hall.

Possible answer to CYP :

CYP (1)	Qn. No. 1	Ans. No.
	Qn. No. 2	Ans. It is conducted in contrived situation.
	Qn. No. 3	Ans. No.
	Qn. No. 4	Ans. Consult text.
CYP (2)	Qn. No. 1	Ans. Independent variable, dependant variable. Confounding variable.
	Qn. No. 2	Intervening, extraneous.
	Qn. No. 3	No.
	Qn. No. 4	Extraneous.
	Qn. No. 5	Yes

	Qn. No. 6	Randomization.
CYP (3)	Qn. No. 1	Refer text.
	Qn. No. 2	Nearest correct answer is planning of the experiment.
	Qn. No. 3	Consult text above.
	Qn. No. 4	Consult text above.
	Qn. No. 5	Ans. Judicious use of statistical methods.

Model Questions :

Qn. No. 1. The experiment in Social Sciences (Education) differ from experiments of physical sciences. State whether you agree with this statement.

Qn. No. 2. It is possible to exercise control over the extraneous variables. Justify the statement with your views as well as those of the educationists.

Qn. No. 3. Propose an investigation programme with your plan of action. Do you expect to arrive at a good finding ? Give Reasons.

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BLOCK - IV

SAMPLING TECHNIQUES AND RESEARCH TOOLS

Block Introduction :

Unit-I of this Block covers the concept of population and sample. It also deals with probability and non-probability sampling. Moreover, this unit deals with the different types or methods of probability sampling such as Simple Random Sampling, Stratified Random Sampling, Cluster Sampling and Multistage Sampling. It also describes the different types of non-probability sampling such as Purposive Sampling, Quota Sampling, Incidental Sampling and Judgemental Sampling.

Unit-II covers the tools and techniques of research. Different types of tools and techniques of research such as psychological test, observation, interview, questionnaire, sociometric techniques, etc. are also described in this unit.

In the first and second Blocks of this course, you have already learnt about characteristics of research, scientific thinking, research process, etc. You have also learnt that the main purpose of research is to discover valid and universally acceptable principles, laws, theories, etc. In order to arrive at valid conclusion, a researcher needs to collect data from the target group. In most of the situations, the target group is quite large and it is almost impracticable to collect information from the entire target group. In order to overcome this problem, the researchers collect information or data from a much smaller group which has same characteristics as the target group. Such groups of persons or non-human entities are known as samples. There are different methods of selecting a sample from the target group. These methods are known as **Sampling Techniques**. These techniques are explained in the first unit of this block. Besides this, a researcher needs some devices or tools for collection of data from the

selected group. There are different tools of research to collect information from the selected group or the sample. Depending upon the purpose of the researcher, he/she must select appropriate tools of research. Some of these tools of research with their methods of construction are explained in the second unit of this block.

Unit - I : SAMPLING TECHNIQUES

Structure:

1.0 Objectives :

After reading this unit, you will be able to

- define population, sample, sampling unit and sampling frame.
- explain population and sample citing appropriate example.
- describe the steps involved in the process of sampling.
- describe the purposes and principles of sampling.
- describe probability and non-probability sampling.
- discuss different methods of probability sampling such as simple random sampling, stratified random sampling, cluster sampling and multistage sampling.
- discuss different methods of non-probability sampling such as purposive sampling, quota sampling, incidental sampling, etc.
- distinguish between stratified and quota sampling, and cluster and multistage sampling.

1.1 Introduction :

You have already learnt about the research process and the different methods of educational research in the previous Blocks of this Course. Now you need to get yourself ready for collection of data. You have to collect the required information from the target group of people or objects. It is often not feasible to collect data from the entire group under the study as it involves time, money, access and other resources. How can you solve this problem? In this Unit we will discuss how we can select an appropriate group (called the sample) from the original target group (called the population) for collection of data without compromising with the objectives and results of the study.

1.2 Concept of Population and Sample :

The concept of population has been discussed thoroughly in the following sub-sections:

1.2.1 Population:

We have used the term 'population' in the previous section. You have come across the term 'population' in your day-to-day life as well. What does it signify? In general, population means the number of people residing in a place, a state or a country. However, in research, population (also called Universe) refers to a well-specified and easily identifiable group with specific characteristics about which/whom researcher wants information. **For example**, if a researcher wants to study academic achievement of class X Secondary school students of Assam, then all the Class X Secondary school students of Assam constitute the population. The population here specifies **a particular group** with **specific characteristics**. In this case, the population of the study includes all the C**lass X Secondary School students** of **Assam**. It specifies a particular **grade** of students i.e. C**lass X**, particular **type** of school i.e. **Secondary Schools**, students of secondary schools of a particular **State** i.e. **Assam**. Please note that a Class IX student will not be a member of this population. Similarly, a Class X student studying in a secondary school of Shillong will not be included in this population.

Definition of population:

Population has been defined by different authors in different ways. However, all these definitions refer to what we have discussed above. A few of these definitions have been presented below:

"A population is any group of individuals that have one or more characteristics in common that are of interest to the researcher. The population may be all the individuals of a particular type, or a more restricted part of that group." (Best and Kahn, 1989)

"A population refers to any collection of specified group of human beings or of non-human entities such as objects, educational institutions, time units, geographical areas, prices of wheat or salaries drawn by individuals". (Koul, 1994)

"Population refers to all those people with the characteristics which researcher wants to study within the context of a particular research problem". (Ahuja, 2003)

Thus, from the above definitions, it is clear that in research population could be all the students of a college, all the students of a University, all the students of a department of a university, all the persons working in an office, all the doctors and patients of a hospital, all the individuals of a particular community/ caste. It may also include non-human entities such as educational institutions situated in a state or a district, objects of a departmental store, geographical area, all the cars of a particular model, all the computers produced by a company, all the bottles of shampoo of a particular brand produced by a company, etc.

Finite Population: *A population which contains finite number of individuals or any non-human entities is called a finite population*. **For example**: Class XI students of Don Bosco Higher Secondary School, Dibrugarh. Since it consists of a definite and known number of students, therefore, it constitutes a finite population. It means if the number of individuals of the population is known to the researcher, then the population is termed as finite population.

Infinite Population: *A population with infinite number of units is known as an infinite population*. **For example**: The population of temperature readings of Dibrugarh Town at every instant from first January, 2010 onwards is an example of infinite population. The number of ways of combination of different traits which constitutes personality is an example of infinite population

1.2.2 Sample:

Let us start our discussion with a familiar situation. When we want to buy rice from a departmental store, what do we do? We take a small amount of rice from the sack or packet and observe carefully. Then we decide whether the rice of that packet is good for purchase.

In this process, by observing a small amount of rice we get information about the whole packet of rice. We do not try to check all the rice grains of that packet because that will be wastage of time as well as effort to do the activity. Similarly, when the population identified by a researcher is very large then it is impracticable to collect information from all the individuals or about all the objects. Now, a question arises, 'How can we minimise this problem faced in data collection and yet arrive at a valid and universally acceptable conclusion?' Can we use the same method that we used in verifying the quality of rice as mentioned above? In research also we can take help of a similar method. In order to make the data collection process feasible and practicable, a researcher may select a small number of individuals / units from the larger group (population) which has all the characteristics of the population. That small group of individuals / units is known as sample. However, the sample selected should be representative (i.e. sample with same basic characteristics with the population) of the identified population. Thus, **a sample refers to a small representative portion of the population with same basic characteristics of the population**. To select a representative sample, a researcher needs to use proper techniques of selecting sample from the population and these techniques are known as **sampling techniques**.

Definition of a Sample:

The above discussion on sample is authenticated by the following definitions given by different authors:

"A sample is a small proportion of a population selected for observation and analysis". (Best and Kahn, 1989)

"The representative proportion of the population is called a sample". (Koul, 1984)

"A sample is any number of persons selected to represent the population according to some rule or plan" (Singh, 1997)

"A sample is a portion of people drawn from a larger population". (Ahuja,2003)

Check Your Progress - 1

1.1 What is meant by 'population' in research?

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1.2 Which one of the following is an example of infinite population?

a) All the first semester students (session August, 2012-December, 2012) of Post Graduate Degree programme of Dibrugarh University.
b) All the spots in the Brahmaputra river from which water samples may be collected for analysis.
c) All the cars prepared by Toyota Company.
d) All the individuals working in ONGC in the year 2011.
e) All the primary school students studying at present in different primary schools of Assam under SEBA.

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1.3 What is meant by a sample?

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1.2.3 Purposes of Sampling:

We have already discussed the basic purpose of selecting a sample from a population in the previous section. The purpose of sampling may be summarised as follows:

- Population in many cases may be so large and scattered that a complete coverage may not be possible.

- In a short period of time valid and comparable results can be obtained.
- Sampling is economical since it contains fewer units.
- Research projects sometimes may require destruction of the units being tested. So it saves destruction of units. Say for example a pottery company going to declare that the plates of a particular brand (melamine) are not broken even if it is fallen down from a table. In order to test the quality of these plates, whether shall we try to throw and break all the prepared plates? It is possible to get information about all the plates of that brand just by throwing only one plate (i.e. a sample selected from the population). Thus we can avoid the destruction of all the units of the population.

1.2.4 Principles of Sampling:

The main principle of sampling is that the researcher seeks knowledge about the population by observing a fewer units and extend the inference about the sample to the entire population.

The principles of sampling are:

- Sample units must be chosen in a systematic and objective manner.
- Sample units must be clearly defined and easily identifiable.
- Sample units must be independent of each other.

Check Your Progress 2

2.1 Write three purposes of sampling.

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2.2 Write three principles of sampling.

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1.2.5 Steps involved in the process of sampling:

The following steps are involved in the process of sampling:

- **Defining the population:**

The population is to be clearly defined so that there must not be any ambiguity in identifying the population. E**xample 1**: A researcher wants to study the attitude of students towards Mathematics. Then the researcher is to specify the class or grade of the students. If necessary, he/she is to specify the types of schools i.e. government, provincialized or private, etc., the academic year, the geographical area, etc. **Example 2**: A researcher defines the population as '*the Class IX students of Dibrugarh District'*. While collecting data from the Class IX students of schools situated in Dibrugarh District, he/she may come across some students who are residents of some other districts. Immediately confusion arises in the mind of the researcher whether these students belong to his population. Besides, some Class IX students of Dibrugarh District may be studying in schools situated in other districts. Therefore, it is necessary to define the population unambiguously and clearly. The researcher can define the population as '***the students studying in Class IX in the secondary schools of Dibrugarh District'***. Now, it becomes easier for the researcher to locate the units of the population. Moreover, he/she will not make any confusion in identifying the units.

- **Listing the population :**

After defining the population clearly, it is necessary to have a complete and accurate list of all the individuals or units of the population. Such a list is known as **sampling frame**. For **example 1**:

A researcher wants information from all the adults (who are above 18 years of age) of a particular village regarding administration of that village. The researcher may use the up-to-date voters' list as the sampling frame. **Example 2**: Another researcher wants information from degree students of a college. Then the lists of names written in register books act as a sampling frame. Thus **sampling frame is the complete list of all units of the population from which the sample is drawn**. It is not a sample but it is the operational definition of the population that provides the basis for sampling.

- **Selecting a representative sample**:

Then the researcher selects a sample of units from the population. However, the sample selected must be representative of the entire population. Appropriate sampling technique must be used to ensure representativeness of the sample. For details of the sampling techniques see section 1.3 and 1.4.

- **Obtaining an adequate sample**:

The researcher now needs to decide about the size of the sample. While doing so, he is often confronted with a question, how large should the sample be in order to mark it as representative of the population. The adequacy of a sample size depends upon a number of factors:

i) Number of variables to be studied,

ii) Nature of the population (whether the population is homogeneous or heterogeneous),

iii) Number of groups or strata,

iv) How small or large the expected differences or relationships are, and

v) How accurately measurement of the variables is to be made.

Besides, the sample size may also be constrained in terms of time, money, stress, administrative support, number of researchers and resources. However, for better generalization of the information received from the sample, the size of the sample should be larger.

Check Your Progress - 3

3.1 Write the steps followed in the process of sampling.

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3.2 What are the factors a researcher needs to take care in selecting an adequate sample size?

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1.3 Probability Sampling :

There are a number of sampling techniques. These techniques may be broadly divided into two main groups - Probability and Non-Probability Sampling techniques. Probability sampling is also known as **Random Sampling**.

Probability Sampling is one in which every unit of a population has a fixed probability of being included in the sample. Sample selected using this method offers a high degree of representativeness. However, it is not possible to apply this technique in all situations. Thus, we must know the conditions to be satisfied for probability sampling techniques. Let us discuss these conditions.

Conditions to be satisfied for Probability sampling:

- Size of the population must be known. That is number of individuals or units in the sampling frame must be known to the researcher.

- Complete list of units (i.e. the sampling frame) to be studied must be available.
- Each element must have an equal chance of being selected.
- The form of the distribution of the trait in the population can be reasonably assumed to be normal. For example: A researcher wants to study achievement of class X secondary school students of Dibrugarh District under SEBA. He /She must have the idea of the frequency distribution and the shape of the distribution should be approximately normal.
- Same units of sample should be used throughout the study.
- The selection process should be based on some sound criteria and should avoid errors, bias and distortions.

Check Your Progress - 4

4.1 Which of the following is not a condition for using probability sampling technique?

a) The size of the parent population must be known to the investigator.

b) No unit of the population has fixed chance of being included in the sample.

c) The form of the distribution of the trait in the population can be reasonably assumed to be normal.

d) The sampling frame must be available.

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Methods of Probability Sampling: There are different methods of probability sampling. All these methods have some advantages and disadvantages. Depending upon the purpose of one's study, one must select the appropriate technique or method of sampling. Let us discuss these methods in details. Following are the different methods or techniques of probability sampling:

- Simple or Unrestricted Random sampling

- Stratified Random Sampling
- Area or Cluster Sampling
- Multi-Stage **Sampling**

1.3.1 Simple or Unrestricted Random Sampling:

This technique is applied in a homogeneous population. Here, homogenous population means all the units of the population have a common characteristic (or variable) about which the researcher is interested. For example, a researcher is interested to collect information from Class-IX secondary school students. This group is homogenous with respect to standard of learning i.e. Class-IX about which the researcher is interested. However, the same group may not be homogenous with respect to their caste because there may be students from ST, SC, OBC, and General categories in Class IX. Thus the same group is non-homogenous with respect to their caste. Thus, homogeneity of a group can be determined only with respect to the variable concerned.

Simple Random Sampling means each unit of the population has an equal chance of being selected for the sample and selection of one unit as sample does not affect the selection of the other.

Methods Adopted: A number of methods are used for selecting the units of the sample through technique. A brief description of these methods is presented below:

- **Lottery Method**: The following steps are followed in lottery method.
  - Step 1: First, the Sampling Frame is to be prepared.
  - Step 2: Then, the numbers listed in the sampling frame are to be written on small pieces of papers and be placed them in a container.

- Step 3: All these pieces of papers are to be mixed well and drawn out one piece of paper at a time from the basket or container till the required sample is drawn.

- **Using Random Number table**: we have already learnt the lottery method of selecting sample from the population. However, it is a very tedious method of selecting sample from the population if the size of the population is very large. In such cases, use of random number table is more convenient than lottery method. What is then a random number table? A random number table consists of some arbitrarily (without any specific order) selected four to five digit numbers. These tables may be used in different ways for selecting a sample. A very simple method is described here. In order to use random number table to select sample from a population, the sampling frame must be available with serial number assigned against each unit of the population. Then you can enter the random number table at any page, row or column and move up or down, from left to right, from right to left, or diagonally. In this process of selection, the numbers which are larger than the size of the population or which have already been selected or drawn must not be selected. The process of selection must continue systematically through the table until the required number of units is drawn. Let us take an example: we want to select a sample of size 25 units from a population of size 575. We may enter the random number table as shown below (a part of a random number table is given below in Table-1.1) at the 1st row, 2nd column and going down through the table. The random number table consists of five digit numbers; we can select first three digits, or middle

three digits, or last three digits of each number since our population size is a three-digit number i.e.575.

Table-1.1: A part of a Random Number Table

13962 70992 65172 28053 02190 83634 66012 70305
43905 46941 72300 11641 43548 30455 07686 31840
00504 48658 38051 59408 16508 82979 92002 63606
61274 57238 47267 35303 29066 02140 60867 39847
43753 21159 16239 50595 62509 61207 86816 29902
83503 51662 21636 68192 84294 38754 84755 34053
36807 71420 35804 44862 23577 79551 42003 58684
19110 55680 18792 41487 16614 83053 00812 16749
82615 86984 93290 87971 60022 35415 20852 02909
05621 26584 36493 63013 68181 57702 49510 75304
06936 37293 55875 71213 83025 46063 74665 12178
84981 60458 16194 92403 80951 80068 47076 23310
66354 88441 96191 04794 14714 64749 43097 83976
49602 94109 36460 62353 00721 66980 82554 90270
78430 72391 96973 70437 97803 78683 04670 70667

Let us select the middle three digits. Therefore, the first number is 099, next is 694. However, 694 cannot be selected because it is greater than the total size of the population i.e. 575. This way if we

go on selecting numbers from the random number table then we will get the following numbers as shown below in Table-.1.2

Table-1.2 The Sample Drawn from the Random Number Table

099 517 805 219
694 230 164 354
865 805 940
723 726 530
115 623 059
166 163 819
142 580 486
568 879 148
698 329 797
658 649 301
729 587 121
045 619 240
844 619 479
410 646 235
239 697 043

In Table-1.2, the red coloured numbers are greater than 575. Therefore, these numbers should be deleted from the required list of

sample. Thus a total of 25 numbers are selected which constitutes the sample. Therefore, the names listed against these numbers in the sampling frame will constitute the required sample.

Advantages of Simple Random Sampling:

- The sample so formed is highly representative of the population.
- Simple random sampling is used in combination with other methods of probability sampling.
- Sampling error can be minimized if we use this as a technique of sampling.

Disadvantages of Simple Random Sampling: Though simple random sampling ensures best and valid result, it has few disadvantages. These are

- Simple random sampling is not possible to apply to select sample from the population if the sampling frame is not available or not complete. Again, even if it is available, preparation of sampling frame may be very expensive in terms of time and money. Thus a researcher may not be able to afford it.
- If the population is heterogeneous, then a simple random sample may not necessarily represent the characteristics of the population. In a heterogeneous population, some type of units may get greater representation in the sample than other types of units.

Check Your Progress - 5

5.1 What is meant by Random sampling?

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5.2 Write the steps followed in lottery method of sampling.

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5.3 Write two advantages and two disadvantages of random sampling.

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1.3.2 Stratified Random Sampling :

Already you have studied the disadvantages of Simple Random Sampling in Section 1.3.1. Then, how can we minimize sampling error which may arise if we use simple random sampling technique? Problem arises when the population is heterogeneous and if we want to use simple random sampling technique then the selected sample may not include units from all the cross section of the population which is heterogeneous in nature. In order to overcome this problem of simple random sampling, another

technique is applied in which the population is divided into some categories or strata and then simple random sampling technique is used to select sample from each strata of the population. Thus this technique is known as **Stratified Random Sampling**. Now, what is the advantage of stratification? It helps us to make the heterogeneous population into some homogeneous sub-groups i.e. units within a subgroup are homogeneous with respect to the variable concerned. **For Example**: Suppose we want to study caste-wise comparison of achievement of Class X Secondary school students of Dibrugarh District. If we use simple random sampling technique, then, proportionate inclusion of students from each caste may not be possible. However, if we divide the population into number of strata (i.e. SC, ST, OBC and General) and select the sample from each stratum, then the selected sample will include students from each stratum proportionately. Now, could you identify the steps followed in Stratified Random Sampling technique? These are

Step I: First, the population is to be divided into a number of homogeneous strata or sub-groups based on one or more criteria.

Step II: Then, a sample is to be drawn from each stratum using simple random technique.

Types of Stratified Random Sampling: On the basis of the proportion of units drawn from each stratum, this technique may be divided into two different types:

(i) **Proportionate Stratified Random Sampling**: In this technique an equal proportion (percentage) of units are selected from each stratum of the population. For example, a researcher wants to study the problems faced by patients in a civil hospital situated in a district head quarter. The researcher also wants to compare the problems faced by the patients in the different departments (i.e. Medicine, Surgery, ENT etc) of the hospital. In this case, it is necessary to include patients

from each department. There are five departments in the hospital *viz. Medicine, Surgery, ENT, Gynaecology and TB.* Now, in order to select a sample through Proportionate Stratified Random Sampling Technique, the researcher should divide the total population (i.e. all the patients admitted in the different departments of the hospital, say 600) into five strata i.e. Medicine, Surgery, ENT, Gynaecology and TB. Then, from each stratum a fixed proportion of the units (say, 10%) is drawn following simple random sampling technique discussed in the previous section. Thus, from the stratum of Medicine Department we get 20 patients, from Surgery Department 10, from ENT Department 15, from Gynaecology Department 10 and from TB Department 5 patients. Thus the total number of units in the sample is 60 (=10% of 600). A schematic diagram is shown in Fig.1.1.

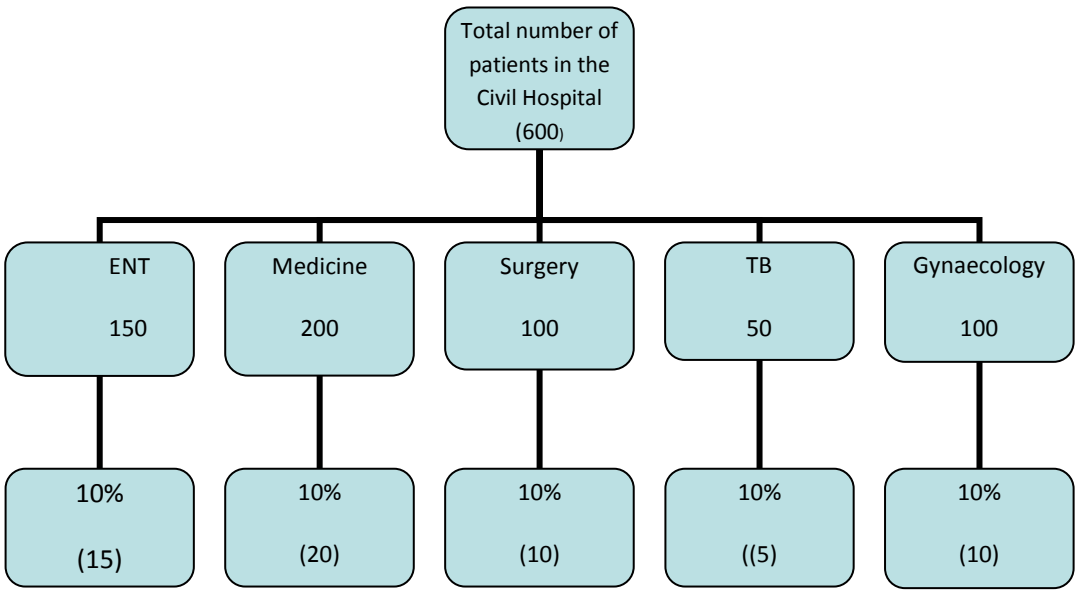

Fig.1.1 Sample Drawn using Proportionate Stratified Random Sampling Technique

Let us take another example to make the concept clearer. Suppose, you want to compare the study habit of urban and rural

boys and girls studying in Class X. Let the size of the population be 2000 and you desire to select 20% of the population (i.e. 400) as your sample. Now, first, you need to divide the entire population into two strata viz. Rural (say, 1200) and Urban (say, 800) students. Then, each of these strata has to be divided into stratum of Boys and Girls as shown in Fig. 2. Then, from each of these four strata 20% of the units are to be drawn following simple random sampling technique. Thus, you have selected a sample of 400 Class X students comprising of 100 urban boys, 140 urban girls, 90 rural boys and 70 rural girls. Figure 2 shows the detail process.

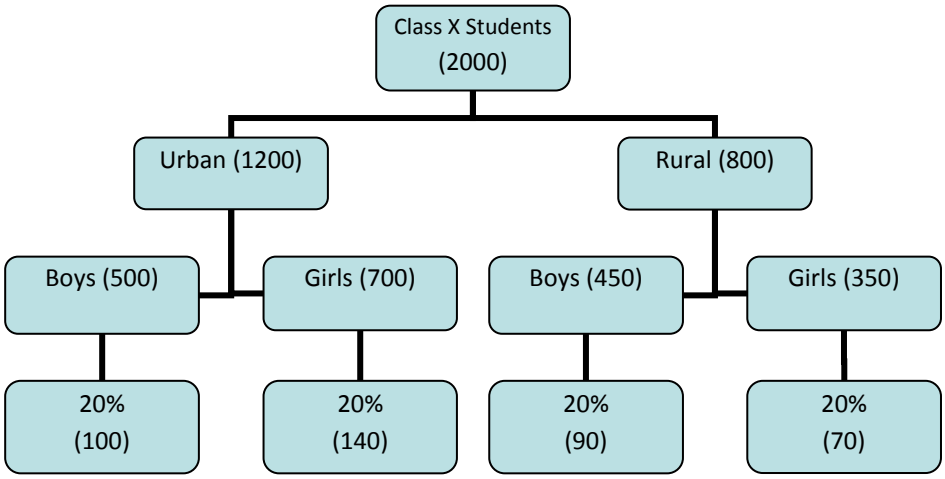

Fig.1.2 Sample Drawn using Proportionate Stratified Random Sampling Technique

Advantages of Proportionate Random Sampling:

- Proportionate random sampling increases the representativeness of the sample drawn as it ensures inclusion of units from each stratum of the population.
- The sample drawn using this technique possesses all the characteristics of the population and thereby minimises the sampling error.

Disadvantages of proportionate random sampling:

- This technique of sampling is particularly not suitable when there are very few units in a stratum in comparison to other strata. In such cases proportionate selection of units from the stratum with very few units may not be representative of that group and thus it may lead to erroneous result or invalid conclusion.
- This method of sampling assumes that the researcher knows the size of the parent population well ahead the actual sampling process starts.
- It is a time consuming method of sampling as it requires preparation of strata-wise sampling frames before the selection of the sample.

(ii) **Disproportionate Stratified Random Sampling:** There is much similarity between disproportionate stratified random sampling technique and proportionate stratified random sampling technique. The only difference lies in the fact that in this technique units are not selected in a fixed proportion from the different strata. Instead, equal number of units is drawn from each stratum. The population is first divided into a number of categories or strata and from these strata a fixed number of units are selected. This technique is particularly useful when the proportionate selection of units from each stratum may affect the result of the study. For example, when there is very less number of units in a stratum in comparison to other strata, this technique becomes more appropriate. In the example mentioned in the previous section, say, there are only 50 rural girl students who are included in the population. If we select only 10% of these 50 students i.e. 5, then the 5 rural girl students may not be representative of the whole population. Thus, to make the sample of rural girl students representative of the population, we can include a fixed number of students (say 50) from each stratum. Then the

numbers of students from each stratum included in the sample are not proportionate to number of units present in each stratum. Therefore, this technique of sampling is known as Disproportionate Stratified Random Sampling.

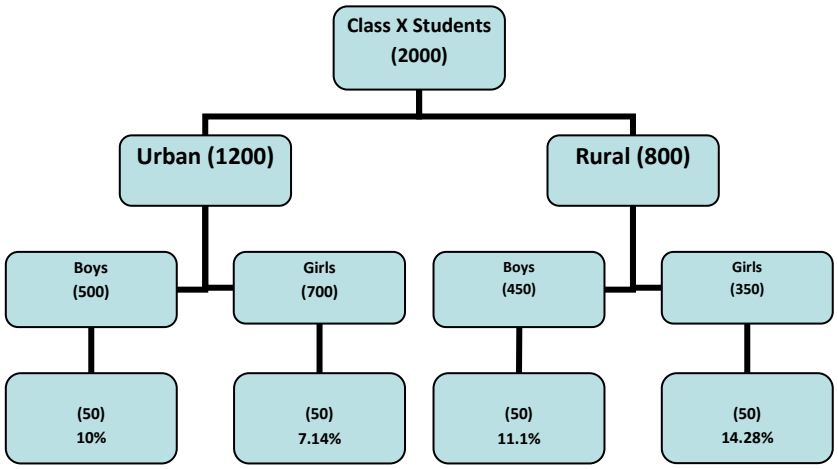

Fig 1.3 Disproportionate Stratified Random Sampling

Advantages of Disproportionate Stratified Random Sampling:

a) It is comparatively less time consuming than proportionate stratified random sampling.

b) Proper representation of each stratum is ensured through this technique. If the number of units included in a particular stratum is very less, proportionate stratified random sampling cannot be applied.

Disadvantages of Disproportionate Stratified Random Sampling:

a) If we use this sampling technique, some of the strata of the population may be over-represented and some other strata may remain under-represented.

b) If the investigator has no prior idea about the composition of the original population, this sampling technique cannot be used.

Check Your Progress 6

6.1 What is meant by stratified random sampling?

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6.2 Distinguish between proportionate and disproportionate stratified random sampling in 50 words.

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6.3 Write two advantages and two disadvantages of proportionate stratified random sampling.

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6.4 Write two advantages and two disadvantages of disproportionate stratified random sampling.

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1.3.3 Area or Cluster Sampling:

This technique is particularly useful when the population is scattered in a very large area. In this technique, the whole area that includes the units of the population is divided into number of smaller area or clusters. Then from these smaller areas or clusters, a sample of clusters is selected using simple random sampling. Then, data are collected from all the units of the selected clusters. In other words, each unit or individual of the selected clusters are considered to be the sample of the population. Thus, in this technique, it is not necessary to prepare the list of individual units in the selected clusters. However, the number of clusters in the total area covered by the population is required so that random sampling technique can be used to select clusters. **For Example**: a researcher decided to study the Role of *Gaon Panchayat* in implementation of rural development policies in Assam. The researcher wanted to use cluster sampling technique because the *gaon panchayats* are scattered in all over Assam. To proceed with cluster sampling, the researcher must divide the whole Assam into districts. There are 27 districts in Assam. The list of 27 districts constitutes the first sampling frame. From these districts the researcher selects few districts (say, 5 districts) using random sampling technique. Again, each district consists of some blocks. List of these blocks constitute the second sampling frame. Then from each district one block is selected using simple random sampling. Again, each block consists of some *gaon Panchayats*. List of these gaon Panchayats constitute the third sampling frame. Then, from each block again one *gaon Panchayat* is selected using random sampling technique. Then, all the members of the selected *gaon Panchayats* constitute the sample for the study. From the above discussion about area or cluster sampling, can you identify the steps followed in this sampling technique? The steps followed in area or cluster sampling technique are briefly described below:

- **Step-I**: The population scattered in the total area is divided into a number of smaller areas or clusters each having a number of units.
- **Step-II**: Instead of drawing a single unit, clusters of units are drawn using simple random technique.
- **Step-III** : Usually clusters are drawn in multi-stages.
- **Step-IV**: Usually all the units of the clusters drawn are used as the sample.

Advantages of Area Sampling: It is appropriate to use area sampling when the population is scattered in a very large geographical area because it saves time, money and effort needed to collect data.

a) It is not necessary to prepare the list of individual units in the selected clusters. However, the number of clusters in the total area covered by the population is required so that random sampling technique can be used to select clusters.

b) A respondent can readily be substituted by another respondent of the same cluster because in area sampling a cluster of units are selected as sample not as individual units.

Disadvantages of Area Sampling:

a) There is no way to ensure that each cluster are equal in size in terms of number of units i.e. number of units in each cluster may not be equal.

b) In area sampling it is also difficult to ensure that the individuals included in one cluster are independent of other clusters although clusters are selected randomly.

c) Thus, the degree of sampling error is high in area sampling in comparison to other methods of probability sampling techniques.

Check Your Progress - 7

7.1 When would you use Area Sampling?

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7.2 Write the steps followed in Area Sampling Technique.

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1.3.4 Multi-stage sampling:

When we need to cover a large number of units spread over a large geographical area, we may opt for multi-stage sampling. In this method, sampling is done in various stages, but only the sample of the last stage or units is studied.

- **Step-I** : The population is divided into a number of areas or clusters.
- **Step-II :** A sample of clusters is drawn (1^{st} Stage)
- **Step-III** : Each selected cluster is divided into more sub-groups (clusters).
- **Step-IV** : A sample of sub-groups is drawn randomly (2^{nd} stage).

- **Step-V** : Sample of units are drawn randomly from the selected sub-groups (3^{rd} stage)

Advantages of Multistage Sampling:

- The selected sample using this technique is more representative than other methods of sampling.
- It is less expensive and less time consuming method of sampling than the simple random sampling.
- It is particularly applicable in large scale surveys in which it is necessary to collect more comprehensive data.

Disadvantages of Multistage Sampling:

- Sampling bias is more if the sizes of sub-samples are unequal.

Check Your Progress - 8

8.1 Write the steps followed in multistage sampling.

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8.2 Write one advantage and one disadvantage of multistage sampling.

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From the discussions made in the Section 1.3, we can summarize the advantages and disadvantages of Probability Sample as follows:

Advantages of Probability Sampling:

- Sample selected through probability sampling are representative and hence conclusion arrived are valid and results obtained can be generalised for the entire population.
- Each element of the population has a fixed chance of being included in the sample.
- It is possible to determine Sampling error in probability sampling.
- Statistical measures may safely be used from the data obtained from a probability sample.

Disadvantages of Probability Sampling:

- Methods of probability sampling are time consuming and costly.
- If sampling frame is not available or incomplete then probability sampling techniques cannot be used.

1.4 Non-Probability Sampling:

The non-probability sampling techniques are those in which the units of the population do not have a fixed probability of being included in the sample. In other words, in these techniques, there is no way to determine the probability of the units of population being included in the sample. No specific process of selection is followed in these techniques. These techniques are usually used when sampling frame is not available.

Methods or types of non-probability sampling:

- Quota Sampling
- Purposive Sampling or Judgmental Sampling
- Accidental or Incidental Sampling

1.4.1 Quota Sampling :

The quota sampling technique is used when the population is heterogeneous with respect to the variable concerned. In this method of sampling the population is divided into different strata and then from each stratum a fixed number or quota of individuals is selected as sample according to the convenience and judgment of the researcher. Thus, it is known as **quota sampling**. There is a similarity between quota sampling and stratified sampling. In both the methods, the population is divided into some strata. Only difference lies in the fact that in quota sampling, final selection of individuals or units are done according to the convenience/judgement of the researcher (but not done randomly); on the other hand, in stratified sampling the final selection of individuals or units are done randomly. **For example**: A researcher wants to study awareness of upper primary students of a school towards environmental problems. Here upper primary students include students from Class-VI to Class-VIII. Thus it is a heterogeneous group with respect to level of learning or class. Therefore the population is first divided into three strata i.e. Class-VI, Class-VII and Class-VIII students. There are, say, 300 students in Class-VI, 250 in Class-VII and 200 students in Class-VIII. Then, the researcher has decided to select a quota of 50 students from each stratum i.e. from each class. Now the researcher can select these 50 students from each class according to his/her convenience/judgment. On the other hand if he/she wants to use stratified random sampling, he/she must select these 50 students from each class using random sampling technique and in that case he/she needs sampling frame or the class-wise list of names of the students.

Steps followed in quota sampling are:

(i) The population is divided into different strata.

(ii) From each stratum a quota is selected using the researcher's judgment or convenience.

Advantages:

(i) Quota samples are the most satisfactory means when quick and crude results are desired.

(ii) It can guarantee the inclusion of individuals from different strata of the population.

(iii) It is less expensive.

Disadvantages:

(i) The selected sample may not be representative of the population because there is no means of establishing randomness.

(ii) In quota sampling, the investigator selects the most accessible units/ individuals which may not be typical of the population.

Check Your Progress 9:

9.1 Distinguish between Quota Sampling and Stratified Random Sampling.

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9.2 Describe one advantages of quota sampling over stratified random sampling.

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9.3 Write two advantages and two disadvantages of quota sampling.

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1.4.2 Purposive or Judgmental Sampling:

The researcher purposively selects those individuals who are considered to be representative of the population. It is also known as **judgmental sample** because the investigator selects the sample on the basis of his/her own judgment. This technique may be used when a researcher is sure about the representativeness of the units being selected as sample. **For example**: A researcher decided to study teaching aptitude of B.Ed. students studying in different secondary teacher training institutions under Dibrugarh University. He/she can select purposively any of these secondary teacher training institutions under Dibrugarh University (say any four) for the above mentioned study. All the students of these selected four institutions constitute the sample for the study. As the same admission procedure is followed in all these institutes, the sample includes students from all

the sections of the society, from all the caste, from different locality, etc. and makes the sample representative of the whole population.

Advantages of Purposive Sampling:

(i) It is less expensive and more readily accessible to the researcher.

(ii) Purposive sampling guarantees that those individuals who are representative of the population are included in the sample.

Disadvantages of Purposive Sampling:

(i) Purposive sampling introduces subjectivity in the sampling because too much emphasis is given on the ability of the investigator to assess which element is typical or representative of the population.

(ii) In the case of purposive sampling the inferential statistics can't be used legitimately, because, under all inferential statistical techniques, there is an assumption of randomness.

Check Your Progress 10:

10.1 What is purposive sampling?

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10.2 Write two advantages and two disadvantages of purposive sampling.

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1.4.3 Incidental or Accidental Sampling:

It refers to a sampling procedure in which the investigator selects the persons/ units that are most conveniently available or that accidentally come in contact during a certain period of time in the research. For Example1: A researcher wants to study exit poll of *panchyat* election of a village. He can select individuals who are conveniently available on the date of election in different centres of that village and interview some of the individuals. Example2: A researcher wants to study attitude of teachers of secondary schools under SEBA towards teaching profession. Then the researcher may collect data from the teachers who are present on the day of visit of a particular school.

Advantages of Incidental Sampling:

- It is less time consuming and less expensive.
- A researcher can select individuals who are conveniently available at the time of data collection or collect information from individuals who are incidentally come in contact with the researcher.

Disadvantages of Incidental Sampling:

- There is no guarantee that the selected sample is representative of the population.

- In the case of Incidental sampling the inferential statistics can't be used legitimately, because, under all inferential statistical techniques, there is an assumption of randomness.

Advantages of non-probability sampling:

- All the non-probability sampling techniques are less expensive than probability sampling techniques because the sample selected are more readily accessible to the researcher in non-probability sampling.
- These techniques can be used even if in certain situations sampling frame is not available to the researcher.

Disadvantages of Non-Probability Sampling:

- The selected sample using non-probability sampling technique is not representative of the population because there is no means of establishing randomness.
- Sampling error cannot be calculated in case of non-probability sampling techniques.
- In the case of non-probability sampling the inferential statistics can't be used legitimately, because, under all inferential statistical techniques, there is an assumption of randomness.

Check Your Progress 11:

11.1 What is incidental sampling?

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11.2 Write two advantages and two disadvantages of incidental sampling.

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11.3 Mention advantages and disadvantages (two each) of Non Probability sampling.

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1.5 Let Us Sum Up:

Let us see what we have learnt from the above discussions:

- In research, population refers to any well-specified and easily identifiable group with specific characteristics about which/whom researcher wants information.
- A sample refers to a small representative portion of the population with same basic characteristics of the population.
- There are different techniques of sampling by which one can select sample of appropriate size. These techniques are broadly divided into two types. These are:
    a) Probability Sampling and
    b) Non-probability Sampling
    - Probability Sampling is one in which every unit of a population has a fixed probability of being included in the sample.
    - There are different techniques of probability sampling. Four most important techniques of

probability sampling used in educational research are:

a) Simple random sampling
b) Stratified random sampling
c) Area or Cluster sampling
d) Multistage sampling

- The non-probability sampling techniques are those in which units do not have a fixed probability of being included in the sample.
- There are different techniques of non-probability sampling. Major non-probability techniques are;

a) Quota Sampling
b) Purposive sampling or judgmental sampling
c) Incidental Sampling or accidental sampling

1.6 Key Words :

- Sampling: Sampling is a process in which a small but representative portion of individuals or objects or units is selected from the population to arrive at valid and acceptable conclusion about the entire population.
- Sampling Unit: Each entity of the population is known as sampling unit. It may be an individual, an object, an institution, a family, a village, an event or a group of individuals, etc.
- Sampling Frame: Sampling frame is the complete list of all units of the population from which the sample is drawn.

Suggested Readings :

Ahuja, Ram (2003) ***Research Methods***, Rawat Publications, Jaipur and New Delhi.

Best, John W. & Kahn, James V. (1989) ***Research in Education***, Prentice-Hall of India Private Limited, New Delhi-110001.

Koul, Lokesh (1988) ***Methodology of Educational Research***, Second Revised Edition, Vikas Publishing House PVT LTD, New Delhi-110014.

Singh, A. K. (1997) ***Test, measurements and Research Methods in Behavioural Sciences,*** Second Edition, Bharati Bhawan Publishers and Distributors, Patna-800 003.

Possible Answer to CYP:

1.1 Ans: Please read Sub-section 1.2.1

1.2 Ans: (b)

1.3 Ans: Please read Sub-section 1.2.2

2.1 Ans: Write any three purposes of sampling given in Sub-section 1.2.3

2.2 Ans: Write the principles of sampling given in Sub-section 1.2.4

3.1 Ans: Please read the Sub-section 1.2.5

3.2 Ans: Please read the Sub-section 1.2.5

4.1 Ans: (b)

5.1 Ans: **Random Sampling** means each unit of the population has an equal chance of being selected for the sample and selection of one unit as sample does not affect the selection of the other.

5.2 Ans: Read Sub-section 1.3.1

5.3 Ans: Read Sub-section 1.3.1

6.1 Ans: Read Sub-section 1.3.2

6.2 Ans: In disproportionate sampling technique, units are not selected in a fixed proportion from the different strata. Instead, equal

number of units is drawn from each stratum. On the other hand in proportionate sampling units are selected in a fixed proportion from the different strata. Explain it with examples.

6.3 Ans: Read Sub-section 1.3.2 (i)

6.4 Ans: Read Sub-section 1.3.2 (ii)

7.1 Ans: Area or Cluster sampling is particularly useful when the population is scattered in a very large area.

7.2 Ans: Read Sub-section 1.3.3

8.1. Ans: Read Sub-section 1.3.4

8.2 Ans: Read Sub-section 1.3.4

9.1 Ans: (i) The main distinction between Quota and Stratified Random Sampling is that in quota sampling, final selection of individuals or units are done according to the convenience/judgement of the researcher (but not done randomly); on the other hand, in stratified sampling the final selection of individuals or units are done randomly. (ii) The sampling frame of each stratum is not essential for selection of sample when a researcher wants to use Quota sampling; On the other hand the sampling frame is essential in selecting sample from each stratum when a researcher wants to use Stratified Random Sampling.

9.2 Ans: One advantage of Quota Sampling over Stratified Random Sampling is that in quota sampling, final selection of individuals or units are done according to the convenience/judgement of the researcher; however, in stratified random sampling the final selection of individuals or units are done randomly.

9.3 Ans: Read Sub-section 1.4.1

10.1 Ans: Read Sub-section 1.4.2

10.2 Ans Read Sub-section 1.4.2

11.1.Ans: Read Sub-section 1.4.3

11.2 Ans: Read Sub-section 1.4.3

11.3 Ans: Please read the paragraphs under the headings Advantages of Non-Probability Sampling and Disadvantages of Non-Probability sampling.

References:

Ahuja, Ram (2003) ***Research Methods***, Rawat Publications, Jaipur and New Delhi.

Best, John W. & Kahn, James V. (1989) ***Research in Education***, Prentice-Hall of India Private Limited, New Delhi-110001.

Koul, Lokesh (1988) ***Methodology of Educational Research***, Second Revised Edition, Vikas Publishing House PVT LTD, New Delhi-110014.

Singh, A. K. (1997) ***Test, measurements and Research Methods in Behavioural Sciences,*** Second Edition, Bharati Bhawan Publishers and Distributors, Patna-800 003.

Stanley, Julian C. & Hopkins, Kenneth D. (1978) ***Educational & Psychological Measurement & Evaluation***, Prentice-Hall of India Private Limited, New Delhi-110001.

Model Questions:

1. What is meant by population in research? Explain finite and infinite population with appropriate examples.
2. What is meant by sampling? How does sampling helps a researcher?
3. Describe Simple Random Sampling.
4. Explain Stratified Random Sampling with appropriate examples.
5. Distinguish between probability and non-probability Sampling.
6. Distinguish between Stratified Random Sampling and Quota Sampling.
7. Describe with examples when to use disproportionate stratified random sampling techniques.

Unit-II : Research Tools and Techniques

Structure:

2.0 Objectives:

After reading this unit, you will be able to

- Explain the need of research tools and techniques in research.
- Describe different types of tools and techniques of research viz. psychological tests, questionnaire, observation, interview and socio-metric techniques.
- Differentiate between power test versus speed test, individual test versus group test, objective type test versus essay type test, standardized test versus teacher made test, etc.
- Describe the process of standardization of a test.
- Describe the steps followed in the construction of a test *viz.* planning, preparation of the preliminary draft, tryout of the test, item analysis and final draft.

2.1 Introduction:

In the previous unit you have learnt about population and sample. You have also learnt about the different sampling techniques such as probability and non-probability sampling techniques through which a representative sample can be selected. In order to test research hypotheses, a researcher needs to collect data or evidences from the selected sample. Again, to collect data or evidences, some devices or tools and techniques are required through which reliable evidences can be collected. Such devices are called tools and techniques of research. There are different types of tools and techniques of research. However, each tool is appropriate to collect only certain type of data. Thus a researcher should know the nature, merits and demerits of each of the available tools and techniques of research as well as their construction procedure. This unit describes the different tools and techniques of research including their construction as well as merits and demerits.

2.2 Tools and Techniques of Research:

You are aware that for measuring any physical quantity we need a tool. To measure the length and breadth of any object, what do we need? A 'meter scale' is needed to measure the length and breadth of an object. Similarly for measuring temperature, we need a thermometer; for measuring atmospheric pressure, we need a barometer and so on. These are physical tools or instruments or devices with which we can measure physical quantities such as length, breadth, temperature, pressure etc. Similarly, while doing research we may require to measure how intelligent or how creative an individual is; or how much an individual has achieved in Mathematics etc. In order to measure these types of psychological traits, we also need some devices or tools. These instruments or devices are often used to collect data in research, and hence termed as tools and techniques of research. Thus, ***the devices or instruments used to collect data or evidences for testing hypotheses or finding out valid answers to the research questions are called tools and techniques of research.*** The selection of tools or techniques for a research work depends on the objectives of research. **For example,** if you want to study the level of intelligence of Class X students, then you would use an intelligence test; again if you want to study the level of achievement of Class X students in Science, then you would use an achievement test in Science; in order to study group dynamics of Class V students, one must use socio-metric techniques or observation, etc. Thus depending upon the purpose of research, a researcher must select and use appropriate tools or techniques of research to collect valid and reliable information.

The major data-gathering tools and techniques of educational research are:

- Psychological Tests
- Inquiry Forms
- Observation
- Interview
- Socio-metric Techniques

2.3 Psychological Tests:

Among all the data-gathering devices, psychological tests are the most useful and widely used tools of educational research. ***A psychological test is a device consisting of a series of questions or items designed to measure certain aspects of human behavior such as achievement, intelligence, aptitude, creativity, etc.*** It is a standardized procedure used to describe different aspects of human behaviour quantitatively. Thus a psychological test provides objective and standardized descriptions of human behaviour.

In the words of Best and Kahn (1989), 'a psychological test is an instrument designed to describe and measure a sample of certain aspects of human behaviour'.

Singh (1997) defines a psychological (or educational) test as 'a standardized procedure to measure quantitatively or qualitatively one or more than one aspect of trait by means of a sample of verbal or non-verbal behavior'.

According to Kohl (1984), psychological tests are devised to evaluate or measure behaviour in a standardized way for the purpose of selection, classification, prediction and guidance as well as for the evaluation of educational programmes.

Cronbach (1964) defines a test as a systematic procedure for comparing the behaviour of two or more persons at a particular time; or one or more persons at different time.

An analysis of the above definitions of psychological test reveals that:

- It is a device used to measure certain aspects of human behaviour.
- It is a standardized procedure to measure one or more aspects of a trait.
- It is a systematic procedure for comparing the behaviour of two or more persons on the same trait or comparing the behaviour of same person on two or more aspects of a trait.
- It describes the human behaviour quantitatively.

Check Your Progress 1

1.1 What is meant by Tools and Techniques of Research?

1.2 What are the major data gathering tools of research?

1.3 What is meant by psychological test?

2.3.1 Characteristics of Tests:

A good test should possess a number of characteristics. The following are the characteristics of a good test :

- Validity
- Reliability
- Norms
- Usability

    a) Objectivity

    b) Economy of Time

    c) Cost

d) Ease of Administration

e) Ease of Scoring

f) Ease of Interpretation

g) Face validity

2.3.1 (a) Validity:

Validity is one of the most important characteristics of a test. The term 'Validity' means truthfulness or fidelity (faithfulness). ***Validity refers to the degree to which a test measures what it wants to measure***. **For example**, if an achievement test in Mathematics is constructed to measure the reasoning ability of students, then all the items of the test must measure the reasoning ability only. Validity is measured by correlating the test with some outside independent criteria which are considered to be the ideal measure of the trait or ability being measured by the test. The correlation coefficient between the test and the ideal measure of the trait or ability is called the **validity coefficient**. If the value or measure of validity coefficient is high, then the test is considered to be highly valid. On the other hand if the value of validity coefficient is low then the test is considered to be not valid or having low validity depending upon the value of coefficient of correlation.

Different educationists have defined validity as different ways. A few definitions given by different authors have been presented below:

- *Validity is that quantity of a data-gathering instrument or procedure that enables it to measure what it is supposed to measure.* (Best and Kahn, 1989)
- *The validity of a test concerns what the test measures and how well it does so.* (Anastasi, 1988)
- *Validity of a test is defined as the accuracy with which it measures that which is intended to measure or as the degree to which it approaches infallibility in measuring what it purports to measure.* (Lindquist, 1951)

- *The validity of a test, or of any measuring instrument, depends upon the fidelity with which it measures what it purports to measure (Garrett, 1981).*
- *Validity refers to the extent which the test measures what we actually wish to measure (Thorndike and Hagen, 1956).*

All these definitions express the views given in the first paragraph of this section.

Types of Validity: Validity can be divided into a number of types depending on the purpose of the test. Some of these types are given below:

- Content Validity
- Criterion-Related Validity
  - a) Concurrent Validity
  - b) Predictive Validity
- Construct Validity

Content validity:

Content validity is the degree to which the items of a test cover the content prescribed for a particular programme studied by students. It is estimated by evaluating the adequacy of the test items, in relation to instructional objectives of the course content studied. Content validity is determined on the basis of logical analysis. It is particularly useful for achievement test. To test the content validity of a test, we must ask ourselves:

- Are the test items relevant with respect to the objectives of the curriculum?
- Are there balance between the test and content of the curriculum?

Criterion-Related Validity:

Criterion related validity is the degree to which the test scores correlate with the scores on a criterion available at present or to be available in the future. Depending upon the comparison of test scores with the criterion available at present or to be available in the future, it is dived into two types. These are

a) **Concurrent Validity:** Concurrent validity refers to the degree to which a test is correlated with a criterion which is available at present. Concurrent validity of a test is generally found out by calculating the coefficient of correlation between the test scores and the scores obtained by the group in another test or judgments given by experts about the group on the trait under study.

b) **Predictive Validity:** Predictive validity refers to the degree to which a test is correlated with a criterion measure which will be available in the future. It refers to the association between present results as indicated by a test and future behaviour of an individual in a suitable measure of latter success. The latter measure is called criterion measure. Thus, in the process of validation, the effectiveness of a test is judged by the accuracy with which the test scores predict the future behaviour of individuals. It is particularly useful in admission or entrance test related to any programme of study or job entrance test. For example, if the students who scored high marks in the medical entrance test also score high marks in the medical programme as well, the predictive validity of the admission test is considered to be high.

Construct Validity:

Construct validity refers to the degree to which certain psychological traits or constructs are actually represented by test performance. It is used when a test is prepared to describe the degree to which an individual manifests an abstract psychological trait or construct. Construct validation is an analysis of the meaning of test scores in terms of psychological constructs (Cronbach and Meehl , 1955). Psychological constructs are abstract as well as unobservable variables such as intelligence, anxiety, achievement motivation, critical thinking, etc.

Check Your Progress - 2

2.1 Write the characteristics of a good test?

2.2 What is meant validity of a test?

2.3 Describe content validity of a test.

2.4 Distinguish between concurrent and predictive validity of a test.

2.3.1 (b) Reliability:

Suppose, an achievement test (a question Paper) in mathematics is administered to a group of students and the scores are

calculated. If the same test is administered to the same group of students after a gap of few days and if there is consistency in the scores obtained in the two administrations, we say that the test is reliable in measuring achievement in mathematics.

*Reliability has to do with accuracy and precision of a measurement procedure. Indices of reliability give an indication of the extent to which a particular measurement is consistent and reproducible (*Thorndike and Hagen, 1956).

A test score is called reliable when we have reasons for believing the score to be stable and trustworthy (Garrett, 1981).

Thus,

- Reliability refers to the precision or accuracy of the measurement or score.
- It refers to the consistency of scores or measurement which is reflected in the reproducibility of the scores.
- Reliability refers to the consistency of scores obtained by the same individuals when re-examined with test on different occasions, or with different sets of equivalent items, or under other variable examining conditions. 'A test score is called reliable when we have reasons for believing the score to be stable and trustworthy (Garrett, 1981).

Methods of Estimating Reliability:

There are four most common methods of estimating reliability coefficient. These methods are

- Test-Retest Reliability
- Internal Consistency Reliability
- Alternate or Parallel Forms Reliability
- Methods of Rational Equivalence

Test-Retest Reliability:

In test-retest reliability, the single form of the test is administered twice on the same sample with a reasonable time gap and the same test yields two independent sets of scores in two administrations. If the correlation coefficient between the two sets of the test scores is high, then the test is said to be reliable. A high test-retest reliability coefficient indicates that the examinee who obtains low score on first administration tends to score low on the second administration, and the examinee that scores high on first administration, tends to score high on second administration.

Advantages :

- It is the most appropriate method of estimating reliability of both speed and power tests.
- The test-retest method is the most appropriate method of computing reliability of heterogeneous test.

Disadvantages :

- It is a time consuming method.
- This method assumes that the examinee's physical and psychological set-up remains unchanged in both the situations.
- If the test is administered immediately without a proper time gap, examinees may remember much of the questions and may devote their time to new materials. That would enhance their scores.

Alternate forms Reliability:

In alternate forms reliability, two forms of the test are required and the two forms of the test are administered to the same sample with a time interval. Correlation Coefficient between two sets of scores obtained from two equivalent forms becomes the measure of reliability. It measures the consistency of the examinees' scores between two administrations of parallel forms of a single test.

Internal Consistency Reliability (Split-Half Reliability):

The most common method of estimating reliability is the **split-half method** in which a test is divided into two equal or nearly equal halves. The common method of splitting the test is the odd-even method. In this method all odd-numbered items (such as 1st, 3rd, 5th items etc) constitute one part of the test and all even-numbered items (such as 2nd, 4th, 6th items etc.) constitute another part of the test. Each examinee, thus, receives two scores: the marks obtained on all odd-numbered items constitute one score and the marks obtained on all even-numbered items constitute the other score for the same examinee. The correlation coefficient is calculated between the two sets of scores, which is the reliability of the half test. The Spearman Brown Prophecy Formula is used for estimating the reliability of the whole test.

Reliability of the whole test =

$$\frac{2 \times \text{reliability of the half test}}{1 + \text{reliability of the half test}}$$

Method of Rational Equivalence:

This method stresses the inter-correlations of the items in the test and the correlations of the items with the test. Kuder and Richardson did series of researches to remove some of the difficulties of the split-half method and devised a formula for estimating the internal consistency of the test. Kuder-Richardson reliability coefficient is actually the mean of all split-half co-efficients resulting from different splitting:

$$KR_{20} = (n/(n-1))[(\sigma_{\text{t}}^{2} - \Sigma\ pq\ )/(\sigma_{\text{t}}^{2}\ )]$$

The main requirements for the use of Kuder- Richardson formula are:

- All items of the test should be homogenous.
- All correct answer should be scored as '+1' and all incorrect answer should be scored as '0'.

Check Your Progress - 3

3.1 What is meant by Reliability of a Test?

3.2 Describe Test-Retest Reliability of a Test.

3.3 Describe Split-Half method of estimating Reliability of a Test.

3.4 What are the main requirements for estimating reliability a test using Kuder- Richardson formula?

2.3.1 (c) Norms:

Norms are defined as the average performance on a particular test made by a standardized sample. Different types of norms are

found depending on the nature and purpose of the test. For example, Standard score norms, Percentile norm, Grade norm, Sex norm etc.

2.3.1 (d) Usability:

Usability of a test includes the following important points:

a) **Objectivity:** A test should provide objective result. The tests should be free from subjectivity in scoring, i.e. there must be complete interpersonal agreement among the experts regarding the meaning of the test items and scoring of the test.

b) **Economy of Time:** Would you feel comfortable if you would sit in an examination of four or five hour duration? It is very difficult for any individual to concentrate for a longer time on same activity. Thus time taken to administer a test is a very important factor one should take care of in the construction of a test. The time taken to administer a test should be reasonable. Then it is easy to achieve cooperation of all those who involved in the test administration as well as those for whom the test meant i.e. examinees.

c) **Cost:** The cost of preparation or construction and administration of a test should be less.

d) **Ease of Administration:** The administration procedure used in a test should be simple or easy. Will it be possible to conduct an oral test for all the examinees of HSLC examination? Have you ever appeared in the APSC or UPSC examinations? If we compare the instructions written on the HSLC Question papers with the question booklets of these types of competitive examinations, then we observe that the instructions written on the HSLC question papers are comparatively easier than competitive examinations. Thus, administration procedure used in competitive

examinations are comparatively complicated than the HSLC examination.

e) **Ease of Scoring:** A test should be easy to score i.e. the scoring procedure should be such that a layman (not related to the area about which the test is constructed) can score the test or a machine can score the test within few hours. Thus specialized person in that area is not required to score the test.

f) **Ease of Interpretation:** A good test is one, which could be easily interpreted by a person or a researcher who constructed the test. If a test requires expert persons to interpret the test score (for example most of the projective test), then the test is not easy to use at any place or situation.

g) **Face validity:** Face validity is the extent to which the test appears superficially to measure what it intends to measure. For example a mathematics question paper must be look like a mathematics question paper having symbols like +, -, x, <, >, =, etc. and numerals such as 1,2,3,4,……, etc.

Check Your Progress - 4

4.1 What is meant by norm of a test?

4.2 What is face validity of a test?

2.3.2 Classification of Tests:

On the bases of different dimensions, Psychological tests are classified into a number of types. Some of these types are shown below:

A. On the basis of Difficulty level of items and Time limit in producing the response:

(a) Power Test:

The test which allows sufficient time to the examinees to respond every item of the test is known as power test. They are meant to measure the ability to perform the assigned work. Usually the items in power test are arranged in increasing order of difficulty.

A power test is a test in which every subject has a chance to attempt every item. (Koul, 1984)

A power test is one which has a generous time limit so that most examinees are able to attempt every item. (Singh, 1997)

(b) Speed Test:

The tests which limit the time to respond all the items of a test are called as speed tests. Speed test measures how rapidly or with what speed the examinees can respond to items given in a test within a given time limit. These types of tests have severe time limit so that no examinees are able to attempt all items. Do you have experience of appearing in banking clerical test? This test measures how quickly one can compute different mathematical calculations, detect errors in a paragraph, etc.

A speed or timed test is often defined as one in which no subject has time to attempt all items (Koul, 1984).

Speed tests are those that have severe time limits but the items are comparatively easy and the difficulties involved therein are more or less of the same degree (Sing, 1997).

B. On the basis of Administrative conditions:

(a) Group test:

A test in which a group of individuals are tested at the same time is called a group test. For example: HSLC examination conducted by SEBA is a group test. In HSLC examination of particular year, a large number of students appear at different examination centers at the same time on the same dates as determined by the SEBA.

(b) Individual test :

A test in which one individual is tested at a time is called an individual test. In Rorschach Inkblot test for personality assessment, one individual is tested at a time. Thus Rorschach Inkblot test is an individual test.

C. On the basis of Purposes:

(a) The Tests of General mental ability or Intelligence:

Intelligence test measures general ability of individuals such as ability to solve problems, perceive relationship, give reason, think critically, apply knowledge in varied ways, etc.

(b) The Tests of Special ability or Aptitudes:

The tests used to measure aptitude are called aptitude tests. Aptitude tests measure or assess the degree or level of one's special ability to succeed in a particular field of activity. These are mainly used to estimate the extent to which an individual would profit from a specific course or training, or to predict the quality of his or her achievement in a given situation.

(c) The Tests of Creativity:

Test of creativity measures divergent thinking (Guilford). Divergent thinking refers to those aspects of the mental process where the individual expands to many correct solutions of problems on the basis of a small amount of information. Whatever is novel, unique, unconventional, original is considered creative. Imagination is the back bone of creativity. It is very difficult to test creativity as it manifests in different forms in different individuals. The test items in creativity tests are typically open-ended. Thus, objective scoring is not possible in this type of test.

(d) The Tests of Attainment or Achievement :

Achievement refers to the extent to which a student is able to acquire the content at the completion of prescribed course or instruction. Achievement tests are designed to measure the effects of a specific programme of instruction or training. The question papers that you had to answer in different examinations are examples of achievement tests.

(e) The Personality Tests and Inventories:

Although the term 'personality' is sometimes employed in a broader sense, in conventional psychometric terminology 'personality tests' are instruments for the measurement of emotional, motivational, interpersonal, and attitudinal characteristics, as distinguished from abilities (Anastasi, 1988). Self-report inventories, interest and value inventories, attitude scales, projective techniques and other personality assessments techniques are included under personality tests and inventories.

D. On the basis of Standardization:

(a) Standardized Tests:

A standardized test is one that has specific directions for administration and scoring, a fixed set of test items, has been administered to representative samples taken from the population for whom the test is intended for the purpose of establishing norms (Koul, 1984). It is used to maintain

uniformity of instructions in administering and evaluating a test.

(b) Non-Standardized Teacher made tests:

The test which is constructed for specific use within a classroom without following any standardized procedure in its construction is known as non-standardized test. The question papers or tests prepared by a teacher to measure the performance of students (of a particular level of learning or class) in a subject area or part of a subject area is an example of a non-standardized teacher made test. In general, this type of test does not have specific direction for administration and scoring. Usually the concerned teacher decides the direction for administration of the test which fits with the local specific situation. The class tests or the unit tests taken in schools are the examples of non-standardized tests.

E. On the basis of Nature of Items:

(a) Verbal Test :

In this type of tests, the instructions are given in words - written, oral or both. The examinees are required to use language, oral or written, for their responses.

(b) Nonverbal Test:

A non-verbal test is one where no language is used at all either in instruction or in construction of items.

(c) Performance test:

Performance tests involve the manipulation of objects, with a minimum use of paper and pencil. The instructions for these types of tests can be given by demonstration, gesture and pantomime, without the use of oral or written language.

F. On the basis of Length of the response and Scoring:

(a) Objective Type Tests:

Objective type tests are those whose items can be scored in such a way that no scope for subjective judgment or

opinion exists and thus, the scoring remains unambiguous. The test in which each item contains only one correct response is called an objective type test. Thus the scoring procedure is free from ambiguity i.e. if the same script is examined by different examiners or the same examiner examines at different occasions, the scoring will be same.

(b) Essay Type Tests:

Did you observe the types of items or questions given in your first degree examination? How did you respond to the items given in these test? The essay type tests get its name from the manner in which the testee responds. An essay type test consists of essay type items or questions. The term essay implies a written response which may consist of many sentences to several pages. The student is given the freedom with respect to the content, wording, length and organization of his/her response.

Check Your Progress - 5

5.1 Differentiate between Power Test and Speed Test.

5.2 Give one example of each of Verbal and Nonverbal Test.

5.3 Give one example of Non-Standardized Test.

5.4 What is meant by Test of Attainment?

5.5 Write two distinguishing characteristics of Essay type and Objective type test.

2.4 Inquiry Forms : Questionnaire

Inquiry forms are a set of data gathering research tools which make use of properly designed proformas for inquiring into and securing information about certain phenomena under investigation.

The main inquiry forms are:

- Questionnaire
- Schedule
- Checklist
- Rating scale
- Score card
- Opinionnaire or Attitude scale

In this section we will discuss the construction and use of questionnaire as a tool of educational research in detail.

Questionnaire: *A questionnaire is a data-gathering instrument consisting of series of systematically organized questions or statements through which factual information can be collected.* It can

provide answers to the questions comprising of generally what, where, when and how. Respondents respond to the questions or statements in writing. It is one of the most widely used data-gathering tools in research.

- A questionnaire is a device consisting of a series of questions dealing with some psychological, social, educational, etc, topic(s) sent or given to an individual or group of individuals, with the object of obtaining data with regard to some problems under investigation (Koul, 1998)

2.4.1 Types of Questionnaire :

On the basis of the type of responses, questionnaire may be divided into two types - a) Fixed Response Questionnaire and b) Open-ended Questionnaire.

In a fixed-response questionnaire, a fixed number of responses are given against each question. The respondents are to select the appropriate option. For example: What is your caste? – SC/ST/OBC/MOBC/ General.

On the other hand, in an open-ended questionnaire, the responses to the questions are not given. The respondents are required to write the responses. For example: What are the problems faced by your institution in implementing Semester System? ……

Again, on the basis of the method of administration, questionnaires may be divided into two types – a) Mailed Questionnaire and b) Face-to-Face Administered Questionnaire.

The questionnaire which is mailed to the respondents with a request to answer the questions and return to the sender through mail are known as mailed-questionnaire. A mail questionnaire generally accompany with a stamped self-addressed envelope so that the respondent may return it easily.

The questionnaire that is administered in the presence of the investigator in a face-to-face situation is known as face-to-face administered questionnaire.

2.4.2 Steps Followed in the Construction of Questionnaire:

The steps involved in construction of a questionnaire may be discussed as given below:

- **Setting the Purpose of the Questionnaire :**

The questions included in a questionnaire must be relevant with respect to the objectives of the research study. Answers to the questions included in the questionnaire must provide the data necessary to explore the area defined by the objectives.

The questions included in the questionnaire must motivate the respondents to provide the required information. A covering letter explaining the purpose of the study must be included with a questionnaire. The language of the covering letter must be courteous declaring that the information provided in the questionnaire will be kept confidential.

- **Writing and Organization of Items:**

After deciding the purposes, next step is to write items for the questionnaire. While writing items for a questionnaire, you should follow the following guidelines:

a) **The terms or words that could easily be misinterpreted need to be properly defined**. For example, the answer to the question in a questionnaire, '*What are you doing now?'* may be '*I am reading a book*' or *'I am drinking a cup of tea'*, etc. but the actual intention of the investigator was to elicit information about the profession of the respondent.

b) **A researcher must be careful in using descriptive adjectives and adverbs that have no agreed upon meaning,** e.g. frequently, rarely, and occasionally, etc in a questionnaire. For example: Do you visit library frequently? One individual responds to this question as yes and thereby he/ she means that visiting library ones in a month is considered as 'frequently'. On the other hand for another individual, visiting library ones in a week is considered to

be 'frequently'. Thus, same question carries two different meaning to two different individuals. The question can be reframed as 'How many times do you visit library per week/month?' A number of responses may be given against this question. The respondents may be asked to choose the response which is appropriate for him/her. Thus a researcher must be very careful in using this type of descriptive adjectives or adverbs in writing question for a questionnaire.

c) Double negative should not be used in writing questions because it is difficult to understand the meaning of such a question. For example: Don't you think that your child should not be sent to English medium School?

d) Be careful of inadequate alternatives, e.g. Alternatives given against each question must be appropriate.

e) There should not be any double barreled questions, i.e. two different questions of different aspects should not be combined to form one question. For example: Does Dibrugarh University follow reservation policy for SCs, STs, OBCs and women for admission in PG programmes? Dibrugarh University follows reservation policy for SCs, STs, and OBCs in admission to the PG programmes but not for women. Thus a respondent may confuse in responding to this question. Hence, two separate questions should be framed to get the required information in such cases.

f) Underline a word (or italicize or write in bold face) if you wish to indicate special emphasis: For example: 'What type of **work** do you like to do in leisure time?', 'Should Government of India provide <u>mid-day meal</u> for all secondary school students?'

g) When asking for rating or comparison a point of reference is necessary: For example: a researcher asked a class X student, ' How would you rate your performance in Mathematics?', Superior-------, Average-------, Below

average-------- In the above example, there is no reference point with respect to which the student may respond to that question. In other words, in responding to that question, with whom the respondent may compare his performance is not mentioned in the question. . Thus the respondent may be confused and might not respond to that question. If the question is 'How would you rate your performance in Mathematics with respect to your class-mates?', then the performance of class-mates in Mathematics acts as reference point.

h) Avoid unwarranted assumptions or Presuming questions**:** Presuming or unwarranted questions are those questions which pre-assume that the information required is known to the respondents. For example: A researcher asks an individual '*Do you find Sunsilk shampoo good for hair*?' who has never used that particular brand of shampoo. Thus, before collection of data the researcher has pre-assumed that the respondent uses that particular brand of shampoo. This type of pre-assumption should be avoided.

i) Phrase questions so that they are appropriate for all respondents.

j) Frame questions that will give a complete response: For example: A researcher wants to study the reading habits of individuals and the question included in the questionnaire is '*Do you read books?*' Yes----------, No---------- A 'yes' or 'no' response given against this question does not reveal the presence and absence of reading habit. To get the complete information some other additional questions might be included following the former question such as 'What type of books do you read?' Novels, Short stories, Biographies, Research journals, Film magazines, Sports magazines, Books on Science fictions and any other please

specify. It might be followed by another question such as *'How many hours do you read books per day?'*

k) Provide for the systematic quantification of responses: If the question is such that the respondent has to check a number of items or equally right answers from the given list, then the respondent may check against number of items or right answers. In such a situation it is difficult to summarize or analyze the responses given in the questionnaire. Hence, it is necessary to modify the question by asking the respondents to rank the items or answers given in the list, in order of preference, a specific number of items.

For example: What are your favorite films? Rank in order of preference your first, second, and third choices from the given list of films.

l) Consider the possibility of classifying the responses yourself, rather than having respondent choose categories: For example, (i) Classify your performance as competent teacher, skilled teacher; (ii) Classify your occupation as skilled labour, clerical work, profession. Do not include these types of questions in a questionnaire.

m) Information level of the respondents: While preparing a questionnaire, the information level of the respondents are to be kept in mind. You should not ask for any information which is not available with the respondent. For example, if you need to collect information regarding financial position of a college, you should collect information from the Principal and not from the teachers.

n) Social acceptance of responses/Embarrassing questions: A questionnaire must not have any embarrassing questions such as questions related to stealing, cheating in the examinations, sexual behaviour, views towards an unauthorized militant group, etc. Individuals may refuse to

respond or distort true answers to these types of questions. For collecting data regarding these aspects you may use a different technique such as an interview.

o) **Avoid leading questions:** For example, 'Don't you agree that secondary school teacher's views should be taken into account in constructing secondary level curriculum of a state?' Response against this type of question always comes in favour of the statement. Thus a question should not provide any leading suggestions to the respondents.

p) **Sequence of questions:** One question should be related to one concept or one idea only. The question included in a questionnaire must be arranged in a logical order considering the psychology of individuals. The general, easy, closed ended or unrestricted questions should be included in the beginning of a questionnaire. The specific, difficult, open ended or restricted questions should be given in the latter part of the questionnaire.

q) **The forms or types of questions:** A questionnaire may consist of closed ended or open ended questions or combination of both. A question with fixed given responses about which respondents respond are known as ***closed ended question***. If respondents are allowed to respond freely against a question, then the question is known as ***open ended question***.

r) **Length of the questionnaire:** A questionnaire should not be unnecessarily lengthy one. If research problem is such that it needs inclusion of large number of questions to collect all necessary information, then it should be divided into two questionnaires of reasonable length. Moreover, each of these two questionnaires should be administered at two different occasions so that the respondents do not feel tired.

- **Construction of the first draft:** Following the guidelines as mentioned above and arranging the questions in a logical order the

first draft of a questionnaire is prepared. Then, it is sent to the experts for suggestions.

- **Experts' opinion:** After receiving suggestions from the experts, some questions are eliminated, some changed and some new questions are added.
- **Pre-test or Pilot study or Preliminary tryout:** Modified questionnaire is then administered to a small representative sample to examine if any ambiguous item is still present and also to examine whether the items may fulfill the purpose of the study. A pre-test or pilot study is necessary to check the suitability of the questionnaire as a whole.
- **Preparation of the Final Draft of the Questionnaire**: After the preliminary tryout, items are again modified and final draft of the questionnaire is prepared. Editing, checking spelling, space for responses, etc, is also important before preparation of the final draft.
- **Validation of a questionnaire:** validation of a questionnaire refers to how effectively items of a questionnaire serve the purpose of the study i.e. each item of a questionnaire must be relevant with respect to the objectives of the study.
- **Reliability of a questionnaire**: The test-retest method is usually used to determine reliability of a questionnaire.

2.4.2 Advantages and Disadvantages of Questionnaire :

A questionnaire has a number of advantages over other data gathering tools :

a) Questionnaire is one of the most popular data gathering tools in social science and behavioural science research, because of its simplicity in nature. It can be very easily constructed and administered. No special technique or training is required for its administration.

b) It is very useful when factual information are to be collected by the investigator.

c) Through questionnaire, data could be collected from respondents who are at a far distance from the investigator and it is not possible to personally contact them.

d) It can be administered to a large number of respondents at a time.

Despite having these advantages, there are also some limitations of questionnaire as a tool of research:

a) Questionnaires cannot be administered to children and illiterates.

b) The rate of return of mailed questionnaire is very low, which may decrease the representativeness of the sample.

c) In case of a mailed questionnaire, the investigator cannot be sure if the responses are provided by the respondents themselves.

d) All the respondents may not be willing to respond in writing to some intimate questions or to questions involving controversial issues.

e) If a respondent misinterprets some question, there is no way to rectify it.

Check Your Progress - 6

6.1 What is a questionnaire?

6.2 Mention at least five points kept in your mind while writing questions for a questionnaire.

Activity 1

Prepare a questionnaire to collect data regarding physical facilities available in the elementary schools in your locality.

2.5 Observation:

Observation is one of the widely used tools in behavioural research. Observation refers to watching and listening to the behaviour of other persons over time without manipulating and controlling it and record findings in ways that allow some degree of analytical interpretation and discussion (Ahuja). It is 'a process in which one or more persons observe what is occurring in some real-life situation, and they classify and record pertinent happenings according to some planned scheme.' (Kohl, 1994). It is used to record the overt behaviour of individuals in controlled and uncontrolled situations.

Contents/Dimensions of Observation:

- *Physical Actions*, e.g., pattern of working, watching television, etc.
- *Verbal Behaviour*, e.g., conversation between husband and wife, colleagues, workers, etc.
- *Expressive Behaviour*, e.g., tone of voice, facial expression, etc.
- *Spatial Relations*, e.g., physical distance between workers in a factory.
- *Temporal Patterns*, e.g., time spent in performing rituals, in shopping, in talking, in watching T.V., etc. *Verbal Records*, e.g., content of memoranda, slogan shouted, etc.

Characteristics of Observation:

- Behaviour is observed in natural settings.

- It helps in determining reality of any phenomenon.
- It is hypotheses free enquiry.
- Manipulations of independent variables are not required in observation.
- It avoids selective recording of the observed phenomenon.

2.5.1 PROCESS OF OBSERVATION:

In research the following steps are followed in the process of observation:

- **Selecting a topic or problem for observation:** Selecting a problem means determining the issue or phenomenon such as students' learning style, behaviour of students' at the time of playing, teachers' teaching methods and skills, students' reading style in a library, behaviour of drug addicts, living conditions of slum people, behaviour of animals at the time of solar eclipse, behaviour of members of the parliament at the time of parliamentary session, etc. to be studied through observation.
- **Choosing a site for observation:** After selecting the problem for observation the observer must decide the place for observation. Place of observation must be decided on the basis of the problem to be studied. **For example**: To study the behaviour of students' at the time of playing, the place of observation will be a play ground of a school.
- **Gaining access in setting:** After selecting the site for observation, a researcher must think about how to enter in the place of observation. If a researcher wants to study the learning style of student of a school, he/she must take permission from the authority or the principal of the school. If the researcher wants to study the behaviour of drug addicts, then he/she must consult with the police personnel and if required he/she must develop friendship and rapport with one or two drug addicts without mentioning his/her intention. It is better to keep the identity of the researcher confidential if

there is any threat for the observer (Disguised Observation). Thus, ways of gaining access to a research site varies from situation to situation or from problem to problem.

- **Taking roles or playing roles at the time of observation**: After gaining access to research site, the researcher should decide about the role to be played at the time of observation. Depending upon the problem the researcher may take active or passive role during observation.
- **Jotting down field notes or writing field notes**: It is important to write the field notes accurately and objectively. In the beginning a researcher may not be clear about what to record, how to record, when to record, etc. Thus, the researcher should record or write all the details of the observed phenomenon. A field note must include the description of the natural setting in which observation takes place, description of the conversation among persons, unusual discussions or situations or happenings among persons in the research site. It is better to write field notes as quickly as possible after the observation in case of disguised participant observation or during the observation in case of undisguised or non-participant observation. Thus, recording field note depend upon the type of observation as well as the type of events or phenomenon to be observed.

  At the time of observation a researcher can record the scene of the observed phenomenon in verbatim. Writing notes at the time of observation may divert the attention of the observer from the event. Thus, a researcher may record the event in key words or in short phrases which may be completed just after the observation. One may also use tape recorder, video, photographs etc. depending upon the type of observation.
- **Analysis of Data:** Content analysis technique is particularly useful to analyze observation based data. However, if two researchers observe the same situation may provide different

type of conclusion because one may focus on one dimension and other may focus on other as well as their way of seeing the same phenomenon may be different. One may focus on positive aspects of a phenomenon on the other hand the other may focus on negative aspects of a phenomenon. (For details of content analysis technique you can read the book 'Research Methods' by Ram Ahuja, pp. 273-291).

- **Writing Reports:** After analyzing the observation based data a researcher must write a report on it and submit it for publication or to the sponsoring authority.

2.5.2 Advantages of Observation:

The following are the some of the advantages of observation:

- It provides a direct procedure for studying various aspects of human behaviour, which may be the only effective way to gather data in a particular situation.
- It is effective especially for studying social processes in depth over time.
- It is a flexible technique in which research design can be modified at any time.
- It is less complicated.
- It offers data when respondents are unable or unwilling to cooperate for giving information.
- It approaches reality in its natural setting and studies events as they evolve.
- It allows collection of wide range of information**.**

2.5.3 Limitations of Observation:

The following are the some of the disadvantages of observation:

- It cannot be employed when large groups are to be studied.

- A subject may intentionally attempt to exhibit an artificial behaviour when he/she knows that he is being observed.
- Observation method is time consuming and sometimes too costly.

Check Your Progress - 7

7.1 Write any three characteristics of Observation.

7.2 Mention the steps followed in the process of Observation.

7.3 Write two advantages and two disadvantages of Observation.

2.5.4 Types of Observation :

- On the basis of the ability of observational data to generate useful and researchable information Reiss (1971) divides observation into the following two types:

  (a) Systematic Observation

  (b) Unsystematic Observation

Systematic Observation: The observation in which data are collected systematically using structured schedule explicitly specifying objectives of the observation is called as systematic observation. Thus, systematic observation is one which is done according to some explicit procedures as well as in accordance with the logic of scientific inference (Singh, 1997). **For example:** A researcher wanted to observe the learning behaviour of class-I

students of a particular school following systematic procedure and scientific method to study their behaviour is an example of systematic observation.

Unsystematic Observation: The observation in which no explicit procedure or method is followed for data collection is called unsystematic observation. It is a type of casual observation in which no structured schedule is used. Thus, unsystematic observation is a type of causal observation made by investigator without specifying any explicit and objective inference (Singh, 1997). **For example**: A researcher decided to observe the activities of the people present at the time of visiting a book fair and started observing the activities of people in the book fair without using any explicit procedure is an example of unsystematic observation.

- On the basis of role played by the investigator, it is divided into the following two types:

  (a) Participant Observation

  (b) Non-participant Observation

***Participant Observation*:** The observation in which the investigator actively participates in the activities of the observed group is called as participant observation. In general, the identity of the observer is kept confidential to the members of the group to be observed such that the members of the group behave and interact with the investigator in a natural way. This type of observation is known as *disguised* participant observation. On the other hand if the members of the group who are being observed know the identity of the observer, then this type of observation is known as *undisguised* participant observation. Usually, the procedure of observation in participant observation is unstructured and the observer has some flexibility in deciding what to observe, how to record it, when to record it, etc. In disguised participant observation, the observer records the activities of the group in absence of other individuals, may be before going to sleep. **Example of disguised participant observation**: A researcher wants to study the activities of a group of

drug addicts of a region. Here, the researcher needs to participate with the group without disclosing his/ her identity.

Advantages:

- In participant observation since the observation is done in a natural setting, the investigator is able to record the natural behaviour.
- Usually the complete observation by the method of participant observation takes several months or years. As a result, information so collected is very broad and meaningful for understanding human behaviour.

Disadvantages:

- Since participant observation is usually unstructured, it fails to be precise about the procedure of data collection.
- Participant observation is time consuming device and therefore, not all observers become ready to proceed by the procedure of participant observation.
- Since the observer participates in the activities of the group, the observer sometimes starts showing human weaknesses like love, sympathy, hatred, etc. towards the members and their behaviour.

Non-participant Observation: Non-participant observation is the observation in which the investigator observes the behaviour of other persons in a natural setting but does not participate in the activities of the group to be observed. It is usually structured. Therefore, the observer preplans the activities to be observed i.e. whom to observe, what to observe, when to observe, where to observe, problems to be faced due to the presence of the investigator, etc. **For example:** A researcher wants to study the playing style of lower primary students of a co-education primary school. The researcher can preplan the activities to be observed as follows: Place of observation: in the play ground of the selected primary school or any other place, the number of

students playing, what are the common games of that students, whether the girls and boys play separately, what are common game of the girls, what are common games of the boys, Time of observation: whether at recreation time or break given between classes or at the specified time in the schedule time for playing of each class, whether they quarrel among themselves, whether quarrel among the boys are more, whether quarrel among boys and girls are more, etc.

Advantages:

- Since non-participant observation is usually structured, the obtained data are more reliable and representative.
- In non-participant observation the observer is able to concentrate upon any specific aspects of social behaviour in a better way and therefore, gets a better opportunity to find out the solution of the problem.

Disadvantages:

- In non–participant observation, the persons being observed develop consciousness that their behaviour are being observed. This consciousness slightly distorts the natural flow of their behaviour.
- Since the settings are structured, it also affects the person being observed.

2.5.5 Observation Schedule:

Observation schedule is a device used by field researchers to systematically record observations. It employs observation instead of verbal questions. Questions in the observation schedule are answered not by talking but by observations. The schedule is to be filled in by the researcher/observer.

Check Your Progress - 8

8.1 What is meant by systematic observation?

8.2 Write two advantages of non-participant observation over participant observation.

2.6 Interview :

Have you ever observed interviews in the TV programmes? What do the individuals do at the time of interview? In general, in an interview, a person (interviewer) asks questions to other person(s) (interviewees) in a face–to-face situation and they (interviewees) respond verbally. Thus, ***the interview is a process of interaction or communication in which the subject or interviewee gives the needed information verbally as asked by the interviewer in a face-to-face situation***. The interview may be of two types – structured interview and unstructured interview. In structured interview, a set of pre-constructed questions are put to all the interviewees. The interviewer does not have the freedom to change, remove or add any question. On the other hand, an unstructured interview is one where only the outline of the questions is prepared. The Interviewer is free to change, remove or add any new question as the situation arise.

Characteristics of Interview:

- There is a face-to-face contact, conversational exchange and verbal interaction between the interviewer and interviewee.
- Questions are asked and responses are received verbally.
- Information is recorded by the interviewer.
- The format of the interview is considerably flexible.

2.6.1 Techniques of Interviewing:

The techniques of interviewing usually follow the following steps:

- **Preparation for the Interview:** Preparation for the interview means the planning for the interview. Before execution of the actual interview, the researcher must plan to get the required information effectively. Thus the researcher must decide from whom to ask questions, from whom to get the reliable information, where to conduct the interview, when to ask questions, how to ask questions, what are the probable questions to be asked at the time of interview, for how long the interview must be conducted, etc. The interviewer must have also all the necessary information or in depth study related to the problem of study before execution of the interview. Preparation of an outline of questions, to be asked, following proper sequence is very important before execution of an interview.
- **Execution of the Interview:** Before execution of an interview, a cordial and friendly relationship between interviewer and interviewee is very essential. Gaining rapport with the interviewee helps an interviewer to obtain certain confidential information that an individual might be reluctant to respond. In the beginning of the interview, the interviewer can explain the purpose of the interview. An interviewer should start the discussion with simple questions such as questions by which factual information can be obtained or the questions which are non-threatening for the interviewee. Then

he/she should proceed slowly to get the required information by asking questions of deeper meaning. Maintaining proper sequence or coherence in asking questions is very essential for getting required information from an interviewee. Turney and Robb (1971) suggested the following rules to be followed during the execution of an interview:

- Ask only one question at a time.
- Repeat a question if necessary.
- Try to make sure that the subject understands the question.
- Listen carefully to the subject's answers.
- Observe the subject's facial expressions, gestures, and tone of voice.
- Allow the subject sufficient time to answer the question, but do not let the interview drag.
- Avoid suggesting answers to the questions.
- Do not show signs of surprise, shock, anger, or other emotions if unexpected answers are given.
- Maintain a neutral attitude with respect to controversial issues during the interview.
- Take note of answers that seem to be vague, ambiguous, or evasive.
- In the unstructured interview, ask additional questions to follow up clues or to obtain additional information.
- Use tact and skill in getting the subject back to an area of inquiry when he has stayed too far from the original question.

Recording of the Interview: Taking notes at the time of interview is essential. Information provided by an interviewee must be written as far as possible in the same way as he/she expresses. For this purpose, it is better to use tape-recorder or video-record at the time of execution of an interview. However, it is important to take permission for recording

from the interviewee. Recording the interviews on tape is preferable because it is a convenient and less expensive process. Recording the interview on tape also helps the interviewer to replay as often as necessary for getting complete information or analysis at a later time. Moreover, an interviewer may miss some important information or distort some of the information while writing notes at the time of execution of an interview.

2.6.2 Advantages of Interview :

- It provides an opportunity to the interviewer to question thoroughly certain areas of inquiry.
- The interview is often superior to other data gathering tools as people usually more willing to talk than to write.
- It permits greater depth of response.
- It enables the interviewer to get information concerning feelings, attitudes or emotions in relation to certain questions.
- Interview allows greater flexibility in the process of questioning.

2.6.3 Disadvantages of Interview:

- It is a time consuming technique.
- The effectiveness of interview depends upon the skill of interviewer.
- There is a constant danger of subjectivity on the part of the interviewer.
- The interview is most difficult to employ successfully, when some interviewees do not respond freely, frankly and accurately, for even in the presence of a skilled interviewer.

Check Your Progress - 9

9.1 What is an Interview?

9.2 Mention any three characteristics of Interview.

9.3 Write any four rules followed at the time of execution of an Interview.

9.4 Mention two advantages of Interview.

9.5 Mention two disadvantages of Interview.

2.7 Sociometry:

Sociometry is an indirect technique for measuring and describing social relationships among the members of a group. Sociometric techniques are used to measure social relationships or interactions among the members of a group. These techniques attempt to measure attractions or repulsions, likes or dislikes, selections or rejections between the group members by asking them to indicate whom they would choose or reject, like or dislike in

various situations such as in inviting to a birthday party, in doing a project, in playing, in solving mathematical problems, etc.

The following definitions given by different authors have illustrated the concept of Sociometry very clearly:

Sociometry is a technique for describing the social relationships among the individuals in a group. (Best and Kahn, 1989).

Sociometry is the study of interrelationship among members of a group-that is, its social structure: how each individual is perceived by the group. (Stanley and Hopkins, 1972).

The term sociometry is defined as the measurement of the social relationships that exists among the members of a group. (Koul, 1998).

2.7.1 Uses of Sociometric Techniques:

Sociometric techniques are used to study:

- Social adjustment
- Group dynamics
- Learning
- Motivation
- Discipline

2.7.2 Different Types of Sociometric Techniques:

There are different types of Sociometric techniques. Some of these are illustrated below:

- Sociogram
- Socimetric Matrices
- Guess-Who Technique
- Social Distance scale

2.7.2 (a) Sociogram:

Sociogram is a diagrammatic representation of the interrelationships of members of a group. It is used to study the interpersonal relationships of members of a group. A social structure of a class can be studied with this technique.

Steps followed in construction of Sociogram: The following steps are followed in the construction of a sociogram.

- Researcher begins with a question such as "With whom would you like to play toys? Give your first, second and third choice."
- Each member of the group is provided with a form on which he/she can write the names of the members he/she has chosen.
- The group members are assured that strict confidentiality would be maintained regarding the information given by them.
- The choices made by the group members are then tabulated.
- The members who are chosen most often are referred to as 'stars', those not chosen by others as 'isolates'. Small groups made of members who choose one another are called 'cliques'.

Procedure for Construction of Sociogram: There are different ways of arrangement of Sociogram. Each arrangement follows definite rules. In general, the following rules are followed in constructing a Sociogram:

- The names of the stars are placed in the centre of the sociogram.
- Different symbols are used to denote boys (eg. Triangles) and girls (eg. Circles).
- The names of those receiving the next highest scores are placed near the names in the centre and so on. However, there should be enough space to permit the drawing of lines connecting triangles and circles.

- The isolates and the seldom chosen individuals are placed around the periphery of the sociogram.
- A choice may be represented by a single pointed arrow, a mutual choice by an arrow pointing in opposite direction and rejection may be represented by dotted line.
- Lines with arrow heads are used to indicate direction of choice. A solid line might be used for a first choice, a broken line for second choice and a dot-dash line for third choice. Different colours can also be used for denoting first, second and third choice.

Let us learn how to draw a sociogram with the help of the following example: A teacher wanted to give a science project in group of Class VI students. For successful completion of the project he wanted to select group leader according to the choices given by the students. And for the purpose of selection of group leader he decided to draw a sociogram. Hence, the teacher gave each student a sheet of paper consisting of the following question:

With whom would you like to work in a group project? Please mention the name of your three friends in order of preferences

I. First choice----------

II. Second choice----------

III. Third choice----------

Let, there are six girls and nine boys in that class and the results are shown in the Table-I. Capital letters A, B, C, D, E, F are used to denote girls and small letters a, b, c, d, e, f, g, h, i are used to denote boys. Moreover, the first choice is denoted by I, second choice by II, and third choice by III in that table.

Table-I: Choices of three friends by a class of 6 girls and 9 boys with whom they like to do science project.

	A	B	C	D	E	F	a	b	c	d	e	f	g	h	i
A		II		I				III							
B			III		II					I					
C	I			II				III							
D		II			III					I					
E	I	II		III											
F	I			II				III							
a								II		I	III				
b							II		I	III					
c	I						II				III				
d				III				I				II			
e									II	I			III		
f								III		I				II	
g						II				III	I				
h							I		II		III				
i	III							II	I						
1st choice	4			1			1	1	2	5	1				
2nd choice		3		2	1	1	2	2	2			1		1	
3rd choice	1		1	2	1			4		2	3		1		
Total times chosen	5	3	1	5	2	1	3	7	4	7	4	1	1	1	0

The data given in Table-I can be represented with a Sociogram as shown in Fig-I.

Interpretation of Sociogram:

- The sociogram is interpreted by noting its general shape and pattern.

- If the lines indicating choices show that a few individuals have chosen each other but seldom anyone else, a clique is indicated. These cliques indicate lack of cooperation and maintaining a distance from others.
- When a segment of the group is completely cut off from the rest of the group, there is evidence of a cleavage or social split in the group.
- Long lines with much over-lapping of choice and many individuals choosing each other indicate a well-integrated group. It means that the group has good leadership, cooperation and group spirit.
- Isolates are the members who have not been chosen by others. They may need counseling or the teacher may need to take special measures to make him feel a part of the group.
- The stars are the members who have leading capabilities.

2.7.2 (b) Sociometric Matrices :

A Sociometric matrix is a rectangular arrangement of numbers indicating the choices made by the members of a group.

Steps followed: The following steps are followed to use this technique**:**

- Researcher begins with a question such as "*With whom would you like to play badminton? Choose three mates."*
- A matrix is formed as shown in Fig-2. The Fig-2 shows the Sociometric matrices of ten Class V students.
- The numeral '1' is used to indicate 'a choice' and '0' is used to indicate 'no choice'.
- Add the choices in each column.
- The sum total of each column indicates the extent to which any group member chosen by others in the group.
- The members, who are chosen most, are referred as 'stars'.
- The members, who are not chosen at all, is termed as 'isolates'.

Table II : A Sociometric Matrix of a Ten Member Group on a Three-Choice Question

Student	Akash	Ayan	Pradip	Abhi	Debesh	Deep	Mayur	Rahul	Rubul	Nehal
Akash	0	1	0	0	0	0	0	1	0	1
Ayan	1	0	0	1	0	0	0	0	0	1
Pradip	0	0	0	0	1	0	1	0	1	0
Abhi	0	1	0	0	0	0	0	1	0	1
Debesh	0	0	1	1	0	0	1	0	0	0
Deep	1	0	0	1	0	0	1	0	0	0
Mayur	0	1	0	0	0	0	0	1	0	1
Rahul	0	1	0	1	0	0	0	0	0	1
Rubul	1	0	1	0	0	0	0	1	0	0
Nehal	1	1	0	1	0	0	0	0	0	0
Total	4	5	2	5	1	0	3	4	1	5

- Various sociometric indices can be computed from the sociometric data. The choice status is a type of sociometric index. The **choice status** is the measure of the extent to which a member is chosen by the group.

  $CS_j = \sum c_j/(N-1)$

  CS_j= The choice status of the individual 'j'.

  $\sum c_j$= The sum of the choices in the subject column.

  N=The number of individuals in the group.

  For example:

  Choice status of Akash=(4/9)=0.44,

  Choice status of Nehal=(5/9)=0.55, and

  Choice status of Debesh=(1/9)=0.11, etc.

2.7.2 (c) Guess-who Technique:

- The guess-who technique was developed by Hartshorne and May (1929). They used this technique among the children.
- In this technique a descriptive statement is provided to the students and they are asked to write the name of student(s) who best fits with that description. They are also allowed to write their own name if they think that they themselves fit with the statement.
- For example:

  (a) He /She is always eager to help others. …….

  (b) He/She quarrels with others all the time. ……

Check Your Progress - 10

10.1 What is meant by Sociometry?

10.2 Write the steps followed in the construction of a sociogram.

Activity 2

Please visit an elementary school of your locality and ask class-V students with whom they like to play. Draw a sociogram and determine who is/are 'star(s)' and who is/are 'isolate(s)'.

2.8 Let Us Sum Up:

Let us see what we have learnt from the above discussions:

- The devices or instruments used to collect data or evidences for testing hypotheses or finding out valid answers to the research questions are called tools and techniques of research.

- The major data-gathering tools and techniques of educational research are:
    - Psychological Tests
    - Inquiry Forms
    - Observation
    - Interview
    - Socio-metric Techniques
- A psychological test is a device consisting of a series of questions or items designed to measure certain aspects of human behavior such as achievement, intelligence, aptitude, creativity, etc. The characteristics of a good test are: Validity, Reliability, Norms and Usability.
- A questionnaire is a data-gathering instrument consisting of systematically organized series of questions or statements through which factual information can be collected.
- Observation refers to watching and listening to the behaviour of other persons over time without manipulating and controlling it and record findings in ways that allow some degree of analytical interpretation and discussion. Observation may be both participant and non-participant.
- The interview is a process of interaction or communication in which the subject or interviewee gives the needed information verbally as asked by the interviewer in a face-to-face situation.
- Sociometry is an indirect technique for measuring and describing social relationships among the members of a group. Sociometric techniques are used to measure social relationships or interactions among the members of a group.

Key Words:

Psychological Test: A psychological test is a device consisting of a series of questions or items designed to measure certain aspects of

human behavior such as achievement, intelligence, aptitude, creativity, etc.

Validity: Validity of a test refers to the degree to which a test measures what it wants to measure.

Reliability: Reliability of test score refers to consistency of scores.

Norm: It is the average performance of a representative sample on a test.

Questionnaire: A questionnaire is a data-gathering instrument consisting of systematically organized series of questions or statements through which factual information can be collected.

Observation: It is a process of watching and listening to the behaviour of other persons in a natural setting without manipulating and controlling it.

Interview: It is a process of face-to-face interaction between interviewer and interviewee in which interviewee gives the needed information verbally as asked by the interviewer.

Sociometry: Sociometry is an indirect technique for measuring and describing social relationships among the members of a group.

Sociogram: Sociogram is a diagrammatic representation of the interrelationships of members of a group.

Sociometric Matrix: A Sociometric matrix is a rectangular arrangement of numbers indicating the choices made by the members of a group.

Suggested Readings:

Ahuja, Ram (2003) ***Research Methods***, Rawat Publications, Jaipur and New Delhi.

Best, John W. & Kahn, James V. (1989) ***Research in Education***, Prentice-Hall of India Private Limited, New Delhi-110001.

Koul, Lokesh (1988) ***Methodology of Educational Research***, Second Revised Edition, Vikas Publishing House PVT LTD, New Delhi-110014.

Singh, A. K. (1997) ***Test, measurements and Research Methods in Behavioural Sciences,*** Second Edition, Bharati Bhawan Publishers and Distributors, Patna-800 003.

Possible Answer to CYP:

1.1 Ans: The devices or instruments used to collect data or evidences for testing hypotheses or finding out valid answers to the research questions are called tools and techniques of research.

1.2 Ans: Please read sub-section 2.2

1.3 Ans: Please read sub-section 2.3

2.1 Ans: Please read sub-section 2.3.1

2.2 Ans: Validity refers to the degree to which a test measures what it wants to measure. For example, if an achievement test in Mathematics is constructed to measure the reasoning ability of students, then all the items of the test must measure the reasoning ability only.

2.3 Ans: Please read sub-section 2.3.1 (a)

2.4 Ans: Concurrent validity refers to the degree to which a test is correlated with **a criterion which is available at present**. On the other hand, predictive validity refers to the degree to which a test is correlated with **a criterion measure which will be available in the future. (**Also, please read sub-section 2.3.1 (a)**).**

3.1 Ans: Please read sub-section 2.3.1 (b)

3.2 Ans: Please read sub-section 2.3.1 (b)

3.3 Ans: Please read sub-section 2.3.1 (b)

3.4 Ans: The main requirements for the use of Kuder- Richardson formula are:

- All items of the test should be homogenous.
- All correct answer should be scored as '+1' and all incorrect answer should be scored as '0'.

4.1 Ans: Please read sub-section 2.3.1 (c)

4.2 Ans: Please read sub-section 2.3.1 (d)

5.1 Ans: The distinction between power and speed test are: (i)The test which allows sufficient time to the examinees to respond every item of the test is known as power test. On the other hand, the tests which limit the time to respond all the items of a test are called as speed tests. (ii) Power tests are meant to measure the ability to perform the assigned work. On the other hand, speed tests measure how rapidly or with what speed the examinees can respond to items given in a test within a given time limit.

5.2 Ans: Please read sub-section 2.3.2

5.3 Ans: Please read sub-section 2.3.2

5.4 Ans: Please read sub-section 2.3.2

5.5 Ans: Please read sub-section 2.3.2

6.1 Ans: A questionnaire is a data-gathering instrument consisting of series of systematically organized questions or statements through which factual information can be collected. (Also read sub-section 2.4.1).

6.2: Please read sub-section 2.4.1

7.1 Ans: Please read sub-section 2.5

7.2 Ans: Please read sub-section 2.5.1

7.3 Ans: Please read sub-section 2.5.2 and 2.5.3

8.1 Ans: Please read sub-section 2.5.4

8.2 Ans: Please read sub-section 2.5.4

9.1 Ans: The interview is a process of interaction or communication in which the subject or interviewee gives the needed information verbally as asked by the interviewer in a face-to-face situation.

9.2 Ans: Please read sub-section 2.6

9.3 Ans: Please read sub-section 2.6.1

9.4 Ans: Please read sub-section 2.6.2

9.5 Ans: Please read sub-section 2.6.3

10.1 Ans: Sociometry is an indirect technique for measuring and describing social relationships among the members of a group.

10.2 Ans: Please read sub-section 2.7.2(a)

References :

Ahuja, Ram (2003) ***Research Methods***, Rawat Publications, Jaipur and New Delhi.

Anastasi, Anne (1988) ***Psychological Testing,*** Macmillan Publishing Company, New York.

Best, John W. & Kahn, James V. (1989) ***Research in Education***, Prentice-Hall of India Private Limited, New Delhi-110001.

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Singh, A. K. (1997) ***Test, measurements and Research Methods in Behavioural Sciences,*** Second Edition, Bharati Bhawan Publishers and Distributors, Patna-800 003.

Stanley, Julian C. & Hopkins, Kenneth D. (1978) ***Educational & Psychological Measurement & Evaluation***, Prentice-Hall of India Private Limited, New Delhi-110001.

Model Questions:

1. What is meant by a psychological test?
2. What are the characteristics of a good questionnaire? What are its advantages and limitations?
3. Describe observation as a tool of data collection indicating its advantages and limitations.
4. What is meant by participant and non-participant observation?
5. Define interview. Describe the advantages and limitations of an interview as a tool of educational research.
6. Define sociometry. Describe sociogram as a technique of measuring social interaction within a group.

***

BLOCK INTRODUCTION

This block deals with the Statistics in Educational Research. This block consists of four units. The 1st unit talks about the importance of Descriptive and Inferential statistics in Education. This unit also covers Normal Probability Distribution, Characteristics of Normal Probability Curve (NPC), divergence from normality, application of NPC etc. In the 2nd unit of this block, the concept Correlation is discussed. Assumptions, computations and uses of correlation and Interpretation of product moment coefficient of correlation are also discussed in this unit for the better understanding of the learners. The 3rd unit of this block deals with the issue Significance of Mean. Statistical inferences based on Parametric Tests, procedure for testing a Hypothesis, difference between large and small samples, Significance of difference between Independent & Correlated Means, One tailed and two tailed Tests of Significance, Type I and Type II errors etc are illustrated in this unit. The fouth and last unit deals with Analysis of Variance, its concept, assumptions and computation of one way ANOVA.

Unit – I

Normal Probability Distribution

STRUCTURE

1.0. OBJECTIVES :

Statistical methods are extensively used in educational research. They provide an indispensable tool for collecting, organizing, analysis and interpreting data expressed in numerical forms. By synthesizing the data, these methods can facilitate the derivation of conclusion and formulation of generalizations. You have used histograms and frequency polygons to illustrate the shape of frequency distribution at school level. you have also calculated the measures of central tendency to describe the central value of the frequency distribution and the measures of variability to indicate its variation either at the school level or college level. All these descriptions have gone a long way in providing information about a set of scores. Sometimes we need procedures for describing an individual's position in the group, or the cutting points to categorise the group according to the level of ability, or the nature of test paper which a teacher has used to assess the learning outcomes of the students. For such problems, Normal Probability Curve, which is bell shaped is very helpful. You will study this curve in this unit.

After reading this unit you will be able to

- explain the concept of Normal Distribution and Normal Probability Curve and its theoretical base.
- explain the properties of Normal Probability Curve; .
- recognize the various divergence in the normal curve
- appreciate the importance of normal curve in educational measurement
- read the table of Area under the normal curve

- apply the knowledge of Normal Probability curve in solving the various practical problems related to educational evaluation and mental measurement.

1.1. INTRODUCTION :

In Educational Research, while measuring mental and physical traits, we gather data for various attributes or qualities which exhibit differences in magnitude, and which vary along some dimensions. Such attributes or qualities are called variables. Most of the variables in mental and physical measurement fall into continuous series. A continuous series is one which is capable of any degree of sub-division. IQs, for example, are usually thought of as increasing by increments of one unit along an ability continuum which runs from idiot to genius. The most widely used distribution to describe measurements on continuous variables such as IQs' test scores is a normal distribution that peaks at the mean and tails off at its extremities.

The normal distribution is a concept with which most people have some familiarity, although they often have never heard of the term. A more familiar name for the normal distribution is the bell curve, because a normal distribution forms the shape of a bell. The normal distribution is extremely important to statistics and has some specific characteristics that make it so useful in social science research.

In this unit, you will study the concept and use of normal curve in relation to educational evaluation, by use of suitable illustration and examples.

1.2. DEFINING NORMAL DISTRIBUTION :

To understand the normal distribution or the normal curve let us consider an example. Suppose a teacher conducted a test on Mathematics among 150 students of class X. The scores obtained by the students are arranged in a frequency distribution with class interval of 5 to have a better idea about their performance. The frequency distributions of the scores are presented in the table1.1

Table1.1. Frequency distribution of scores in Mathematics

Class interval	Frequency
15-20	1
20-25	2
25-30	4
30-35	7
35-40	10
40-45	16
45-50	20
50-55	30
55-60	20
60-65	16
65-70	10
70-75	7
75-80	4
80-85	2
85-90	1

In table 1.1. of frequency distribution, one thing is apparent that the maximum frequency which is 30 is concentrated in the central part of the frequency distribution and the other frequencies gradually spread away from the maximum frequency on both sides. If we draw a histrogram and a frequency polygon to the aforementioned data we will have curve as shown in figure 1.1. and 1.2.

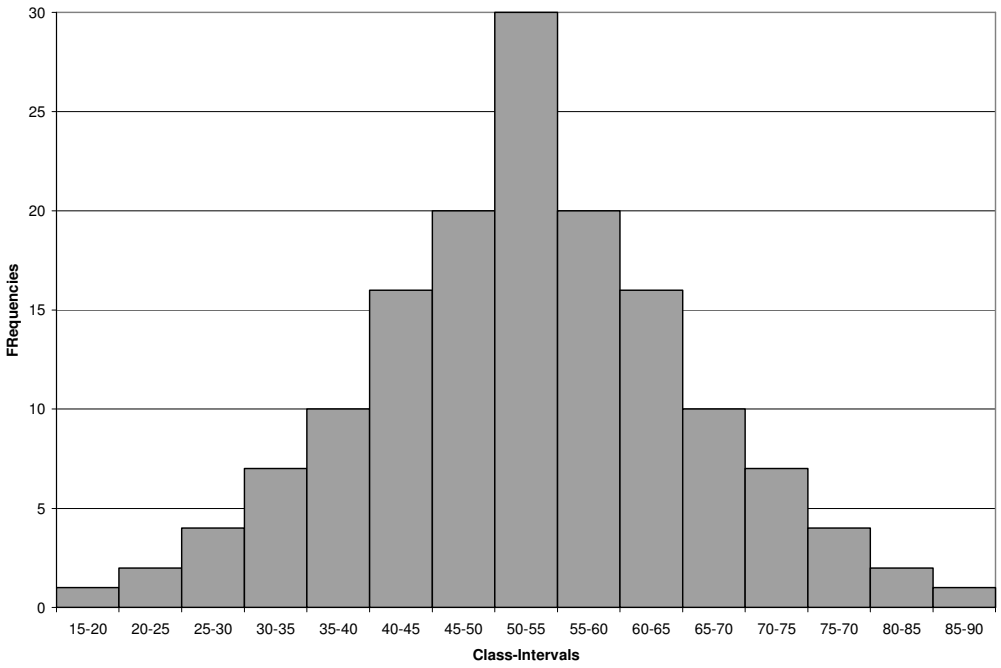


Figure 1.1. : Histrogram showing marks of students

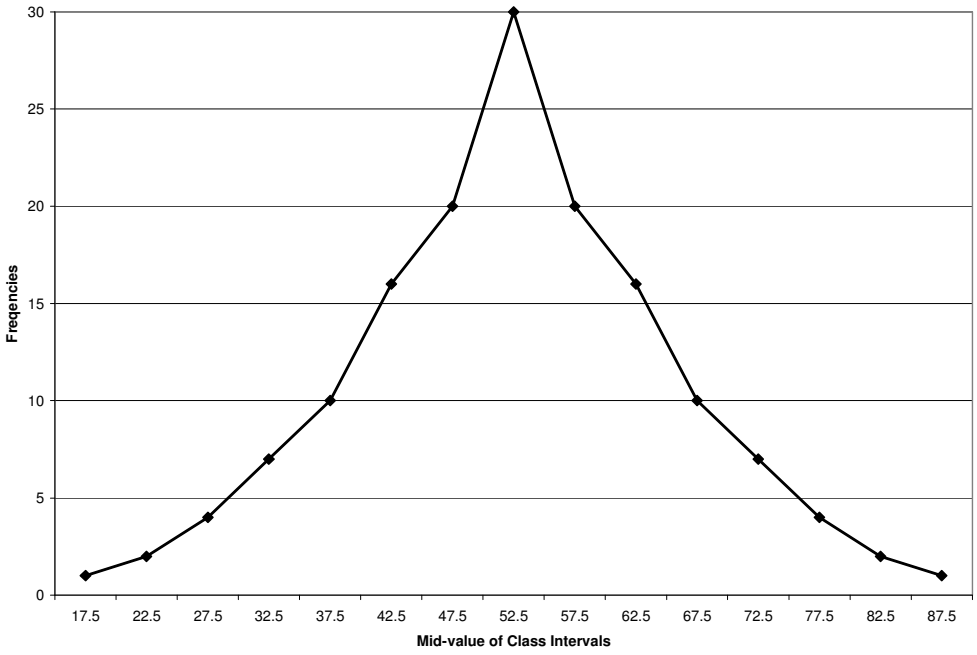


Figure 1.2.: Frequency Polygon showing the marks of students

If we observe the shape of the curve showing in the figure 1.2 we can recognize a more or less bell shape pattern. Also the curve is symmetrical on both sides from the maximum frequency. If we compute the values of mean, median and mode of the frequency distribution, you will find that these three are approximately same which is in this case is 52.

This type of bell shaped curve is technically known as Normal Probability Curve or simply Normal Curve and the corresponding frequency distribution of scores having equal values of mean, median and mode is known as Normal Distribution.

1.3. PROPERTIES OF NORMAL CURVE :

By observing the shape of the normal distribution curve, you may notice that the normal distribution is symmetrical i.e. if you divide the area under the curve (the area under the curve and x-axis) by drawing a line perpendicular from the highest point (i.e., mean) to the x-axis, this line bisects the whole area in to two parts which are very much similar in shape and size. The two parts are mirror images of each other. Another important property of normal distribution is that if you calculate the mean, median and mode of data following normal distribution it will be always same. In the normal curve, the mean, median and mode lies at the centre of the distribution. One interesting property of the normal curve is that it is asymptotic, means that the upper and lower tails of the curve never actually touch the X -axis (baseline). Normal distribution follows the functional form,

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp(-(x-\mu)^2 / 2\sigma^2); \qquad -\infty \le x \le \infty$$

Where μ and σ are the mean and standard deviation of X scores respectively. Another important from of the normal distribution is the standard normal form where we convert the X

scores to Z scores by using the transformation, $Z = \frac{X - \mu}{\sigma}$. The mean and standard deviation of Z scores is 0 and 1 respectively. The functional form of standard normal distribution is,

$$f(z) = \frac{1}{\sqrt{2\pi}} \exp(-\frac{z^2}{2}) \qquad -\infty \leq Z \leq \infty$$

1.3.1. Table of Area under Normal Curve:

Let us construct a normal curve based on the scores of the students obtained in a test as mention in section 1.2. The total area of the curve is arbitrarily considered as 100. By studying the area under the normal curve you will be able to learn what percentage of students is above or below a particular test score. If the total area under the normal curve is considered arbitrarily as 100, we can divide the area of the normal curve as follows,

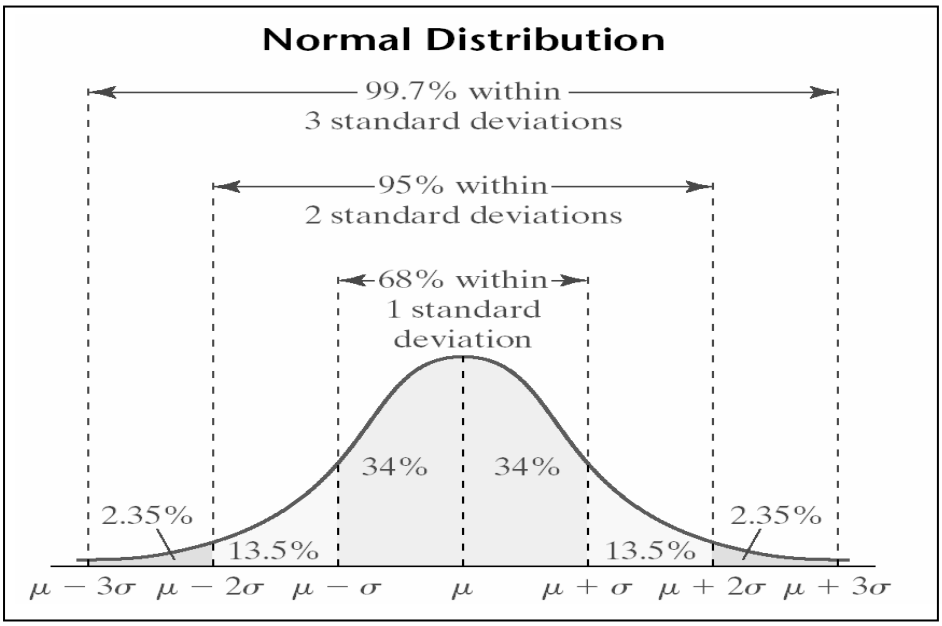


Figure 1.3.: Area under normal probability curve

From the figure 1.3 it is observed that 68.3% of the area of the curve falls between $\mu-\sigma$ and $\mu+\sigma$. In the present example, mean score of the student is 52 and standard deviation is 13, then from the area property we can say that the scores of about 68.3% of the students falls in the rage of 39 to 65. Again, the area fall under the area of $\mu-2\sigma$ and $\mu+2\sigma$ is about 95.4% ; while under $\mu-3\sigma$ and $\mu+3\sigma$ the area is about 99.7%. The table A in the Appendix gives the fractional part of the total area under the normal curve for different values deviation of mean from standard deviation (σ) .We can also find the area above or below a score or between two scores by using the table A given in the appendix after transforming the X scores to standard normal variate i.e., to Z scores by using the transformation $Z=\frac{X-\mu}{\sigma}$. Suppose for example, we want to see the percentage of students getting scores between 80 to 90. As we know that the mean and standard deviation of the score is 52 and 13 respectively. The steps for calculating percentage of students falls between 80 to 90 i.e., $80\le X\le 90$ is described below,

First we have to compute Z scores for both of the X scores i.e., 80 and 90.

The Z score for $X_1=80$ is $Z_1=\frac{80-52}{13}=2.15$

The Z score for $X_2=90$ is $Z_2=\frac{90-52}{13}=2.92$

The proportion of students or the area lying between 80 to 90 of the normal curve of original X scores is presented in figure 1.4.

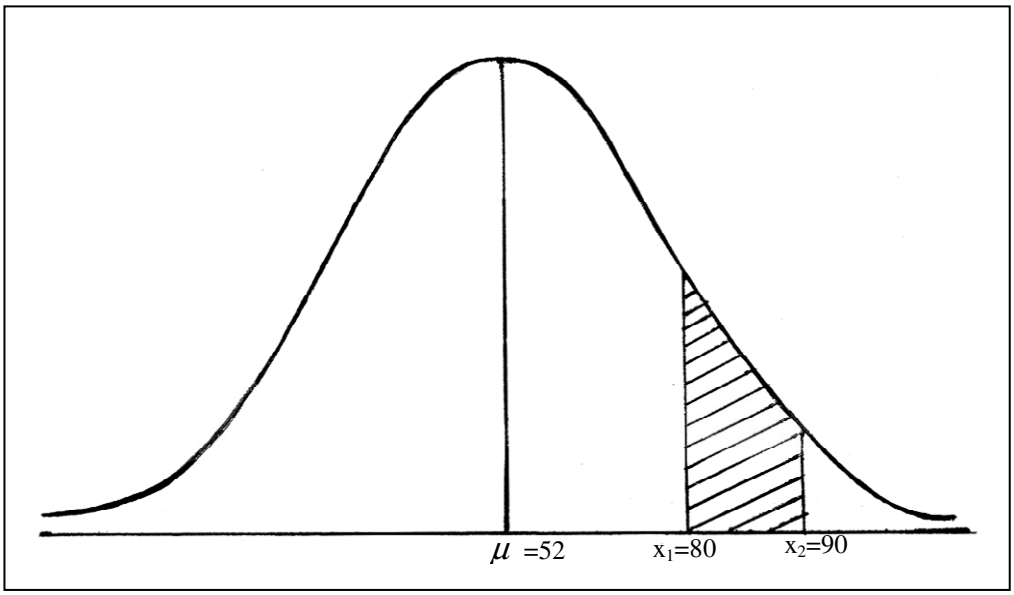


Figure 1.4

The equivalent standard normal curve of Z scores is in figure 1.5.

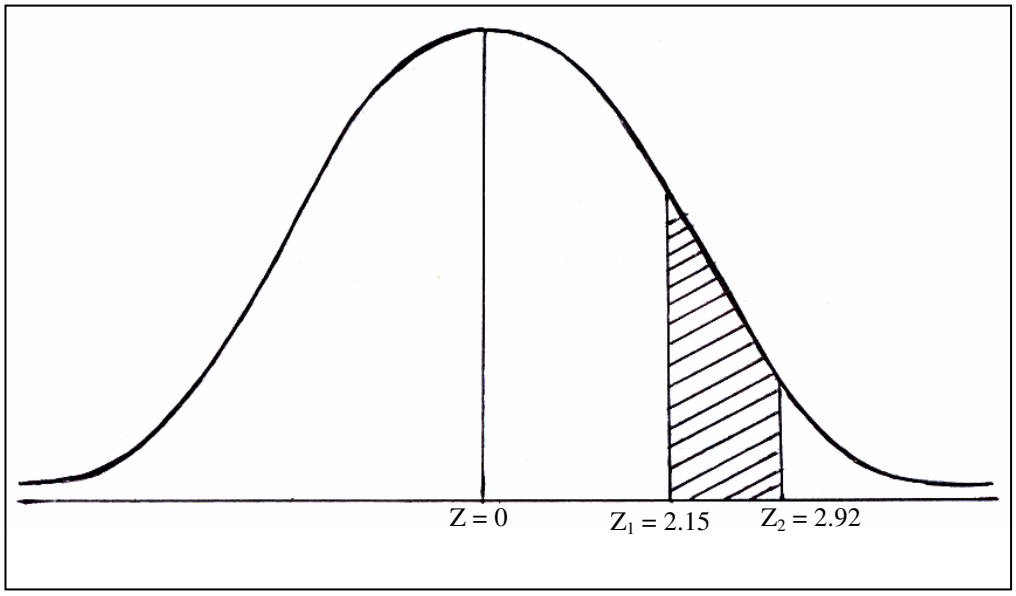


Figure 1.5

Thus in this case, we have to find the proportion of area covered by the standard normal curve between 2.15 to 2.92.

Since the table – I in the Appendix gives the fractional part of the total area (taken as 100) under the Normal Probability curve, corresponding to distances on the baseline between the mean and successive points. So from the table, we will not get the area between 2.15 and 2.92 directly; on the other hand, we will get the area between 0 (the mean of Z curve) to 2.15 and 0 to 2.92 separately. Letus denote the area covering from 0 to 2.15 be A and the area covering from 0 to 2.92 be B. Now, the area covering between the points $Z_1(2.15)$ to $Z_2(2.92)$ can easily obtained by subtracting A from B i.e., B-A. From the table the area of A and B are 48.42 and 49.82 respectively. Thus the area between the points 48.42 and 49.82 is 1.40. Thus, we can conclude that 1.4% of the students have secured marks between 80 to 90. The whole process is explained through figure 1.6.

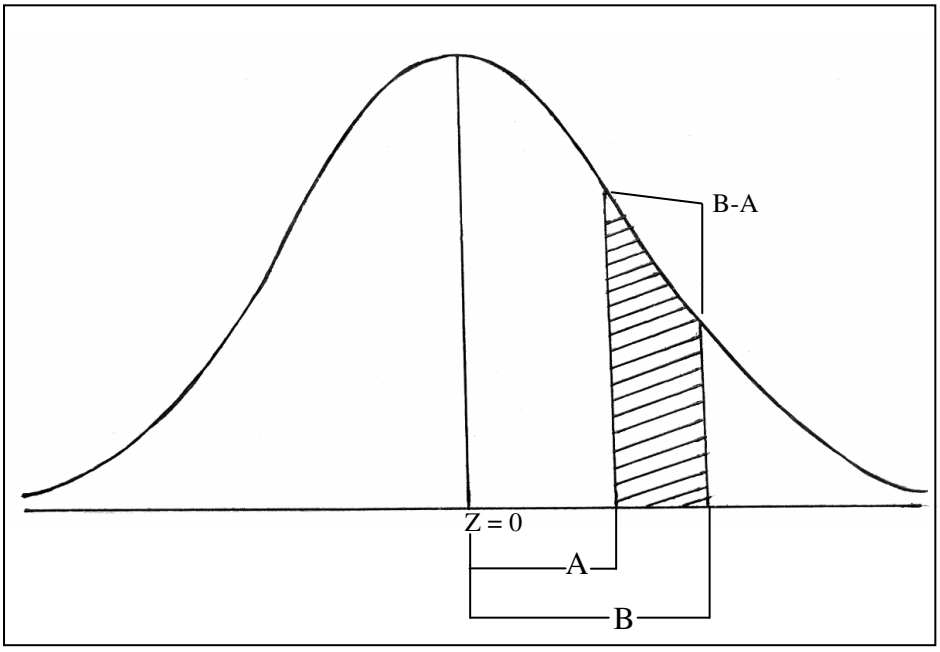


Figure 1.6

Check Your Progress I:

Q. 1. In a sample of 1000 cases the mean score of a certain test is 14.40 and standard deviation is 2.50. Assuming normality of distribution

(a) How many individuals score between 12 and 16?

(b) How many of them score above 18?

Q.2. State true or false

(a) The shape of the normal curve is bell shaped.

(b) The mean, median and mode of a frequency distribution possessing normality is not equal.

(c) The area covered by $\mu - \sigma$ and $\mu + \sigma$ in a normal probability curve is about 68.3% of the total area.

1.4. IMPORTANCE OF NORMAL DISTRIBUTION/CURVE IN EDUCATIONAL RESEARCH :

The normal distribution/curve has wide spread applications in educational measurement and evaluation. This distribution can be used to

i) determine percentages of cases (in a normal distribution) within given limits or scores

ii) determine the percentage of cases that are above or below a given score or reference point.

iii) determine the limits of scores which include a given percentage of cases.

iv) determine the percentile rank of a student in his own group.

v) determine the percentile value of a student's percentile rank

vi) compare two distributions in terms of overlapping.

vii) determine the relative difficulty of test items.

viii) divide a group into sub-groups according to certain ability and assigning the grades.

ix) generalize about population from which the samples are drawn by calculating the standard error of mean and other statistic.

x) normalize a frequency distribution which is important in standardizing a psychological test.

1.5. MEASURING DIVERGENCE FROM NORMAL PROBABILITY CURVE :

In Normal curve, the mean, the median and the mode all coincide and there is prefect balance between the right and the left side of the curve. Divergence from normality gives us curves of different shapes. Generally two types of divergence occur in the normal curve.

1.5.1. Skewness (S_k) :

The situation of skewness which means lack of symmetry occurs in a curve when the mean, median and mode of the curve are not coincide i.e., falls at different points and the balance of the curve is shifted to one side or the other – to left or right. In a normal curve mean equals median and thus skewness is zero. The more nearly the distribution approaches the normal form, the mean and median become more closer and subsequently gives us less skewness.

Skewness is denoted in mathematical notation by S_k. There are two types of skewness that appear in a distribution.

a) Negative Skewness : A distribution of scores is said to be negatively skewed when the scores are massed at the right side of the curve, and are spread out gradually towards the left side of the curve. In a negatively skewed curve the value of median is higher than the mean. The curve of negative skewness is depicted in figure 1.7.

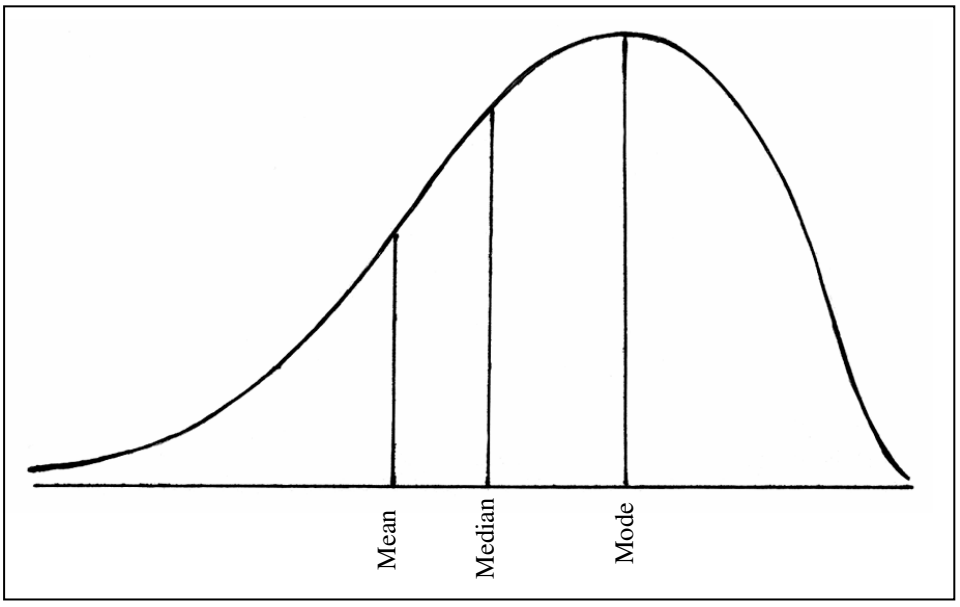


Figure 1.7

b) Positive Skewness : A distribution of scores is said to be positively skewed when the scores are massed at the left side of the curve, and are spread out gradually toward the right side of the curve. In curve of positive skewness the value of median is less than that of mean. The curve of positive skewness is shown in figure 1.8.

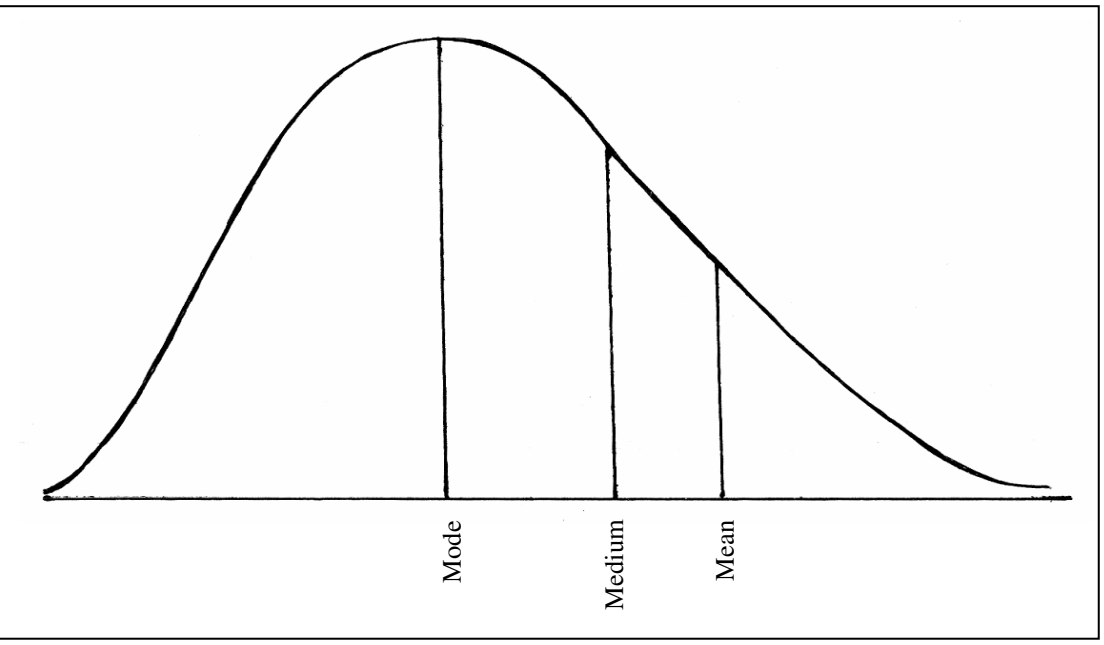


Figure 1.8

Measurement of Skewness : By measuring the skewness we can have idea about the nature of the curve whether it is symmetrical (normal) or positively or negatively skewed. The skewness of a distribution can be measured by using the formula,

$$\text{Skewness } (S_k) = \frac{3(mean - median)}{\sigma}$$

The value of the measure of skewness (S_k) lies within the range of -3 to +3.

If, S_k =0, then the distribution is symmetric i.e., normal

$S_k \rangle 0$, then the distribution is positively skewed

$S_k \langle 0$, then the distribution is negatively skewed

1.5.2. Kurtosis (K_u)

Kurtosis refers to the divergence in the height of the curve particularly to the peakness or flatness of a frequency distribution as compared with the normal. A frequency distribution more peaked than normal is said to be leptokurtic curve; on the other hand, a curve flatter than the normal is called platykurtic. The normal curve is known as mesokurtic curve. The following figure 1.9 shows the three types of curves.

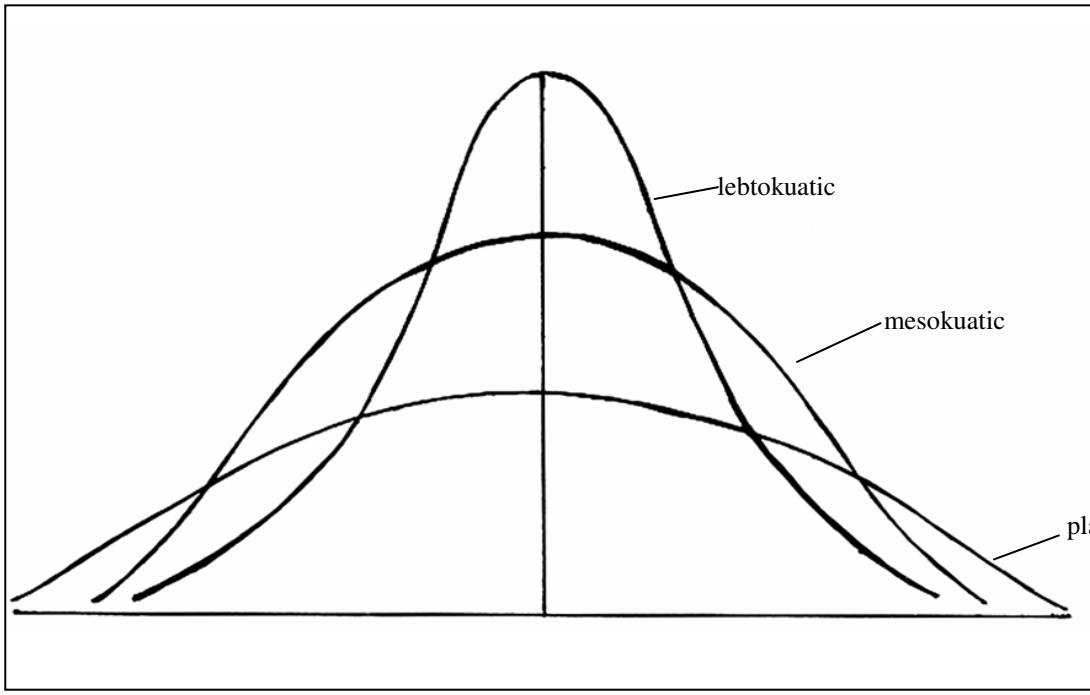


Figure 1.9

Kurtosis of a frequency distribution, measured in terms of percentiles, can be measured by using the formula,

$$K_u = \frac{Q}{(P_{90} - P_{10})}$$

Where Q is the quartile deviation, $Q = \frac{Q_3 - Q_1}{2}$; Q_1 and Q_3 are the first and third quartiles. P_{90} and P_{10} are the 90th and 10th percentile values.

If $K_u \langle 0.263$, the curve is more peaked than normal curve i.e., leptokurtic curve

$K_u = 0.263$, the curve is normal or mesokurtic

$K_u \rangle 0.263$, the curve is more flatter than normal curve i.e., playkurtic curve.

Example 1.1: The scores of 25 students are given below

72	75	77	67	72
81	78	65	86	73
67	82	76	76	70
83	71	63	72	72
61	67	84	69	64

Calculate (1) Skewness

(2) Kurtosis

(3) whether the scores follow normal distribution.

From the score given, we can calculate,

The arithmetic mean, $\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n} = 72.92$

The median, $M_d = 72$

The standard, $\sigma = \frac{1}{n}\sum_{i=1}^{n}(X_i - \bar{X})^2 = 6.86$

The first quartile $Q_1 = 67.00$

The third quartile $Q_3 = 77.50$

The 10th Percentile, $P_{10} = 63.6$

The 90th Percentile, $P_{90} = 83.4$

(1) The skewness

$$(S_k) = \frac{3(mean - median)}{\sigma}$$

$$= \frac{3(72.92 - 72)}{6.86}$$

$$= \frac{2.76}{6.86} = 0.40$$

(2) Kurtosis,

Since, $Q_1 = 67$ and $Q_3 = 77.5$

Therefore, the quartile deviation,

$$Q = \frac{Q_3 - Q_1}{2}$$

$$= \frac{77.5 - 67}{2}$$

$$= 5.25$$

Now, Kurtosis,

$$K_u = \frac{Q}{(P_{90} - P_{10})}$$

$$= \frac{5.25}{(83.4 - 63.6)}$$

$$= 0.26$$

(3) Since Skewness (S_k)=0.4, the curve is positively skewed. As if the value of skewness is very close to zero, therefore, the curve approaches to Normal Probability cuver. Again Kurtosis (K_u)= 0.26 means the curve is approximately mesokurtic i.e, Normal curve.

Example 1.2: If the mean, standard deviation and skewness of a frequency distribution are 60, 45 and -0.4 respectively. Find the median of the frequency distribution.

= Given that, Mean $(\bar{X})$=60

Standard deviation $(\sigma) = 45$

And skewness (S_k) =-0.4

Since we know that, $S_k = \frac{3(mean - median)}{\sigma}$

From this relationship we can get

$$median = \frac{1}{3}\{3mean - \sigma S_k\}$$

$$= \frac{1}{3}\{3 \times 60 - 45 \times (-0.4)\}$$

$$= 66$$

Thus median of the frequency distribution is 66.

Check your progress II

Q.1. Examine the shape of the curve with the help of Skewness and Kurtosis.

Class Interval (Score)	Frequency
140-145	1
145-150	2
150-155	4
155-160	5
160-165	8
165-170	10
170-175	6
175-180	4
180-185	4
185-190	2
190-195	3
195-200	1

Q.2. Fill up the blanks :

(a) Skewness of a curve means lack of _____.

(b) In a negatively skewed curve _____ is higher than _____.

(c) In case of positive skewness of a set of data _____ is higher than _____.

(d) if $S_k < 0$, then the distribution is _____ skewed.

(e) Normal curve is also known as _____.

(f) A curve flatter than normal is called _____.

(g) If the value of kurtosis is equal to zero than the curve is _____.

1.5. LET US SUM UP :

After reading this unit you are able to know

(1) The basic idea about normal distribution/curve i.e., normal curve is symmetrical, mean, median and mode of the normal distribution is equal and the normal curve is asymptotic about the baseline.

(2) The number of students securing marks within a range, above or below a particular cut off point can be obtained by using normal probability cure.

(3) Normal probability distribution/curve can also be used for achieving other purposes of educational research such as determination of the percentile rank of a student in his own group, assessing the relative difficulty of test items etc.

(4) Skewness and kurtosis are used to study the divergence of a frequency distribution from normal distribution.

1.6. KEY WORDS :

Normal distribution : Normal distribution is a probability distribution which is symmetrical and asymptotic about x-axis.

Standard Normal variate : The standard normal variate (Z) is obtained by using the transformation $Z = \frac{X - \mu}{\sigma}$

Skewness : Skewness gives the idea about the lack of symmetry of a curve. Skewness are of two types viz. negative and positive skewness.

Kurtosis : Kurtosis measure the faltness or peakness of a curve compared to normal curve. A more peaked curve than normal curve is called leptokurtic while a more flat curve than normal is called platykurtic curve.

1.7. SUGGESTED READINGS :

1. Gupta S.C. and Kapoor V.K. .2000. Fundamentals of Mathematical Statistics. Sultan Chand & Sons. New Delhi.
2. Spiegel M.R. and Stephens L.J. 1999.Schaum's Outlines : Statistics. Third Edition. Mcgraw-Hill International Editions, Schaum's Outline Series.
3. Agarwal B.L. Programme Statistics, Second Edition. New Age International Publishers. 2003

Possible Answers to Check your Progress :

Check Your Progress - I

Suppose, the variable X denotes the scores of a test. It is given that X follows normal distribution. The mean and standard deviation of X is μ = 14.40 σ = 2.50 respectively. Let us consider the standard normal variate,

$$Z = \frac{X - \mu}{\sigma} = \frac{X - 14.40}{2.5}$$

(a) In this case we have to find the number of individuals score between 12 and 16. For this, first we have to find the proportion of area cover in the normal curve in between the score of 12 and 16. In this normal curve (given below in figure 1), we have to find the area of the shaded part.

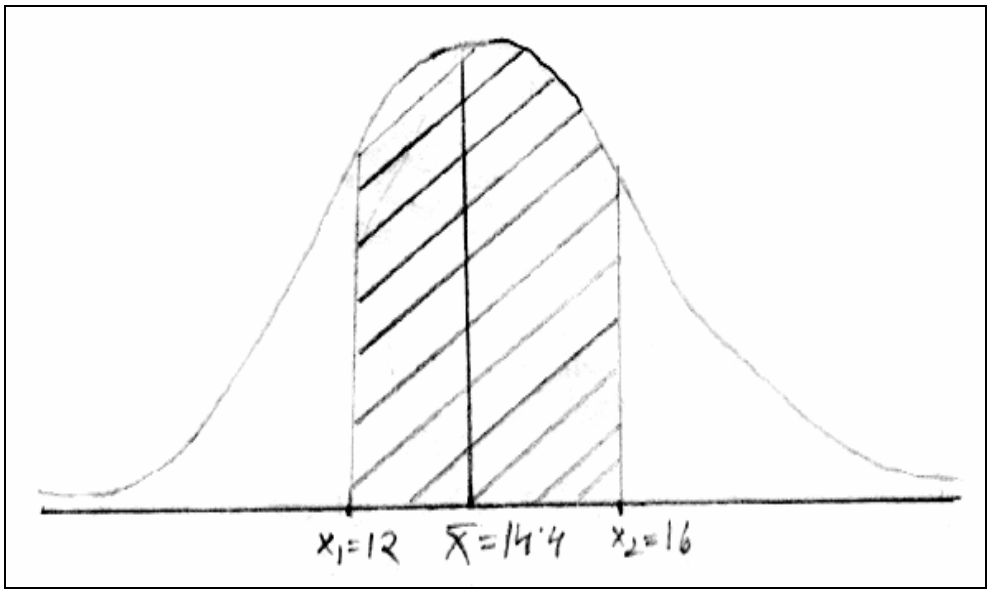


Figure – 1

Let us convert $X_1 = 12$ and $X_2 = 16$ to Z scores as $Z_1 = \frac{12 - 14.40}{2.50} = -0.96$ and $Z_2 = \frac{16 - 14.40}{2.50} = 0.64$. In the standard normal curve we have to find the shaded area between the points $Z_1 = -0.96$ and $Z_2 = 0.64$ given in figure 2.

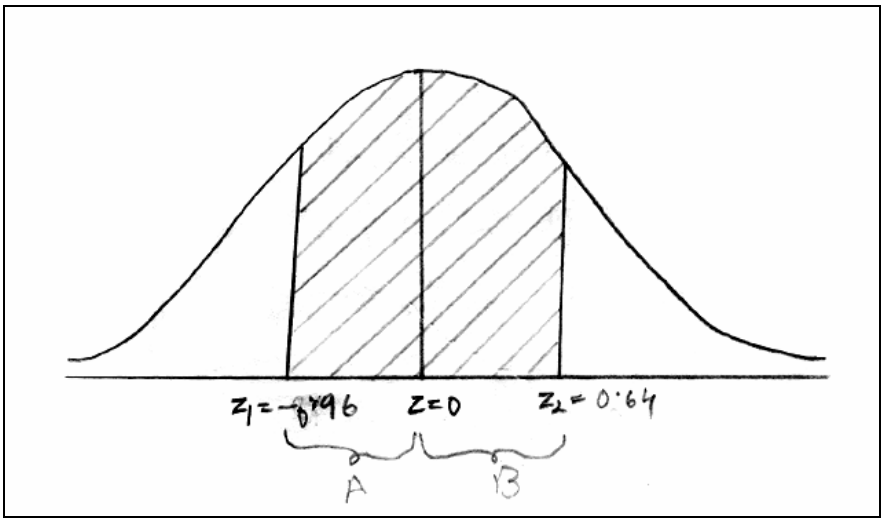


Figure – 2

Now, Let us divide the area between the points Z_1 and Z_2 into two parts A and B as shown in figure 2.

From table - I given in Appendix, the area of A i.e. Z to Z_1 is 33.15.

Again, the area of B i.e. Z to Z_2 is 23.89.

Therefore, the area between the points Z_1 to Z_2 is A + B = 33.15 + 23.89

= 57.04

The total area of the carve is 100 and out of them 57.04 are within the score of 12 to 16.

Since we have 1000 students,

So, $\frac{57.40}{100} \times 1000 = 574$ students scored between 12 to 16.

(b) Here we have to find the number of students score above 18. Figure 3 shows the shaded area we need to find.

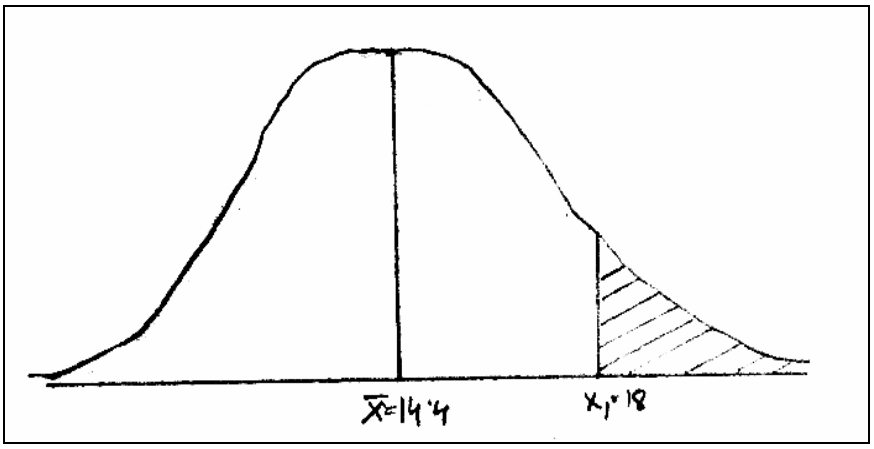


Figure – 3

Convert X_1 to $Z_1 = \frac{X_1 - \mu}{\sigma} = \frac{18 - 14.40}{2.50} = 1.44$

The equivalent standard normal curve is shown in Fig. 4.

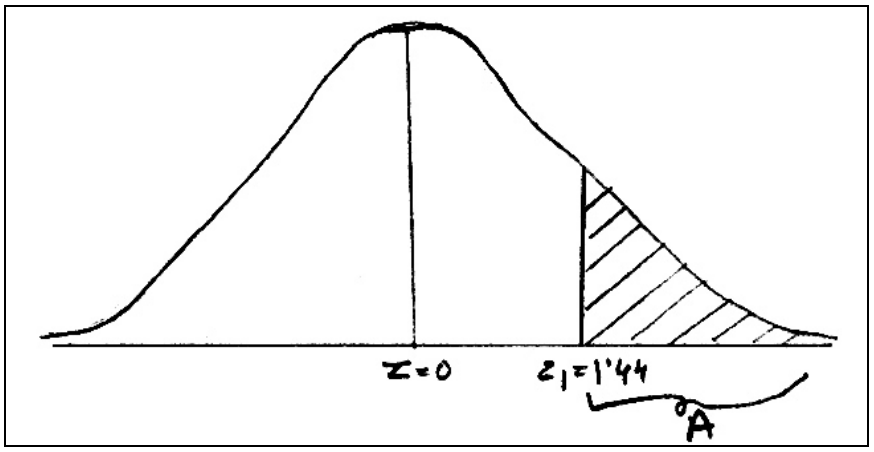


Figure – 4

Since the area of the curve is 100 and the point Z=0 divide the whole curve into two equal parts. The area of the curve to the right to

Z=0 is 50. The area between the two points Z and Z_1 is 42.51 (Table – I). Thus the area of the region A as shown in Figure 4 is 50 – 42.51=7.49.

Thus the total number of students scoring above 80 is $\frac{7.49}{100} \times 1000 = 74.9$ which is approximately 75.

Q.2. (a) True

(b) False

(c) True

Check your progress – II

Skewness : The formula for calculating skewness of a curve is,

$$S_k = \frac{3(mean - median)}{\sigma}$$

From the data given in the table,

$$\text{Mean } (\bar{x}) = \frac{\sum_{i=1}^{12} f_i x_i}{N} = 168.7 \text{ , where } N = \sum_{i=1}^{12} f_i$$

$$\text{Median } (Md) = l + \frac{h}{f}(N/2 - c) = 167.5$$

The median class of this data set 165-170, l is the lower limit of the median class, h and f is the magnitude and frequency respectively of the median class. c is the cumulative frequency of the class preceding the median class.

$$\text{The standard deviation } (\sigma) = \frac{1}{N}\sum_{i=1}^{12} f_i x_i^2 - \bar{x}^2 = 159.56$$

$$\text{The skewness } S_k = \frac{3(168.7 - 167.5)}{159.56} = 0.023$$

Here, in this case, $S_k > 0$ but close to zero. therefore, the curve of the data is slightly skewed.

Kurtosis : The formula for calculating kurtosis is,

$K_u = \frac{Q}{(P_{90} - P_{10})}$, Where Q is the quartile deviation, $Q = \frac{Q_3 - Q_1}{2}$; Q_1 and Q_3 are the first and third quartiles.

$Q_1 = 160.313, \quad Q_3 = 176.875$

$$Q = \frac{Q_3 - Q_1}{2} = 8.281$$

The percentile values,

$$P_{10} = 152.5 \text{ and } P_{90} = 187.5$$

The Kurtosis, $K_u = \frac{8.281}{(187.5 - 152.5)} = 0.237$

Since, $K_u \langle 0.263$,

Thus, the curve is more peaked than normal curve, i.e., leptokurtic curve.

Q.2. (a) Symmetric

(b) Median, Mean

(c) Mean, Median

(d) Negatively

(e) Mesokurtic

(f) Platykurtic

(g) Normal

1.8. REFERENCES :

1. Garrett H.E. and Woodworth R.S. Statistics in Psychology and Education. Vakils, Feffer and Simons Ltd. 1981.
2. Koul L. Methodology of Educational Research. Fourth Edition. Vikas Publishing House Pvt. Ltd. 2009
3. Arora P.N., Arora Sumeet and Arora S. Comprehensive Statistical Methods. S.Chand and Company Ltd. 2007
4. Urdan T.C. Statistics in Plain English, Second Edition. lawrence Erlbaum Associates, Publishers. 2005

Model Questions :

1. Define normal distribution. Explain its properties.
2. In a test the scores obtained by the students is essentially normally distributed with mean $\mu = 100$ and standard deviation $\sigma = 20$. Find
   (a) what percentage of scores lies between 85 and 125?
   (b) The middle 50% falls between two points.
3. Explain different uses of normal distribution
4. Compute the measures of skewness and kurtosis of the following frequency distribution and give interpretation about the shape of the curve.

Scores	**Frequency** (f)
100-109	5
90-99	9
80-89	14
70-79	19
60-69	21
50-59	30
40-49	25
30-39	15
20-29	10
10-19	8
0-9	6

UNIT - II : MEASURES OF RELATIONSHIP: CORRELATION

STRUCTURE

2.0 Objectives:

In Unit I, we have discussed the statistical description of a single variable through normal probability curve. You are also familiar with the basic descriptive statistics like mean, median, mode, standard deviation, dispersion etc. After going through this unit you will be able to:

- explain the purpose of correlation
- define the product moment and rank difference correlations
- compute and interpret the product moment and rank difference correlations
- interpret the results of computed correlation
- explain what is scatter diagram and how it is used for studying correlation

2.1 Introduction:

The study related to the characteristics of only one variable such as height, weight, ages, marks, wages, etc., is known as *univariate analysis*. The statistical analysis related to the study of the problem of describing the simultaneous variation of two variables is known as *bivariate analysis*. The data in which we obtain measures of two variables for each individual is called bivariate data. For example, scores of the tests in Science and Assamese for a group of school going students. The essential feature of bivariate data is that one measure can be paired with another measure for each member of the group. While studying bivariate data you may like to know the degree of relationship between two variables known as correlation. Correlation analysis is a tool for studying bivariate relation of data. However, this can be extended for more than two variables, which is beyond the scope of our present discussion. The objective of

correlation analysis is to gain insight into the strength of the relationship between the variables under study. When conducting correlation analysis, we use the term *association* to mean "linear association".

Out of the different methods of measuring correlation such as product moment correlation, rank correlation, scatter diagram, method of concurrent deviation etc., in this unit you will study the method of Pearson's (r) product moment correlation, Scatter Diagram and Spearman's rank difference (ρ) correlation.

2.2 Studying Correlation: Pearson's Product Moment Correlation :

In many investigations we may have measurements on two variables expressed in interval or ratio level of measurements. Here the sample consists of pairs of values and the research objective is concerned with the association between these variables. Correlation is a concept that carries the common colloquial implication of association like "association between mother's weight and baby's weight" for measuring the degree of strength of the relationship between mother's weight and baby's weight. A statistical procedure namely, Pearson's product moment correlation will tell you the strength of the association between these two variables.

The *Pearson simple (linear) correlation coefficient*, also known as the *simple correlation coefficient (r) or product-moment correlation coefficient or simply correlation coefficient,* was introduced by Galton in 1877 and developed later by Professor Karl Pearson. It measures the degree of linear relationship between two variables under study usually labeled as X and Y. A linear correlation

coefficient can be computed by means of the data and their sample means under the **assumptions** that

1. The two series under study should be affected by a large number of independent causes which approaches to the normal distribution.
2. The forces affecting the distribution of items in the two series should be related to each other in some meaningful manner i.e. in terms of linearity and randomness (occurrences based on chance).

Thus, under the existence of above assumptions, for two variables X and Y, it is defined as follows:

$$r = \frac{\sum XY - n\,\overline{X}\,\overline{Y}}{\sqrt{\sum X^2 - n\,\overline{X}^2}\ \sqrt{\sum Y^2 - n\,\overline{Y}^2}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (2.1)$$

$$= \frac{\sum x\,y}{\sqrt{\sum x^2 - \sum x^2}} \quad where\ x = X - \overline{X}\ and\ y = Y - \overline{Y} \ldots\ldots\ldots\ldots (2.2)$$

where $\overline{X}$ = Average (Mean) of X series.

$\overline{Y}$ = Average (Mean) of Y series.

n = number of pair of observations

Example 2.1: Calculate the Pearson's product moment correlation coefficient for the given data of reading scores and arithmetic scores

Reading Scores:	95	90	85	80	75	70	65	60	55
Arithmetic Scores:	76	78	77	71	75	76	73	75	74

Solution: <u>Method 1(Refer to the formula (2.1)</u>

Here,

$$r = \frac{\sum XY - n\,\overline{X}\,\overline{Y}}{\sqrt{\sum X^2 - n\,\overline{X}^2}\ \sqrt{\sum Y^2 - n\,\overline{Y}^2}}$$

Table for Computation

	X	Y	X^2	Y^2	XY
	95	76	9025	5776	7220
	90	78	8100	6084	7020
	85	77	7225	5929	6545
	80	71	6400	5041	5680
	75	75	5625	5625	5625
	70	76	4900	5776	5320
	65	73	4225	5329	4745
	60	75	3600	5625	4500
	55	74	3025	5476	4070
Total	675	675	52125	50661	50725

$$\overline{X} = \frac{\sum X}{n} = \frac{675}{9} = 75$$

$$\overline{Y} = \frac{\sum Y}{n} = \frac{675}{9} = 75$$

$$\therefore \quad r = \frac{50725 - 9\times 75\times 75}{\sqrt{52125 - 9\times 75^2}\ \sqrt{50661 - 9\times 75^2}} = \frac{100}{\sqrt{1500}\ \sqrt{36}} = \frac{100}{232.379} = 0.4303$$

$$= 0.43$$

You can solve the above problem by applying following method too.

Method 2(Refer to the formula (2.2)

Denoting reading scores and arithmetic scores by X and Y variables respectively, we have

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}}$$ Such that

$$\overline{X} = \frac{\sum X}{n} = \frac{675}{9} = 75$$ and

$$\overline{Y} = \frac{\sum Y}{n} = \frac{675}{9} = 75$$

Table for Computation

	X	Y	$x = X - \bar{X}$	$y = Y - \bar{Y}$	X^2	Y^2	XY
	95	76	20	1	400	1	20
	90	78	15	3	225	9	45
	85	77	10	2	100	4	20
	80	71	5	- 4	25	16	- 20
	75	75	0	0	0	0	0
	70	76	- 5	1	25	1	- 5
	65	73	- 10	- 2	100	4	20
	60	75	- 15	0	225	0	0
	55	74	- 20	- 1	400	1	20
Total	675	675			1500	36	100

$$\therefore \quad r = \frac{100}{\sqrt{1500 \times 36}} = \frac{100}{\sqrt{54000}} = \frac{100}{232.379} = 0.4303 = 0.43$$

Example 2.2: From the following information, calculate the coefficient of correlation by Karl Pearson's method:

X: 6 2 10 4 8
Y: 9 11 5 8 7
A.M. of X and Y series are 6 and 8 respectively.

Solution: <u>Method 1(Refer to the formula (2.1)</u>

$$r = \frac{\sum XY - n\bar{X}\bar{Y}}{\sqrt{\sum X^2 - n\bar{X}^2}\sqrt{\sum Y^2 - n\bar{Y}^2}}$$

Table for Computation

	X	Y	X^2	Y^2	XY
	6	9	36	81	54
	2	11	4	121	22
	10	5	100	25	50
	4	8	16	64	32
	8	7	64	49	56
Total	30	40	220	340	214

$$\bar{X} = \frac{\sum X}{n} = \frac{30}{5} = 6$$

$$\bar{Y} = \frac{\sum Y}{n} = \frac{40}{5} = 8$$

$$r = \frac{214 - 5\times 6\times 8}{\sqrt{220 - 5\times 6^2}\ \sqrt{340 - 5\times 8^2}} = \frac{214 - 240}{\sqrt{220 - 180}\ \sqrt{340 - 320}} = \frac{-26}{\sqrt{40}\sqrt{20}} = \frac{-26}{\sqrt{800}} = \frac{-26}{28.2843} = -0.92$$

You can solve the above problem by applying following method too.

Method2 (Refer to the formula (2.2)

Here, $$r = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}}$$

Table for Computation

X	Y	$x = X - \bar{X}$	$y = Y - \bar{Y}$	x^2	y^2	xy
6	9	0	1	0	1	0
2	11	-4	3	16	9	-12
10	5	4	-3	16	9	-12
4	8	-2	0	4	0	0
8	7	2	-1	4	1	-2
30	40			40	20	-26

$$\therefore \quad r = \frac{-26}{\sqrt{40\times 20}} = \frac{-26}{\sqrt{800}} = \frac{-26}{28.2843} = -0.92$$

Example 2.3: Compute product moment correlation coefficient from the following data

$\bar{X} = 12, \bar{Y} = 9, n = 10, \sum X^2 = 2000, \sum Y^2 = 1200$ *and* $\sum XY = 622$

Solution: Here,

$$r = \frac{\sum XY - nXY}{\sqrt{\sum X^2 - n\,X^2}\ \sqrt{\sum Y^2 - nY^2}} =$$

$$\frac{622 - 10\times 12\times 9}{\sqrt{2000 - 10\times 12^2}\ \sqrt{1200 - 10\times 9^2}} = \frac{622 - 1080}{\sqrt{560}\sqrt{390}} = \frac{-458}{\sqrt{218400}} = -0.98$$

2.2.1 Properties of Product Moment Correlation Coefficient (r) :

***Property1*:** Correlation coefficient lies between –1 and +1. i.e.

$-1 \leq r \leq 1$.

***Property2*:** Correlation coefficient is independent of change of origin and scale.

Property 3: It is a pure number independent of units of measurement.

Property 4: Independent variables are uncorrelated but the converse may not be true.

Property 5: The correlation coefficient of X and Y is symmetric. i.e., correlation coefficient between X and Y is equal to the correlation coefficient between Y and X.

2.2.2 Interpreting the values of Product Moment Correlation:

Based on the above property we can make following interpretations on different values of Product Moment Correlation Coefficient (r):

- $0 < r < 1$ implies that there is positive correlation between X and Y. Closure the value of r to 1 stronger is the positive correlationship, and closure the value of r to 0 (the value being positive) the weaker is the positive correlationship.
- $r = 1$ implies that there is perfect positive correlation between X and Y.
- $-1 < r < 0$ implies that there is negative correlation between X and Y. Closure the value of r to -1 stronger is the negative correlationship, and closure the value of r to 0 (the value being negative) the weaker is the negative correlationship.
- $r = -1$ implies that there is perfect negative correlation between X and Y.

- r =0 implies that there is zero correlation or no correlation between X and Y. In this case X and Y are said to be uncorrelated.

The pairs of variables are said to be positively correlated if one increases, the other tends to increase like intelligence and academic achievement in the perspective of education. The variables are said to be negatively correlated if one increases, the other tends to decrease like academic achievement and hours per week spend on entertainment programme in television. There are other traits that probably have no correlation like body weight and intelligence.

Note : A correlation of 0 doesn't mean that there is no association; it means that there is no linear association. You can have a correlation near 0 and yet have a very strong association, such as the case when the data fall neatly on a sharply bending curve.

CHECK YOUR PROGRESS – I

Q.1. Find the correlation coefficient between the following set of scores using product moment method.

Subject: A	B	C	D	E	F	G	H	I	J	
Test scores X:	13	12	10	10	8	6	6	5	3	2
Test scores Y:	11	14	11	7	9	11	3	7	6	1

Q.2. Calculate the correlation coefficient by adopting product moment method from the following data.

$\overline{X} = 4, \overline{Y} = 3, n = 30, \sum X^2 = 600, \quad \sum Y^2 = 350 \text{ and } \sum XY = 456$

Q.3. State true or false:

(a) Correlation coefficient in unaltered due to change of origin and scale.

(b) Product moment correlation is used for both qualitative and quantitative data.

(c) Value of r = 0.89 means negative correlation exists between the variables under study.

2.3: Studying Correlation: Spearman's Rank Correlation :

The Spearman's rank correlation coefficient (ρ) is the correlation coefficient between the ranks (the relative order) of two variables based on qualitative characteristics such as intelligence, beauty, honesty, ability etc. It was first introduced by Charles Edward Spearman in 1904. The Spearman ρ is used to measure the monotonic relationship between two categorically measured variables. It can be used even if the data are erratic or irregular and therefore, the normality assumptions of data like Pearsonian correlation are not applicable over here. It is studied when no assumption about population parameter is made. One advantage of this method is that it can be applied to the variables which are also measured in interval or ratio scales. However, in this case the given measurements are to be converted to the ordinal scale. The computation procedure of Spearman's rank correlation is as follows:

Let $R_1, R_2, R_3, \ldots, R_n$ be the difference in ranks of n qualitatively measured paired observations (X, Y) then the rank correlation coefficient between X and Y is:

$$\rho = 1 - \frac{6\sum d^2}{n(n^2-1)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (2.3)$$

where d = difference in ranks of X and Y series; *n* be the total no. of paired observations.

Example2.4: Based on the following rank given by expert in two tests conducted on a certain group of students, calculate Spearman's rank correlation coefficient.

Rank in reading:	1	2	3	4	5	6	7	8	9
Rank in arithmetic:	4	2	3	9	5	1	7	8	6

Solution: The formula for rank correlation coefficient is:

$$\rho = 1 - \frac{6\sum d^2}{n(n^2-1)}$$

Rank in reading (R_1)	Rank in arithmetic (R_2)	$d = R_1 - R_2$	d^2
1	4	-3	9
2	2	0	0
3	3	0	0
4	9	-5	25
5	5	0	0
6	1	5	25
7	7	0	0
8	8	0	0
9	6	3	9
			$\sum d^2 = 68$

Thus, $\rho = 1 - \frac{6 \times 68}{9(9^2 \times 1)} = 1 - \frac{408}{720} = 1 - \frac{408}{720} = 1 - 0.0.567 = 0.433$

Example2.5: Calculate Spearman's rank correlation coefficient between advertisement cost and sales from the following data:

Adv. Cost (Rs. 1000) : 39 65 62 90 82 75 25 98 36 78

Sales (Rs. 100000) : 47 53 58 86 62 68 60 91 51 84

Solution: The formula for rank correlation coefficient is:

$$\rho = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

Table for Computation

Adv. Cost (X)	Sales (Y)	Rank in X (R_1)	Rank in Y (R_2)	$d = R_1 - R_2$	d^2
39	47	8	10	-2	4
65	53	6	8	-2	4
62	58	7	7	0	0
90	86	2	2	0	0
82	62	3	5	-2	4
75	68	5	4	1	1
25	60	10	6	4	16
98	91	1	1	0	0
36	51	9	9	0	0
78	84	4	3	1	1
					$\sum d^2 = 30$

Thus, $\rho = 1-\frac{6\times 30}{10\left(10^2-1\right)}=1-\frac{180}{990}=1-0.1818=0.8182=0.82$

Note: Ranks started from 1, 2, …, 10 are to be considered either from the highest value or from the lowest value in order. In this problem ranks are given starting from the highest value in a series i.e. rank 1 to the highest value, rank 2 to the next one and so on and so forth.

CHECK YOUR PROGRESS – II

Q.1. Find the rank correlation coefficient from the following data

Individuals:	A	B	C	D	E	F	G	H
Marks in Hindi:	30	40	50	20	10	45	22	18
Marks in English:	55	75	60	12	11	38	25	15

Q.2. Calculate the coefficient of correlation by rank difference method in the following groups:

Rank in X:	2	4	1	5	6	7	3
Rank in Y:	1	3	2	5	7	6	4

2.4 Studying Correlation: Scatter Diagram :

Scatter plot is the way of studying correlation through diagrammatic representation by which one can easily understood what type of linear relationship exists between two types of variables X and Y (say) and what the strength of such relation is. If we let each pair of numbers (X, Y) be represented by a dot in a diagram with the X's on the horizontal axis and Y's on vertical axis, we have Figure 2.1 and 2.2. The dots do not fall perfectly on a straight line in general (*if lies on a straight line then a perfect association exists between variables under study*), but rather, scatter around a line. Because of

this scattering of dots, the diagram is called a **scatter diagram**. The positions of the dots provide some information about the direction as well as the strength of the association under the investigation. If they tend to go from lower left to upper right, you will get a positive association; if they tend to go from upper left to lower right, a negative association exhibited over there. The relationship becomes weaker and weaker as the distribution of the dots clusters less closely around the line, and becomes virtually no correlation (*i.e. linear*) when the distribution approximates a circle or oval.

Based on the discussion given in section 2.3.1under Property 1 we have following scatter plots to define different types of linear association that can be exhibited between two variables X and Y.

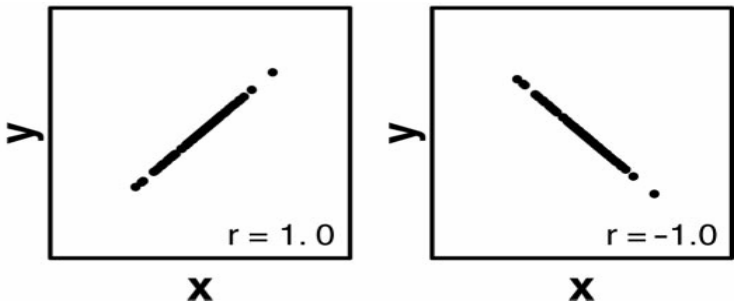


Figure 2.1: Scatter plots of two sets of data generated by means of the Pearson correlation coefficients (from left to right): $r = 1.0$ (perfectly positively correlated), and $r = -1$ (perfectly negatively correlated).

Apart from this, based on different values of r discussed so far, we have following representations of linear correlation which can be illustrated through scatter plot.

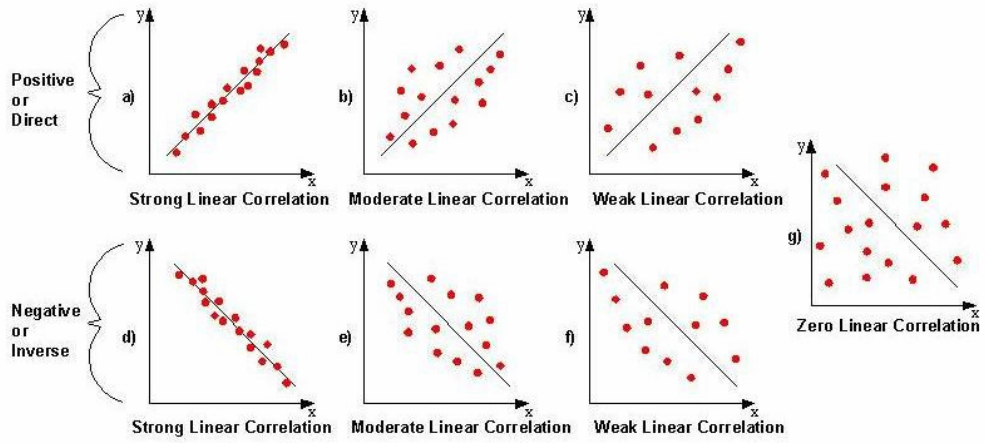


Figure 2.2: Scatter plots of two sets of data generated by means of the Pearson correlation coefficients for positive, negative and zero correlation.

2.5 Uses of Correlation in Educational Research :

In education particularly in psychology, there are times when it is needed to know whether there exists any relationship between the different abilities of the individual or they are independent of each other. Consequently, there are numerous questions like the following which have to be answered:

1. Does scholastic achievement depend upon the general intelligence of a child?
2. Is it true that the height of the children increases with the increase in their age?
3. Is there any relationship between the size of the skull and general intelligence of the individuals?
4. Is it true that dull children tend to be more neurotic than bright children?

The questions and problems like the above in which there is a need to find out the relationship between two variables (age and

height, intelligence and achievement etc.) can be tackled properly by the method of correlation. In addition to this, the coefficient of correlation can be used in the following areas of advanced educational research:

(i) testing reliability and validity of psychological tests and inventories

(ii) technique of factor analysis

(iii) predicting one value from the other and

(iv) technique of path analysis.

2.6 Let us sum up :

After going through this unit, you have learnt correlation as a measure degree of relationship between two variables. What have been revealed from this unit is summarized as:

1. Correlation analysis deals in the data which are bivariate (data in which we obtain measures of two variables for each individual on ratio or interval scales) in nature.
2. The main objective of correlation analysis is to gain insight into the strength of the relationship between two variables.
3. Karl Pearson's product moment correlation is used to obtain the linear relationship between two quantitative variables while Spearman's rank difference correlation is used to measure the relationship between two qualitatively measured variables. However, the later can be used in case of quantitatively measured variables too.
4. Coefficient of correlation ranges between -1 and +1.
5. Zero correlation means that no linear association exists between the variables under study.

6. Scatter diagram is the diagrammatic representation of correlation and it provides us an approximate idea of the direction of the relationship.

2.7 Key words :

Nominal Data: The unordered categorical data

Ordinal Data: The ordered categorical data

Interval Data: Data arranged with meaningful and uniform differences

Ratio Data: Data arranged with meaningful zero point

Linear correlation: Linear association between two variables to measure the degree of relationship between them.

Rank difference correlation: Correlation between two qualitatively measured variables.

Scatter diagram: Diagrammatic representation to study correlation.

2.8 Suggested Readings :

Best, J.W. and Kahn, J.V., "Research in Education"; 10th ed., PHI Learning Private Limited, New Delhi, 2010.

Mangal, S.K., "Essentials of Educational Psychology"; 1st ed. (Third Printing), PHI Learning Private Limited, New Delhi, 2009.

Sidhu, K.S., "Statistics in Education and Psychology"; 11th revised and enlarge ed., Sterling Publishers Private Limited, New Delhi (India), 2010(reprint).

Possible answers to Check Your Progress :

CHECK YOUR PROGRESS – I

Q.1. Here,

$$r=\frac{\sum XY-n\bar{X}\bar{Y}}{\sqrt{\sum X^2-n\bar{X}^2}\sqrt{\sum Y^2-n\bar{Y}^2}} \text{ such that } \bar{X}=\frac{75}{10}=7.5 \text{ and } \bar{Y}=\frac{80}{10}=8$$

Table for Computation

Subject	*X*	*Y*	X^2	Y^2	*XY*
A	*13*	*11*	*169*	*121*	*143*
B	*12*	*14*	*144*	*196*	*168*
C	*10*	*11*	*100*	*121*	*110*
D	*10*	*7*	*100*	*49*	*70*
E	*8*	*9*	*64*	*81*	*72*
F	*6*	*11*	*36*	*121*	*66*
G	*6*	*3*	*36*	*9*	*18*
H	*5*	*7*	*25*	*49*	*35*
I	*3*	*6*	*9*	*36*	*18*
J	*2*	*1*	*4*	*1*	*2*
Total		*75*	*80*	*687*	*784*	*702*

$$\therefore \quad r=\frac{702-10\times7.5\times8}{\sqrt{678-10\times7.5^2}\sqrt{784-10\times8^2}}=\frac{102}{\sqrt{124.5}\sqrt{144}}=\frac{102}{133.8955}=0.76$$

Q.2. Here,

$$r=\frac{\sum XY-n\bar{X}\bar{Y}}{\sqrt{\sum X^2-n\bar{X}^2}\sqrt{\sum Y^2-n\bar{Y}^2}}=$$

$$\frac{456-30\times4\times3}{\sqrt{600-30\times4^2}\sqrt{350-30\times3^2}}=\frac{456-360}{\sqrt{120}\sqrt{80}}=\frac{96}{\sqrt{9600}}=0.98$$

Q.3. (a) ***True;*** *(b)* ***False;*** *(c)* ***False.***

CHECK YOUR PROGRESS – II

Q.1. The formula for rank correlation coefficient is:

$$\rho=1-\frac{6\sum d^2}{n\left(n^2-1\right)}$$

Table for Computation

Individuals	Marks in Hindi (X)	Marks in English (Y)	Rank in X (R_1)	Rank in Y (R_2)	$d = R_1 - R_2$	d^2
A	30	55	4	3	1	1
B	40	75	3	1	2	4
C	50	60	1	2	-1	1
D	20	12	6	7	-1	1
E	10	11	8	8	0	0
F	45	38	2	4	-2	4
G	22	25	5	5	0	0
H	18	15	7	6	1	1
						$\sum d^2 = 12$

Thus, $\rho = 1 - \frac{6 \times 12}{8(8^2 - 1)} = 1 - \frac{72}{504} = 1 - - 0.1429 = 0.8571 = 0.86$

Q.2. The formula for rank correlation coefficient is:

$$\rho = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

Table for Computation

Rank in X (R_1)	Rank in Y (R_2)	$d = R_1 - R_2$	d^2
2	1	1	1
4	3	1	1
1	2	-1	1
5	5	0	0
6	7	-1	1
7	6	1	1
3	4	-1	1
			$\sum d^2 = 6$

Thus, $\rho = 1 - \frac{6 \times 6}{7(7^2 - 1)} = 1 - \frac{36}{336} = 1 - 0.1071 = 0.8929 = 0.89$

References :

Garrett, H.E.; "Statistics in Psychology and Education, Indian ed., Vakils, Feffer and Simons, Mumbai, 1971.

Model Questions :

Q.1. What is correlation? Write down the formula for measuring Karl Pearson's coefficient of correlation.

Q.2. Mention the properties of coefficient of correlation.

Q.3. Mention the usefulness of correlation in the field of education.

Q.4. Define bivariate data with example.

Q.5. Mention the assumptions of Karl Pearson correlation.

Q.6. What do you mean by scatter diagram? Draw the scatter diagram to represent perfect positive and perfect negative correlation.

Q.7. Define Spearman's rank correlation.

Q.8. Find the Karl Pearson's product moment correlation coefficient from the following data.

X:	80	76	72	68	64	60
Y:	73	59	66	54	52	38

Q.9. From the following data calculate coefficient of correlation between X and Y and give your comment on the result.

$\sum X = 50, \sum Y = 100, \sum X^2 = 255, \sum Y^2 = 4594, \sum XY = 630$ and $n = 10$

Q.10. From the following data calculate the coefficient of rank correlation between X and Y.

X: 36	56	20	65	42	33	44	50	15	60
Y: 50	35	70	25	58	75	60	45	80	38

Q.11. Find rank correlation coefficient between the given ranks

R_1 :	1	2	3	4	5	6	7	8
R_2 :	7	6	5	4	1	2	8	3

UNIT – III

TESTS OF SIGNIFICANCE

STRUCTURE

3.0 OBJECTIVES :

After completing the block – IV dealing with sampling techniques and research tools used in educational research, you are exposed to some important sampling techniques. The purpose of the present unit is to acquaint with some statistical tools, commonly used for testing significance of statistical constants based on samples. After studying this unit you will be able to :

- Define statistical inference
- Define parametric test
- Define tests of significance
- Define Null and Alternative hypothesis
- Define type – I and type – II error in testing of hypothesis and also the level of significance
- Distinguish between one-sided and two-sided tests
- Distinguish between large and small samples
- Test the significance of single mean for both large and small samples
- Test the significance difference between two means for independent and cor-related samples

3.1 INTRODUCTION :

The values of descriptive statistics namely mean, median, mode, standard deviation, correlation etc are used to describe properties of particular samples. It is not possible to infer or make generalizations about the populations from the measures of the samples. The branch of statistics which enable the research to make

generalizations about a population characteristic (parameter) from a sampling characteristic (statistic) is known as *inferential statistics*. The researcher computes certain statistics (values based on sample observations) as the basis for inferring what the corresponding parameters (values based on population observations) might be as it is not possible to measure all of the members (units of given population). It may be noted that the values of the parameters for a given population are generally unknown. Now, the researcher's aim is to decide where the sample values can be used to represent the population or whether the populations differ significantly with respect to particular parameter etc. This is a problem of tests of significance for which at first the researcher has to setup a null-hypothesis. So why, the whole procedure is also called testing of hypothesis. While it is possible to make inferences about various parameters, in the unit we shall limit our discussion to single mean and two means using parametric tests. In the next unit, we will consider the case of test of significance for more than two means.

3.2 STATISTICAL INFERENCES BASED ON PARAMETRIC TESTS:

Parametric tests are useful in making the inferences about the population mean, variance correlation co-efficient etc. with the help of sampling constants such as mean, variance, correlation co-efficient etc. However, their use is based upon certain assumptions. These assumptions are based on the nature of the population distribution and on the way the type of scale is used to quantify the data measures. It may be mentioned that there are some parametric tests,

namely, t-test and F-test which are quite robust and all appropriate even when some assumptions are not met.

The assumptions for most parametric tests are:

1. The characteristics and the study are expressed in interval or ratio scales and not in nominal or ordinal scales of measurement.
2. The population values are normally distributed
3. The samples have equal or nearly equally variances when test is for testing the significance for some other parameter (s)
4. The observations are independent. The selection of one case in the sample is not dependent upon the selection of any other case.

In the following discussion, you will learn how to draw statistical inferences about the mean of large and small samples using tests of significance. However, we will start our discussion from general procedure for testing of a hypothesis.

3.3 PROCEDURE FOR TESTING A HYPOTHESIS :

The steps in hypothesis testing or tests of significance follow –

(1) **Setting up the hypothesis –** A statistical hypothesis or simply hypothesis is a statement about the population. The hypothesis is some assumption or statement that may or may not be true, which is to be tested. There are two types of hypothesis, namely null-hypothesis and alternative hypothesis.

(a) **Null-hypothesis –** It is a statement about a population parameter. It is denoted by H_0. It is setup in testing hypothesis

only to decide whether to accept or to reject the null-hypothesis. It is formulated in a way so that it assorts that there is no difference between the statistic and the parameter.

(b) **Alternative hypothesis –** Any hypothesis which is not null-hypothesis is called alternative hypothesis and it is denoted by H_1. It is setup in a way that the rejection of null-hypothesis lead to the acceptance of the alternative hypothesis. There can be more than one alternative hypothesis. Let us explain this with an example. Suppose you are interested to check the performance levels of two schools say A and B based on their class 10^{th} exam results. Then, your null-hypothesis will be H_0: there is no significant difference between the performance levels of the two schools, A and B. In other words, both the two schools perform equally.

In this situation, depending on a reality, you may take any one of the following as alternative hypothesis; H_1 : Alternative hypothesis

(I) The performance level of school A is better than school B

(II) The performance level of school B is better than school A

(III) There is difference between the performance levels of the two schools A and B.

(2) Test-statistic: After formulating the two-hypothesis, there are various test-statistics available to test the acceptance and rejection of null-hypothesis. Some of the commonly used test-statistics are Z-test, t-test F-test etc. While taking the decision regarding the null-hypothesis, some errors may occur.

(3) Type-I, Type-II errors and level of significance: The hypothesis testing procedure begins with the assumption of true null-hypothesis

and our aim is to arrive at a decision to either accept the null-hypothesis, when it is true or reject the null-hypothesis, when it is false. But, in many situations, this may not be the case always. In the example of performance levels of two schools, suppose, performances are same for both the schools, but you may reject the null-hypothesis due to inadequate evidences, or situations may of opposite kind also i.e. when the performances are not same for the two schools, but still you failed to reject the null-hypothesis due to lack of proper evidences. Thus, there is a possibility of taking wrong decision. In testing of hypothesis, these two kinds of errors are called type-I error and type-II error. Thus,

Type-I error: Reject the null-hypothesis, when it is true

Type-II error: Do not reject (i.e. accept) the null-hypothesis when it is false.

The specific errors from school performance level hypothesis testing example can be expressed as –

	Null-hypothesis is true	Null-hypothesis is false
Accept the null-hypothesis	Correct Decision	Type-II error
Reject the null-hypothesis	Type-I error	Correct Decision

The minimizing of both the errors simultaneously is impossible. The theory of tests of significance is based on the principle – finding of type-I error and minimization of type-II error. So, we have to fix the level (maximum chance) of making the type-I errors. This is called level of significance. Thus, it is the maximum level up to which we may commit a type-I error. It is denoted by

Greek letter α (alpha). On the other hand, confidence of making a correct decision is $(1-\alpha)$.

The commonly used level of significances are 5% (or 0.05) and 1% (0.01), but which one is to be considered will depend on the seriousness of the types of errors. If you use $\alpha = 0.05$, it means that the probability of making type-I error is 0.05 or 5% i.e. the maximum chance of making a wrong decision (type-I error) is 5 out of 100. On the other hand, you are 95% confident of a correct decision. Similarly, if $\alpha = 0.01$, the maximum probability of making error is 1 out of 100. It is to be noted that, if no level of significance is specified, in that case, it is always advisable to use $\alpha = 0.05$.

The region of the set of values for which the null-hypothesis is rejected is called critical region or the rejection region.

(5) One-tailed and two tailed tests:

Consider the situation when

Null hypothesis, H_0 : The mean score of students in a test is 60

Alternative-hypothesis, H_1 : The mean score of students in the test is not 60

The meaning of the alternative-hypothesis is that there is chance of having average score of 55 (less than 60) or 62 (greater than 60).

In this, the alternative-hypothesis is in two directions, thus it is called two-tailed test or two sided test. The two directions are under the same normal probability curve. In two tailed test, the level of significance is considered as half of the given level of significance graphically as shown in figure – 1.

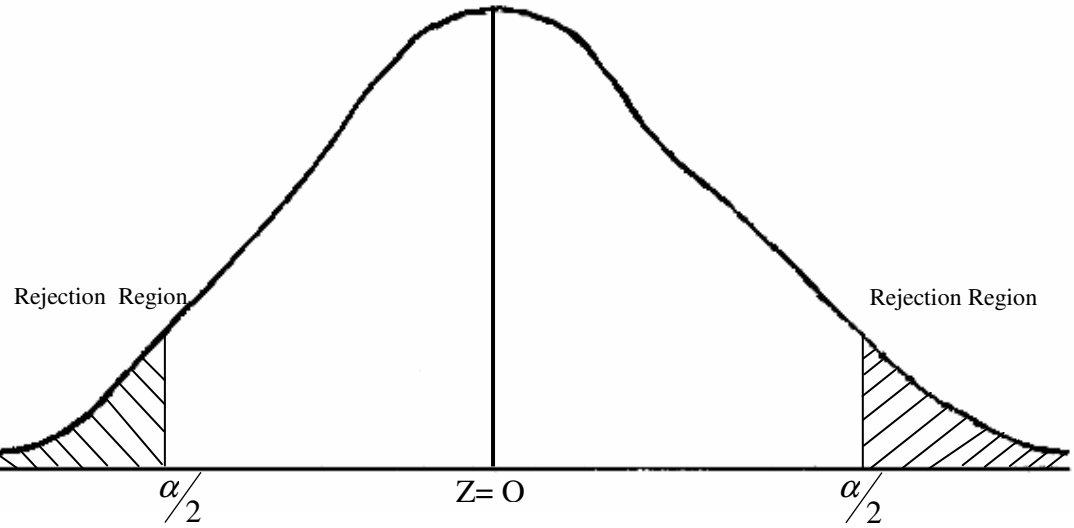


Fig. – 1 : Two tailed test at significance level α

Again, in the same example, suppose your hypotheses are :

Null-hypothesis, H_0 : The mean score of students in a test is 60.

Alternative hypothesis, H_1 : The mean score of students in the test is less than 60.

Thus, here the alternative hypothesis is one-sided and so it is called one-tailed test or one sided test. There are two types of one-tailed or one sided tests:

(i) Right Tailed test : Here, the critical region or the rejection region lies on the right tail of the normal curve graphically as shown in figure 2.

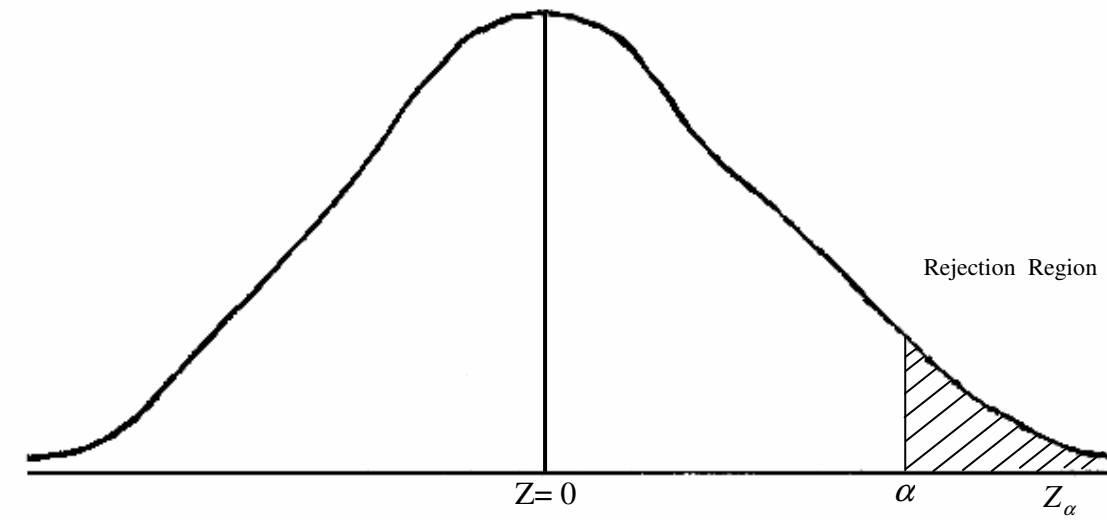


Fig. – 2 : Right tailed test at significance level - α

(ii) Left-Tailed test : Here, the critical region or the rejection region lies on the left tail of the normal curve graphically as shown in figure 3.

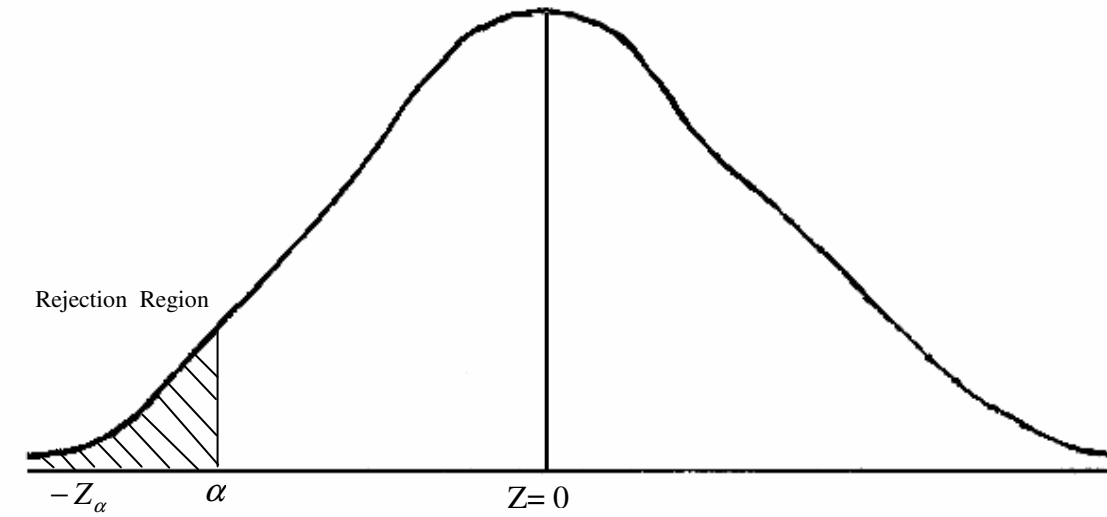


Fig. – 3: Left tailed test at significance level - α

The following table will give the critical value of Z i.e. Z_α at 1%, 5%, 10% level of significance.

Table for critical values Z_α or Z

Critical value (Z_α)	**Level of significance**		
Type of the test	1%	5%	10%
Two-tailed test	2.58	1.96	1.645
One-tailed test	2.33	1.645	1.28

(6) Decision about the null-hypothesis :

The last step in testing of hypothesis is to take a right decision about the null-hypothesis, more clearly whether the stated hypothesis may be accepted or rejected. This decision is taken by comparing the calculated value of the test-statistic with some predetermined tabulated value of the test-statistic with the pre-fixed level of significance. In brief, the mechanism is as follows :

Condition	**Decision**
If calculated value of test-statistic is less than the tabulated value.	There is not enough evidence to reject the null-hypothesis or you may accept the null-hypothesis
If calculated value of test-statistic is greater than or equal to tabulated value	Reject the null-hypothesis

In case, if a test statistic results in negative value, you have to consider the modulus of the test-statistic. Just simply ignore the negative sign. In order to conduct the above mentioned procedure of testing of hypothesis, our basic requirement is a sample. Based on the size (total number of items) of the sample, you may have two types of samples – large samples and small samples.

3.4 DIFFERENCE BETWEEN LARGE AND SMALL SAMPLES :

Actually to differentiate between large samples and small samples there is no fixed line. For convenience, it is assumed as, if the sample consists of more than 30 items it is a large sample whereas, if there are 30 or less than 30 items in the sample it is considered as a small sample. Thus, if 'n' represents the size of the sample then:

Large samples: if $n > 30$

Small samples: if $n \leq 30$

There are various tests of significance available to be used in large and small samples separately. Before going to the various tests involving large and small samples, you have to know about degrees of freedom as they will be used in the test-statistic value calculations.

Degrees of freedom: In the phrase, "degrees of freedom" the term "freedom" means freedom to vary. Let us illustrate this with an example, suppose, you have 8 scores say, 3,4,7,8,10,12,13 and 15 and the mean is 9. This sample mean i.e. 9 can be used as an estimate of the population mean, then the deviation of the scores from mean 9 are -6,-5,-2,-1,1,3,4 and 6 and the sum of these variation is zero. Now out of these variations, you can choose any 7 variations freely, i.e.

independently, because the sum of variation equal to zero restricts the value of 8^{th} deviate. Thus as the number of restriction increases, your freedom also decreases by 1. If the size of the sample is 'n' then you can choose $(n-1)$ variation freely. This is called degrees of freedom.

3.5 TEST OF SIGNIFICANCE OF SINGLE MEAN: LARGE SAMPLES :

After reading section 3.4 of this unit you might be able to distinguish between large and small samples. In this section and subsequent section you will study some large and small samples parametric tests for single mean and two means, both independent and co-related.

The steps involved in test of significance of a single mean for large samples are described below –

Step I : Setting up the two hypotheses. Formulate them in their usual form and also check the nature of the test, whether it is one tailed or two-tailed based on alternative-hypothesis.

Step II : Compute the test-statistic. In case of large samples, the preferred test-statistic is Z-test. The Z-test can be computed in two ways.

(a) When the standard deviation σ (sigma) of the population is known, then

$$Z = \frac{\text{Difference between the two means}}{\text{Standard Error of sample means}}$$

i.e. if $\bar{x}$ = Sample mean, μ = population mean

σ = Standard deviation of the population and n = sample size. Then the test-statistic can be written as

$$Z = \frac{\bar{x} - \mu}{S.E(\bar{x})} = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}$$

(b) Again, when the standard deviation σ (sigma) of population is not known then

$$Z = \frac{\text{Difference between the two means}}{\text{Standard Error of sample mean}}$$

$$= \frac{\bar{x} - \mu}{s / \sqrt{n}}, \text{ here s = standard deviation of sample}$$

Step III : Set up the level significance (generally 5% or 1%)

Step IV : Find the critical value of Z at the given level of significance using probability table on normal probability curve.

Step V : Take the decision about the null-hypothesis.

Now, let us explain these steps with example. (a) Suppose, you draw a sample of 100 students from a school and the average height of the students was found to be 64 inches. You are interested to test whether this sample could have come from a normal population with mean height 68 inches and standard deviation 8 at 5% level of significance or not.

Then, as your first step, you need to set your hypotheses. These are

Null-hypothesis, H_0 : The sample have came from a normal population with mean 68 and standard deviation 8.

Alternative hypothesis, H_1 : The sample is not taken from the normal population with mean 68 and standard deviation 8.

Now, to set the level of significance, since this is a two-tailed test, so level of significance is 0.025 (i.e. half of 0.05)

Now, your available information are sample mean $\bar{x}$ = 64; population mean $\mu = 68$ Population standard deviation, $\sigma = 8$ and size of the sample, $n = 100$ and **α=5%**

Thus, the test statistic

$$Z= \frac{\bar{x}-\mu}{\sigma/\sqrt{n}} = \frac{64-68}{8/\sqrt{100}} = \frac{-4}{8/10} = 4\times\frac{10}{8} = -5$$

Ignoring the negative sign, the value of test statistic is 5.

From the table, at $\alpha = 0.025$ (two-tailed) the value of the test-statistic Z is 1.96, which is less than the calculated Z value.

Since, the calculated Z- value is greater than the tabulated Z-value, so you may reject the null-hypothesis and conclude with the statement that, the sample has not been drawn from a normal population with mean 68 and standard deviation 8.

(b) In the above example, the population standard deviation σ was known. Let us try another one when the population standard deviation σ is not known. Suppose, a sample of 400 observations has mean 95 and standard deviation 12 you are asked to find out whether the sample is from a population with mean 98 or not with 95% confidence. Then accordingly, your hypotheses will be:

Null-hypothesis, H_0 : There is no significant difference between the sample mean and the population mean or in other words, you can say that the sample is drawn from the population with mean 98.

Alternative hypothesis, H_1 : The sample is not taken from the population whose mean is 98

Here, the alternative hypothesis is of two-tailed so, it is a two tailed test and thus for tabulated value you look at $\alpha = 0.025$

Now, from the question, you have values of sample size, $n = 400$; sample mean, $\bar{x} = 95$; sample standard deviation, s = 12 and the population mean, $\mu = 98$.

So, as a large sample, the test-statistic will be

$$Z = \frac{\text{Difference between the two means}}{\text{Standard Error of sample mean}}$$

$$\frac{\bar{x} - \mu}{s/\sqrt{n}} = \frac{95 - 98}{12/\sqrt{400}} = \frac{-3}{12/20} = \frac{-3 \times 20}{12} = -5$$

Thus, ignoring the negative sing, the calculated value of the test-statistic is 5.

From the table, it is observed that the tabulated value of Z at 0.025 confidence level is 1.96. Now, only by observing you can say that the calculated value is much greater than the tabulated value which leads to the rejection of the null-hypothesis. Thus, finally, you can conclude that the sample mean is not taken from the population whose mean is 98.

Check Your Progress – I :

Example (i) : A sample of 450 students is taken from a population of students whose standard deviation is 20. The mean of the sample is 30. Test whether the sample has come from a population of students with mean 29 at 5% level.

Example (2) : A sample of 100 students is taken from a large population. The mean height of these students is 64 cm and the standard deviation is 4 cm. Can it be regarded that in the population, the mean height is 60 cm?

3.6 Test of significance of single mean : small samples :

The steps involved in test of significance of single mean for small samples are described below:

Step I : Set up the two hypotheses in the prescribed format.

Step II : Compute the test-statistic. In case of small samples, the prescribed test-statistic is t-test. The t-test can be computed in two ways –

(a) When the standard-deviation (s) of the sample is known then,

$$t = \frac{\text{Difference between the two means}}{\text{Standard Error of sample mean}}$$

Thus, if sample mean, population mean , sample standard deviation and size of the sample is represented by $\bar{x}, \mu$ s and n respectively then.

$$t = \frac{\bar{x} - \mu}{s / \sqrt{n-1}}$$

(b) When the standard deviation (s) of the sample is not known then.

$$t = \frac{\text{Difference between the two means}}{\text{Standard Error of sample mean}}$$

Thus, when 's' is not known, you have to calculate sample variance represented by S^2 by the formula $S^2 = \frac{\sum (x - \bar{x})^2}{n-1}$, where x is individual sample values and $\bar{x}$ is sample mean, which is calculated by $\frac{\sum x}{n}$

Thus, $t = \frac{\bar{x} - \mu}{\sqrt{S^2 / n}}$

Step III : Setup the level of significance (generally 5% or 1%)

Step IV : Find the critical value of t at the given level of significance and with $(n-1)$ degrees of freedom

Step V : Take decision about the null-hypothesis comparing the test-statistic values.

Now, let us explain these steps with example. (a) Suppose, the mean yearly performance of students in school week competitions of schools in a district was 146.3 per school. After imposing some training in extracurricular activity the mean yearly performance in 22 schools for a year increased to 153.7 and showed a standard deviation of 17.2. Now, you wish to test was the training a successful one.

Then, at the very beginning setup the two hypotheses as

Null-hypothesis, H_0 : There is no significant difference in the performances after the extra training course.

Alternative-hypothesis, H_1 : The training was successful. It's a one tailed test. Since the level of significance is not mentioned here, so for convenience it will be considered as 0.05 i.e. $\alpha = 0.05$

After setting up the null-hypothesis, the test-statistic is

$$t = \frac{\text{Difference between the two means}}{\text{Standard Error of sample mean}}$$

Now, the information available are

Population mean, $\mu = 146.3$

Sample mean, $\bar{x} = 153.7$

Sample size, $n = 22$

Sample standard deviation, s = 17.2

Hence,

$$t = \frac{153.7 - 146.3}{17.2/\sqrt{22-1}} = \frac{7.4}{17.2/\sqrt{21}} = \frac{7.4 \times \sqrt{21}}{17.2} = \frac{7.4 \times 4.58}{17.2} = \frac{33.91106}{17.2} = 1.97$$

Here, the calculated value of the test-statistic is 1.97 and the tabulated value of the test-statistic at 5% level of significance with (22-1) = 21 degrees of freedom is 1.721. Thus, comparing these two values you can conclude with the rejection of the null-hypothesis and may say that the training was successful.

(b) The above example is for test of significance of single mean with known sample standard deviation. Now, let us try another one when the sample standard deviation is not known. Suppose, a random sample of 10 girls had the following I.Q.S 60, 110, 100, 70, 97, 95, 85 93, 79, 66. you can check whether or not these data support the assumption of a population mean IQ of 100.

Then your hypotheses are :

Null-hypothesis, H_0 : There is no significant difference in between the data and the population mean IQ.

The alternative hypothesis, H_1 : The data are not consistent with the population mean IQ.

It is a two tailed test.

The available information are :

Sample size $n = 10$ and population mean $\mu = 100$ so, the test –statistic is

$$\text{t} = \frac{\text{Difference between the two means}}{\text{Standard Error of sample mean}}$$

$$= \frac{\bar{x} - \mu}{\sqrt{S^2 / n}}$$

Now, $\bar{x}$ and S^2 are to be calculated from the sample values of I.Q's

CALCULATION FOR SAMPLE MEAN & SAMPLE VARIANCE

x	$\left(x - \bar{x}\right)$	$\left(x - \bar{x}\right)^2$
60	60 - 85.5 = 25.5	650.25
110	110 - 85.5 =24.5	600.25
100	100 - 85.5 =14.5	210.25
70	70 - 85.5 =15.5	240.25
97	97 - 85.5 =11.5	132.25
95	95 - 85.5 = 9.5	90.25
85	85 – 85.5 = 0.5	0.25
93	93 – 85.5 = 7.5	56.25
79	79 – 85.5 = 6.5	42.25
66	66 – 85.5 = 19.5	380.25
$\sum x = 855$		$\sum \left(x - \bar{x}\right)^2 = 2402.5$

$$\bar{x} = \frac{1}{n}\sum x = \frac{1}{10} \times (855) = 85.5$$

$$\therefore S^2 = \frac{1}{n-1}\sum \left(x - \bar{x}\right)^2 = \frac{2402.5}{10-1} = \frac{2402.5}{9} = 266.94$$

Now, $t = \dfrac{\bar{x} - \mu}{\sqrt{S^2/n}} = \dfrac{85.5 - 100}{\sqrt{266.94/10}} = \dfrac{-14.5}{\sqrt{26.694}} = -\dfrac{-14.5}{5.17} = -2.804$

Ignoring the negative sign, the calculated value of the test-statistic is 2.804

From the table, it is observed that the calculated value at 5% level of significance with (10-1) = 9 degrees of freedom is 2.262. Hence as the calculated t is larger than the tabulated t so, the null-hypothesis is rejected and you may conclude that the data are not consistent with the assumption of a mean I.Q. of 100 in the population.

Check Your Progress – II :

Example 1 : Suppose, a sample of 15 students was drawn from a school and average weight of the students was 50 kg with standard deviation 10. Test the significance at 5% that this sample could have come from a population with mean weight 75 kg.

Example 2 : The students are selected at random from a college and their heights are found to be 100, 104, 108, 110,118, 120, 122, 124, 126 and 128 cms. In the light of these data discuss the suggestion that the mean height of the students of the college is 110 cms. Use 5% level of significance.

3.7 Test of significance of difference between two means : Large samples :

Suppose, you have two groups of populations say A and B with two different means say μ_1 and μ_2 and variances σ_1^2 and

σ_2^2 respectively. Let you are asked to draw two independent samples of sizes n_1 and n_2 from these two groups of populations and let the sample means of these two samples are $\bar{x}_1$ and $\bar{x}_2$ respectively. Now, you are interested to test.

(i) The equality of the two population means.

(ii) The significance of the difference between two independent sample means drawn by you.

Here, the two samples are completely independent of each other and the steps involved here are –

Step I : Formulate the hypotheses as

Null-hypothesis, H_0 : The two samples have been drawn from the same parent population.

Alternative hypothesis, H_1 : There is difference between the two means.

Step II : Compute the test-statistic. Here, you have two cases –

Case I : When the population standard deviation σ_1 and σ_2 are known. The test-statistic is

$$Z = \frac{\text{Difference between the two means}}{\text{Standard Error of sample means}}$$

$$= \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

Case II : When the population standard deviation σ_1 and σ_2 are unknown. In that case, the given sample standard deviation s_1 and s_2 are to be used to calculate the standard error of difference of sample means. The test-statistic is

$$Z = \frac{\text{Difference between the two means}}{\text{Standard Error of sample means}}$$

$$= \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

Step III, Step IV and Step V are all same like the previous tests.

Now, let us try two examples of these two types of cases:

Case I : Suppose, a college conducts both day and night classes intended to be identical. A sample of 100 day students yields examination result as under $\overline{x_1} = 72.4$ and $\sigma_1 = 14.8$. Again another sample of 200 night students yields examination results as under $\overline{x_2} = 73.9$ and $\sigma_2 = 17.9$. You are interested to check are the two means statistically equal at 5% level. Here, you first setup the two hypotheses as: Null-hypothesis, H_0 : There is no significant difference between two populations with respect to mean. Alternative hypothesis, H_1 : The two population means differ significantly.

It is a two tailed test as the alternative hypothesis is in two directions.

Now, your test-statistic is

$$Z = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

$$= \frac{72.4 - 73.9}{\sqrt{\frac{(14.8)^2}{100} + \frac{(17.9)^2}{200}}}$$

$$= \frac{-1.5}{\sqrt{\frac{219.04}{100} + \frac{320.41}{200}}} = \frac{-1.5}{\sqrt{2.1904 + 1.60205}} = \frac{-1.5}{\sqrt{3.79245}} = \frac{-1.5}{1.9474} = -0.77$$

Thus, Z = 0.77 (ignoring the negative sign). From the table at 5% level of significance the Z – value is 1.96. Then you may conclude that there is not enough evidence to reject the null-hypothesis as the calculated Z is less than the tabulated Z-value.

Case II : Now, let us try the other case, when the population standard deviation are not known. Suppose, the research unit in an organization wishes to determine whether scores on the scholastic aptitude test are different for male and female applicants. Random samples of applicants file are taken and summarized below

Applicants

	Female	**Male**
Sample mean	502.1	512.5
Sample standard deviation	89.3	92.4
Sample size	254	305

Now, you can test the null-hypothesis that the average score is same for the population of male and female applicants, using 5% significant level. So here your hypotheses are:

Null-hypothesis H_0 : There is no difference in the average score for the population of male and female.

Alternative-hypothesis, H_1 : The average score for the two groups are not same.

It is a two tailed test

Here, available information are

$\overline{x_1} = 502.1$ $\quad$ $\overline{x_2} = 512.5$

$s_1 = 89.3$ $\quad$ $s_2 = 92.4$

$n_1 = 254$ $\quad$ $n_2 = 305$

Thus, the test-statistic will be

$$Z = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$= \frac{502.1 - 512.5}{\sqrt{\frac{(89.3^2)}{254} + \frac{(92.4)^2}{305}}}$$

$$= \frac{-10.4}{\sqrt{\frac{7974.49}{254} + \frac{8537.76}{305}}}$$

$$= \frac{-10.4}{\sqrt{31.39 + 27.99}} = \frac{-10.4}{\sqrt{59.38}} = \frac{-10.4}{7.705} = -1.35$$

Ignoring the negative sign, the value of the test-statistic is 1.35 and from the table, the Z-value is 1.96 at 5% level. ‘

Thus, you can conclude that there is no difference in the average score for the population of male and female, since the calculated value of the test-statistic is less than the tabulated Z-value.

Check Your Progress : III :

Example 1 : A college conducts a pre exam test for both regular and private students. A sample of 95 regular students performed in the examination as under $\overline{x_1} = 62.5$ and $\sigma_1 = 21$. Again another sample of 72 private students performed as $\overline{x_2} = 61$ and $\sigma_2 = 18.2$. Are the two means statistically equal at 5% level?

Example 2 : A random sample of 100 girl student from class 10^{th} shows that their mean height is 100 cm with a standard deviation of

14.7. Another random sample of 80 boys from class 9th shows that their mean height is 110 cm with standard deviation of 18.2. is there any difference between their mean level of heights?

3.8 Test of significance of difference between two means : small samples :

After formulating the two hypotheses, the test statistic for test of significance of difference between two independent means for small sample is

$$t = \frac{\text{Difference between the two means}}{\text{Standard Error of sample means}}$$

$$= \frac{\overline{x_1} - \overline{x_2}}{\sqrt{S^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Where, S^2 is sample variance. Now, there may be two cases as:

Case I: If the sample standard deviations s_1 and s_2 are given then sample variance S^2 is calculated by the formula $\frac{n_1 s_1^2 + n_2 s_2^2}{n_1 + n_2 - 2}$, where n_1 and $n_2$are the sizes of the two samples.

Case II: In case, if the values of the two standard deviations s_1 and s_2 are not given then you have to calculate S^2 by the formula $\frac{\sum d_1^2 + \sum d_2^2}{n_1 + n_2 - 2}$ where $d_1 = \left(x_1 - \overline{x_1}\right)$ and $d_1 = \left(x_2 - \overline{x_2}\right)$

Other steps are similar to the earlier tests. Now, Let us try these two cases with examples

Case I: Suppose, the two samples of sizes 7 and 5 gave the following data.

	Sample I	**Sample II**
Mean	30	20
Standard deviation	6	10

Now, you are interested to check is the difference of the mean significant?

Here, your two hypotheses are:

Null-hypothesis, H_0: There is no significant difference between the two means.

Alternative hypothesis, H_1: The two means are not same.

The information obtained from the question are

$$\overline{x_1} = 30 \qquad \overline{x_2} = 20$$
$$s_1 = 6 \qquad s_2 = 10$$
$$n_1 = 7 \qquad n_2 = 5$$

Thus, the test statistic is

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{S^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Now, sample variance, $S^2 = \frac{n_1 s_1^2 + n_2 s_2^2}{n_1 + n_2 - 2} = \frac{7(6)^2 + 5(10)^2}{7 + 5 - 2} = \frac{752}{10} = 75.2$

Therefore, $t = \frac{30 - 20}{\sqrt{75.2\left(\frac{1}{7} + \frac{1}{5}\right)}} = \frac{10}{\sqrt{75.2\left(\frac{12}{35}\right)}} = \frac{10}{\sqrt{25.78}} = 1.97$

The calculated value of t is 1.97 and the tabulated value of t at 5% (two-tailed) level with (7+5-2) =10 degrees of freedom is 2.228. Since, the calculated value of t is less than the tabulated value of t, so

you may conclude that there is not enough evidence to reject the null-hypothesis and you may say that, there is no significance difference between the two means.

Case II: Suppose, two sets A and B of the students selected at random from a college were taken, of which one was given the memory test as they were and the other set was given a memory test after two weeks of training and the scores were as follows.

Set A :	10	8	7	9	8	10	9	6	7	8
Set B :	12	8	8	10	8	11	9	8	9	9

Suppose you want to check the presence of significant effect due to training.

Here, your two hypotheses will be

Null-hypothesis, H_0 : There is no significant difference in the groups due to training

Alternative hypothesis, H_1 : There is some effect due to training.

This is a two tailed test.

The available information are –

Size of set A, $n_1 = 10$ and size of set B, $n_2 = 10$ since, the sample standard deviations and means of the samples are not given directly, so you have to calculate them.

The computation of sample mean and standard deviation are :

Set A **Set B**

x_1	$d_1 = (x_1 - \overline{x_1})$	d_1^2		x_2	$d_2 = (x_2 - \overline{x_2})$	d_2^2
10	10 – 8.2 = 1.8	3.24		12	12 – 9.2 = 2.8	7.84
8	8 – 8.2 = 0.2	0.04		8	8 – 9.2 = 1.2	1.44
7	7 – 8.2 = 1.2	1.44		8	8 – 9.2 = 1.2	1.44
9	9 – 8.2 = 0.8	0.64		10	10 – 9.2 0.8	0.64
8	8 – 8.2 = 0.2	0.04		8	8 – 9.2 = 1.2	1.44
10	10 – 8.2 = 1.8	3.24		11	11 – 9.2 = 1.8	3.24
9	9 – 8.2 = 0.8	0.64		9	9 – 9.2 = 0.2	0.04
6	6 – 8.2 = 2.2	4.84		8	8 – 9.2 = 1.2	1.44
7	7 – 8.2 = 1.2	1.44		9	9 – 9.2 =0.2	0.04
8	8 – 8.2 = 0.2	0.04		9	9 – 9.2 =0.2	0.04
$\sum x = 82$		$\sum d_1^2 = 15.6$		$\sum x = 92$		$\sum d_2^2 = 17.6$

$$\overline{x_1} = \frac{1}{n_1}\sum x_1 = \frac{82}{10} = 8.2$$

$$\overline{x_2} = \frac{1}{n_2}\sum x_2 = \frac{92}{10} = 9.2$$

$\therefore$ Standard deviation of the population is

$$S^2 = \frac{\sum d_1^2 + \sum d_2^2}{n_1 + n_2 - 2}$$

$$= \frac{15.6 + 17.6}{10 + 10 - 2}$$

$$= \frac{33.2}{18}$$

$$= 1.84$$

$$\therefore S^2 = 1.84$$

The test-statistic is :

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{S^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$= \frac{8.2 - 9.2}{\sqrt{1.84\left(\frac{1}{10} + \frac{1}{10}\right)}} = \frac{-1.0}{\sqrt{1.84\left(\frac{2}{10}\right)}} = \frac{-1.0}{\sqrt{1.84(0.2)}} = \frac{-1.0}{\sqrt{0.368}} = \frac{-1.0}{0.60} = -1.66$$

Ignoring the negative sign, the value of the test-statistic is 1.66. The tabulated value at 5% level with (10 + 10 -2) = 18 degrees of freedom is 2.101.

Since, the calculated *t* is less than the tabulated *t*, so you may say that there is not enough evidence to reject the null-hypothesis.

Thus you can conclude that there is no significant effect due to training.

Check Your Progress – IV

Example 1 : Following table contains the data resulting from a sample of students trained under different special programs.

Program sample	**Mean sensitivity of the program**	**No. of students**	**Estimated standard deviation for sensitivity after the program**
Formal	92%	12	15%
Informal	84%	15	19%

Test at 0.05 level of significance, whether the sensitivity achieved by the formal program is significantly higher than the informal program.

Example 2 : Below are given the gain in weight (in lbs.) of students after giving two different diets A and B.

Diet A: 42 45 57 63 41

Diet B: 38 42 69 44 64

Test whether the two diets differ significantly as regards their effect of increase in weight

3.9 Test of significance of difference between two co-related samples:

You may face some situations, when the two sample means are obtained from the same sample but on two separate occasions. Then, such means are said to be co-related or dependent. The

working rules for co-related sample means are same like the previous methods starting from the setting up of the hypothesis upto the decision but the difference is present only in the test-statistic.

The test statistic in the test of significance of difference between two co-related sample is :

$$t = \frac{\text{Mean of Difference of two sample}}{\text{Standard Error of mean difference}}$$

or, $t = \dfrac{M_D}{S.E(M_D)}$,

where $\text{MD} = \dfrac{\text{Sum of the difference}}{\text{Size of the sample}} = \dfrac{\sum D}{n}$

$$\text{S.E } (M_D) = \frac{S \tan dard\ deviation\ of\ differences}{\sqrt{n}}$$

and standard deviation of differences $= \sqrt{\dfrac{\sum d^2}{n-1}}$

Where $d = D - M_D$

Now, let us explain, with an example. Suppose, you have administered a test to a group of 12 students and three weeks later have repeated the test again on the same group of students by providing them some extra coaching classes. And the results of the two tests are as follows.

Result I	33	57	52	65	36	55	37	30	21	46	37	35
Result II	45	67	58	79	46	63	57	25	30	56	35	57

Now, you are interested to test the hypothesis that the extra coaching increases the test results, i.e. you want to test the

significance difference between the means of the tests at 5% level of significance.

Here your two hypotheses are.

Null-hypothesis H_0 : The two results after and before extra coaching classes are same

Alternative –hypothesis, H_1 : The extra coaching increases the test-results.

This is a one- tailed test.

Now, construct the following table for the calculation of mean of difference and standard error of mean difference.

Result I	**Result II**	**Difference (D) Result II - Result I**	**d = D - M_D** $(M_D = 9.5)$	**d^2**
33	45	12	2.5	06.25
57	67	10	0.5	0.25
52	58	6	-3.5	12.25
65	79	14	4.5	20.25
36	46	10	0.5	0.25
55	63	8	-1.5	2.25
37	57	20	10.5	110.25
30	25	-5	-14.5	210.25
21	30	9	-0.5	0.25
46	56	10	0.5	0.25
37	35	-2	-11.5	132.25
35	57	22	12.5	156.25
		$\sum D = 114$		$\sum d^2 = 651$

$\therefore$ Mean of difference, $M_D = \dfrac{\sum D}{n} = \dfrac{114}{12} = 9.5$

Standard deviation of difference $= \sqrt{\dfrac{\sum d^2}{n-1}} = \sqrt{\dfrac{651}{11}} = \sqrt{59.18} = 7.69$

Standard error of mean difference = $\dfrac{\text{Standard deviation of difference}}{\sqrt{\text{n}}}$

$= \dfrac{7.69}{\sqrt{12}} = \dfrac{7.69}{3.46} = 2.222$

Now, $t = \dfrac{9.5}{2.222} = 4.27$

Since there are 12 students, so the degrees of freedom will be (12-1) = 11 and at 5% level of significance, the tabulated value of the test-statistic (one-tailed) is 1.796 which is smaller than calculated value. Thus, you may conclude with the rejection of null-hypothesis and can say that the extra coaching class increases the test results.

Check Your Progress – V

Example 1 : An IQ test was administered to 5 students before and after they are trained. The results are given below:

Students	**I**	**II**	**III**	**IV**	**V**
IQ before training	110	120	123	132	125
IQ after training	120	115	127	136	118

Test whether there is any change in I.Q. after the training programme. It is given that $t_{0.01} = 4.6$ for 4 degrees of freedom.

Example 2 : The students were given intensive coaching for a month in statistics. The scores obtained in test 1 and 5 are given below :

St. No. of students	1	2	3	4	5	6	7	8	9	10
Marks in 1st test	50	55	35	40	67	69	57	72	80	53
Marks in 5th test	65	55	60	67	48	72	50	53	47	87

Does the score from test 1 to test 5 show an improvement? Test at 5% level of significance.

3.10 Let us sum up :

After-studying this unit you have got the detail idea of inferential statistics based on parametric tests and its related topics. The discussion in this unit is summarized as :

1. Statistical inferences are useful in making generalization about population characteristic from the sampling characteristic.
2. Parametric tests are useful in making the inferences about the descriptive statistics.
3. Hypothesis is a statement about the population.
4. Type – I error occurs when a true null-hypothesis is rejected and type – II error occurs when a false null-hypothesis is accepted.
5. If the size of the sample is less than 30 then it's a small sample and when the size of the sample is greater than 30 then it is called large sample.

6. Depending upon the size of the sample different test-statistics are used for tests of significance for single and double mean(s). For large samples preferred test-statistic is Z-test on the other hand for small-samples t-test is applicable.

3.11 Key words :

Null-hypothesis: It is hypothesis of no difference

Type – I error: Rejection of true null-hypothesis is called type – I error

Type – II error: Acceptance of false null-hypothesis

Level of significance: Maximum chance of making a type – I error.

Two-tailed test: If the alterative hypothesis is in two directions, it is called two- tailed test.

One-tailed: If the alternative hypothesis is in one direction, then it is called one-sided or one-tailed test.

Degrees of freedom: It means the freedom to vary.

3.12 Suggested Readings:

Best, J.W. and Kahn, J.V, "Research in Education", 10th ed., PHI Learning Private Limited, New Delhi 2010.

Arora, P.N, Arora Sumeet and Arora, S, "Comprehensive Statistical Methods", Rajendra Ravindra Printers (Pvt.) Ltd., 7361, New Delhi 110055.

Possible Answers to check Your Progress:

Check Your Progress – I:

The two-hypotheses are

Null hypothesis, H_0: The sample is taken from that population whose mean is 29 i.e., there is no difference between the sample and the population.

Alternative-hypothesis, H_1: The sample is not drawn from the population that has mean 29

Here $\alpha = 0.05$ (two-tailed)

Now, from the question, it is observed that sample size $n = 450$, sample mean $\bar{x} = 30$, population standard deviation $\sigma = 20$, population mean $\mu = 29$

Now, the test-statistic is

$$Z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}} = \frac{30 - 29}{20/\sqrt{450}} = \frac{1}{20/21.21} = \frac{21.21}{20} = 1.06$$

Thus, the calculated Z = 1.06 and

The tabulated Z = 1.96

Hence calculated value < tabulated value

Conclusion :

Since, the calculated value is less than the tabulated value, you may accept the null-hypothesis. In other words, you can say that there is not enough evidence to reject the null-hypothesis and conclude that the sample of students is taken from that said population of students whose mean in 29.

Example 2:

The two hypotheses are:

Null-hypothesis, H_0: The sample of students is from the population whose mean height is 60 cm.

Alternative-hypothesis, H_1: The sample mean is not same as the population mean.

It is a two tailed test.

From the question, you have sample size $n = 100$, sample mean $\bar{x} = 64$, sample standard deviation $s = 4$ and the population mean $\mu = 60$

So, the test statistic is

$$Z = \frac{\bar{x} - \mu}{s/\sqrt{n}} = \frac{64 - 60}{4/100} = \frac{4}{4/10} = \frac{4 \times 10}{4} = 10$$

The calculated value = 10 and the tabulated Z = 1.96

Conclusion :

Since, the calculated value is much larger than the tabulated value, so you can conclude with the rejection of null-hypothesis.

Check Your Progress – II

Example 1:

The two-hypotheses are

Null-hypothesis, H_0: The sample is taken from the population with mean weight 70 kg.

Alternative-hypothesis, H_1: The sample is not drawn from the population whose mean weight is 70 kg.

It is a two-tailed test

From the question,

Sample size $n = 15$; sample mean $\bar{x} = 50$ sample standard deviation, $s = 10$ and population mean $\mu = 75$.

The test-statistic is

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n-1}} = \frac{50 - 75}{10/\sqrt{15-1}}$$

$$= \frac{-25}{10/\sqrt{14}}$$

$$= \frac{-25}{10/3.742}$$

$$= \frac{-25 \times 3.742}{10}$$

$$= \frac{-93.541}{10}$$

$$= -9.354$$

Ignoring the negative sign, the test-statistic is 9.354

The tabulated t at 5% level of significance with (15-1) = 14 degrees of freedom is 2.145

Conclusion:

Since, the calculated *t* value is much larger than the calculated t thus the test leads to rejection of null-hypothesis and conclude that the sample of students is not taken from the population whose mean weight is 75 kg.

Example 2:

The two hypotheses are

Null-hypothesis, H_0: There is no significant difference in between the data and the population mean height.

Alternative hypothesis, H_1: The data are not consistent with the population mean height

It is a two-tailed test

The available information are :

Sample size $n = 10$, population mean $\mu = 110$

The test-statistic is, $t = \dfrac{\bar{x} - \mu}{\sqrt{S^2/n}}$

Now, $\bar{x}$ and S^2 are to be calculated from the sample values of heights.

Calculations for sample mean & sample variance

x	$\left(x - \bar{x}\right)$	$\left(x - \bar{x}\right)^2$
100	100 – 116 = - 16	256
104	104 – 116 = -12	144
108	108 – 116 = - 8	64
110	110 – 116 = - 6	36
118	118 – 116 = 2	4
120	120 – 116 = 4	16
122	122 – 116 = 6	36

124	124 – 116 = 8	64
126	126 – 116 = 10	100
128	128 – 116 = 12	144
$\sum x = 1160$		$\sum \left(x - \bar{x}\right)^2 = 864$

Now, $\bar{x} = \frac{1}{n}\sum x = \frac{1}{10} \times 1160 = 116$

$\therefore S^2 = \frac{1}{n-1}\sum \left(x - \bar{x}\right)^2 = \frac{1}{10-1}(864) = \frac{864}{9} = 96$

Now, $t = \frac{\bar{x} - \mu}{\sqrt{S^2/n}} = \frac{116 - 110}{\sqrt{96/10}} = \frac{6}{\sqrt{9.6}} = \frac{6}{3.09} = 1.94$

Thus, the calculated value of $t = 1.94$ and the tabulated value of t at 5% level (two-tailed) of significance with (10-1) = 9 degrees of freedom is 2.262.

Conclusion: Since, the calculated value of t is less than the tabulated value of t so, you may conclude that there are not enough evidences to reject the null-hypothesis. Thus, you can say that the mean height of the students can be taken as 110 cms.

Check Your Progress – III:

Example 1:

Here,

Null-hypothesis: The performances of both the regular and private students are same

Alternative-hypothesis: The performances are not same for both the groups of students.

It is a two-tailed test

From the question, the available information are

Regular	**Private**
$\overline{x_1} = 62.5$	$\overline{x_2} = 61$
$\sigma_1 = 21$	$\sigma_2 = 18.2$
$n_1 = 95$	$n_2 = 72$

The test-statistic is

$$Z = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

$$= \frac{62.5 - 61}{\sqrt{\frac{(21)^2}{95} + \frac{(18.2)^2}{72}}} = \frac{1.5}{\sqrt{\frac{441}{95} + \frac{331.24}{72}}} = \frac{1.5}{\sqrt{4.64 + 4.60}} = 0.493$$

The calculated Z = 0.493 and the tabulated Z at 5% (two-tailed) level of significance is 1.96

Conclusion:

Since, the calculate Z is less than the tabulated Z at 5% level of significance, so, you may say that there are not much evidences to reject the null-hypothesis and conclude that the two means are statistically equal.

Example 2:

Here,

Null-hypothesis, H_0: There is no significant difference between the mean heights of the two groups.

Alternative-hypothesis; H_1: The two groups do not possess the same mean height

It is a two tailed test

From the question, the available information are –

Girls of class 10th	**Boys of class 9th**
$n_1 = 100$	$n_2 = 80$
$\overline{x_1} = 100$	$\overline{x_2} = 110$
$s_1 = 14.7$	$s_2 = 18.2$

Thus, the test-statistic is

$$Z = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

$$= \frac{100-110}{\sqrt{\frac{(14.7)^2}{100} + \frac{(18.2)^2}{80}}} = \frac{-10}{\sqrt{2.1609 + 4.1405}} = \frac{-10}{\sqrt{6.3014}} = \frac{-10}{2.51} = -398$$

Ignoring the negative sign, the value of the test-statistic Z = 3.98

From the table, the value of Z at 5% (two-tailed) level is 1.96

Conclusion:

Since, the calculated Z – value is greater than the tabulated value, so you may reject the null-hypothesis and conclude that the groups do not possess the same mean height.

Check Your Progress – IV:

Example 1:

The two hypotheses are –

Null-hypothesis, H_0: There is no significant difference between the formal and informal groups. In other words, the sensitivity of the two groups is same.

Alternative –hypothesis, H_1: The sensitivity of students under the formal training program is more than the informal training program.

It is a one-tailed test.

From the given problem, we have sample size, $n_1 = 12$; sample size, $n_2 = 15$ sample mean, $\overline{x_1} = 92$; sample mean $\overline{x_2} = 84$, sample standard deviation $s_1 = 15\%$; sample standard deviation $s_2 = 19\%$

Now, the test-statistic will be

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{S^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$\therefore S^2 = \frac{n_1 s_1^2 + n_2 s_2^2}{n_1 + n_2 - 2} = \frac{12 \times (15)^2 + 15 \times (19)^2}{12 + 15 - 2} = \frac{2700 + 5415}{25} = \frac{8115}{25} = 324.6$$

$$\therefore t = \frac{92-84}{\sqrt{324.6\left(\frac{1}{12}+\frac{1}{15}\right)}} = \frac{8}{\sqrt{324.6\left(\frac{15+12}{180}\right)}} = \frac{8}{\sqrt{324.6\left(\frac{27}{180}\right)}} = \frac{8}{\sqrt{48.69}} = \frac{8}{6.977} = 1.146$$

The given level of significance is 5% and for (12+15-2) = 25 degrees of freedom for one-tailed-test the tabulated *t* value is 1.708.

Conclusion :

Since, it is observed that the calculated value of the test-statistic is less than the tabulated value, so you may conclude that the null-hypothesis may be accepted i.e. there are not much evidence to reject the null-hypothesis and you can say that the sensitivity achieved by the two groups are same.

Example 2:

Here,

Null-hypothesis, H_0: There is no significant difference between the two diets A & B.

Alternative hypothesis, H_1: The two diets are not same.

It is a two tailed test and α= .05

The information obtained from the question are: sample size $n_1=n_2=5$

The computation of sample mean and sample standard deviation are:

Diet A				Diet B		
x_1	$d_1 = (x_1 - \overline{x_1})$	d_1^2		x_2	$d_2 = (x_2 - \overline{x_2})$	d_2^2
42	42–49.6 = -7.6	57.76		38	38–51.4 =-13.4	179.56
45	45–49.6 =-4.6	21.16		42	42 – 51.4 = -9.4	88.36
57	57 –49.6 =7.4	54.76		69	69– 51.4 = 17.6	309.76
63	63–49.6 = 13.4	179.56		44	44 –51.4=-7.4	54.76
41	41– 49.6 = - 8.6	73.96		64	64– 51.4 = 12.6	158.76
$\sum x$=248		$\sum d_1^2$ = 384.2		$\sum x$ = 257		$\sum d_2^2$ = 791.2

$$\overline{x_1} = \frac{1}{n_1}\sum x_1 = \frac{248}{5} = 49.6$$

$$\overline{x_1} = \frac{1}{n_1}\sum x_2 = \frac{257}{5} = 51.4$$

Standard deviation of the population is

$$S^2 = \frac{\sum d_1^2 + \sum d_2^2}{n_1 + n_2 - 2}$$

$$= \frac{384.2 + 791.2}{5 + 5 - 2}$$

$$= \frac{1175.4}{8}$$

$$= 146.93$$

$$\therefore S^2 = 146.93$$

The test-statistic is :

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{S^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$= \frac{49.6 - 51.4}{\sqrt{146.93\left(\frac{1}{5} + \frac{1}{5}\right)}} = \frac{-1.8}{\sqrt{146.93\left(\frac{2}{5}\right)}} = \frac{-1.8}{7.67} \backslash = -0.23$$

Ignoring the negative sign, the value of the test-statistic is 0.23. The tabulated value at 5% level with (5 + 5 -2) = 8 degrees of freedom is 2.306.

Since, the calculated t is less than the tabulated t. Thus you can conclude that there is not enough evidence to reject the null-hypothesis and you can say that, there is no significant difference between the two diets A and B.

Check Your Progress – V:

Example 1:

The two hypotheses are

Null-hypothesis, H_0: There is no difference between the two tests.

Alternative-hypothesis, H_1 : The two tests are not same.

It is a two tailed test

Now, construction of mean of difference and standard error of mean difference is given below:

I.Q. Before training(I)	**I.Q. After training(II)**	**Difference(D) (II)-(I)**	$d = D - M_D$	d^2
110	120	10	8.8	77.44
120	115	-5	-6.2	38.44
123	127	4	2.8	7.84
132	136	4	2.8	7.84
125	118	-7	5.8	33.64
		$\sum D = 6$		$\sum d^2 = 165.2$

Mean of differences $M_D = \frac{\sum D}{n} = \frac{6}{5} = 1.2$

Standard deviation of difference $= \sqrt{\frac{\sum d^2}{n-1}} = \sqrt{\frac{165.2}{5-1}} = \sqrt{41.3} = 6.43$

Standard error of mean differences $= \frac{6.43}{\sqrt{5}} = \frac{6.43}{2.24} = 2.87$

Now, $t = \frac{1.2}{2.87} = 0.42$

The calculated value is 0.42 and the tabulated value of t at (5 – 1) = 4 degrees of freedom is 4.6.

Conclusion :

Since the calculated value is less than the tabulated value so, you may conclude that there is not evidence to reject the null-

hypothesis and can say that there is no significant difference between the test results.

Example (2):

The hypotheses are:

Null-hypothesis, H_0: There is no significant difference between the two tests

Alternative-hypothesis, H_1: There is no improvement from test 1 to test 5.

It is a one-tailed test

Now, the calculation of mean of difference and standard error of mean difference are as follows –

Sl.No.	**1st test**	**5th test**	**Difference (D)**	$d = D - M_D$	d^2
1	50	65	15	12.4	153.76
2	55	55	0	-2.6	6.76
3	35	60	25	22.4	501.76
4	40	67	27	24.4	595.36
5	67	48	-19	-21.6	46915.56
6	69	72	3	0.4	0.16
7	57	50	-7	-9.6	92.16
8	72	53	-19	-21.6	466.56
9	80	47	33	-35.6	1267.36

10	53	87	34	31.4	985.96
			$\sum D = 26$		$\sum d^2 = 50985.4$

$$M_D = \frac{\sum D}{n} = \frac{26}{10} = 2.6$$

Standard deviation of difference

$$= \sqrt{\frac{\sum d^2}{n-1}} = \sqrt{\frac{50985.4}{10-1}} = \sqrt{5665.04} = 75.26$$

Standard Error of mean difference $= \frac{75.26}{\sqrt{10}} = \frac{75.26}{3.162} = 23.80$

$$\therefore t = \frac{2.6}{23.80} = 0.109$$

Calculated *t* value is 0.109 and tabulated *t* value at 5% level with (10-1) = 9 degrees of freedom is 1.833.

Conclusion: Since the calculated value is less than the tabulated value so, you may conclude with the statement that there is no difference between the two test. In other words, there is not enough evidence to reject the null-hypothesis.

References :

Garrett, H.E.; statistics in Psychology and Education, Indian ed., Vakils Feffer and Simons, Mumbai, 1971.

Model Questions :

1. A random sample of 900 items is drawn from a normal population whose mean and the standard deviation are 4. Can

a sample with mean 4.5 be regarded as truly random one at 5% level of significance?

2. The mean lifetime of a sample of 200 fluorescent lights tube produced by a company is found to be 1500 hours with a standard deviation of 150 hours. Test the hypothesis that the mean lifetime of the bulbs produced by the company is 1600 hours against alternative hypothesis that it is greater than 1600 hours at 5% level of significance.

3. Let a sample of 25 students is selected randomly from a class. The average height and standard deviation of that sample is found to be 105 cms and 7 respectively. Test at 5% significance, whether the sample is drawn from a population whose mean height is 115 cms.

4. Suppose, from a school, 10 students are selected randomly and their ages are recorded as 12, 15, 17, 13, 15, 11, 14, 18, 12 and 16 years. Can you say that this group of students is selected from a population of students whose mean age is 15 years?

5. A sample of 35 scouts performed in front of a selection committee as under $\overline{x_1}$ =23.5 and σ_1= 15. Again another sample of 30guides performed in front of the same selection committee under $\overline{x_2}$ = 21 and σ_2= 10. You are asked to test the equality of the two means at 5% significant level.

6. You are given the following information relating to student's weight from two classes

Class	**No of students**	**Mean weight**	**Standard deviation**

A	50	65	10
B	70	67	12

Using 5% significant level, test the equality of weights of the students of this two classes.

7. The means of two random samples of sizes 21 ad 18 are 48 and 40.2 respectively. Its standard deviations are recorded as 10 and 8 respectively. Check, whether the difference of the means is significant or not.

8. Two kinds of extra coaching classes were provided to students of class 10^{th} of a school before the pre-final exam. The performances in an exam are recorded as:

   Coaching I: 53 72 55 45 47 79 42 67

   Coaching II: 64 43 53 62 74 57 41 78

   Is there any significant difference between the two coaching classes?

9. The sales data of an item of 7-shops before and after special promotional campaign are as follows:

Shop	I	II	III	IV	V	VI
Before	55	43	62	31	45	29
After	57	54	60	61	40	35

   Can you say that the campaign was a successful one, at 5% significant level?

Unit – IV

Introduction to Analysis of Variance (ANOVA)

STRUCTURE

4.0 OBJECTIVES :

You have got ideas of measures of central tendency as well as measures of dispersion, either at school or college level. Accordingly, you have got ideas of mean (arthmatic mean) and variance. Further in Unit – III of Block – IV, you have got ideas of testing equality of two means. But if situation requires testing equality of several (more than two) means, then you have to use Analysis of variance or simply ANOVA technique.

In this unit you will study the nature of one way and two way classifications of data and assumption and applications of ANOVA for testing the significance of the difference between the means of three and more samples.

After reading this unit you will be able to –

- Distinguish between one way and two way classification.
- Understand the technique of one way ANOVA.
- Elucidate assumptions of ANOVA.
- Identify the situations where ANOVA is applicable.

4.1 INTRODUCTION :

We compute 't' values to determine if there is any significant difference between the means of two random samples. Suppose you have K (K>2) random samples and you are interested to determine whether there are any significant differences among their means. Let K = 3, i.e. there are three random samples viz sample – I (Mathematics marks of the students of school – I), sample – II (Mathematics marks of the students of school – II), sample – III (Mathematics marks of the students of school – III). Then you have to compare the means of

- Samples – I & sample – II

- Sample – II & sample – III
- Sample – III & sample – I

Thus you have to compute $\frac{k(k-1)}{n} = \frac{3(3-1)}{2} = 3$ values of t to determine the significance of difference between 3 means by taking two at a time. This procedure is time consuming, and an alternative to this procedure was developed by Prof. R.A. Fisher. This procedure is known as ANOVA technique. This technique has wide applicability in different Physical and Social Sciences including Education.

ANOVA technique is based on partitioning the total variability into different components. In Unit – III of Block – IV, you have got the ideas of tests of significance. You have also got ideas of t-test and Z-test. In ANOVA technique another test viz., F test or variance ratio test is applied to arrive at a conclusion. In this unit, you will study the concept, assumptions of ANOVA and applications of one way ANOVA for testing the significance of difference between the means of three or more samples.

4.2 ONE WAY VS. TWO WAY CLASSIFICATION AND ANOVA :

Suppose you are collecting scores of 5 groups of students / students from 5 schools (each group has four students) and the same is presented below –

Groups/Schools				
1	**2**	**3**	**4**	**5**
50	51	61	59	61
55	52	62	40	62
60	53	63	35	70
65	54	64	50	40

This classification is called one way classification. Because here the observation are viewed / classified from only one dimension / direction (here it is school). Further you may be also interested to know if the performance of all the schools is same or not. This can be answered by ANOVA and this is known as ANOVA for one way classification.

Again suppose you have conducted a series of 3 tests among 4 students and you have got the following marks distribution.

		Students / Individual			
		1	2	3	4
Test	I	41	30	35	50
	II	51	62	63	60
	III	61	70	40	30

This classification is an example of two way classification, because here the observations are viewed/ classified from two dimensions / directions (in this case students and tests).

Here also you may be interested to know if the performance of all the 4 students (irrespective of test) is same or not as well as if the performance in different 3 tests (for all the students) is same or not. This can also be answered with the help of ANOVA and this is known as two way ANOVA/ANOVA for two way classification.

4.2.1 Examples of one way classification :

4.2.1.1 Hypothetical experiment in which 48 subjects are divided at random to 8 groups. Groups are tested under 8 different experimental conditions – A, B, C, D, E, F, G, and H.

A	B	C	D	E	F	G	H
63	75	76	78	63	75	78	55
73	61	83	91	65	93	46	66
68	90	97	97	44	78	41	49
77	80	69	82	77	71	50	64
56	97	95	93	91	85	65	52
47	80	83	65	71	74	72	80

The objective of the experiment is to find if the group means differ significantly or not.

4.2.1.2 In a learning experiment 30 subjects are assigned at random to each of the 6 groups. Each group performs the same task but under slightly different experimental conditions. The objective of experiment is to ascertain if the group performances are significantly different or not.

Groups

1	**2**	**3**	**4**	**5**	**6**
51	40	65	39	61	39
52	32	61	42	65	38
61	40	30	51	70	44
60	51	70	55	42	66
41	62	48	62	55	70

Check Your Progress – I :

(1) Which of the following cases is one way classification(s) ?

(a) Twenty subjects are paired on the basis of their initial scores on a test. Ten are assigned to an experimental group and ten to a control group. The experimental group is given special practice and both groups are retested. The objectives of the tests are to test if –

- the groups differ significantly in mean performance ?
- the subjects differ significantly ?

The data for final scores are as follows –

Subjects

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Control group	25	46	93	45	15	65	85	45	51	42
Experimental group	36	57	89	67	19	73	96	35	61	50

(b) In a learning experiment 5 subjects are assigned at random to each of the 4 groups. Each group performs same task but under slightly different experimental conditions. The objective of the test is to ascertain if the group means differ significantly or not. The data are given below –

1	**2**	**3**	**4**
45	62	50	30
55	61	60	20
63	63	70	45
61	64	80	55
52	53	40	80

(c) In the following table the entries represent blood cholesterol readings taken from 10 patients in April, May & June. The objectives of the experiment are to determine if the monthly readings differ significantly as well as, if the individual readings (regardless of month) differ significantly. The readings are given below –

Individual	**April**	**May**	**June**
1	137.5	172.0	162.5
2	145.5	152.5	148.3
3	130.5	147.0	152.4
4	141.0	127.5	132.0
5	150.5	149.5	148.2
6	142.5	152.5	153.6
7	148.5	147.5	149.6
8	137.5	130.6	127.6
9	150.1	152.5	153.6
10	161.5	170.3	172.4

4.3 ASSUMPTIONS OF ANOVA :

There are some assumptions behind the use of ANOVA. These are –

(i) The observations should be independent.

(ii) The population from which the observations are taken is – normal.

(iii) The different treatment and environmental effects are additive in nature.

4.4 COMPUTATIONAL TECHNIQUE OF ONE WAY ANOVA :

Step – I : Calculation of Correction factor (C.F.) –

$$C.F. = (\sum x)^2 / N$$

Where x is observation and N is the total no. of observations.

Step – II : Computation of Total Sum of Squares (T.S.S.) –

$$T.S.S. = \sum x^2 - C.F.$$

Step – III : Computation of Treatment Sum of Squares (S.S.T.) / Sum of squares among different means –

$$SST = \left(\frac{T_1^2}{n_1} + \frac{T_2^2}{n_2} + \ldots \right) \text{- C.F.}$$

Where T_1 denotes total of 1st treatment, T_2 denotes total of 2nd treatment and so on; n_1 denotes no. of observations of 1st treatment, n_2 denotes the number of observations of 2nd treatment and so on

Step 4 : Computation of sum of squares due to Error (SSE) –

S.S.E = T.S.S. – S.S.T.

Step 5 : Computation of Mean sum of Square due to Treatment (MST)

MST = S.S.T./(k-1)

Where k is no. of treatments / classifications.

Step 6 : Computation of Mean Sum Squares due to Error (MSE)

MSE = S.S.E. / (N-k)

Step 7 : Computation of F –

F = MST/MSE

Step 8 : Tabulation of the Computed Values (this table is called ANOVA table)

ANOVA TABLE

Source	**d.f.**	**S.S.**	**M.S.S.**	**F**
Treatment	k-1	S.S.T.	MST	MST/MSE
Error	N-k	S.S.E.	MSE	-
Total	N-1	T.S.S.	-	-

Step 9 : Making Conclusion –

If computed F is smaller than table value of F corresponding to k-1 and N-k degrees of freedom, then conclude that the treatment means are not significantly different

But if computed F is greater than table value of F, conclude that treatment means are significantly different.

The above technique is explained with the help of following example –

A hypothetical experiment in which 24 subjects are assigned at random to 4 groups. Each group is tested under 4 different experimental conditions. You have to test if different experimental conditions have same effect or not. The scores are given below.

Groups

A	**B**	**C**	**D**
65	51	52	41
63	43	53	30
61	62	46	35
64	70	62	46
52	48	61	52

Solution :

$$\text{C.F.} = (\sum x)^2 / N$$

$$\text{Now } \sum x = 65 + 63 + 61 + 64 + 52 + 51 + 43 + 62 + 70 + 48 + 52 + 53 + 46 + 62 + 61 + 41 + 30 + 35 + 46 + 52$$

$$= 1057$$

$$\therefore C.F. = \frac{(1057)^2}{20}$$

$$= 55862.45$$

$$\text{T.S.S.} = \sum x^2 - C.F.$$

$$\text{Now, } \sum x^2 = (65)^2 + (63)^2 + (61)^2 + (64)^2 + (52)^2 + (51)^2 + (43)^2 + (62)^2 + (70)^2 + (48)^2 + (52)^2 + (53)^2 + (46)^2 + (62)^2 + (61)^2 + (41)^2 + (30)^2 + (35)^2 + (46)^2 + (52)^2$$

$$= 58033$$

$$\therefore \text{ T.S.S} = 58033 - 55862.45$$

$$= 2170.55$$

$$\text{S.S.T.} = \left(\frac{T_1^2}{n_1} + \frac{T_2^2}{n_2} + \frac{T_3^2}{n_3} + \frac{T_4^2}{n_4} \right) - C.F.$$

Now,

$T_1 = 65 + 63 + 61 + 64 + 52$

$= 305$

$T_2 = 51 + 43 + 62 + 70 + 48$

$= 274$

$T_3 = 52 + 53 + 46 + 62 + 61$

$= 204$

& $n_1 = n_2 = n_3 = n_4 = 5$

$$\therefore S.S.T. = \frac{(305)^2}{5} + \frac{(274)^2}{5} + \frac{(274)^2}{5} + \frac{(204)^2}{5} - 55862.45$$

$= 1096.15$

SSE = TSS – SST

$= 2170.55 - 1096.15$

$= 1074.40$

$$\text{MST} = \frac{SST}{k-1}$$

Here k is 4

$$\therefore \quad M.S.T. = \frac{1096.15}{4-1}$$

$= 365.38$

$$MSE = \frac{SSE}{N-k}$$

$$= \frac{1074.40}{20-4}$$

$= 67.15$

$$F = \frac{MST}{MSE}$$

$$= \frac{365.38}{67.15}$$

$$= 5.44$$

Table of ANOVA

Source	d.f.	S.S.	M.S.S.	F
Treatment	3	1096.15	365.38	5.44
Error	16	1074.40	67.15	-
Total	19	2170.55	-	-

Now table value of F for 3 and 16 d.f. is 3.24 (at 5% level of significance) and this is smaller than computed value of F. Therefore different experimental conditions mayn't have same effect (The table value of F is found out from the table as – d.f. for greater mean square is 3 and d.f. for smaller mean square 16. Now corresponding to 3 and 16 the table value is 3.24).

Check your progress – II

1. In a learning experiment 20 subjects are assigned to each of the 5 group. Each group performs the same task under slightly different experimental condition. You have to test if the groups differ in their mean performances ?

Group

A	B	C	D	E
56	44	36	43	60
50	45	37	52	71
52	46	42	61	52
51	43	46	60	64

2. Hypothetical experiment in which 20 subjects are divided at random to each of 4 groups. Groups are tested under 4 different experimental conditions A, B, C, & D. Test whether the performances of the group differ significantly or not ?

A	B	C	D
52	61	45	56
46	62	70	32
37	44	50	45
42	52	51	64
43	51	47	53

4.5 LET US SUM UP :

- ANOVA is a technique used for testing equality of more than two sample means.
- ANOVA is based on partioning total variability into different individual components.
- F-test is used in ANOVA technique.

- In oneway ANOVA, the observations are viewed / classified from only one dimension / direction and then it is tested if the means of different classes differ significantly or not.

4.6 KEYWORDS :

One way classification : In this classification, observation are viewed/ classified from only one dimension / direction.

ANOVA : ANOVA stands for Analysis of variance. It is a technique used for testing equality of more than two sample means.

4.7 SUGGESTED READINGS :

1. Statistics in Psychology and Education, 10th Indian Reprint, 1981, Vakily Fiffer & Simons Ltd., Bombay, Garrett H.S.

2. Fundamentals of Applied Statistics, 3rd Editions, 2005. S. Chand & Sons, New Delhi – 110002, Gupta S.C. & Kappor V.K.

Possible answers to C.Y.P. – I :

Q.1. (a) This is a two way classification. Because, here observations are viewed / classified from two dimensions, subject and grouping of individuals.

(b) This is an one way classification. Because here observations are viewed/ classified from only one dimension – group.

(c) This is a two way classification. Because, here observations are viewed/classified from two dimensions – individual and month.

Possible answers to C.Y.P. – II :

Q.1. $\text{C.F.} = \dfrac{(\sum x)^2}{N}$

$= \dfrac{(1011)^2}{20}$

$= 51106.05$

$\text{T.S.S.} = (\sum x)^2 - C.F.$

Now $\sum x^2 = 52727$

$\therefore T.S.S. = 52727 - 51106.05$

$= 1620.95$

$\text{S.S.T.} = \left(\dfrac{T_1^2}{n_1}\right) + \left(\dfrac{T_2^2}{n_2}\right) + \left(\dfrac{T_3^2}{n_3}\right) + \left(\dfrac{T_3^2}{n_3}\right) + \left(\dfrac{T_4^2}{n_4}\right) + \left(\dfrac{T_5^2}{n_5}\right) - C.F.$

$= \dfrac{(209)^2}{4} + \dfrac{(178)^2}{4} + \dfrac{(161)^2}{4} + \dfrac{(216)^2}{4} + \dfrac{(247)^2}{4} - 51106.05$

$= 10920.25 + 7921 + 6480.25 + 11.664 + 15252.25 - 51106.05$

$= 1131.7$

$\therefore SSE = T.S.S. - S.S.T.$

$= 489.25$

$$\therefore MST = \frac{1131.7}{4}$$

$$= 282.93$$

$$\therefore MSE = \frac{489.25}{15}$$

$$= 32.62$$

$$\therefore F = \frac{MST}{MSE}$$

$$= \frac{282.93}{32.62}$$

$$= 8.67$$

Table of ANOVA

Source	d.f.	S.S.	M.SS	F
Treatment	4	1131.7	282.93	8.67
Error	15	489.25	32.62	-
Total	19	1620.95	-	-

Now table value of F for 4 and 15 d.f. (at 5% level of significance) is 3.06 and this is smaller than calculated value of F. Therefore we conclude that the group means may differ significantly.

Question No. 2 :

$$\text{C.F.} = (\sum x)^2 / N$$

$$= \frac{1006009}{20}$$

$$= 50300.45$$

T.S.S. = $\sum x^2 - C.F$

Now $\sum x^2 = 51933$

$\therefore \quad TSS = 51933 - 50300.45$

$= 1632.55$

$$\text{SST} = \left(\frac{T_1^2}{n_1}\right) + \left(\frac{T_2^2}{n_2}\right) + \left(\frac{T_3^2}{n_3}\right) + \left(\frac{T_3^2}{n_3}\right) + \left(\frac{T_4^2}{n_4}\right) - C.F.$$

$$= \frac{(220)^2}{5} + \frac{(270)^2}{5} + \frac{(263)^2}{5} + \frac{(250)^2}{5} \quad - \quad C.F.$$

$= 293.35$

SSE = TSS = S.S.T.

$= 1632.55 - 293.35$

$= 1339.2$

$$\text{MST} = \frac{SST}{3}$$

$= 97.28$

$$\text{MSE} = \frac{SSE}{N = K}$$

$= 83.7$

$$\therefore F = \frac{MST}{MSE}$$

$= 1.17$

Table of ANOVA

Source	d.f.	S.S.	MSS	F
Treatment	3	293.35	97.78	1.17
Error	16	1339.2	83.7	-
Total	19	1632.5	-	-

Now table value of F for 3 and 16 d.f. (at 5% level of significance) is 3.24 and this is greater than calculated value of F. Therefore it can be said that the group means mayn't differ significantly.

References :

1. Research in Education, 10th Edition P.H.I. Learning Pvt. Ltd., New Delhi, 2010, Best J.W. & Kalm J.V.
2. Methodology of Educational Research, 4th Edition, Vikas Publishing House Pvt. Ltd.

Model Questions :

1. What is ANOVA ?
2. When ANOVA is used ?
3. Differentiate between one and two way classification with illustration.
4. The result of a series of memory tests conducted among the students of class 9th of a school are presented in the following table by dividing them into three groups A, B and C.

A	B	C
50	38	42
45	40	58
40	62	52
55	48	48
60	52	55

Test whether the performances of the 3 groups differ significantly or not ?

APPENDICES

TABLE - I
ARES UNDER NORMAL CURVE

Normal probability curve is given by

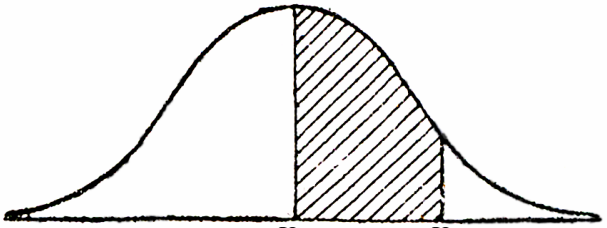
$$f(x)=\frac{1}{\sigma\sqrt{2\pi}}\exp\left\{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right\}-\infty<x<\infty$$

and standard normal probability curve is given by

$$\phi(z)=\frac{1}{\sqrt{2\pi}}\exp\left(-\frac{1}{2}z^2\right),-\infty<z<\infty$$

Where $Z=\frac{X-E(X)}{\sigma x}\sim N(0,1)$

Areas under Normal Curve



The following table gives the shaded are in the diagram viz. $P(0<Z<z)$ for different values of *z*.

TABLE OF AREAS

$\downarrow Z \rightarrow$	0	1	2	3	4	5	6	7	8	9
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0759
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2703	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3655	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319

$\downarrow Z \rightarrow$	0	1	2	3	4	5	6	7	8	9
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4678	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4959	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.1960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
3.1	.4990	.4991	.4991	.4991	.4992	.4992	.4992	.4992	.4993	.4993
3.2	.4993	.4993	.4994	.4994	.4994	.4994	.4994	.4995	.4995	.4995
3.3	.4995	.4995	.4995	.4996	.4996	.4996	.4996	.4996	.4996	.4997
3.4	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4998
3.5	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998
3.6	.4998	.4998	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999
3.7	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999
3.9	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000

TABLE - II
SIGNIFICANT VALUES $t_v(\alpha)$ OF *t*- DISTRIBUTION
(TOW TAIL AREAS)

$$P\left[\left| t \right| > t_v(\alpha)\right] = \alpha$$

$d.f.(v)$	*Probability (Level of Significance)*					
	0.50	0.10	0.05	0.02	0.01	0.001
1	1.00	6.31	12.71	31.82	63.66	636.62
2	0.82	0.92	4.30	6.97	6.93	31.60
3	0.77	2.35	3.18	4.54	5.84	12.94
4	0.74	2.13	2.78	3.75	4.60	8.61
5	0.73	2.02	2.57	3.37	4.03	6.86
6	0.72	1.94	2.45	3.14	3.71	5.96
7	0.71	1.90	2.37	3.00	3.50	5.41
8	0.71	1.80	2.31	2.90	3.36	5.04
9	0.70	1.83	2.26	2.82	3.25	4.78
10	0.70	1.81	2.23	2.76	3.17	4.59
11	0.70	1.80	2.20	2.72	3.11	4.44
12	0.70	1.78	2.18	2.68	3.06	4.32
13	0.69	1.77	2.16	2.05	3.01	4.22
14	0.69	1.76	2.15	2.62	2.98	4.14
15	0.69	1.75	2.13	2.60	2.95	4.07
16	0.69	1.75	2.12	2.58	2.92	4.02
17	0.69	1.74	2.11	2.57	2.90	3.97
18	0.69	1.73	2.10	2.55	2.88	3.92
19	0.69	1.73	2.09	2.54	2.86	3.88
20	0.69	1.73	2.09	2.53	2.85	3.85
21	0.69	1.72	2.08	2.52	2.83	3.83
22	0.69	1.72	2.07	2.51	2.82	3.79
23	0.69	1.71	2.07	2.50	2.81	3.77
24	0.69	1.71	2.06	2.49	2.80	3.75
25	0.68	1.71	2.06	2.49	2.79	3.73
26	0.68	1.71	2.06	2.48	2.78	3.71
27	0.68	1.70	2.05	2.47	2.77	3.69
28	0.68	1.70	2.05	2.47	2.76	3.67
29	0.68	1.70	2.05	2.46	2.76	3.66
30	0.68	1.70	2.04	2.46	2.75	3.65

TABLE - III
SIGNIFICANT VALUES OF THE VARIANCE-RATIO
F-DISTRIBUTION (RIGHT TAIL AREAS)
5 PER CENT POINTS

υ_1 / υ_2	1	2	3	4	5	6	8	12	24	∞
1	161.4	199.5	215.7	224.6	230.2	234.0	238.9	243.9	249.0	254.3
2	18.51	19.00	19.16	19.25	19.30	19.35	19.37	19.41	19.45	19.50
3	10.13	9.55	9.28	9.12	9.01	8.94	8.84	8.74	8.64	8.55
4	7.71	6.64	6.59	6.39	6.26	6.16	6.04	5.91	5.77	5.65
5	6.61	5.79	5.41	5.19	5.05	4.95	4.82	4.68	4.53	4.96
6	5.99	5.14	4.76	4.53	4.39	4.28	4.15	4.00	3.84	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.78	3.57	3.41	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.44	3.28	3.12	2.93
9	5.12	4.26	3.865	3.63	3.48	3.37	3.23	3.07	2.90	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.07	2.91	2.74	2.54
11	4.84	3.98	3.59	3.365	3.20	3.09	2.95	2.79	2.61	2.40
12	4.75	3.88	4.49	3.26	3.11	3.00	2.85	2.69	2.50	2.30
13	4.67	3.80	5.41	3.18	3.02	2.92	2.77	2.60	2.42	2.21
14	4.60	3.74	3.54	3.11	2.96	2.85	2.70	2.53	2.35	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.64	2.48	2.29	2.07
16	4.49	3.63		3.01	2.85	2.74	2.59	2.42	2.24	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.55	2.38	2.19	1.96
18	4.41	3.55	3.96	2.93	2.77	2.66	2.51	2.34	2.15	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.48	2.31	2.11	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.45	2.28	2.08	1.84
21	4.32	3.47	3.07	2.84	2.68	2.57	2.42	2.25	2.05	1.81
22	4.30	3.44	3.05	2.82	2.66	2.55	2.40	2.23	2.03	1.76
23	4.28	3.42	3.03	2.80	2.64	2.53	2.38	2.20	2.00	1.76
24	4.26	4.40	3.01	2.78	2.62	2.51	2.36	2.18	1.98	1.73
25	4.24	3.38	2.99	2.76	2.60	2.49	2.34	2.16	1.96	1.71
26	4.22	3.37	2.98	2.74	2.59	2.47	2.32	2.15	1.95	1.60
27	4.21	3.35	2.96	2.73	2.57	2.46	2.30	2.13	1.93	1.67
28	4.20	3.34	2.95	2.71	2.56	2.44	2.29	2.12	1.91	1.65
29	4.18	3.33	2.93	2.70	2.54	2.43	2.28	2.10	1.90	1.64
30	4.17	3.32	2.92	2.69	2.53	2.42	2.27	2.09	1.89	1.62
40	4.08	3.23	2.84	2.61	2.45	2.34	2.18	2.00	1.79	1.51
60	4.00	3.15	2.76	2.52	2.37	2.25	2.10	1.92	1.70	1.30
120	3.92	3.87	2.68	2.45	2.29	2.17	2.02	1.83	1.62	1.25
240	3.84	2.99	2.60	2.37	2.21	2.09	1.94	1.75	1.52	1.00