M.A. 4th Semester

Course : EDUCC 113

Course Type / Nature: Core

METHODS AND TECHNIQUES OF EDUCATIONAL RESEARCH

Dr. VISHAL SOOD

DR. RITIKA SHARMA

DR. (MRS.) MONIKA SOOD

Centre for Distance and Online Education

Himachal Pradesh University

Gyan Path, Summerhill, Shimla - 171005

Course Type / Nature: Core

Course Code: EDUC311

Course Title: METHODS AND TECHNIQUES OF EDUCATIONAL RESEARCH

Credits = 4 {Marks = 100 (70 + 30)}

Course Objectives:

To enable the learners to;

- Understand the Meaning, Importance, Steps and Types Of Descriptive Research
- Understand the Meaning, Nature, Importance and Steps involved in Historical Research
- Understand the Meaning, Importance, Steps and Components of Experimental Research
- Understand the Different Approaches of Qualitative Research.
- Analyze the Qualitative Data.
- Understand the concepts and nature of educational data and data analysis / basic descriptive statistical analysis techniques.

INSTRUCTIONS FOR THE PAPER SETTER AND CANDIDATES

The question paper for ESE will carry a total of 70 marks and consist of five sections: A, B, C, D & E. Section A will consist of 6 objective type questions (MCQ, True/False, Completion type) carrying one mark each and 4 short answer type questions carrying 2 marks each which will cover the entire syllabus uniformly. Sections B, C, D & E will have two long answer type questions from the respective Units 1, 2, 3 & 4 of the syllabus & carry 14 marks each. The long answer type questions may contain subparts carrying different marks. The marks for each sub-part and required word limit will be shown against it. Section A of the question paper will be compulsory and the candidates are required to attempt one question (and/or its sub-parts) each from the sections B, C, D and E of the question paper. Answers to short questions should be completed in around 80 to 100 words each. Answers to long answer type question should be completed in around 800 words.

UNIT 1 Descriptive Research and Historical Research 1 Credit

Descriptive Research: Meaning, Importance, Steps and Types of Descriptive Research (Survey Study Method, Correlational Study Method and Case Study), Historical Research: Meaning, Nature, Importance and Steps involved; Primary and Secondary Sources of Information.

External and Internal Criticism of the Historical Data Sources

UNIT 2 Experimental Research and Research Designs 1 Credit

Experimental Research: Meaning, Importance, Steps and Elements of Experimental Research, Methods of Controlling Extraneous Variables

Research Designs: One Group Pre-Test-Post-Test Design, Two Groups Randomized Subjects (Post Test only) Design and Simple Factorial Design (2X2).

UNIT 3 Approaches and Analysis of Qualitative Data 1 Credit

Difference between Qualitative and Quantitative Data.

Qualitative Research: Grounded Theory Research, Mixed Methods Research, Logical Positivism, Phenomenological Inquiry, Interpretivism & Ethnography

Analysis of Qualitative Data with Emphasis on Content Analysis including Logical & Inductive Analysis, Discourse Analysis, Analyses of Interview-based and Observation-based Data.

UNIT – 4 Analysis of Quantitative Data: Basics about Descriptive Statistics

1 Credit

Types of Data (Continuous and Discrete Data), Frequency Distribution and its Graphic Representation (Histogram, Frequency Polygon, Pie Chart).

Measures of Central Tendency (Mean, Median and Mode).

Measures of Variability (Range, Quartile Deviation, SD, Variance),

Sessional Work / Activities

Marks = 5 (under CCA Component)

A candidate is required to undertake any one of the following activities and submit a detailed report to the concerned teacher / PCP Coordinator. The activity will carry 5 marks:

1. Preparation of a research proposal on an identified research problem.
2. Any other activity / activities that the concerned course teacher may think appropriate can be allotted during PCP to the candidates.

Suggested Readings:

Agarwal. L. P.(2007).Modern Educational Research, Dominant Publishers and Distributers. New Delhi.

Best, J.W. & Kahn J.V. (1995): Research Education, Prentice Hall of India Pvt. Ltd., New Delhi.

Best, John, W., & Kahn James V. (2005). Research in Education", Prentice Hall of India Pvt.Limited, 9th Edition, New Delhi.

Bhandarkar,P.L., Wilkinson,T.S, & Laldas,D.K. (2004), "Methodology and Techniques of Social Research",Himalaya Publishing House, Mumbai.

Cohen,Louis; Manion, Lawrence & Morrison, Keith (2011). Research Methods in Education, 7th Edition. Cambridge University Press, India Private Limited.

Creswell, John W. (2014) Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research, Fourth Edition. PHI Learning Private Limited, Delhi.

Kaul, Lokesh (1984): Methodology of Educational Research, Vikas Publishing House Pvt. Ltd., New Delhi.

Keeves, John. P,(1998). Educational Research Methodology and Measurement, An International Hand Book, Pergamon Press, Oxford.

Kerlinger, F.N. (1986), Foundations of Behavioural Research 3rd Edition, New York, Holt, Rinehart and Winston.

Kothari.C.R.(1998).Quantitative techniques. Vikas Publishing House, New Delhi.

Radha Mohan (2006). Research Methods in Education. Neelkamal Publications Pvt. Ltd., Hydrabad.

Siddhu, Kulbir Singh (2002). Methodology of Research in Education. Sterling publications, New Delhi.

Borg. B.L. (2004) Qualitative Research Methods. Boston: Pearson.

Contents

UNIT-1

DESCRIPTIVE RESEARCH-I

Structure

1.1 INTRODUCTION

The descriptive research method has undoubtedly been the most popular and the most widely used research method in education. It helps to explain educational phenomena in terms of the conditions or relationships that exist, opinions that are held by the students, teachers, parents and experts, processes that are going on, effects that are evident, or trends that are developing.The primary goal is to provide a detailed account of the situation or subject under investigation. This type of research is often used when the researcher wants to gain a better understanding of the existing conditions, relationships, or patterns in a given context. Because of the apparent ease and directness of this method, a researcher can gather information in terms of an individual's opinion about some issue, by a simple questionnaire. At times, the descriptive survey is the only means through which opinions, attitudes, suggestions for the improvement of educational practices and instruction, and other data can be obtained.

1.2 LEARNING OBJECTIVES

After carefully reading this Lesson you will be able to meet the following objectives:

- Meaning and importance of descriptive research
- Explain the nature of Descriptive research.
- Steps in Descriptive Research
- Discuss the various types of Descriptive Research.
- Discuss the nature, types and purpose of Survey Studies.

1.3 EDUCATIONAL RESEARCH AND METHODOLOGY OF EDUCATIONAL RESEARCH

Educational research refers to a variety of methods, in which individuals evaluate different aspects of education including: "student learning, teaching methods, teacher training, and classroom dynamics".

Educational researchers have come to the consensus that educational research must be conducted in a rigorous and systematic way, although what this implies is often debated. There are a variety of disciplines which are each present to some degree in educational research. These include psychology, sociology, anthropology, and philosophy The overlap in disciplines creates a broad range from which methodology can be drawn. The findings of educational research also need to be interpreted within the context in which they were discovered as they may not be applicable at every time or place.

Characteristics

Gary Anderson outlined ten aspects of educational research:

- Educational research attempts to solve a problem.
- Research involves gathering new data from primary or first-hand sources or using existing data for a new purpose.
- Research is based upon observable experience or empirical evidence
- Research demands accurate observation and description.

- Research generally employs carefully designed procedures and rigorous analysis.
- Research emphasizes the development of generalizations, principles or theories that will help in understanding, prediction and/or control.
- Research requires expertise-familiarity with the field; competence in methodology; technical skill in collecting and analyzing the data.
- Research attempts to find an objective, unbiased solution to the problem and takes great pains to validate the procedures employed.
- Research is a deliberate and unhurried activity that is directional but often refines the problem or questions as the research progresses.
- Research is carefully recorded and reported to other persons interested in the problem.

Approaches:

There are two main approaches to educational research. The first is a basic approach. This approach is also referred to as an academic research approach. The second approach is applied research or a contract research approach. Both of these approaches have different purposes which influence the nature of the respective research.

Basic approach:

Basic, or academic research focuses on the search for truth or the development of educational theory. Researchers with this background "design studies that can test, refine, modify, or develop theories". Generally, these researchers are affiliated with an academic institution and are performing this research as part of their graduate or doctoral work.

Applied approach:

The pursuit of information that can be directly applied to practice is aptly known as applied or contractual research. Researchers in this field are trying to find solutions to existing educational problems. The approach is much more utilitarian as it strives to find information that will directly influence practice. Applied researchers are commissioned by a sponsor and are responsible for addressing the needs presented by this employer. The goal of this research is "to determine the applicability of educational theory and principles by testing hypotheses within specific settings"

Comparison of basic and applied research:

The following are several defining characteristics that were written by Gary Anderson to compare basic (academic) and applied (contract) research.

	Basic (Academic) Research	Applied (Contract) Research
1	Is sponsored by an agency committed to the general advancement of knowledge	Is sponsored by an agency with a vested interest in the results.
2	Results are the property of society and the research community.	Results become the property of the sponsor.
3	Studies rely on the established reputations of the researchers and are totally under their control.	Studies follow explicit terms of reference developed by the sponsor to serve the sponsor's needs.
4	Budget allocations are generally based Ion global proposals and accounting is left to the researchers.	Budget accountability is directly related to the sponsor and relates to agreed terms of reference, time frames and methodologies.
5	The conduct of research is based on 'good faith' between funder and researcher.	The work is contractual between sponsor and researcher.
6	The research produces findings and conclusions, but rarely recommendations except those related to further research needs.	The research includes applied recommendations for action.
7	Academic research tends to extend an identifiable scholarly discipline.	By its nature, contract research tends to be interdisciplinary.
8	Academic research is typically focused on a single set of testable hypotheses.	Contract research frequently analyzes the consequences of alternative policy options.
9	Decision-rules relate to theoretically- based tests of statistical significance.	Decision-rules relate to predetermined conventions and

		agreements between the sponsor and the researcher.
10	Research reports are targeted to other specialized researchers in the same field.	Research reports are intended to be read and understood by lay persons.

METHODOLOGY OF RESEARCH

The basis for educational research is the scientific method. The scientific method uses directed questions and manipulation of variables to systematically find information about the teaching and learning process. In this scenario, questions are answered by the analysis of data that is collected specifically for the purpose of answering these questions Hypotheses are written and subsequently proved or disproved by data which leads to the creation of new hypotheses. The two main types of data that are used under this method are qualitative and quantitative

Qualitative research:

Qualitative research uses data that is descriptive in nature. Tools that educational researchers use in collecting qualitative data include observations, conducting interviews, conducting document analysis, and analyzing participant products such as journals, diaries, images or blogs.

Types of qualitative research:

- Case study
- Ethnography
- Phenomenological Research
- Narrative Research
- Historical Research

Quantitative research

Quantitative research uses data that is numerical and is based on the assumption that the numbers will describe a single reality. Statistics are often applied to find relationships between variables.

Types of quantitative research

- Descriptive research
- Correlational research

- Experimental research

SELF-CHECK EXCERCISE-1

Q1. What is the primary purpose of educational research?

A) To make a profit

B) To develop theories and principles

C) To entertain students

D) To ensure students pass exams

Q2. What is the purpose of a literature review in educational research?

A) To collect primary data

B) To analyze statistical data

C) To summarize existing research on a topic

D) To design an experiment

1.4 DESCRIPTIVE RESEARCH

Meaning and Importance of Descriptive Research

Descriptive research is a type of research design that focuses on describing and documenting the characteristics, behaviors, or conditions of a particular phenomenon without manipulating it. The primary purpose is to provide a detailed and accurate account of what exists, offering a snapshot of the subject under investigation. Unlike experimental research, descriptive research does not involve changing variables or establishing cause-and-effect relationships. Instead, it seeks to answer the question "what is?"

Importance of Descriptive Research:

The importance of descriptive research lies in its ability to provide a foundational understanding of a phenomenon, offering valuable insights and serving as a crucial step in the research process. Here are key reasons why descriptive research is important:

Initial Exploration:

It serves as a starting point for researchers to explore a topic, identify key aspects, and formulate research questions.

Understanding Phenomena:

Descriptive studies help researchers gain a clear understanding of a subject by documenting its characteristics, behaviors, or conditions.

Problem Identification:

Identifies problems or issues that may require further investigation, guiding researchers toward specific areas of interest.

Baseline Information:

Establishes baseline information for a phenomenon, allowing researchers to track changes or trends over time.

Hypothesis Formulation:

Findings inspire the formulation of hypotheses for subsequent studies, providing a basis for more targeted research.

Decision Making

Assists decision-making processes in school, organizations, or policymaking by providing relevant data.

Policy Development:

Contributes data in social sciences for informed policy development based on societal trends, demographics, and behaviours.

Validation of Previous Research:

Validates or challenges findings from earlier research, enhancing the overall reliability of knowledge in a particular field.

Effective Communication:

Results are presented in a clear and accessible manner, facilitating the communication of information to a broad audience.

Ethical Research Approach:

Considered ethical, particularly in situations where experimental manipulation might be impractical or unethical, allowing study in a natural state.

Real-World Context:

Research conducted in natural settings provides a realistic view of the subject, enhancing the external validity of the findings.

Flexibility in Design:

Offers flexibility in choosing data collection methods, allowing adaptation to the specific research context.

In essence, descriptive research plays a crucial role in the research process by offering a foundational understanding of a subject, guiding subsequent research endeavours, and contributing valuable information for decision-making and policy development.

NATURE OF DESCRIPTIVE RESEARCH

The nature of descriptive research can be understood through key points:

Observation and Description:

Descriptive research focuses on observing and accurately describing a phenomenon without changing or manipulating it.

No Manipulation of Variables:

Unlike experimental research, there is no intentional alteration of variables. Descriptive studies aim to capture the natural state of the subject.

Real-World Context:

Research is often conducted in natural settings, providing a realistic view of the subject in its everyday environment.

Objective and Unbiased:

The researcher aims to present an objective and unbiased account of the subject, minimizing personal opinions or interpretations.

Quantitative and Qualitative Data:

Both numeric data (quantitative) and non-numeric data (qualitative) are used to provide a comprehensive understanding of the phenomenon.

Exploratory Nature:

Descriptive research serves as an initial exploration of a topic, laying the groundwork for more detailed investigations.

Answering "What Is?":

The primary question addressed is "What is happening?" or "What are the characteristics?" rather than exploring cause-and-effect relationships.

Documenting Facts:

It involves systematically documenting facts, details, and features of the subject under study.

Facilitates Further Research:

Descriptive research often leads to the formulation of hypotheses and guides subsequent research phases by identifying areas for more in-depth study.

Flexible Research Design:

Researchers have flexibility in choosing data collection methods, including surveys, observations, case studies, and content analysis.

Problem Identification:

Helps in identifying problems or areas that may require further investigation, contributing to the research process.

Baseline Information:

Establishes baseline information for a phenomenon, enabling the tracking of changes or developments over time.

Communication of Findings:

Results are communicated in a clear and straightforward manner, making it accessible to a broad audience.

Ethical Considerations:

Descriptive research is often considered ethically sound, particularly in situations where experimental manipulation might be impractical or unethical.

In summary, descriptive research is about keen observation, presenting facts objectively, and providing a foundation for deeper exploration in research. It captures the "what is" of a subject in a straightforward and accessible manner.

STEPS OF DESCRIPTIVE RESEARCH

Descriptive research involves systematically observing, recording, and analysing characteristics of a phenomenon without manipulating variables. Here are the general steps typically involved in conducting descriptive research:

1. Identify the Research Problem:

Clearly articulate the specific aspect or characteristics of the phenomenon you want to study. Define the scope and purpose of your research.

2. Review of Existing Literature:

Conduct a literature review to understand what is already known about the topic. Identify gaps in knowledge that your descriptive research aims to fill.

3. Formulate Hypotheses and Objectives:

While descriptive research is primarily focused on describing, rather than explaining, phenomena, you may still develop hypotheses if they help guide your observations or data collection.

4. Choose the Appropriate Methodology for Research:

Select the appropriate research design, sampling technique, tools and data collection method based on your research and objectives. Common designs include observational studies, case studies, surveys, content analysis, and others.

5. Collect Data:

Implement your data collection plan. Once data is collected, organize it in a meaningful way. This may involve creating tables, charts, or graphs to summarize and present the information.

6. Perform Descriptive Analysis:

Analyse the data descriptively. This could include calculating measures of central tendency (e.g., mean, median, mode), measures of variability (e.g., range, standard deviation), and other relevant statistical summaries. Interpret the results

And Draw necessary Conclusions.

These steps provide a structured approach to conducting descriptive research.

Types of DescriptiveResearch

- Survey Study Method
- Correlational Study Method
- Case Study Method

SELF-CHECK EXCERCISE-2

Q.1. What is the primary goal of descriptive research?

a. To establish cause-and-effect relationships

b. To explore the underlying reasons for a phenomenon

c. To describe and summarize characteristics of a population or phenomenon

d. To test hypotheses through experimental manipulation

Q.2. Which of the following is a common method used in descriptive research?

a. Randomized Controlled Trials (RCTs)

b. Case studies

c. Experiments

d. None of the above

Q 3. What is the main limitation of descriptive research?

a. Lack of generalizability

b. Difficulty in establishing causation

c. Inability to collect quantitative data

d. Dependence on subjective interpretations

1.5 SURVEY STUDY METHOD

A survey is a method of collecting data in a consistent way. Survey research is useful for documenting existing community conditions, characteristics of a population, and community opinion. In this chapter, you will find an outline of the steps needed to conduct surveys using both the questionnaire and interview methods. Details on preparing questionnaires and interview schedules are presented, along with a Comparison of both methods for different community-based situations. Survey data is not only useful for immediate community development purposes, but it can also serve the future of a community efforts by providing the baseline data needed later to demonstrate progress. Surveys are one of the most common forms of research to reach native communities, to the point that the common community reaction is "Not another survey!" Such a reaction is usually due to the hundreds of surveys conducted by academic researchers and federal agencies, where the results rarely came back to the community directly. In these times of change, many community groups are conducting their own surveys and participating in the definition of the questions asked by the surveys of other researchers. This type of cooperative survey effort can be a strong tool for community development.

More specifically, surveys can be useful for:

- Determining the characteristics of a population or a community
- Defining existing conditions in a community or region
- Documenting community opinion

- Comparing groups of communities

All of the above purposes for conducting surveys can be directly applied to the development and management of community resources. More specifically, a survey is a method of collecting data in a consistent, or systematic, way This usually involves constructing a set of questions that are either asked by means of a questionnaire or through an interview.

TYPES OF SURVEYS

There are several different approaches to conducting a survey. One very common approach is the cross-sectional survey, where a set of information is collected for a sample at one point in time. Data may be collected from a sample of the population or from the entire population or community. When the data can be collected from an entire population, as may be the case in the small community or tribe, then the survey is sometimes called a census. When the data are analyzed from a cross-sectional survey, the results can vary from tabulations of answers on single questions to a more complex analysis exploring the relationships between variables. Even though the data are collected at one point in time with the cross- sectional survey there are methods of comparing items or looking for change. For example, the questions asked may be time-ordered, referring to events in the past, present, or the future. The responses on such questions can provide a basis for looking at change, but with the disadvantage that the person answering the questions may distort impressions of an event over time.

The longitudinal survey provides another means of looking at changes over time. With this type of survey, the data are actually collected at different points in time. This can be accomplished by either sampling from a population at different points in time, or by following-up on a group of individuals at different points in time. The main problem seen with follow-up on a group of individuals is loss of participants (also known as drop-out or attrition). With the small community, it may be possible to follow-up with nearly the entire population and tracking those who may have moved through the community network

An example of a longitudinal survey would be a study of native language use within the community, where questions on language use are asked five years apart to see if there had been any change in the amount of language use. Such a study might look at reasons for decreased or increased language use and relate these changes to cultural change. The data obtained from such a study could be useful in documenting the structure of a bilingual education program.

Several distinctions are sometimes made within the longitudinal survey design. With the trend study, a general population is sampled at more than one point over time. While the same individuals are not surveyed each time, the assumption is made that each sample represents the same population. During the cohort study, a specific population is followed over a period of time. For example, high school graduates at different years might be surveyed to note changes in this group over the years. For a panel study, a specific sample of individuals is followed at different points in time. Attrition tends to affect this last type of longitudinal study

Although many researchers are in favor of the more complex survey design, it cannot be overemphasized that even the most descriptive tabulations of simple responses on culturally appropriate questions are more valuable than complex, statistically sophisticated analyses on questions that may be inappropriate to the community. A basic, descriptive design is also often a good first step toward finding direction for a more complex design later on. The most important factors in choosing a design are the needs and the resources of the community.

Steps For Conducting A Survey:

The following steps are intended as a general outline of the methods generally used in conducting a survey. Consideration of these steps is useful in completing the survey design before the actual research begins.

Step 1: Defining the purpose of the survey is an important first step in developing the research design. The more tightly focused the study, the more useful the results are likely to be for community development. One common mistake made in a community survey is to collect a wide range of data that does not relate to a specific purpose. This is different from conducting a multi-purpose survey, where several different goals are decided upon and the questions are designed to address the different goals. Since the time involved with conducting a survey is usually extensive, it may be more economical to the community to design a multipurpose survey that could be used for planning and development efforts in several areas For example, a survey to determine existing health levels might be directed at development of a health care delivery system and an alcohol treatment centre as well. Deciding the general purpose of the study is usually a step that enables a group to begin focusing the project. Then, determining the goals and objectives of the project further focuses the purpose of the study to the point that the methodology can be developed Goals are long-term general outcomes; whereas, objectives are short-term, and more specific. For example, in the language survey sample carried throughout this chapter, the goal of the survey would be: "To examine the extent to which use of the native language is maintained in the community Specific objectives would be:

"To determine language use of adult community members,"

"To determine present language use of children in the community."

"To determine the first language -acquired by children in the home," and

"To determine the domains of interaction where native language is used in the community."

The results of such a survey might be used to develop adult language classes or bilingual education programs. Other educational programs might be developed with the use of such data, for maintenance of the native language is often used as an indicator of retention of traditional culture. Objectives can also reflect relationships between variables.

Step 2: Locating previously conducted surveys on similar topics is a step that enables the researcher to discover examples of different types of survey designs and instruments to collect data Research results are often published through some of the library and data base sources listed in the chapter on LIBRARY AND INFORMATION SERVICES Materials that were prepared in conjunction with a survey project, such as training manuals or complete instruments can often be obtained by writing to the author Other types of studies conducted with the survey population can also yield valuable information for the project.

Step 3: Deciding on the type of survey design that will best accomplish the goals and objectives of the project is a very critical step in the survey process. One common mistake made in research efforts is to begin designing an instrument to collect data before the overall research design is planned. The appropriate survey design will vary according to the goals of the project, the time limits that may exist, and the resources available to the project. For example, if documentation is needed on the socioeconomic conditions of an area for the purpose of immediate development work, then a cross-sectional survey might provide the best design. Or, if existing conditions in two communities (perhaps two Indian communities or an Indian and a non-Indian community) are to be compared at the present time, again the cross-sectional approach can be considered. If the purpose of the project is to see if change is occurring over time, then the longitudinal method would be the more appropriate design. For example, if a community is implementing an economic development project, a survey effort might be useful in documenting socio-economic conditions at the start of the project and then at a later date to see if improvement has occurred. Evaluation projects often use the longitudinal survey approach.

One of the practical decisions of choice relates to the resources available. Longitudinal studies require continuity of staff and funds over time. Turnover of personnel and loss of interest in the study are some of the more frequent reasons why longitudinal efforts fail to reach completion. Often a two-year or a three-year funding commitment can be gained for the study in advance, if the research design is developed before the start of the project. Follow-up on individuals takes a great deal of attention, rapport, and the development of a good tracking system. Yet, the strength that many project gain from demonstrating change over time is a very valuable development asset. In addition to documenting the effectiveness of new techniques, the ability of showing change over time increases accountability to the community.

Step 4: Selecting the sampling methods to be used relates to the type of survey design and to the population included in the study. The first step in choosing the sampling method is to define clearly the population to be reached. Is the population included in the study a community, a tribe, or a whole region? The resources available, in terms of both personnel and funding are important considerations. It may be more useful in documenting socio-economic conditions to have a completed survey of a well-sampled community, rather than a less-thorough survey of the larger population or tribe. If differences between communities (for example, economic, environmental, bands or other groupings) are not great, the study of one community can provide an example and often serves as a starting place or a pilot study for expanding the study to other communities.

Common mistakes in survey sampling are:

1) Not narrowing down or focusing the sampling enough to accomplish the objectives of the study.

2) Focusing on a well-defined sample, but choosing a sample of individuals that cannot provide the Information needed for the survey, and

3) Selecting the sample by convenience (persons most readily available), rather than selecting a random or a representative sample.

Sampling becomes much more of a challenge in rural communities, where the conventional sampling techniques developed for urban areas often do not apply. One successful technique for the small community is exhaustive sampling, or including all of the households in the community. When an exhaustive sample is possible, the use of descriptive statistics is simplified.

The cross-sectional survey often uses subsamples within the larger sample for comparison purposes. Care should be taken that each of these subsamples are representative of the total population. And for statistical purposes, each of the subsamples should include a substantial number of people.

In sampling for the longitudinal survey, the total number in the initial sample should take into account the drop-out, or loss of participants that is bound to occur over time. Although there are no set rules for the adequate sample size, one rule of thumb often used is that the total sample size would comprise 10 % of the total population. In determining the sample size and procedures, when an exhaustive sample is not possible, it is wise to consult a statistician.

Step 5: Deciding on a method of collecting the data is an important step in designing the survey. The more common methods of data collection are the questionnaire and interview schedule, although this type of data is sometimes supplemented by organizational records, census data, and the data from previously conducted surveys. A questionnaire is a set of questions that are answered directly on paper by the respondent, while an interview schedule is a set of questions that are asked to the respondent by an interview. These questions can be listed with highly structured responses (closed form), or may be open ended (open form), allowing for additional comments. In choosing between the questionnaire and the interview methods, some of the factors to consider concerning appropriateness for community use are, whether a mailed questionnaire would be returned, literacy levels of respondents, language dominance of respondents, and the advantage of the more personal interview contact. If the target group of respondents is school administrators, the questionnaire method might be appropriate, whereas, for a rural community survey, the interview method is more likely to succeed. When the research design is prepared, generally a preliminary instrument for data collection is prepared with the understanding that the final instrument would be developed at the start of the project. Time for development and pretesting of the instrument, as well as staff training to use the instrument, needs to be allowed in the project timetable. These tasks can take several weeks. Research projects usually develop a new instrument to test a new idea; however, the many instruments now in existence can serve as a starting place for ideas. During the literature search for related work, references to instruments from previous studies can be located.

Step 6: Conducting a pretest with the questionnaire or interview schedule is a step to minimize problems before the actual data collection begins. One of the first ways to check over the instrument is to read it yourself to see if there are any uncertain or vague questions. Then, after this preliminary check, a pretest or trial run of the data collection method should be conducted. For the pretest, a sample of individuals similar to those planned for the survey sample is chosen. Generally, about ten to twenty respondents are asked to participate in the pretest. The pretest provides an opportunity to see if the data collection methods are culturally appropriate, easily understood, or complete. The questionnaire or interview schedule is generally revised, or rewritten, if the pretest indicates that changes are needed. Certain federal offices require approval of the data collection instrument before use, so funded projects might be wise to check into the current policies.

Step 7: Collecting the data involves effective use of the instruments developed for data collection. Techniques that might be incorporated into the research design for the community-based effort are often less formal and more culturally sensitive than in many academic projects. A letter of introduction, sometimes called a transmittal letter, is an important aid in gaining cooperation for the questionnaire. A good explanation of the purpose of the project (and why the respondent is important to the project) is one of the more important factors in obtaining a high response rate. Likewise, the introduction provided by the interviewer is a very critical point in gaining cooperation for the interview. Giving back to the community while collecting the data is one of the most effective ways of reciprocating during a study. Although an explanation of the benefits expected to come to the community from the study is one form of sharing, the offering of information or services at the time of the data collection is a more immediate demonstration of the thoughtfulness put into the project. For example, information booklets on available services can be produced very inexpensively and given to families at the time of the interview or mailed with the questionnaire. Such a booklet can also contain an explanation of the purpose of the survey and the plans for applying the survey results to develop further resources. Another means of giving to community members in exchange for their time is to provide transportation to a needed service. Particularly if two interviewers are working together, the interview may be conducted on the way to the destination. For example, in conducting a survey of existing health conditions, an offer of transportation to obtain health services might be appropriate. Two pitfalls to watch for in this type of exchange are:

1) Skewing the sample by gaining cooperation from a population segment that is more apt to seek out a particular type of service, or

2) Becoming involved as a transportation provider to the extent that the survey effort becomes neglected.

When there are available funds for the project, it may be possible to pay the respondent for the time taken during the interview. The introduction of money into the exchange may be less culturally appropriate than other forms of sharing, and may make the respondent feel as though all questions must be answered. Time given by community members is a valuable contribution, and the extent to which this is recognized by the researcher, the better the project is likely to be accepted in the community.

Maintaining confidentiality of the data, the identity of the respondent unknown, is an ethical consideration in the data collection process. If safeguards are taken to protect the identity of the respondent, it will often put him at ease to explain these either on the letter accompanying the questionnaire or during the interview. The most common form of protecting the respondent's identity is through the use of a respondent number. That is, a master list is kept of respondent's names, addresses, and assigned numbers by the research project staff. Only the respondent number appears on the data record sheets and the master list is then kept in a locked or confidential place. For a returned questionnaire, the name of the respondent is usually identified to enable a follow-up in the case of non-responses. The respondent number can be used in recording the data, though, to provide confidentiality when the data are processed and the results reported. The anonymous questionnaire, where the respondent does not reveal his identity, may be necessary for collecting very sensitive types of data, however, the follow-up is difficult, if not impossible when this technique is used. A system for maintaining confidentiality is particularly important for the interview method, where the interviewer is visible in the community. Explaining the system by which the data will be kept confidential often helps to gain the trust of the respondent

The collection of data is one of the most time consuming and expensive parts of the survey project. In addition to plans for the actual data collection methods, the research design must adequately provide for staff time and funds to complete the project. The questionnaire method requires funds for questionnaire duplication, preparation of the letter of introduction, postage and envelopes for both the initial contact and return of the completed instrument, duplication and postage for follow-up on non-responses, payment to participants involved in the pretest, materials given to respondents, as well as funds for the data analysis. The interview method requires funds for duplication of the instrument, payment of the pretest participants, salary for the interviewers (initial contacts and follow-up), transportation for the interviewers, and materials given to respondents, in addition to the costs of the data analysis. The amount of time required for each interview can be estimated from the pretest interviews, and transportation time can be calculated according to the average distance to be travelled. A timetable for the research design is a good planning measure and later provides a valuable guide for staff members to follow during the project.

Completion of the data collection plan is critical to the survey effort, for failure to complete any segment of the plan due to a shortage of time or funds would severely affect the sampling for the project. Adequate attention to this task in the research design cannot be overemphasized.

Step 8: Follow-up is an important step to plan for in the survey process, for a certain number of respondents frequently do not mail back questionnaires or cooperate on the Interview at the first try. With the questionnaire method and initial response rate of less than 50 percent may indicate problems with the questionnaire or the method of communicating with the respondent. In some survey efforts, a, completely new approach needs to be tried if the response rate is extremely low. In most surveys, however, a follow-up letter with another copy of the questionnaire and a self-addressed, stamped envelope will increase the return rate.

Follow-up with the interview approach can become more complex, for there are several different reasons that can be the cause of the non-interview:

1) In one type of situation, there is no one at home at the residence. Contacting the respondent in advance by telephone or by mail to arrange a time for the interview decreases the likelihood of this situation. Call-backs increase the response rate when the interviewer finds no one at home.

2) A related situation occurs when the respondent is not at home. This may happen when the chosen respondent is to be the head of the household or an adult. Arrangements may be made with other members of the family for a return visit.

3) Another non-interview situation occurs when the respondent is not available. If the person is busy or ill, but willing to cooperate, then arrangements can usually be made for a later date.

4) An outright refusal on the part of the respondent can be for several different reasons, yet the end result is the same. Since refusals introduce bias into the survey effort, interviewer training to deal with those hesitant to cooperate is important.

Whether using the questionnaire or the interview method, a record keeping system for follow-up is important to include in the research design. Follow-up is an expensive step in the survey process, and funds are usually budgeted for this additional effort. Beyond a good follow-up effort, the researcher needs to accept the fact that, for a variety of reasons, some people will not respond. Remember that people have the right to refuse the respond, and don't take such refusals personally.

Step 9: An outline of how the analysis of the data will be conducted is an important part of the research design. This step is interrelated with the design of the data collection instruments, for the data must be collected according to a certain format (such as numerical or descriptive) to allow for certain types of summaries. One of the more common mistakes in survey research occurs when the data collection instruments are designed without giving thought to the techniques that would be used to summarize or tabulate the data. Well-coordinated data collection and analysis plans allow for the maximum use of the data. For example, whether data are collected in a numerical, grouped, or ranked format, they will allow for different statistical analysis. Many uses of the data may be lost if the data are collected and then a statistician is approached later to help with analysis.

Step 10: Reporting or sharing the results of the survey is a vital step in returning the efforts to the community.

These are a few of the items that help complete the survey report-

- Purpose of the study
- Review of previous studies or surveys
- Survey method (population, sampling method, sample size, data collection method, method of data analysis, attrition rate, examples of questionnaires or interview schedules used)
- Analysis of data (presentation of data, interpretations)
- Conclusions (overview of the study, results, recommendations)

To enable the reader of the report to use the study results effectively, the data should be presented in a clear manner. This is most commonly done in the form of tables where the responses to questions are summarized. Whenever a table is included, a clear presentation includes mention of the purpose of including the data and the interpretation of the data. One common mistake that loses the reader is cluttering the report with too much data, or with data that is not interpreted in relation to the findings.

Again, we emphasize that writing a clear report may make the difference between the study that is useful to a community and the study result that sits on a shelf.

More Common Mistakes Made During Survey Research

These are a few of the mistakes more frequently made in community-based survey efforts:

- Specific goals and objectives are not defined for the project, reducing the effectiveness of the data-gathering
- Comparisons between groups are overlooked
- Sampling is not representative
- The sample group does not have the information needed for the study
- Questionnaire method is used in a community where attitudes are not receptive to the less personal method and the return rate is low
- The questionnaire method is used where the literacy level of the community members is low, thus preventing completion of the form in a large number of cases
- The questionnaire is too long, causing the respondent to become impatient
- The questionnaire is worded in a vague or unclear manner, causing interpretations among respondents
- Questionnaire contains researcher bias
- Either questionnaire or interview schedule is not pretested to discover problems
- Coding format is not developed before the data collection, for purposes of summarizing the data numerically
- Interview format is not structured enough to allow for the collection of the same kinds of data for each case included in the sample Interviewer is not effective due to association with certain factions in the community
- Interviewer is not trained in interview skills
- Interviewer shows bias during the interview, swaying the responses
- Follow-up not conducted on no-responses, for either questionnaire or interview method
- Confidentiality is not kept on respondent data
- Checks not conducted to test the reliability of data
- Survey report contains too much jargon, or technical words, for community use

Adequate planning of the survey design can help the research staff in avoiding these possible problem areas.

SELF-CHECK EXCERCISE-3

Q.1 What is a common advantage of using surveys in educational research?

A) They allow for in-depth exploration of complex phenomena.

B) They can collect data from a large number of respondents quickly and efficiently.

C) They are more reliable than experimental methods.

D) They do not require a large sample size.

Q.2 Which of the following is a common type of survey question format?

A) Open-ended questions

B) Dichotomous questions

C) Likert scale questions

D) All of the above

Q.3 What is one of the main challenges of using surveys in research?

A) Surveys are expensive to administer.

B) Surveys provide qualitative data that is hard to analyze.

C) Surveys may suffer from low response rates and potential biases.

D) Surveys are time-consuming to conduct.

1.6 SUMMARY

The descriptive investigations are of immense value in solving the problems about children, school organization, supervision and administration, curriculum, teaching methods and evaluation. There are a number of questions that arise concerning these aspects of education. For example, one may want to know how many of the teachers in a district possess a bachelor's Degree in Education. How do these figures compare with the tendency throughout the state? How many minutes per week are normally devoted to the teaching of English spelling? What proportion of the total state budget is reasonable to set aside for adult education? What kind of curriculum do people really want their children to have at the secondary school stage? At what age and grade level do pupils leave school? What happens to students after they leave school? And so on. Such Information is useful to teachers and administrators in understanding the existing educational problems and also in suggesting ways of meeting them. The descriptive type of research is useful in the development of data-gathering instruments and tools like tests, checklists, schedules, questionnaires and rating scales. It also provides the background ideas and data from which many more refined or controlled studies of causal relations are made.

1.7 GLOSSARY

1. **Educational Research**

Educational research is the systematic investigation aimed at developing new knowledge and improving educational practices, policies, and outcomes.

2. Descriptive Research

Descriptive research systematically describes a population, situation, or phenomenon by providing an accurate account of characteristics, frequencies, and trends.

3.Survey Study Method

The survey study method involves collecting data from respondents through questionnaires or interviews to gain insights on various topics.

1.8 ANSWERS TO SELF- CHECK EXERCISES

EXERCISE-1

Answer 1. B) To develop theories and principles

Answer 2. C) To summarize existing research on a topic

EXERCISE-2

Answer 1. c. To describe and summarize characteristics of a population or phenomenon

Answer 2. b. Case studies

Answer 3. a. Lack of generalizability

EXERCISE-3

Answer 1. B) They can collect data from a large number of respondents quickly and efficiently.

Answer 2. D) All of the above

Answer 3. C) Surveys may suffer from low response rates and potential biases.

1.9 REFERENCES / SUGGESTED READINGS

- Best, J.W and J.V.Kahn, Research in Education (7th Ed.) New Delhi: Prentice Hall of India Pvt Ltd.1998
- Sanswal, N.D. (2020). *Research Methodology and Applied Statistics.* (1st ed.). Shipra Publications.
- Kaul, L. (2009). *Methodology of Educational Research.* (4th ed.). Vikas Publishing House Private Limited.

1.10 TERMINAL QUESTIONS

Q1: Describe the nature of descriptive research.

Q2: Discuss the nature and types of survey research.

Q3: Explain the steps that the researcher may adopt in conducting the descriptive type of research.

UNIT- 2

DESCRIPTIVE RESEARCH-II

Structure

2.1 INTRODUCTION

Correlational studies and case study methods are two distinct but valuable research approaches used to explore and understand various phenomena.Correlational studies focus on examining the relationships between two or more variables to determine if they are associated. This method uses statistical techniques to measure the strength and direction of relationships, helping researchers identify patterns and predict potential interactions among variables. While correlational studies can highlight significant connections, they do not establish causation, meaning they cannot determine whether one variable causes changes in another.

On the other hand, the case study method involves an in-depth, detailed examination of a single subject, group, or event. This approach allows researchers to explore complex issues within real-life contexts, providing a comprehensive understanding of the subject under investigation. Case studies are particularly useful for studying unique or rare phenomena, generating rich qualitative data, and offering insights into the intricate dynamics of specific cases. By focusing on a single case or a small number of cases, researchers can delve deeply into the contextual factors and unique aspects that may influence outcomes.Together, these methods offer complementary strengths: correlational studies provide a broad overview of relationships between variables, while case studies offer detailed and context-specific insights. Using both approaches can enhance the robustness and depth of research findings, contributing to a more comprehensive understanding of the phenomena being studied.

2.2 LEARNING OBJECTIVES

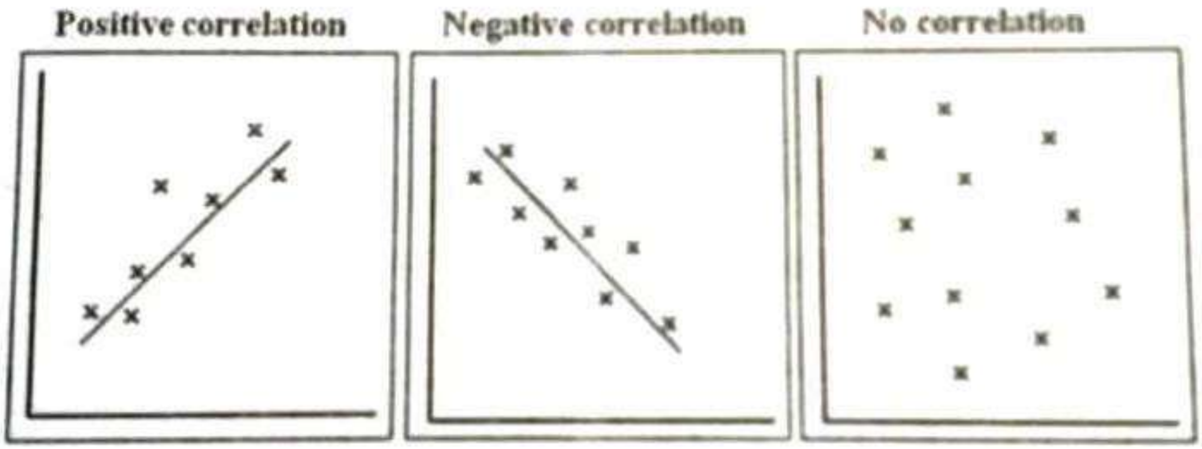
After completing this Unit, the Learners will be able to;

- Understand relationships between variables using statistical techniques without inferring causation
- Interpret relationships between variables using statistical techniques
- Develop skills to conduct in-depth investigations of specific subjects or events to gain comprehensive insights.

2.3 CORRELATION STUDY METHOD

Correlation means association more precisely it is a measure of the extent to which two variables are related. If an increase in one variable tends to be associated with an increase in the other then this is known as a positive correlation. An example would be height and weight. Taller people tend to be heavier. If an increase in one variable tends to be associated with a decrease in the other then this is known as a negative correlation. An example would be height above sea level and temperature. As you climb the mountain (increase in height) it gets colder (decrease in temperature). When there is no relationship between two variables this is known as a zero correlation. For example, there is no relationship between the amount of tea drunk and level of intelligence.

A correlation can be expressed visually. This is done by drawing a scatter diagram - that is one can plot the figures for one variable against the figures for the other on a graph.



The points lie close to a straight line, which has a positive gradient.
This shows that as one variable increases the other increases.

The points lie close to a straight line, which has a negative gradient.
This shows that as one variable increases, the other decreases.

There is no pattern to the point.

This shows that there is no connection between the two variables.

When you draw a scatter diagram it doesn't matter which variable goes on the x-axis and which goes on the y-axis. Remember, in correlations we are always dealing with paired scores, so the values of the 2 variables taken together will be used to make the diagram. Decide which variable goes on each axis and then simply put a cross at the point where the 2 values coincide.

Strictly speaking correlation is not a research method but a way of analyzing data gathered by means. This might be useful, for example, if we wanted to know if there were an association between watching violence on TV. and a tendency towards violent behaviour in adolescence. Another area where correlation is widely used is in the study of intelligence where research has been carried out to test the strength of the association between the I.Q. levels of identical and non-identical twins.

Some uses of correlations:

Prediction

If there is a relationship between two variables, we can make predictions about one from another.

Validity

Concurrent validity between a new measure and an established measure)

Reliability

Test-retest reliability (are measures consistent).

Inter-rater reliability (are observers consistent).

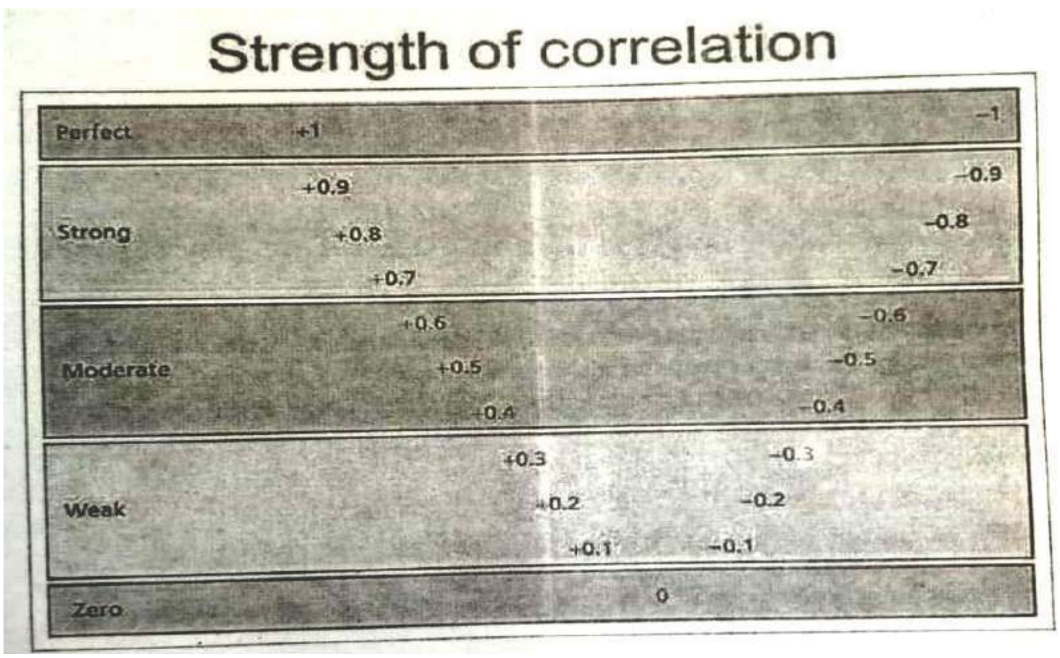
Theory verification

Predictive validity.

Correlation Coefficients

Instead of drawing a scattergram a correlation can be expressed numerically as a coefficient, ranging from -1 to +1. When working with continuous variables, the correlation coefficient to use is Pearson's r.

The correlation coefficient (r) indicates the extent to which the pairs of numbers for these two variables lie on a straight line. Values over zero indicate a positive correlation, while values under zero indicate a negative correlation.



Differences between experiments and correlations

An experiment isolates and manipulates the independent variable to observe its effect on the dependent variable, and controls the environment in order that extraneous variables may be eliminated. Experiments establish cause and effect.

A correlation identifies variables and looks for a relationship between them.

An experiment tests the effect that an independent variable has upon a dependent variable but a correlation looks for a relationship between two variables.

This means that the experiment can predict cause and effect (causation) but a correlation can only predict a relationship, as another extraneous variable may be involved that it not known about.

Strengths of correlations

1. Correlation allows the researcher to investigate naturally occurring variables that maybe unethical or impractical to test experimentally. For example, it would be unethical to conduct an experiment on whether smoking causes lung cancer.

2. Correlation allows the researcher to clearly and easily see if there is a relationship between variables. This can then be displayed in a graphical form.

Limitations of correlations

1. Correlation is not and cannot be taken to imply causation. Even if there is a very strong association between two variables, we cannot assume that one causes the other. For example, suppose we found a positive correlation between watching violence on TV and violent behavior in adolescence. It could be that the cause of both these is a third (extraneous) variable say for example, growing up in a violent home - and that both the watching of T.V. and the violent behavior are the outcome of this.

2. Correlation does not allow us to go beyond the data that is given. For example, suppose it was found that there was an association between time spent on homework (1/2 hour to 3 hours) and number of passes (1 to 6). It would not be legitimate to infer from this that spending 6 hours on homework would be likely to generate 12 passes.

SELF- CHECK EXERCISE-1

Q.1 What is the primary purpose of a correlational study?

A) Establishing causation between variables

B) Describing a single case in detail

C) Examining the relationship between variables

D) Conducting experiments

Q.2 Which of the following statements is true about correlational studies?

A) They can determine cause and effect

B) They are primarily qualitative

C) They use statistical techniques to measure associations

D) They only focus on a single subject or event

2.4 CASE STUDY METHOD

Case studies are in-depth investigations of a single person, group, event or community Typically, data are gathered from a variety of sources and by using several different methods (e.g. observations & interviews) The research may also continue for an extended period of time, so processes and developments can be studied as they happen.

The case study research method originated in clinical medicine (the case history, Le. the patient's personal history).

The case study method often involves simply observing what happens to, or reconstructing 'the case history' of a single participant or group of individuals (such as a school class or a specific social group), i.e. the idiographic approach. Case studies allow a researcher to investigate a topic in far more detail than might be possible if they were trying to deal with a large number of research participants with the aim of 'averaging'.

The case study is not itself a research method, but researchers select methods of data collection and analysis that will generate material suitable for case studies. Amongst the sources of data the psychologist is likely to turn to when carrying out a case study are observations of a person's daily routine, unstructured interviews with the participant herself (and with people who know her), diaries, personal notes (e.g. letters, photographs, notes) or official document (e.g. case notes, clinical notes, appraisal reports). Most of this information is likely to be qualitative (i.e. verbal description rather than measurement) but the psychologist might collect numerical data as well.

The data collected can be analyzed using different theories (e.g. grounded theory, interpretative phenomenological analysis, text interpretation, e.g. thematic coding) etc. All the approaches mentioned here use preconceived categories in the analysis and they are ideographic in their approach, i.e., they focus on the individual case without reference to a comparison group.

Case studies are widely used in psychology and amongst the best known were the ones carried out by Sigmund Freud. He conducted very detailed investigations into the private lives of his patients in an attempt to both understand and help them overcome their illnesses.

Freud's most famous case studies include Little Hans (1909a) and The Rat Man (1909b). Even today case histories are one of the main methods of investigation in abnormal psychology and psychiatry. For students of these disciplines, they can give a vivid insight into what those who suffer from mental illness often have to endure.

Case studies are often conducted in clinical medicine and involve collecting and reporting descriptive information about a particular person or specific environment, such as a school in psychology, case studies are often confined to the study of a particular individual. The information is mainly biographical and relates to events in the individual's past (i.e. retrospective), as well as to significant events which are currently occurring in his or her everyday life.

In order to produce a fairly detailed and comprehensive profile of the person, the psychologist may use various types of accessible data, such as medical records, employer's reports, school reports or psychological test results. The interview is also an extremely effective procedure obtaining information about an individual, and it may be used to collect comments from the person's friends, parents, employer, work mates and others who have a good knowledge of the person, as well as to obtain facts from the person him or herself.

This makes clear that the case study is a method that should only be used by a psychologist, therapist or psychiatrist, i.e. someone with a professional qualification. There is an ethical issue of competence. Only someone qualified to diagnose and treat a person can conduct a formal case study relating to atypical (ie. abnormal) behaviour or atypical development.

The procedure used in a case study means that the researcher provides a description of the behaviour. This comes from interviews and other sources, such as observation. The also detail of events from his or her point of view. The researcher then writes up the information from both sources above as the case study, and interprets the information.

Interpreting the information means the researcher decides what to include or leave out. A good case study should always make clear which information is factual description and which is an inference or the opinion of the researcher.

Steps in case study

Case study research is a qualitative method that involves a detailed, in-depth examination of a specific subject, event, or phenomenon within its real-life context. Here are the key steps typically involved in conducting a case study:

1. **Selecting the Case:** The first step is to select a case that is relevant to the research objectives. Cases can range from individuals to groups, organizations, events, or even communities. The selection should be guided by the research questions and the need to gain a deeper understanding of the subject under investigation.
2. **Defining the Research Questions:** Clear and specific research questions or objectives should be defined to guide the case study. These questions help focus the study and ensure that relevant data is collected to address specific aspects of the case.
3. **Collecting Data:** Data collection in case study research is comprehensive and multifaceted. Researchers typically use multiple methods such as interviews, observations, documents, and artifacts related to the case. Each method provides different perspectives and insights into the case, contributing to a rich and nuanced understanding.
4. **Analyzing the Data:** Once data is collected, it is systematically analyzed to identify patterns, themes, and relationships relevant to the research questions. Analysis in case study research often involves coding qualitative data, comparing and contrasting information across different sources, and developing theoretical frameworks or models that explain the findings.
5. **Interpreting the Findings:** Data interpretation involves making sense of the analyzed data in relation to the research questions. Researchers critically examine the findings to draw conclusions and generate insights that contribute to theoretical understanding or practical applications within the field of study.
6. **Writing the Case Study Report:** The case study report is structured to present a coherent narrative of the research process and findings. It typically includes an introduction that sets the context and outlines the research questions, a literature review

to position the study within existing knowledge, a detailed description of methods used for data collection and analysis, findings presented with supporting evidence, and conclusions that summarize key insights and their implications.

7. **Drawing Generalizations (if applicable):** Depending on the scope and purpose of the case study, researchers may discuss broader implications or generalizations that can be drawn from the findings. While case studies are often context-specific and do not aim for generalizability in the traditional sense, they can provide insights and theoretical frameworks that are applicable to similar contexts or settings.

8. **Ensuring Validity and Reliability:** Validity and reliability in case study research are ensured through rigorous methods in data collection, analysis, and interpretation. Researchers use techniques such as triangulation (using multiple data sources or methods) and member checking (seeking feedback from participants) to enhance the credibility and trustworthiness of the findings.

9. **Peer Review and Revision:** Before finalizing the case study report, researchers may seek feedback from peers, advisors, or experts in the field. Peer review helps validate the findings and ensures that the report is clear, accurate, and contributes effectively to the body of knowledge in the research area.

10. **Disseminating Findings:** Finally, researchers disseminate case study findings through academic publications, conference presentations, or other relevant channels. Dissemination of findings contributes to scholarly discourse and may inform practice, policy-making, or further research within the field.

By following these steps, case study research provides a rigorous and systematic approach to investigating complex phenomena within their natural settings, offering valuable insights and contributing to advancements in knowledge and understanding.

STRENGTHS OF CASE STUDIES

- Provides detailed (rich qualitative) information.
- Provides insight for further research.
- Permitting investigation of otherwise impractical (or unethical) situations.

Because of their in-depth, multi-sided approach case studies often shed light on aspects of human thinking and behaviour that would be unethical or impractical to study in other ways. Research that only looks into the measurable aspects of human behaviour is not likely to give us insights into the subjective dimension to experience which is so important to psychoanalytic and humanistic psychologists.

Case studies are often used in exploratory research. They can help us generate new ideas (that might be tested by other methods). They are an important way of illustrating the ones and can help show how different aspects of a person's life are related to each other. The method is therefore important for psychologists who adopt a holistic point of view (i.e. humanistic psychologists).

LIMITATIONS OF CASE STUDIES

- Can't generalize the results to the wider population.
- Researchers' own subjective feeling may influence the case study (researcher bias).
- Difficult to replicate.
- Time consuming.

Because a case study deals with only one person/event/group we can never be sure whether the conclusions drawn from this particular case apply elsewhere. The results of the study are not generalizable because we can never know whether the case we have investigated is representative of the wider body of "similar" instances

Because they are based on the analysis of qualitative (i.e. descriptive) data a lot depends on the interpretation the psychologist places on the information she has acquired. This means that there is a lot of scope for observer bias and it could be that the subjective opinions of the psychologist intrude in the assessment of what the data means.

SELF- CHECK EXERCISE-2

Q.1 What is a key characteristic of the case study method?

A) It uses large samples to generalize findings

B) It involves in-depth, detailed examination of a specific case

C) It primarily focuses on quantitative data

D) It establishes causal relationships

Q.2 In which scenario is the case study method most useful?

A) When studying the relationship between two variables

B) When needing to generalize findings to a larger population

C) When exploring complex issues within a real-life context

D) When conducting a survey on a large group of people

2.5 SUMMARY

In summary, correlational studies focus on examining relationships between variables using statistical measures, without implying causation. They are valuable for identifying patterns and predicting associations in research.

On the other hand, the case study method involves a detailed investigation of a specific subject, event, or phenomenon within its real-life context. It provides comprehensive insights through qualitative data collection and analysis, offering in-depth understanding of complex issues.

Both methods contribute uniquely to research: correlational studies provide broad insights into relationships, while case studies offer detailed examinations of specific cases. Together, they enrich our understanding of diverse phenomena and contribute to advancements in knowledge and practice within their respective fields of study.

2.6 GLOSSARY

1. Correlation: A statistical measure that indicates the extent to which two or more variables fluctuate together. It does not imply causation but helps in understanding relationships.

2. Case Study: An in-depth, detailed examination of a specific subject, event, or phenomenon within its real-life context.

2.7 ANSWERS TO SELF- CHECK EXERCISE

Exercise-1

Answer 1. C) examining the relationship between variables

Answer2. C) they use statistical techniques to measure associations

Exercise-2

Answer 1. B) it involves in-depth, detailed examination of a specific case

Answer 2. C) when exploring complex issues within a real-life context

2.8 REFERENCES / SUGGESTED READINGS

- Best, J.W and J.V.Kahn, Research in Education (7th Ed.) New Delhi: Prentice Hall of India Pvt Ltd.1998
- Sanswal, N.D. (2020). *Research Methodology and Applied Statistics.* (1st ed.). Shipra Publications.
- Kaul, L. (2009). *Methodology of Educational Research.* (4th ed.). Vikas Publishing House Private Limited.

2.9 TERMINAL QUESTIONS

Q1. What does a correlation coefficient (such as Pearson's r) measure in a correlational study? Provide an example.

Q2. Briefly explain why correlational studies cannot establish causation between variables.

Q3. Describe the steps involved in conducting a case study. Discuss the importance of selecting an appropriate case.

UNIT- 3

HISTORICAL RESEARCH-I

Structure

3.1 INTRODUCTION:

History usually refers simply to an account of the past of human societies. It is the study of what "can be known... (to the historian). through the surviving record." Gottschalk referred to this as 'history as a record'. He further stated that "The process of critically examining and analysing the records and survivals of the past is... called historical method. The imaginative reconstruction of the past from the data derived by that process is called historiography (the writing of history)".

3.2 LEARNING OBJECTIVES

After reading this unit you will be able to:

- Define the meaning of historical research, its purpose and characteristics, scope and approaches to the study of history
- Explain the steps of historical research.
- State the Weaknesses to be avoided in Historical Research.

3.3 MEANING, NATURE AND IMPORTANCE OF HISTORICAL RESEARCH

Historical research has been defined as the systematic and objective location, evaluation and synthesis of evidence in order to establish facts and draw conclusions about past events. It involves a critical inquiry of a previous age with the aim of reconstructing a faithful representation of the past. In historical research, the investigator studies documents and other sources that contain facts concerning the research theme with the objective of achieving a better understanding of present policies, practices, problems and institutions. An attempt is made to examine past events or combinations of events and establish facts in order to arrive at conclusions concerning past events or predict future events. Historical research is a type of analytical research. Its common methodological characteristics include (i) identifying a research topic that addresses past events, (ii) review of primary and secondary data, (ii) systematic collection and objective evaluation of data related to past occurrences with the help of techniques of criticism for historical searches and evaluation of the information and (iv) synthesis and explanation of findings in order to test hypotheses concerning causes, effects or trends of these events that may help to explain present events and anticipate future events. Historical studies attempt to provide information and understanding of past historical, legal and policy events. The historical method consists of the techniques and guidelines by which historians use historical sources and other evidence to research and then write history.

Scope of Historical Research in education:

1. General educational history of specific periods such as (a) ancient India, (b) A during British rule, (c) Independent India etc.
2. History of specific levels of education (a) primary education, (b) secondary education, (c) tertiary education etc. in India.
3. History of specific types of education such as (a) adult education, (b) distance education, (c) disadvantaged education, (d) women's education in India.
4. Historical study of specific educational institutions such as (1) University of Mumbai, (ii) Aligarh Muslim University and so on.
5. History of the role of the teacher in ancient India.

6. History of specific components of education such as (a) curriculum, (b) textbooks, (c) teaching-learning methods, (d) aims and objectives of education, (e) teacher- student relationships, (f) evaluation process and so on.
7. History of national education policies in India.
8. History of admission processes in professional/technical courses (medicine, engineering, management) in India.
9. History of teacher education.
10. Historical biographies of major contributors to education such as Mahatma Gandhi, Maharshi Karve, Maharshi Phule, Shri Aurobindo, Gurudev Tagore and so on.
11. History of educational administration.
12. History of public financing of education.
13. History of educational legislation in India
14. History of educational planning.
15. History of contemporary problems in India.
16. Historical study of the relationship between politics and education in India.
17. Historical study of the impact of the British rule in India.
18. Comparative history of education in India and some other country/countries.
19. Historical study of the system of state-sponsored inspection in India.
20. Historical study of education in specific Indian states such as Maharashtra, Tamil Nadu, Madhya Pradesh, Rajasthan etc.

In other words, historical research in education may be concerned with an individual, a group, an idea a movement or an institution. If a historical study focuses on an entire country/society/system, i.e., if it is broad in scope, it is said to be a macro-level historical research. On the other hand, if its focus is narrow and includes a selective set of people or events of interest, it is said to be a micro-level historical research.

Approaches to the study of history:

According to Monaghan and Hartman, there are four major approaches to the study of the past:

Qualitative Approach:

This is what most laypersons think of as history the search for a story inferred from a range of written or printed evidence. The resultant history is organized chronologically and presented as a factual tale: a tale of a person who created reading textbooks, such as a biography of William Holmes McGuffey (Sullivan, 1994) or the Lindley Murray family (Monaghan, 1998) in the Western context. The sources of qualitative history range from manuscripts such as account books, school records, marginalia, letters, diaries and memoirs to imprints such as textbooks, children's books, journals, and other books of the period under consideration.

Quantitative Approach:

Here, rather than relying on "history by quotation," as the former approach has been negatively called, researchers intentionally look for evidence that lends itself to being counted and that is therefore presumed to have superior validity and generalisability. Researchers have sought to estimate the popularity of a particular textbook by tabulating the numbers printed, based on copyright records. The assumption is that broader questions such as the relationship between education and the political system in India or between textbooks and their influence on children can thus be addressed more authoritatively.

Content Analysis:

Here the text itself is the focus of examination. This approach uses published works as its data (in the case of the history of textbooks, these might be readers or examples of the changing contents of school textbooks in successive editions) and subjects them to a careful analysis that usually includes both quantitative and qualitative aspects. Content analysis has been particularly useful in Investigating constructs such as race, caste, etc.

Oral History:

Qualitative, quantitative, and content approaches use written or printed text as their database. In contrast, the fourth approach, oral history, turns to living memory. For instance, oral historians interested in women's education could ask their respondents about their early experiences and efforts in women's education.

These four approaches are not, of course, mutually exclusive. Indeed, historians avail themselves of as many of these as their question, topic, and time period permit. This integration is possible because the nature of historical research cuts across a variety of approaches, all of which commence with the recognition of a topic and the framing of a question In other words, a historical study may be quantitative in nature, qualitative in nature or a combination of the approaches. Its purpose can be mainly descriptive, aiming to understand some specific development in a particular period of time in a particular culture; or it could be explanatory, trying to test and accept / reject widely held assumptions

A historical investigation is conducted with objectivity and the desire to minimize bias, distortion and prejudice. Thus, it is similar to descriptive method of research in this aspect. Besides, it aims at describing all aspects of the particular situation under study (or all that is accessible) in its search for the truth. Thus, it is holistic, comprehensive in nature and is similar to the interpretive approach.

Though it is not empirical in nature (it does not collect data through direct observation or experimentation), it does make use of reports (all the available written and/or oral material), and it definitely qualifies to be a scientific activity: This is because it requires scholarship to conduct a systematic and objective study and evaluation and synthesis of evidence so as to arrive at conclusions. In other words, historical research is scientific in nature.

Moreover, any competent researcher in other types of empirical studies reviews the related literature so as to find out prior research and theoretical work done on a particular topic. This requires studying journals, books, encyclopaedias, unpublished theses and so on. This is followed by an interpretation of their significance.

These steps are common to empirical research and historical research i.e., to some extent, every researcher makes use of the historical method in his/her research However, it should be mentioned here that historical researchers in education "discovers already existing data from a wide range of historical sources such as documents, relics autobiographies, diaries or photographs. On the other hand, in other types of educational studies, the researcher "creates data through observations, measurement through tests and experimentation. To this extent, historical research differs from descriptive and experimental research.

The purpose of Historical Research:

Conducting historical research in education can serve several purposes as follows:

1. It enables educationists to find out solutions to contemporary problems which have their roots in the past i.e., it serves the purpose of bringing about reforms in education. The work of a historical researcher sometimes sensitizes educators to unjust or misguided practices in the past which may have unknowingly continued into the present and require reform. A historical researcher studies the past with a detached perspective and without any ego involvement with the past practices. Hence it could be easier for educationists to identify misguided practices thus enabling them to bring about reforms.
2. It throws light on present trends and can help in predicting future trends. If we understand how an educationist or a group of educationists acted in the past, we can predict how they will act in future. Similarly, studying the past enables a researcher to understand the factors/causes affecting present trends, in order to make such future predictions reliable and trustworthy, the historical researcher needs to identify and clearly describe in which ways the past differs from the present context and how the present social, economic and political situations and policies could have an impact on the present and the future.
3. It enables a researcher to re-evaluate data in relation to selected hypotheses, theories and generalizations that are presently held about the past.
4. It emphasizes and analyzes the relative importance and the effect of the various interactions in the prevailing cultures.
5. It enables us to understand how and why educational theories and practices developed.

Characteristics/Importance of Historical Research

These are as follows:

1. It is not a mere accumulation of facts and data or even a portrayal of past events.
2. It is a flowing, vibrant report of past events that involves analysis and explanation of these occurrences with the objective of recapturing the nuances, personalities and ideas that influenced these events.
3. Conducting historical research involves the process of collecting and reading the research material collected and writing the manuscript from the data collected. The

researcher often goes back and forth between collecting, reading, and writing. i.e., the process of data collection and analysis are done simultaneously and are not two distinct phases of research.

4. It deals with the discovery of data that already exists and does not involve the creation of data using structured tools.
5. It is analytical in that it uses logical induction.
6. It has a variety of foci such as issues, events, movements and concepts.
7. It records and evaluates the accomplishments of individuals, agencies or institutions.

SELF- CHECK EXERCISE-1

Q1. Which of the following is NOT typically considered a primary source in historical research?

a) Letters and diaries

b) Photographs and artifacts

c) Official records

d) Academic books and articles

Q2. In historical research, what is the purpose of establishing a chronological framework?

a) To identify biases in primary sources

b) To understand the sequence and cause-and-effect relationships of events

c) To gather multiple viewpoints on a topic

d) To categorize sources into primary and secondary

3.4 STEPS IN HISTORICAL RESEARCH:

The essential steps involved in conducting historical research are as follows:

A. Identify a topic/subject and define the problems/questions to be investigated

B. Search for sources of data

C. Evaluate the historical sources.

D. Analyze, synthesize and summarize interpreting the data/information.

E. Write the research report.

Since most historical studies are largely qualitative in nature, the search for sources of data, evaluating, analyzing, synthesizing and summarizing information and interpreting the findings may not always be discreet, separate sequential steps ie the sequence of steps in historical research is flexible. Let us now look at each of these steps in detail.

A. Identify a Topic and Define the Problem

According to Borg, "In historical research, it is especially important that the student carefully defines his problem and appraises its appropriateness before committing himself too fully. Many problems are not adaptable to historical research methods and cannot be adequately treated using this approach. Other problems have little or no chance of producing significant results either because of the lack of pertinent data or because the problem is a trivial one.

Beach has classified the problems that prompt historical inquiry into five types:

1. Current social issues are the most popular source of historical problems in education e.g., Rural education, adult and continuing education, positive discrimination in education etc.
2. Histories of specific individuals, histories of specific educational institutions and histories of educational movements. These studies are often conducted with "the simple desire to acquire knowledge about previously unexamined phenomena".
3. A historical study of interpreting ideas or events that previously had seemed unrelated. For example, the history of educational financing and the history of the aims of education in India may be unrelated. But a person reviewing these two researches separately may detect some relationship between the two histories and design a study to understand this relationship.
4. A historical study aimed at synthesizing old data or merges them with new historical facts discovered by the researcher.
5. A historical inquiry involving reinterpretation of past events that have been studied by other historical researchers. This is known as revisionist history. On the other hand, in order to identify a significant research problem, Gottschalk recommends that four questions should be asked:
   (i) Where do the events take place?
   (ii) Who are the persons involved?

(iii) When do the events occur?

(iv) What kinds of human activity are involved?

The scope of the study can be determined on the basis of the extent of emphasis placed on the four questions identified by Gottschalk ie. the geographical area included, the number of persons involved, the time span included and the number and kinds of human activities involved often, the exact scope and delimitation of a study is decided by a researcher only after the relevant material has been obtained. The selection of a topic in historical research depends on several personal factors of the researcher such as his/her motivation, Interest, historical knowledge curiosity ability to interpret historical facts and so on. If the problem selected involves understanding an event, an institution, a person, or a past period, more clearly, it should be taken up for research.

The topic selected should be defined in terms of the types of written materials and other resources available to you. This should be followed by formulating a specific and testable hypothesis or a series of research questions if required. This will provide a clear focus and direction to data collection, analysis and interpretation i.e. it provides a structure to the study.

According to Borg, without hypotheses, historical research often becomes little more than an aimless gathering of facts.

B. Search for Sources of Data

Historical research is not empirical in that it does not include direct observation of events or persons. Here, the researcher interprets past events on the basis of traces they have left. He uses the evidence of past acts and thoughts. Thus, he/she does not use his/her own observation but on other people's observations. The researcher's job here is to test the truthfulness of the reports of other people's observations. These observations are obtained from several sources of historical data. Let us now try to discuss various sources of historical data.

Sources of Historical Data

These sources are broadly classified into two types:

(a) Primary Sources: Gottschalk defines a primary data source as "the testimony of any eye witness, or of a witness by any other of the senses, or of a mechanical device like the Dictaphone - that is, of one who was present at the events of which he tells. A primary source must thus have been produced by a contemporary of the events it narrates. In other words, primary sources are tangible materials that provide a description of a historical event and were produced shortly after the event happened. They have a direct physical relationship to the event being studied. Examples of primary sources include new paper reports, letters, public documents, court decisions, personal diaries, autobiographies, artefacts and eyewitness's verbal accounts. These primary sources of data can be divided into two broad categories as follows:

(i) The remains or relics of a given historical period. These could include photographs, coins, skeletons, fossils, tools, weapons, utensils, furniture, buildings and pieces of art and culture. Though these were not originally meant for transmitting information to future generations they could prove very useful sources in providing reliable and sound evidence about the past. Most of these relics provide non-verbal information.

(ii) Those objects that have a direct physical relationship with the events being reconstructed. This includes documents such as laws, files, letters, manuscripts, government resolutions, charters, memoranda, wills, newspapers, magazines, journals, films, government or other official publications, maps, charts, log-books, catalogues, research reports, the record of minutes of meetings, recording, inscriptions, transcriptions and so on.

(b) Secondary Sources: A secondary source is one in which the eyewitness or the participant i.e., the person describing the event was not actually present but obtained his/her descriptions or narrations from another person or source. This other person may or may not be a primary source. Secondary sources, thus, do not have a direct physical relationship with the event being studied. They include data that are not original. Examples of secondary sources include textbooks, biographies, encyclopaedias, reference books, replicas of art objects and paintings and so on. It is possible that secondary sources contain errors due to the passing of information from one source to another. These errors could get multiplied when the information passes through many sources thereby resulting in an error of great magnitude in the final data. Thus, wherever possible, the researcher should try to use primary sources of data. However, that does not reduce the value of secondary sources.

In conclusion, the various sources of historical information both primary and secondary can be summarized as follows:

It must be mentioned here that the branch of historical research using all or some types of oral records is known as oral history. It should also be mentioned here that some objects can be classified as documents or relics depending on the how they are used in a historical study. For example, in a research study on how a historical figure (a politician, a freedom fighter or a social reformer) is presented in textbooks of different periods, the textbook will be classified as a document as the emphasis here is on analysing its content matter given in a verbal form. On the other hand, in a research study on printing methods in the past, the textbook can be used as a relic as the focus here is not on analysing its contents but on its physical, outward characteristics or features.

Sources of Historical Information

- Documents Quantitative Oral Records Relics (written/printed) Records (Spoken words) (Physical or Visual objects)
- diaries-School budgets - Ballads - School Buildings
- memoirs Student attendance - Tales - School Furniture
- notebooks records - Saga - Textbooks
- yearbooks Staff attendance - Oral interviews - Pictures
- memos records of eyewitnesses - Drawings
- logbooks - Student's marks and participants - Architectural
- laws-School results Plans
- Court testimony - Financial statements - Instructional
- Committee reports - Census records Aids
- Government

Searching for Historical Data

The procedure of searching for historical data should be systematic and pre-planned the researcher should know what information he needs so as to identify important sources of data and provide a direction to his search for relevant data Using his knowledge, imagination and resourcefulness, he needs to explore the kinds of data required, persons involved, institutions involved. This will help him to identify the kinds of records he requires and whom he should interview. Since historical research is mainly qualitative in nature all the primary and secondary sources cannot be identified in advance. It is possible that as one collects some data, analyses and interprets it, the need for further pertinent data may arise depending on the interpretive framework. This will enable him to identify other primary or secondary sources of data.

The search for sources of data begins with wide reading of preliminary sources including published bibliographies, biographies, atlas, specialized chronologies, dictionaries of quotations and terms. Good university and college libraries tend to have a great deal of such preliminary materials This will enable a researcher to identify valuable secondary sources on the topic being studied such books on history relating to one's topic. For extensive materials on a subject, the researcher may need to go to a large research library or a library with extensive holdings on a specific subject. Such secondary materials could include other historian's conclusions and interpretations, historical information, references to other secondary and primary sources. The historical researcher needs to evaluate the secondary sources for their validity and authenticity. Now the researcher should turn his attention to the primary sources. These are usually available in the institution or the archives especially if the source concerns data pertaining to distant past or data pertaining to events in which the chief witnesses are either dead or inaccessible. In case of data concerning the recent past, the researcher can contact witnesses or participants themselves in order to interview them and/or study the documents possessed by them. However, it is not possible for a historical researcher to examine all the material available. Selecting the best sources of data is important in a historical study. In a historical study the complete "population" of available data can never be obtained or known.

Hence the sample of materials examined must always be a purposive one. What it represents and what it fails to represent should be considered. The researcher needs to identify and use a sample that should be representative enough for wider generalization.

C. Evaluation of the Historical Sources

The data of historical sources is subject to two types of evaluation. These two types are (i) external evaluation or criticism and (ii) internal evaluation or criticism. Let us now look at these in detail.

(i) External Criticism of Data:

This is sometimes also known as lower criticism of data. External criticism regards the issue of authenticity of the data from the psychological attitude of the researcher in that it is primarily concerned with the question, is the source of data genuine? External criticism seeks to determine whether the document or the artefact that the researcher is studying is genuinely valid primary data. It is possible to get counterfeit documents or artefacts. External criticism of the sources of data is of paramount importance in establishing the credibility of the research. Although, theoretically, the main purpose of external criticism is the establishment of historical truth, in reality, its actual operation is chiefly restricted to the negative role i.e. to identify and expose forgeries, frauds, hoaxes desertions and counterfeits. In order to identify such forgeries, the researcher needs to look at problems pertaining to plagiarism, alterations of documents, insertions, deletions or unintentional omissions. This will reveal whether the historical source of data is authentic or not. Establishing the authenticity of documents may involve carbon dating handwriting analysis, identification of ink and paper, vocabulary usage, signatures, script, spelling, names of places writing style and other considerations. In other words, it examines the document and its external features rather than the statements it contains. It tries to determine whether (a) the information it contains was available at the time the document was written. (b) This information is consistent with what is known about the author or the period from another source?

In other words, external criticism is aimed at answering questions about the nature of the historical source such as who wrote it? Where? When? Under which circumstances? Is it original? Is it genuine? And so on.

ii) Internal Criticism of Data:

Having established the authenticity of the source of historical data, the researcher now focuses his/her attention on the accuracy and worth of the data contained in the document. Internal criticism is concerned with the meaning of the written material. It is also known as higher criticism of data. It deals with answering questions such as what does it mean? What was the author attempting to say? What thought was the author trying to convey? Is it possible that people would act in the way described in the document? Is it possible that the events described occurred so quickly? What inferences or interpretations could be extracted from these words? Do the financial data/figures mentioned in the document seem reasonable for that period in the past? What does the decision of a court mean? What do the words of the decision convey regarding the intent and the will of the count? Is there any (unintended) misinformation given in the document? Is there any evidence of deception? And so, on here, the researcher needs to be very cautious so that he does not reject a statement only because the event described in the document appears to be improbable.

In addition to answering these questions, internal criticism should also include establishing the credibility of the author of the document. According to Travers, the following questions could be answered so as to establish the author's credibility: Was he a trained or untrained observer of the event? ie. How competent was he? What was his relationship to the event? To what extent was he under pressure, from fear or vanity resulting in distortion or omission of facts? What was the intent of the writer of the document? To what extent was he an expert at recording the particular event? Were the habits of the author such that they might interfere with the accuracy of recording? Was he too antagonistic or too sympathetic to give a true picture? How long after the event did, he record his testimony? Was he able to remember accurately? Is he in agreement with other independent witnesses? These questions need to be answered for two reasons:

i) Perceptions are individualized and selective Even if eyewitnesses are competent and truthful, they could still record different descriptions of the events they witnessed or experienced.

ii) Research studies in Psychology indicate that eyewitnesses can be very unreliable, especially if they are emotionally aroused or under stress at the time of the event. (e.g., at the time of the demolition of Babri Masjid or at the time of Gujarat riots in 2002.

This brings us to the question of bias especially when life histories or communal situations are being studied. According to Plummer, there are three possible sources of bias as follows:

Source One: The Life History Informant

Is misinformation (unintended) given?

Has there been evasion?

Is there evidence of direct lying and deception?

Is a 'front' being presented?

What may the informant 'take for granted' and hence not reveal?

How far is the informant 'pleasing you'?

How much has been forgotten?

How much may be self-deception?

Source Two: The Social Scientist Research

Could any of the following be shaping the outcome?

(a) Attitudes of researcher: age, gender, class, race etc.

(b) Demeanour of researcher: dress, speech, body language etc.

(c) Personality of researcher: anxiety, need for approval, hostility, warmth etc.

(d) Attitudes researcher: religion, politics, tolerance, general assumptions

(e) Scientific role of researcher: theory held etc. (researcher expectancy)

Source Three: The Interaction

The joint act needs to be examined. Is bias coming from?

(a) The physical setting-'social' space

(b) The prior interaction?

(c) Non-verbal communication?

(d) Vocal behaviour?

Often, internal and external criticism are interdependent and complementary processes. The internal and external criticism of data requires a high level of scholarship.

D. Analysis, Synthesis, Summarizing and Interpretation of Data:

We have seen how data can be located and evaluated. Let us now look at how to collect and control the data so that the greatest return from the innumerable hours spent in archives, document rooms and libraries can be reaped. The researcher should not only learn how to take notes but also learn how to organize the various notes, note cards, bibliography cards and memoranda so as to derive useful and meaningful facts for interpretation. Hence before beginning historical research, the researcher should have a specific and systematic plan for the acquisition, organization, storage and retrieval of the data. Following are some suggestions that may help you in systematizing your research efforts.

(i) Note cards and Bibliography Cards:

It would be convenient for you to prepare bibliography cards of size 3×5 inches for taking down bibliographical notes. A bibliography card is valuable not only for gathering and recording of information but also for locating it again at a future date, if necessary, without going back to the library again and again. Such a card contains the essential information concerning a bibliographical source. Keep plenty of such cards with you when you go to the library so that you can report very valuable references encountered unexpectedly. You can also note down the document's relation to your research. A sample of a bibliographic reference card could be as follows:

Serial No. ___________ Author(s) : _____________

Title of the Document: ___________________________

Name of the Journal: ____________________________

Vol. ________ No. ______ Month ________ Year ______ Page No.(s) _______

Place of publication, Name of Publisher, Edition, Year, Page (in case of a book:

____

Library where information is obtained: _____________________________

Call No. _________________________

Source of bibliographic information: _______________________________

How is it related to the research topic: _____________________________

Additional Comments, if any: _____________________________________

You can ideally have two copies of such a bibliographic card. One copy can be arranged according to the authors' names alphabetically whereas the other copy can be arranged as per serial number of the card. On the other hand, a note card can be of size 4×6 or 5x7 inches for substantive notes. It is advisable to place only one item of information on each card. Each card can be given a code so as to indicate the place /

question/theme/period/person to which the note relates. These cards then can be arranged as per the question, theme, period, place or person under study so as to make analysis easier In other words, note cards can be kept in multiple copies (e.g. in triplicate or quadruplicate) depending on the ultimate analysis of the data. Given here is a sample note card. In this card, one can mention the bibliography card no which can be referred to for further information it required. The reverse of the card can be used if the space is found to be insufficient for necessary information.

(ii) Summary of Quantitative Data:

Usually, historical studies are chiefly qualitative in nature since the data obtained includes verbal and/or symbolic material from an institution, society or culture's past. However, when the study involves quantitative data pertaining to past events, you need to think carefully about the relevance of the data to your research. This is because recording and analysis of quantitative data is time-consuming and sometimes expensive. Examples of quantitative data in historical research include records of students' and teachers' attendance rates, examination results, finances etc.

Main Heading: ____

Sub-Heading: ____

Card No. _________ Source __________: Author : ________________

Year: _________ pp._________ Title :_______ Bibliography card No. ____________

Information such as budgets, income and expenditure statements, salaries, fees and so on. Content analysis is one of the methods involving quantitative data. The basic goal of content analysis is to take a verbal, non-quantitative document and transform it into quantitative data.

(iii) Interpretation of Historical Data:

Once the researcher establishes the validity and authenticity of data, interpretation of the facts in the light of the topic of research is necessary. This step requires caution, imagination, ingenuity, insight and scholarliness. The scientific status of his study depends on these characteristics. The researcher needs to be aware of his/her biases, values, prejudices and interests as these could influence the analysis and interpretation of the data as well as the perceptions of the researcher. He needs to make sense of the multitude of data gathered which generally involves a synthesis of data in relation to a hypothesis question or theory rather than mere accumulation or summarization. In doing so, he/she should avoid biases and unduly projecting his / her own personality onto the data. The data should be fitted into a logically parsimonious structure. The researcher should be clear about the interpretative framework so as to become sensitive towards bias in other historical researchers' interpretations who have conducted research on the same or similar topics.

In historical research, 'causes' are in the form of antecedents or precipitating factors. They are not 'causes' in the strictly scientific sense. Such antecedents are always complex and hence the researcher should avoid oversimplification while interpreting them.

Past events are mainly in the form of human behaviour. Therefore 'causes' in historical research could be interpreted in terms of the motives of the participants involved. The researcher needs to identify the motives of the people involved in the event under study while interpreting the data. These motives may be multiple in natures and interact with each other. This makes interpretation of the data a difficult task. For example, a new government decides to change the prevalent textbooks. The motives here could be many such as its political ideology does not match the prevalent textbooks, it had a personal grudge against the authors of the prevalent textbooks or the ministers concerned wanted to derive personal glory out of his actions. These reasons may influence each other making the task of interpretation of data difficult.

Historical researchers can make use of concepts from other social and behavioural science disciplines in analyzingand interpreting data. Some examples of such concepts may be bureaucracy, role, institution (from sociology), leadership, institutional effectiveness (From management), culture (from anthropology), motive, personality attitude etc. (from psychology) and so on. The researcher also can make use of the concepts of historical time and historical space white interpreting the data.

The concept of historical time makes use of a chronology of events. ie the researcher needs to identify the chain of events (chronology) of substantive history and then try to understand the meaning of these events, the relationship among the events and the relationship of the events to the research topic. The researcher is studying more than one of the chronological data within the same time frame may gain increased insight into multiple events and their causes.

The concept of historical space deals with 'where' the event originated, spread or culminated. This could provide a different insight into the meaning of the data. The historical researcher can also use analogy as a source of hypothesis or as a frame of reference for interpretation i.e. He/she can draw parallels between one historical event and other events. Here, one has to be aware of similarities, differences as well as exceptions while comparing two historical events, otherwise, such an extrapolation will be unreliable Also, it is risky to interpret an event by comparing another event in another culture at another time.

iv) Making Inferences and Generalizations in Historical Research:

In order to identify and explain the cause of a historical event, the researcher must be aware of his/her assumptions which are then used in ascribing causation to subsequent events. Some examples of such assumptions could include (i) history repeats or (ii) historical events are unique. The researcher must make clear whether his/her analysis is based on the former assumption or the latter.

Some examples of 'causes of historical events identified in prior researches include (1) strong ideology (e.g. Maharshi Karve's ideology of women's education) (ii) actions of certain key persons (e.g. Mohamed Ali Jinnah's actions for India's partition), (iii) Advances in Science in technology (e.g. use of computers in education), (iv) economic/ geographical/psychological /sociological factors or a combination of all these (e.g. privatization of education) etc.

The historian's objective is not only to establish facts but also to determine trends in the data and causes of events leading to generalizations i.e. he/she needs to synthesize and interpret and not merely summarize the data. These data, as in other types of researches, are obtained not from the entire population of persons, settings, events or objects pertaining to the topic, but from a small sample. Moreover, this sample is selected from the remains of the past. It cannot be selected from the entire population of documents or relics that existed during the period under study. Such remains may not be representative. This necessitates a very careful and cautious approach in locating consistency in different documents and relics while making generalizations. Also, the researcher should not rely on only one document pertaining to an individual from the past while making a generalization as it will not be known whether the individual held a particular opinion about an educational issue consistently or had changed it over a period of time. If he had changed his opinion, the researcher must find out when and how it was changed, under what conditions and what the consequences were. This makes it imperative that the researcher uses as many primary and secondary sources as possible on a topic. If the evidence is limited, he needs restrict the generalizability of his interpretations to that extent.

E. Writing the Research Report:

This task involves the highest level of scholarship. In historical research, data collection is flexible. Besides, due to the relative lack of conclusive evidence on which valid generalizations can be established, the writing of historical research has to be a little freer so as to allow subjective interpretation of the data. (This by no means implies distortion of truth). Thus, reports of historical research have no standard formats. The presentation of data analysis, interpretations and findings depends on the nature of the problem. There are several broad ways of reporting historical investigation as follows:

i) The researcher can report the historical facts as answers to different research questions. Answers to each question could be reported in a separate chapter.

ii) He/she can present the facts in chronological order with each chapter pertaining to a specific historical period chronologically.

iii) The report can also be written in a thematic manner where each chapter deals with a specific theme/topic.

iv) Chapters could also deal with each state of India or each district of an Indian state separately.

v) The chapter could also pertain to specific historical persons separately.

vi) The researcher can also combine two or more of these approaches while writing the research report.

In addition, the report should contain a chapter each on the introduction, methodology, review of related literature, findings, the researcher's interpretations and reflections on the interpretative process.

Problems and Weaknesses to be avoided in Historical Research:

Some of the weaknesses, problems and mistakes that need to be avoided in historical research are as follows:

1. The problem of research should not be too broad.
2. It should be selected after ensuring that sources of data are existent, accessible and in a language known to the researcher.
3. Excessive use of easy-to-find secondary sources of data should be avoided. Though locating primary sources of data time time-consuming and requires effort, they are usually more trustworthy.
4. Adequate internal and external criticism of sources of historical data is essential for establishing the authenticity and validity of the data. It is also necessary to ascertain whether statements concerning evidence by one participant have influenced the opinions of other historians.

SELF- CHECK EXERCISE-2

Q.1 In historical research, __________ sources include original documents and artifacts created at the time under study.

Q.2 __________ involves understanding the broader social, political, economic, and cultural contexts in which historical events occurred.

3.5 SUMMARY

Historical research involves a systematic investigation into past events, individuals, societies, and cultures to uncover, analyze, and interpret evidence, thus providing a deeper understanding of how and why things happened. The process begins with identifying a research question or topic, followed by an extensive review of both primary and secondary sources. Primary sources include original documents, artifacts, letters, diaries, photographs, and official records created at the time under study, while secondary sources encompass later interpretations or analyses, such as books and articles. Historians then use various research methods, such as archival research, oral history interviews, and content analysis, to gather relevant evidence. Establishing a chronological framework is crucial, as it helps in placing events in their proper order to understand cause and effect relationships. Contextualization involves understanding the broader social, political, economic, and cultural contexts in which events occurred, which aids in interpreting their significance and impact. Critical analysis of sources for bias, reliability, and perspective is essential, requiring historians to assess the credibility of evidence and consider multiple viewpoints to construct a balanced and accurate account. After gathering and analyzing evidence, historians interpret their findings to construct narratives or explanations about past events, often synthesizing information from various sources. The final step in historical research is presenting the findings through books, articles, reports, lectures, or digital media, effectively communicating the results to educate others and contribute to the collective knowledge of history. This meticulous process not only illuminates how societies and cultures have evolved but also offers valuable insights into current issues by highlighting patterns, consequences, and lessons from the past.

3.6 GLOSSARY

Historical Research: Historical research involves a systematic investigation into past events to understand and contextualize the present and forecast future trends.

3.7 ANSWERS TO SELF- CHECK EXERCISE

EXERCISE-1

Answer 1. d) Academic books and articles

Answer 2. b) To understand the sequence and cause-and-effect relationships of events

EXERCISE-2

Answer 1. Primary

Answer 2. Contextualization

3.8 REFERENCES / SUGGESTED READINGS

- Best, J.W and J.V.Kahn, Research in Education (7th Ed.) New Delhi: Prentice Hall of India Pvt Ltd.1998
- Sanswal, N.D. (2020). *Research Methodology and Applied Statistics.* (1st ed.). Shipra Publications.

- Kaul, L. (2009). *Methodology of Educational Research.* (4th ed.). Vikas Publishing House Private Limited.

3.9 TERMINAL QUESTIONS

Q.1 what is historical research? Describe the steps involved in conducting historical research.

Q.2.What care will you take in making inferences and generalizations in historical research?

Q.3. How will you organize writing the research report?

Q.4.What care will you take to avoid weaknesses in conducting historical research?

Q.5. State the criteria of evaluating historical research.

UNIT- 4

HISTORICAL RESEARCH-II

Structure

4.1 INTRODUCTION:

History usually refers simply to an account of the past of human societies. It is the study of what "can be known... (to the historian). through the surviving record." Gottschalk referred to this as 'history as a record'. He further stated that "The process of critically examining and analysing the records and survivals of the past is... called historical method. The imaginative reconstruction of the past from the data derived by that process is called historiography (the writing of history)".

In academic and scholarly research, data is typically categorized into primary and secondary sources. Primary sources provide direct evidence or original data obtained from firsthand observation or experimentation, offering unfiltered insights into specific phenomena. Examples include surveys, interviews, fieldwork observations, and experimental results. **Secondary sources**, in contrast, compile, analyze, or interpret information derived from primary sources. These may include textbooks, review articles, meta-analyses, and statistical databases, offering synthesized perspectives and interpretations based on existing data.

Criticism in research involves evaluating the quality, reliability, and relevance of both primary and secondary sources. External criticism focuses on verifying the authenticity and trustworthiness of sources used, ensuring they meet scholarly standards and ethical guidelines. It examines factors such as the credibility of authors, the accuracy of data collection methods, and the reliability of data sources. **Internal criticism**, on the other hand, scrutinizes the logical coherence and consistency of arguments presented within a study. It assesses whether conclusions drawn from the data are logically sound, supported by sufficient evidence, and free from biases or logical fallacies.These concepts are fundamental in ensuring rigor and credibility in research, guiding researchers in the selection, evaluation, and synthesis of data to support their scholarly inquiries.

4.2 LEARNING OBJECTIVES

After completing this unit you will be able to

- Understand the distinction between primary and secondary sources in historical research.
- Develop skills in identifying and evaluating the credibility and bias of historical sources.
- Gain the ability to critically analyze and interpret evidence from both primary and secondary sources.
- Learn to contextualize historical events by integrating various sources and perspectives.

4.3 PRIMARY AND SECONDARY SOURCES OF DATA

Sources of Historical Data

These sources are broadly classified into two types:

(a) Primary Sources: Gottschalk defines a primary data source as "the testimony of any eye witness, or of a witness by any other of the senses, or of a mechanical device like the Dictaphone - that is, of one who was present at the events of which he tells. A primary source must thus have been produced by a contemporary of the events it narrates. In other words, primary sources are tangible materials that provide a description of a historical event and were produced shortly after the event happened. They have a direct physical relationship to the event being studied. Examples of primary sources include new paper reports, letters, public documents, court decisions, personal diaries, autobiographies, artefacts and eyewitness's verbal accounts. These primary sources of data can be divided into two broad categories as follows:

(i) The remains or relics of a given historical period. These could include photographs, coins, skeletons, fossils, tools, weapons, utensils, furniture, buildings and pieces of art and culture. Though these were not originally meant for transmitting information to future generations they could prove very useful sources in providing reliable and sound evidence about the past. Most of these relics provide non-verbal information.

(ii) Those objects that have a direct physical relationship with the events being reconstructed. This includes documents such as laws, files, letters, manuscripts, government resolutions, charters, memoranda, wills, newspapers, magazines, journals, films, government or other official publications, maps, charts, log-books, catalogues, research reports, the record of minutes of meetings, recording, inscriptions, transcriptions and so on.

(b) Secondary Sources: A secondary source is one in which the eyewitness or the participant i.e., the person describing the event was not actually present but obtained his/her descriptions or narrations from another person or source. This other person may or may not be a primary source. Secondary sources, thus, do not have a direct physical relationship with the event being studied. They include data that are not original. Examples of secondary sources include textbooks, biographies, encyclopaedias, reference books, replicas of art objects and paintings and so on. It is possible that secondary sources contain errors due to the passing of information from one source to another. These errors could get multiplied when the information passes through many sources thereby resulting in an error of great magnitude in the final data. Thus, wherever possible, the researcher should try to use primary sources of data. However, that does not reduce the value of secondary sources.

In conclusion, the various sources of historical information both primary and secondary can be summarized as follows:

It must be mentioned here that the branch of historical research using all or some types of oral records is known as oral history. It should also be mentioned here that some objects can be classified as documents or relics depending on the how they are used in a historical study. For example, in a research study on how a historical figure (a politician, a freedom fighter or a social reformer) is presented in textbooks of different periods, the textbook will be classified as a document as the emphasis here is on analysing its content matter given in a verbal form. On the other hand, in a research study on printing methods in the past, the textbook can be used as a relic as the focus here is not on analysing its contents but on its physical, outward characteristics or features.

Sources of Historical Information

- Documents Quantitative Oral Records Relics (written/printed) Records (Spoken words) (Physical or Visual objects)
- diaries-School budgets - Ballads - School Buildings
- memoirs Student attendance - Tales - School Furniture
- notebooks records - Saga - Textbooks
- yearbooks Staff attendance - Oral interviews - Pictures
- memos records of eyewitnesses - Drawings
- logbooks - Student's marks and participants - Architectural
- laws-School results Plans
- Court testimony - Financial statements - Instructional
- Committee reports - Census records Aids
- Government

Searching for Historical Data

The procedure of searching for historical data should be systematic and pre-planned the researcher should know what information he needs so as to identify important sources of data and provide a direction to his search for relevant data Using his knowledge, imagination and resourcefulness, he needs to explore the kinds of data required, persons involved, institutions involved. This will help him to identify the kinds of records he requires and whom he should interview. Since historical research is mainly qualitative in nature all the primary and secondary sources cannot be identified in advance. It is possible that as one collects some data, analyses and interprets it, the need for further pertinent data may arise depending on the interpretive framework. This will enable him to identify other primary or secondary sources of data.

The search for sources of data begins with wide reading of preliminary sources including published bibliographies, biographies, atlas, specialized chronologies, dictionaries of quotations and terms. Good university and college libraries tend to have a great deal of such preliminary materials This will enable a researcher to identify valuable secondary sources on the topic being studied such books on history relating to one's topic. For extensive materials on a subject, the researcher may need to go to a large research library or a library with extensive holdings on a specific subject. Such secondary materials could include other historian's conclusions and interpretations, historical information, references to other secondary and primary sources. The historical researcher needs to evaluate the secondary sources for their validity and authenticity. Now the researcher should turn his attention to the primary sources. These are usually available in the institution or the archives especially if the source concerns data pertaining to distant past or data pertaining to events in which the chief witnesses are either dead or inaccessible. In case of data concerning the recent past, the researcher can contact witnesses or participants themselves in order to interview them and/or study the documents possessed by them. However, it is not possible for a historical researcher to examine all the material available. Selecting the best sources of data is important in a historical study. In a historical study the complete "population" of available data can never be obtained or known.

Hence the sample of materials examined must always be a purposive one. What it represents and what it fails to represent should be considered. The researcher needs to identify and use a sample that should be representative enough for wider generalization.

C. Evaluation of the Historical Sources

The data of historical sources is subject to two types of evaluation. These two types are (i) external evaluation or criticism and (ii) internal evaluation or criticism. Let us now look at these in detail.

(i) External Criticism of Data:

This is sometimes also known as lower criticism of data. External criticism regards the issue of authenticity of the data from the psychological attitude of the researcher in that it is primarily concerned with the question, is the source of data genuine? External criticism seeks to determine whether the document or the artefact that the researcher is studying is genuinely valid primary data. It is possible to get counterfeit documents or artefacts. External criticism of the sources of data is of paramount importance in establishing the credibility of the research. Although, theoretically, the main purpose of external criticism is the establishment of historical truth, in reality, its actual operation is chiefly restricted to the negative role i.e. to identify and expose forgeries, frauds, hoaxes desertions and counterfeits. In order to identify such forgeries, the researcher needs to look at problems pertaining to plagiarism, alterations of documents, insertions, deletions or unintentional omissions. This will reveal whether the historical source of data is authentic or not. Establishing the authenticity of documents may involve carbon dating handwriting analysis, identification of ink and paper, vocabulary usage, signatures, script, spelling, names of places writing style and other considerations. In other words, it examines the document and its external features rather than the statements it contains. It tries to determine whether (a) the information it contains was available at the time the document was written. (b) This information is consistent with what is known about the author or the period from another source?

In other words, external criticism is aimed at answering questions about the nature of the historical source such as who wrote it? Where? When? Under which circumstances? Is it original? Is it genuine? And so on.

ii) Internal Criticism of Data:

Having established the authenticity of the source of historical data, the researcher now focuses his/her attention on the accuracy and worth of the data contained in the document. Internal criticism is concerned with the meaning of the written material. It is also known as higher criticism of data. It deals with answering questions such as what does it mean? What was the author attempting to say? What thought was the author trying to convey? Is it possible that people would act in the way described in the document? Is it possible that the events described occurred so quickly? What inferences or interpretations could be extracted from these words? Do the financial data/figures mentioned in the document seem reasonable for that period in the past? What does the decision of a court mean? What do the words of the decision convey regarding the intent and the will of the count? Is there any (unintended) misinformation given in the document? Is there any evidence of deception? And so, on here, the researcher needs to be very cautious so that he does not reject a statement only because the event described in the document appears to be improbable.

In addition to answering these questions, internal criticism should also include establishing the credibility of the author of the document. According to Travers, the following questions could be answered so as to establish the author's credibility: Was he a trained or untrained observer of the event? ie. How competent was he? What was his relationship to the event? To what extent was he under pressure, from fear or vanity resulting in distortion or omission of facts? What was the intent of the writer of the document? To what extent was he an expert at recording the particular event? Were the habits of the author such that they might interfere with the accuracy of recording? Was he too antagonistic or too sympathetic to give a true picture? How long after the event did, he record his testimony? Was he able to remember accurately? Is he in agreement with other independent witnesses? These questions need to be answered for two reasons:

i) Perceptions are individualized and selective Even if eyewitnesses are competent and truthful, they could still record different descriptions of the events they witnessed or experienced.

ii) Research studies in Psychology indicate that eyewitnesses can be very unreliable, especially if they are emotionally aroused or under stress at the time of the event. (e.g., at the time of the demolition of Babri Masjid or at the time of Gujarat riots in 2002.

This brings us to the question of bias especially when life histories or communal situations are being studied. According to Plummer, there are three possible sources of bias as follows:

Source One: The Life History Informant

Is misinformation (unintended) given?

Has there been evasion?

Is there evidence of direct lying and deception?

Is a 'front' being presented?

What may the informant 'take for granted' and hence not reveal?

How far is the informant 'pleasing you'?

How much has been forgotten?

How much may be self-deception?

Source Two: The Social Scientist Research

Could any of the following be shaping the outcome?

(a) Attitudes of researcher: age, gender, class, race etc.

(b) Demeanour of researcher: dress, speech, body language etc.

(c) Personality of researcher: anxiety, need for approval, hostility, warmth etc.

(d) Attitudes researcher: religion, politics, tolerance, general assumptions

(e) Scientific role of researcher: theory held etc. (researcher expectancy)

Source Three: The Interaction

The joint act needs to be examined. Is bias coming from?

(a) The physical setting-'social' space

(b) The prior interaction?

(c) Non-verbal communication?

(d) Vocal behaviour?

Often, internal and external criticism are interdependent and complementary processes. The internal and external criticism of data requires a high level of scholarship.

D. Analysis, Synthesis, Summarizing and Interpretation of Data:

We have seen how data can be located and evaluated. Let us now look at how to collect and control the data so that the greatest return from the innumerable hours spent in archives, document rooms and libraries can be reaped. The researcher should not onlylearn how to take notes but also learn how to organize the various notes, note cards, bibliography cards and memoranda so as to derive useful and meaningful facts for interpretation. Hence before beginning historical research, the researcher should have a specific and systematic plan for the acquisition, organization, storage and retrieval of the data. Following are some suggestions that may help you in systematizing your research efforts.

(i) Note cards and Bibliography Cards:

It would be convenient for you to prepare bibliography cards of size 3×5 inches for taking down bibliographical notes. A bibliography card is valuable not only for gathering and recording of information but also for locating it again at a future date, if necessary, without going back to the library again and again. Such a card contains the essential information concerning a bibliographical source. Keep plenty of such cards with you when you go to the library so that you can report very valuable references encountered unexpectedly. You can also note down the document's relation to your research. A sample of a bibliographic reference card could be as follows:

Serial No. ___________ Author(s) : _____________

Title of the Document: ___________________________

Name of the Journal: ____________________________

Vol. _________ No. ______ Month _________ Year ______ Page No.(s) ________

Place of publication, Name of Publisher, Edition, Year, Page (in case of a book:

____

Library where information is obtained: _____________________________

Call No. _________________________

Source of bibliographic information: _______________________________

How is it related to the research topic: _____________________________

Additional Comments, if any: ____________________________________

You can ideally have two copies of such a bibliographic card. One copy can be arranged according to the authors' names alphabetically whereas the other copy can be arranged as per serial number of the card. On the other hand, a note card can be of size 4×6 or 5x7 inches for substantive notes. It is advisable to place only one item of information on each card. Each card can be given a code so as to indicate the place / question/theme/period/person to which the note relates. These cards then can be arranged as per the question, theme, period, place or person under study so as to make analysis easier In other words, note cards can be kept in multiple copies (e.g. in triplicate or quadruplicate) depending on the ultimate analysis of the data. Given here is a sample note card. In this card, one can mention the bibliography card no which can be referred to for further information it required. The reverse of the card can be used if the space is found to be insufficient for necessary information.

(ii) Summary of Quantitative Data:

Usually, historical studies are chiefly qualitative in nature since the data obtained includes verbal and/or symbolic material from an institution, society or culture's past. However, when the study involves quantitative data pertaining to past events, you need to think carefully about the relevance of the data to your research. This is because recording and analysis of quantitative data is time-consuming and sometimes expensive. Examples of quantitative data in historical research include records of students' and teachers' attendance rates, examination results, finances etc.

Main Heading: ____

Sub-Heading: ____

Card No. _________ Source __________: Author : ________________

Year: _________ pp._________ Title :_______ Bibliography card No. ____________

Information such as budgets, income and expenditure statements, salaries, fees and so on. Content analysis is one of the methods involving quantitative data. The basic goal of content analysis is to take a verbal, non-quantitative document and transform it into quantitative data.

(iii) Interpretation of Historical Data:

Once the researcher establishes the validity and authenticity of data, interpretation of the facts in the light of the topic of research is necessary. This step requires caution, imagination, ingenuity, insight and scholarliness. The scientific status of his study depends on these characteristics. The researcher needs to be aware of his/her biases, values, prejudices and interests as these could influence the analysis and interpretation of the data as well as the perceptions of the researcher. He needs to make sense of the multitude of data gathered which generally involves a synthesis of data in relation to a hypothesis question or theory rather than mere accumulation or summarization. In doing so, he/she should avoid biases and unduly projecting his / her own personality onto the data. The data should be fitted into a logically parsimonious structure. The researcher should be clear about the interpretative framework so as to become sensitive towards bias in other historical researchers' interpretations who have conducted research on the same or similar topics.

In historical research, 'causes' are in the form of antecedents or precipitating factors. They are not 'causes' in the strictly scientific sense. Such antecedents are always complex and hence the researcher should avoid oversimplification while interpreting them.

Past events are mainly in the form of human behaviour. Therefore 'causes' in historical research could be interpreted in terms of the motives of the participants involved. The researcher needs to identify the motives of the people involved in the event under study while interpreting the data. These motives may be multiple in natures and interact with each other. This makes interpretation of the data a difficult task. For example, a new government decides to change the prevalent textbooks. The motives here could be many such as its political ideology does not match the prevalent textbooks, it had a personal grudge against the authors of the prevalent textbooks or the ministers concerned wanted to derive personal glory out of his actions. These reasons may influence each other making the task of interpretation of data difficult.

Historical researchers can make use of concepts from other social and behavioural science disciplines in analyzingand interpreting data. Some examples of such concepts may be bureaucracy, role, institution (from sociology), leadership, institutional effectiveness (From management), culture (from anthropology), motive, personality attitude etc. (from psychology) and so on. The researcher also can make use of the concepts of historical time and historical space white interpreting the data.

The concept of historical time makes use of a chronology of events. ie the researcher needs to identify the chain of events (chronology) of substantive history and then try to understand the meaning of these events, the relationship among the events and the relationship of the events to the research topic. The researcher is studying more than one of the chronological data within the same time frame may gain increased insight into multiple events and their causes.

The concept of historical space deals with 'where' the event originated, spread or culminated. This could provide a different insight into the meaning of the data. The historical researcher can also use analogy as a source of hypothesis or as a frame of reference for interpretation i.e. He/she can draw parallels between one historical event and other events. Here, one has to be aware of similarities, differences as well as exceptions while comparing two historical events, otherwise, such an extrapolation will be unreliable Also, it is risky to interpret an event by comparing another event in another culture at another time.

iv) Making Inferences and Generalizations in Historical Research:

In order to identify and explain the cause of a historical event, the researcher must be aware of his/her assumptions which are then used in ascribing causation to subsequent events. Some examples of such assumptions could include (i) history repeats or (ii) historical events are unique. The researcher must make clear whether his/her analysis is based on the former assumption or the latter.

Some examples of 'causes of historical events identified in prior researches include (1) strong ideology (e.g. Maharshi Karve's ideology of women's education) (ii) actions of certain key persons (e.g. Mohamed Ali Jinnah's actions for India's partition), (iii) Advances in Science in technology (e.g. use of computers in education), (iv) economic/ geographical/psychological /sociological factors or a combination of all these (e.g. privatization of education) etc.

The historian's objective is not only to establish facts but also to determine trends in the data and causes of events leading to generalizations i.e. he/she needs to synthesize and interpret and not merely summarize the data. These data, as in other types of researches, are obtained not from the entire population of persons, settings, events or objects pertaining to the topic, but from a small sample. Moreover, this sample is selected from the remains of the past. It cannot be selected from the entire population of documents or relics that existed during the period under study. Such remains may not be representative. This necessitates a very careful and cautious approach in locating consistency in different documents and relics while making generalizations. Also, the researcher should not rely on only one document pertaining to an individual from the past while making a generalization as it will not be known whether the individual held a particular opinion about an educational issue consistently or had changed it over a period of time. If he had changed his opinion, the researcher must find out when and how it was changed, under what conditions and what the consequences were. This makes it imperative that the researcher uses as many primary and secondary sources as possible on a topic. If the evidence is limited, he needs restrict the generalizability of his interpretations to that extent.

E. Writing the Research Report:

This task involves the highest level of scholarship. In historical research, data collection is flexible. Besides, due to the relative lack of conclusive evidence on which valid generalizations can be established, the writing of historical research has to be a little freer so as to allow subjective interpretation of the data. (This by no means implies distortion of truth). Thus, reports of historical research have no standard formats. The presentation of data analysis, interpretations and findings depends on the nature of the problem. There are several broad ways of reporting historical investigation as follows:

i) The researcher can report the historical facts as answers to different research questions. Answers to each question could be reported in a separate chapter.

ii) He/she can present the facts in chronological order with each chapter pertaining to a specific historical period chronologically.

iii) The report can also be written in a thematic manner where each chapter deals with a specific theme/topic.

iv) Chapters could also deal with each state of India or each district of an Indian state separately.

v) The chapter could also pertain to specific historical persons separately.

vi) The researcher can also combine two or more of these approaches while writing the research report.

In addition, the report should contain a chapter each on the introduction, methodology, review of related literature, findings, the researcher's interpretations and reflections on the interpretative process.

SELF- CHECK EXERCISE-1

Q.1. What is the primary purpose of a literature review in historical research?

a) To provide a summary of the main events in history.

b) To evaluate and analyze existing scholarly works on a specific historical topic.

c) To present personal opinions and perspectives on historical events.

d) To create fictional narratives based on historical events.

Q.2. What does the term "primary source" refer to in historical research?

a) Secondary interpretations of historical events.

b) original documents or artifacts created during the time under study.

c) Historical novels written by contemporary authors.

d) Modern commentaries on past events.

4.4 EXTERNAL AND INTERNAL CRITICISM OF DATA

Historical Criticism:

As workers in the field of research gather much of their data and information from records and documents, dissertations must be carefully evaluated so as to attest their worth for the purposes of the particular study Evaluation of historical data and information is often referred to as historical criticism and the reliable data yielded by the process are known as historical evidence. Historical evidence is derived from historical data through the process of criticism, which is of two types-external and internal. This has been discussed earlier also. There are some more clues here:

External Criticism

External criticism is concerned with establishing the authenticity or genuineness of data It is also called lower criticism. It is aimed at the document itself rather than the Interpretation or meaning of it in relation to the study. The tasks of establishing the age or authorship of a document may involve tests of factors such as signatures, handwriting, scripts, type, style, spelling and place names. According to Mouly, "the purpose of external criticism is not so much negative (the detection of fraud) as it is the establishment of historical truth.

As with external criticism, several questions need to be asked in attempting to evaluate the accuracy of a document and the truthfulness of its author.

With regard to the author of the document: -

- Was the author present at the event he or she is describing? In other words, is the document a primary or a secondary source?
- Was the author a participant in or an observer of the event?

- Was the author competent to describe the event?
- Was the author emotionally involved in the event?
- Did the author have any vested interest in the outcomes of the event?

With regard to the contents of the document: -

- Do the contents make sense?
- Could the event described have occurred at that time?
- Would people have behaved as described?
- Does the language of the document suggest a bias of any sort?
- Do other versions of the event exist? Do they present a different description or interpretation of what happened?

Internal Criticism:

Internal criticism which is also known as higher criticism is concerned with the validity. credibility, or worth of the content of the document. Both the accuracy of the information contained in a document and the truthfulness of the author need to be evaluated.

Internal criticism has to do with what the document says. Besides the textual criticism, it also involves such factors as competence, good faith, bias and general reputation of the author. It is positive in nature when the researcher seeks to discover the literal and the real meaning of the text. It is negative when the researcher tries to seek every possible reason for disbelieving the statement made, questioning critically the competence, truthfulness or accuracy and honesty of the author. Both positive and negative criticisms are essential in historical research but the researcher should not go so far as to be cynical and hypercritical.

Travers has listed those characteristics commonly considered in making evaluations of writers.

- Were they trained or untrained observers of the events? What were their relationships to the events?
- To what extent were they under pressure, from fear or vanity, to distort or omit facts?
- What were the intentions of the writers of the documents?
- To what extent were they experts at recording those particular events?

- Were they too antagonistic or too sympathetic to give true pictures? How long after the event did, they record their testimonies?
- And were they able to remember accurately?
- Finally, are they in agreement with other independent witnesses?

HOW EXTERNAL AND INTERNAL CRITICISM IS PERFORMED

External Criticism:

External criticism focuses on evaluating the authenticity, reliability, and relevance of sources used in a research study. It ensures that the information and data drawn from external sources are credible and appropriate for supporting the study's objectives. Here's how external criticism is performed:

1. **Source Evaluation:** Researchers critically assess the credibility and authority of external sources referenced in the study. They consider factors such as the reputation and expertise of authors or organizations producing the sources, the publication or dissemination channels (e.g., peer-reviewed journals, reputable databases), and the peer-review process if applicable. Evaluating source credibility helps ensure that the information used is reliable and trustworthy.
2. **Reliability of Data:** External criticism involves verifying the reliability and accuracy of the data sources used in the research. Researchers examine the methods and procedures used to collect data by external sources, assessing their validity and potential for bias. They scrutinize whether the data sources are transparent about their methodologies, sample sizes, data collection instruments, and any limitations or biases inherent in the data. Reliable data sources contribute to the robustness and validity of the study's findings.
3. **Relevance to Research Objectives:** Assessing the relevance of external sources involves determining whether the information provided directly addresses the research questions and objectives. Researchers evaluate whether the data and insights gained from external sources contribute meaningfully to the study's theoretical framework, empirical analysis, or overall argumentation. Relevance ensures that the study's conclusions are well-supported by pertinent external evidence and information.
4. **Ethical Considerations:** Ethical considerations are crucial in external criticism, ensuring that the use of external sources adheres to ethical guidelines for research

integrity. Researchers verify the accuracy of citations and references, ensuring proper attribution of ideas and data to their original sources. They uphold principles of academic honesty and integrity, avoiding plagiarism and respecting copyright and intellectual property rights. Ethical sourcing of information strengthens the scholarly integrity of the study and upholds ethical standards in academic research.

Internal Criticism:

Internal criticism involves the rigorous evaluation of the logical coherence and consistency of arguments within a research study. It focuses on ensuring that the conclusions drawn from the data are valid, well-supported, and free from bias. Here's how it is performed:

1. **Logical Coherence:** Researchers critically examine the flow of arguments and conclusions within the study. They assess whether there is a clear and logical progression from the research questions to the data collection methods, analysis, and finally, the conclusions drawn. This evaluation ensures that each step in the research process logically connects to the next, supporting the overall validity of the findings.

2. **Consistency:** Internal criticism involves checking for consistency in the interpretation and presentation of data throughout the study. Researchers look for congruence between different parts of the research, such as the alignment between data collected, analysis conducted, and interpretations made. Inconsistencies or contradictions can undermine the credibility of the study's conclusions and suggest areas where further refinement or clarification may be necessary.

3. **Avoidance of Bias:** Bias can significantly impact the objectivity and reliability of research findings. Internal criticism requires researchers to identify and mitigate potential biases that could influence the interpretation of data. This includes recognizing personal biases, methodological biases (such as sampling bias or measurement bias), and biases related to theoretical perspectives or assumptions. Addressing biases helps ensure that the conclusions drawn are based on objective analysis rather than subjective influences.

4. **Use of Valid Methods:** Evaluation of the methods used for data collection and analysis is integral to internal criticism. Researchers assess whether the chosen methods are appropriate for addressing the research questions and objectives. They

scrutinize the reliability and validity of data collection techniques, the rigor of statistical or qualitative analysis methods, and the appropriateness of theoretical frameworks applied. Valid methods contribute to the robustness of the study's findings and enhance confidence in the conclusions drawn.

Performing thorough internal and external criticism is essential for ensuring the validity, reliability, and integrity of research studies. By rigorously evaluating the logical coherence of arguments and the credibility of external sources, researchers enhance the quality and impact of their research findings, contributing to advancements in knowledge and scholarship within their respective fields.

SELF- CHECK EXERCISE-2

Q.1. What is the primary focus of internal criticism in historical research?

a) Examining the influence of external factors on historical events.

b) Assessing the authenticity and reliability of the historical sources themselves.

c) Analyzing the broader societal context of a specific historical period.

d) Exploring the impact of personal biases on historical interpretations.

Q.2. Which of the following best describes the objective of external criticism in historical research?

a) Evaluating the internal consistency of historical documents.

b) Investigating the external influences on historical events and interpretations.

c) Examining the personal motivations of historical figures.

d) Analyzing the chronological order of events in history.

4.5 SUMMARY

Historical research involves a systematic investigation into past events to understand and contextualize the present and forecast future trends. This type of research focuses on reconstructing and critically analyzing historical events, individuals, or phenomena through the examination of various sources of evidence, including documents, archives, artifacts, and oral histories. The primary objective is to provide an accurate and comprehensive account of what transpired, uncover the reasons behind these events, and assess their impact over time.

In the field of education, historical research is particularly valuable as it helps in understanding past educational practices, policies, and outcomes. By analyzing historical data, researchers can identify patterns and trends that inform current educational theories and practices, guiding future directions and improvements. For instance, historical research can reveal how educational reforms were implemented and their effects on different populations, offering lessons that are relevant today.

This research process relies on rigorous methodologies to ensure the reliability and validity of findings. Researchers must critically evaluate the credibility and relevance of their sources, interpret the evidence accurately, and synthesize their findings into a coherent narrative or argument. Ultimately, historical research contributes significantly to our understanding of the past, providing a foundation for informed decision-making in the present and future.

4.6 GLOSSARY

1. Primary Source: Original materials created at the time of an event, such as letters, diaries, photographs, and artifacts, offering firsthand evidence.

2. Secondary Source: Later interpretations or analyses of historical events, such as books, articles, and documentaries, providing context and commentary on primary sources.

4.7 ANSWERS TO SELF- CHECK EXERCISE

EXERCISE-1

Answer 1. b) To evaluate and analyze existing scholarly works on a specific historical topic.

Answer.2 b) original documents or artifacts created during the time under study.

EXERCISE-2

Answer 1. b) Assessing the authenticity and reliability of the historical sources themselves.

Answer 2. b) Investigating the external influences on historical events and interpretations.

4.8 REFERENCES / SUGGESTED READINGS

- Best, J.W and J.V.Kahn, Research in Education (7th Ed.) New Delhi: Prentice Hall of India Pvt Ltd.1998
- Sanswal, N.D. (2020). *Research Methodology and Applied Statistics.* (1^{st} ed.). Shipra Publications.
- Kaul, L. (2009). *Methodology of Educational Research.* (4^{th} ed.). Vikas Publishing House Private Limited.

4.9 TERMINAL QUESTIONS

Q1 Explain the following

(a) Characteristics of historical research in education.

(b) Purposes of historical research.

(a) Give examples of research topics in historical research

(b) Explain the approaches to historical research.

Q2. Explain how will you identify a research topic for studying the history of education.

Q.3. State the criteria for evaluating historical research.

Q.4 What are the different sources of historical data? How will you evaluate these sources?

UNIT-5

EXPERIMENTAL RESEARCH-I

Structure

5.1 Introduction

5.2 Learning Objectives

5.3 Meaning & importance of Experimental Research

Self- check Exercise-1

5.4 Steps involved in Experimental Research

Self- check Exercise-2

5.5 Summary

5.6 Glossary

5.7 Answers to self- check Exercise

5.8 References / Suggested Readings

5.9 Terminal Questions

5.1 INTRODUCTION:

Experimental research describes the process that a researcher undergoes of controlling certain variables and manipulating others to observe if the results of the experiment reflect that the manipulations directly caused the particular outcome. This type of research differs from a descriptive study, and another one of its important aspects is the use of random assignment.

5.2 LEARNING OBJECTIVES

After carefully reading this Lesson you will be able to meet the following objectives:

- Describe the nature of Experimental Research.
- Explain the essential Characteristics of Experimental Research.
- Describe the value of Experimental Research in Education.
- Define an Experimental Design.
- Describe the extraneous variables which affect significantly the internal validity of the design.

5.3 MEANING & IMPORTANCE OF EXPERIMENTAL RESEARCH

Historical Overview and 21ST-Century Trends:

Applying experimental research methods to questions about human behavior is recognized as one of the greatest scientific advances of the 20th century. Between 1975 and 2005, in particular, experimental research methodology has enabled an explosion of educationally relevant findings on how to design effective instruction in subject areas such as reading, writing, mathematics, and science.

In spite of these advances, Peggy Hsieh and colleagues (2005) found that the percentage of articles based on randomized experiments declined from 40 percent in 1983 to 26 percent in 2004 in primary educational psychology journals and from 33 percent in 1983 to 4 percent in 2004 in primary educational research journals. The authors conclude that “the use of experimental methodology in educational research appears to be on the decline”. They characterize the decline as “unfortunate” especially in light of growing concerns about “the untrustworthiness of educational research findings”. In a slightly earlier report to the National Research Council, Shavelson and Towne also noted the consensus view that the “reputation of educational research is quite poor”. The decline in training in experimental research methods in schools of education can be seen as an example of the deskilling of educational researchers, marginalizing one of the most powerful and productive research methodologies and ultimately marginalizing educational researchers as well.

Early 21st-century trends in experimental research include the use of effect size, meta-analysis, randomized field trials, and net impact.

The Use of Effect Size. Effect size is a measure of the strength of an effect in an experiment. Jacob Cohen (1988) suggested a simple measure of effect size—referred to as Cohen's d—in which the mean of the control group is subtracted from the mean of the treatment group and this difference is divided by the pooled standard deviation of the groups. According to Cohen, effect sizes can be classified as small ($d = .2$), medium ($d =.5$) and large ($d = .8$). Use of effect size allows educational policy makers to determine if an instructional treatment causes a statistically significant effect and if it has a practical effect. Hsieh et al. reported an increase in studies reporting effect size in educational psychology journals between 1995 and 2005, starting with 4 percent in

1995 to 61 percent in 2004, whereas the rate remained steady at about 25 percent from 1995 to 2004 for a primary educational research journal (2005).

The Use of Meta-analysis. The effect size measure allows for a particular instructional effect to be compared across experiments using a common metric, yielding a new kind of literature synthesis called meta-analysis. In meta-analysis, researchers tally the effect sizes of the same comparison across many different experiments, yielding an average effect size. For example, Gene Glass and Mary Smith (1978) reported a pioneering meta-analysis of research on class size revealing small positive effects of smaller class size. In the early 2000s meta-analysis is commonly used to review and summarize experimental research.

The Use of Randomized Trials. Randomized field trials (RFT), randomized clinical trials (RCT) and randomized trials (RT) refer to a particularly rigorous form of experimental research in which students (or other entities) are randomly assigned to treatments within an authentic field setting. Gary Burtless states that “a randomized field trial … is simply a controlled experiment that takes place outside a laboratory setting”.

Although randomized trials have been used in medical research and research on public policy, they are rarely used in educational research. However, there are some notable exceptions such as a study of effects of class size conducted in Tennessee, reported by Jeremy Finn and Charles Achilles. *As part of the study, 11,600 students in 79 schools across the state were assigned along with their teachers to small classes* (13–17 students), regular classes (22–26 students), or regular classes with full-time teacher aides. Students stayed in the program from kindergarten through third grade, and then all were returned to regular classes. Importantly, the study showed that students in the small classes outperformed those in the regular classes, with or without aides, and the effects were greatest for minorities. Frederick Mosteller called the Tennessee class size study “one of the most important educational investigations ever carried out”. In the foreword to Evidence Matters by Fredrick Mosteller and Robert Boruch, the authors observe, “When properly conducted, randomized field trials—often called the gold standard in research involving human subjects—allow for fairly precise estimates of programmatic effects”. Using an appropriate unit of measure (for example, individual students, classrooms, or schools) is an important consideration in research using randomized field trials.

Net Impact. Judith Gueron distinguishes between an intervention's outcomes (e.g., the percentage of students graduating from a school or passing a certification test) and its net impact (e.g., the percentage who graduate or who pass a certification test who would not have without the intervention). Gueron argues that “administrators often know and tout their program's outcomes, but they rarely know the program's net impacts”. When administrators focus on the question, “Is the new intervention effective?” they focus only on outcomes. When they focus on the question, “Does the new intervention have more impact than the current practice?” they focus on net impact. In order to determine an intervention's net impact, experimental researchers compare the outcomes with current practice (e.g., current instructional method) to the outcomes with the new intervention (e.g., the new instructional method). In short, Gueron argues that the question “Compared to what?” is an important and profound issue in experimental research.

In their analysis of educational research methodologies, Shavelson and Towne note: “decisions about education are sometimes instituted with no scientific basis at all, but rather are derived from ideology or deeply held beliefs”. In contrast, experimental research methodology has the potential to be a tool for promoting effective change in education in which decisions about instructional interventions are guided by scientific evidence and grounded in research-based theory. In the preface to Gary Phye, Daniel Robinson, and Joel Levin's *Empirical Methods for Evaluating Educational Interventions*, Gary Phye observed: “we are on the cusp of a reaffirmation that experimental research strategies provide the strongest evidence” for testing the effects of educational interventions. Finally, Robert Boruch quotes Walter Lippman who, in the 1930s, said: “Unless we are honestly experimental, we will leave the great questions of society and its improvement to the ignorant opponents of change on the one hand, and the ignorant advocates of change on the other”. In short, the experimental research methodology that fueled an explosion of scientific research about humans in the 1900s remains a powerful and indispensable tool for educational researchers in the new millennium.

Experimental Research Defined:

Experimental research is based on a methodology that meets three criteria:

(a) random assignment—the subjects (or other entities) are randomly assigned to treatment groups,

(b) experimental control—all features of the treatments are identical except for the independent variable (i.e., the feature being tested), and

(c) appropriate measures—the dependent measures are appropriate for testing the research hypothesis.

For example, in the class size example, random assignment involves finding a group of students and randomly choosing some to be in small classes (i.e, consisting of 15 students) and some to be in large classes (i.e., consisting of 30 students). The researcher cannot use pre-existing small or large classes because doing so would violate the criterion of random assignment. The problem with violating random assignment is that the groups may systemically differ; for example, students in the smaller classes may be at more wealthy schools that also have more resources, better teachers, and better-prepared students. This violation of the random assignment criterion, sometimes called *self-selection*, is a serious methodological flaw in experimental research.

In the class size example, the criterion of experimental control is reflected in having the classes equivalent on all relevant features except class size. That is, large and small classes should have teachers who are equivalent in teaching skill, students who are equivalent in academic ability, and classrooms that are physically equivalent; they should also have equivalence in support services, length of school day, percentages based on gender, English language proficiency, ethnicity, and so on. If the groups differ on an important variable other than class size, determining whether differences in test performance can be attributed to class size will be difficult. This violation of the experimental control criterion, called *confounding*, is a serious methodological flaw in experimental research.

Finally, in the class size example, the dependent measure should test the research hypothesis that class size affects academic learning, so an appropriate measure would be to give an achievement test covering the curriculum at the start and end of the year. The appropriate measures criterion would be violated if the dependent measure were a survey asking students how well they enjoyed school this year or an ungraded portfolio of their artwork over the year. When a test does not measure what is intended, the test lacks *validity*; invalid tests represent a serious methodological flaw in experimental research.

Importance of Experimental Research:

An **experimental research** is a procedure carried out to support, refute, or validate a hypothesis. Experiments provide insight into cause and effect by demonstrating what outcome occurs when a particular factor is manipulated. Experiments vary greatly in goal and scale, but always rely on repeatable procedure and logical analysis of the results. There also exists natural experimental studies.

A child may carry out basic experiments to understand gravity, while teams of scientists may take years of systematic investigation to advance their understanding of a phenomenon. Experiments and other types of hands-on activities are very important to student learning in the science classroom. Experiments can raise test scores and help a student become more engaged and interested in the material they are learning, especially when used over time. Experiments can vary from personal and informal natural comparisons (e.g. tasting a range of chocolates to find a favorite), to highly controlled (e.g. tests requiring complex apparatus overseen by many scientists that hope to discover information about subatomic particles). Uses of experiments vary considerably between the natural and human sciences.

Experiments typically include controls, which are designed to minimize the effects of variables other than the single independent variable. This increases the reliability of the results, often through a comparison between control measurements and the other measurements. Scientific controls are a part of the scientific method. Ideally, all variables in an experiment are controlled (accounted for by the control measurements) and none are uncontrolled. In such an experiment, if all controls work as expected, it is possible to conclude that the experiment works as intended, and that results are due to the effect of the tested variable.

SELF- CHECK EXERCISE-1

Q1. Which of the following best describes a dependent variable?

a) A variable that is manipulated by the researcher

b) A variable that remains constant throughout the experiment

c) A variable that is measured to assess the effect of the manipulation

d) A variable that serves as a control

Q2. In an experiment studying the effect of sleep on cognitive performance, the amount of sleep participants get is the __________.

a) Dependent variable

b) Independent variable

c) Control variable

d) Extraneous variable

5.4 STEPS INVOLVED IN EXPERIMENTAL RESEARCH:

When you are involved in conducting a research project, you generally go through the steps described below, either formally or informally. Some of these are directly involved in designing the experiment to test the hypotheses required by the project.

The following steps are generally used in conducting a research project.

1. Review pertinent literature to learn what has been done in the field and to become familiar enough with the field to allow you to discuss it with others. The best ideas often cross disciplines and species, so a broad approach is important. For example, recent research in controlling odors in swine waste has exciting implications for fly and nematode control.

2. Define your objectives and the hypotheses that you are going to test. You can't be vague. You must be specific. A good hypothesis is:

a. Clear enough to be tested

b. Adequate to explain the phenomenon

c. Good enough to permit further prediction

d. As simple as possible

3. Specify the population on which research is to be conducted. For example, specify whether you are going to determine the P requirements of papaya on the Kauai Branch Station or the P requirements of papaya throughout the State, or the P requirements of

papaya in sand or solution culture. The types of experiments required to solve these problems vary greatly in scope and complexity and also in resource requirements.

4. Evaluate the feasibility of testing the hypothesis. One should be relatively certain that an experiment can be set up to adequately test the hypotheses with the available resources. Therefore, a list should be made of the costs, materials, personnel, equipment, etc., to be sure that adequate resources are available to carry out the research. If not, modifications will have to be made to design the research to fit the available resources.

5. Select Research Procedure:

a. Selection of treatment design is very crucial and can make the difference between success and failure in achieving the objectives. Should seek help of a statistical resource person (statistician) or of others more experienced in the field. Statistical help should be sought when planning an experiment rather than afterward when a statistician is expected to extract meaningful conclusions from a poorly designed experiment. An example of a poor selection of treatments is the experiment which demonstrated that each of three treatments, Scotch and water, Gin and water, and Bourbon and water taken orally in sufficient quantities, produce some degree of intoxication. Will this experiment provide information on which ingredient or mixture causes intoxication? Why? How can this experiment be improved? An example related to agriculture is an experiment with 2 treatments, Ammonium Sulfate and Calcium Nitrate, selected to determine whether or not maize responds to N fertilizer on a Typic Paleudult soil. Will this experiment provide the desired information? What is lacking? What sources of confusion are included in the treatments?

b. Selection of the sampling or experimental design and number of replicates. This is the major topic of this course so this will not be discussed further other than to comment that in general one should choose the simplest design that will provide the precision you require.

c. Selection of measurements to be taken. With the computer it is now possible to analyze large quantities of data and thus the researcher can gain considerably more information about the crop, etc. than just the effects of the imposed variables on yield. For example, with corn, are you going to measure just the yield of grain, or of ears, or of grain plus stover? What about days to tasseling and silking? Height of ears, kernel depth, kernel weight, etc. What about nutrient levels at tasseling, or weather conditions, especially if there are similar experiments at other locations having different climates? With animal experiments, you can measure just the increase in weight or also total food intake, components of blood, food digestibility etc.

d. Selection of the unit of observation, i.e., the individual plant, one row, or a whole plot, etc? One animal or a group of animals?

e. Control of border effects or effects of adjacent units on each other or "competition". Proper use of border rows or plants and randomization of treatments to the experimental units helps minimize border effects. Proper randomization of treatments to the experimental unit is also required by statistical theory so be sure this is properly done.

f. Probable results: Make an outline of pertinent summary tables and probable results. Using information gained in the literature review write out the results you expect. Essentially perform the experiment in theory and predict the results expected.

6. *Make an outline of statistical analyses to be performed*. Before you plant the first pot or plot or feed the first animal, you should have set up an outline of the statistical analysis of your experiment to determine whether or not you are able to test the factors you wish with the precision you desire. One of the best ways to do this is to write out the analysis of variance table (source of variation and df) and determine the appropriate error terms for testing the effects of interest. A cardinal rule is to be sure you can analyze the experiment yourself and will not require a statistician to do it for you--he might not be there when you need him. Another danger in this age of the computer and statistical programs, is to believe that you can just run the data through the statistical program and the data will be analyzed for you. While this is true to a certain extent, you must remember that the computer is a perfect idiot and does only what you tell it to do. Therefore, if you do not know what to tell the computer to do and/or of you don't know what the computer is doing, you may end up with a lot of useless output-garbage!! Also, there is the little matter of interpreting all the computer output that you can get in a very short time. This is your responsibility and you had better know what it is all about.

7. Selection of suitable measuring instruments and control of bias in data collection: Measuring instruments should be sufficiently accurate for the precision required. Don't want a gram balance (scale) to weigh watermelons or sugarcane.

Experimental procedure should be free of personal bias, i.e., if treatment effects must be graded (subjective evaluation) such as in herbicide, or disease control experiments, the treatments should be randomized and the grader should not know what treatment he is grading until after he has graded it. Have two people do the data collection, one grade and the other record.

8. Install experiment: Care should be taken in measuring treatment materials (fertilizers, herbicides, or other chemicals, food rations, etc.) and the application of treatments to the experimental units. Errors here can have disastrous effects on the experimental results. In field experiments, you should personally check the bags of fertilizer or seed of varieties which should be placed on each plot, to be certain that the correct fertilizers or variety will be applied to the correct plot before any fertilizer is applied or any seed planted. Once fertilizer is applied to a plot, it generally cannot be removed easily. With laboratory experiments or preparation of various rations for feeding trials, check calculations and reagents or ingredients, etc., and set up a system of formulating the treatments to minimize the possibility of errors.

9. Collect Data: Careful measurements should be made with the appropriate instruments. It is better to collect too much data than not enough. Data should also be recorded properly in a permanent notebook. In many studies data collection can be quite rapid and before you know it you have data scattered in 6 notebooks, 3 folders, and 2 packs of paper towels!! When it is time to analyze the data, it is a formidable task, especially if someone has used the paper towels to dry their hands. Thus a little thought early in the experiment will save a lot of time and grief later. Avoid recording data on loose sheets at all costs as this is one good way to prolong your stay here by having to repeat experiments because the data were lost. Avoid fatigue in collecting data as errors increase as one gets tired. Also avoid recopying data as this is a major source of errors in experimental work. If data must be recopied, check figures against the originals immediately. It is better to have two people do the checking, one read the original data and the other read the copied data. When one person is making measurements and

another recording, have the person recording repeat the value being recorded. This will minimize errors.

10. Make a complete analysis of the data: Be sure to have a plan of analysis, e.g., which analysis and in what order will they be done? Interpret the results in the light of the experimental conditions and hypotheses tested. Statistics do not prove anything and there is always the possibility that your conclusions may be wrong. One must consider the consequences of drawing an incorrect conclusion and modify the interpretation accordingly. Do not jump to a conclusion just because an effect is significant. This is especially so if the conclusion doesn't agree with previously established facts. The experimental data should be checked very carefully if this occurs, as the results must make sense!

10. Finally, prepare a complete, correct, and readable report of the experiment. This may be a report to the farmer or researcher or an extension publication. There is no such thing as a negative result. If the null hypothesis is not rejected, it is positive evidence that there may be no real difference among the treatments tested. In summary, you should remember the 3 R's of experimentation:

1. Replicate: This provides a measure of variation (an error term) which is used in evaluating the effects observed in the experiment. This is the only way that the validity of your conclusions from the experiment can be measured.

2. Randomize: Statistical theory requires the assignment of treatments to the experimental units in a purely random manner. This prevents bias.

3. Request Help: Ask for help when in doubt about how to design, execute or analyze your experiment. Not everyone is a statistician, but should know the important principles of scientific experimentation. Be on guard against common pitfalls and ask for help when you need it. Do this when planning an experiment, not after it is completed.

SELF- CHECK EXERCISE-2

Q1. What is the primary goal of controlling extraneous variables in an experiment?

a) To increase the external validity of the study

b) To ensure the independent variable is the only factor affecting the dependent variable

c) To simplify the experimental procedure

d) To provide more data for statistical analysis

Q2. Which element of experimental research involves systematically manipulating one or more variables?

a) Hypothesis formulation

b) Control groups

c) Experimental design

d) Data analysis

Q3. An experiment investigating the effect of a new drug on blood pressure includes a placebo group. The placebo group is an example of a __________.

a) Dependent variable

b) Experimental group

c) Independent variable

d) Control group

5.5 SUMMARY

Experimental research is a systematic method used to establish cause-and-effect relationships between variables. Key elements include the independent variable, which is manipulated by the researcher, and the dependent variable, which is measured to observe the effects of this manipulation. The experimental group receives the treatment or manipulation, while the control group does not, serving as a baseline for comparison. Random assignment is crucial to ensure that participants are evenly distributed across groups, minimizing bias. Controlling extraneous variables is essential to ensure that any observed effects are due to the manipulation of the independent variable. By adhering to these principles, experimental research can produce reliable and valid results, contributing valuable insights to scientific knowledge.

5.6 GLOSSARY

1. **Dependent Variable**: The variable that is measured to assess the effect of the independent variable.

2. **Experimental Group**: The group in an experiment that receives the treatment or manipulation of the independent variable.

3. **Independent Variable**: The variable that is manipulated by the researcher to observe its effect on the dependent variable.

4. **Control Group**: The group in an experiment that does not receive the experimental treatment and serves as a baseline for comparison.

5.7 ANSWERS TO SELF- CHECK EXERCISE

EXERCISE-1

Answer 1. c) A variable that is measured to assess the effect of the manipulation

Answer 2. b) Independent variable

EXERCISE-2

Answer1. b) To ensure the independent variable is the only factor affecting the dependent variable

Answer2. c) Experimental design

Answer3. d) Control group

5.8 REFERENCES / SUGGESTED READINGS

- Best, J.W and J.V.Kahn, Research in Education (7th Ed.) New Delhi: Prentice Hall of India Pvt Ltd.1998
- Sanswal, N.D. (2020). *Research Methodology and Applied Statistics.* (1st ed.). Shipra Publications.
- Kaul, L. (2009). *Methodology of Educational Research.* (4th ed.). Vikas Publishing House Private Limited

5.9 TERMINAL QUESTIONS

Q.1 Explain the difference between the independent variable and the dependent variable in an experiment. Provide an example to illustrate your explanation.

Q.2 Describe the purpose and importance of a control group in experimental research. How does it help in interpreting the results of an experiment?

Q.3 What is random assignment, and why is it important in experimental research?

UNIT-6

EXPERIMENTAL RESEARCH-II

Structure

6.1 INTRODUCTION

Experimental research is a method used to determine cause-and-effect relationships by systematically manipulating one or more independent variables and observing their impact on dependent variables. This type of research typically begins with a clear hypothesis, which predicts the expected relationship between variables. Key elements of experimental research include the independent variable, which is manipulated by the researcher; the dependent variable, which is measured to assess the effect of the manipulation; control groups, which do not receive the experimental treatment and serve as a baseline for comparison; and random assignment, which helps ensure that participants are evenly distributed across different experimental conditions to reduce bias.

Controlling variables is a crucial aspect of experimental research, as it ensures that the results are valid and reliable. Researchers must carefully control extraneous variables, which are any variables other than the independent variable that could influence the dependent variable. This can be achieved through various techniques, such as randomization, which distributes these variables evenly across groups; matching, which pairs participants with similar characteristics; and standardization, which involves keeping procedures consistent across all experimental conditions. By controlling these variables, researchers can more confidently attribute any observed changes in the dependent variable to the manipulation of the independent variable, rather than to other confounding factors.

6.2 LEARNING OBJECTIVES

After completing this unit, the learners will be able to;

- Understand experimental design principles and methods.
- Develop hypothesis formulation and experimental design skills.
- Learn to control variables for valid experimental outcomes.

6.3 ELEMENTS OF EXPERIMENTAL RESEARCH

Experimental research is a systematic approach used in scientific inquiry to establish cause-and-effect relationships between variables. Here's a detailed explanation of the key elements involved in experimental research:

1. Hypothesis

A hypothesis is a tentative statement that predicts the relationship between variables. It serves as the starting point for experimental research, guiding the researcher's investigation and providing a clear focus. Hypotheses are typically formulated based on existing theories, prior research, or observations.

2. Independent Variable

The independent variable (IV) is the variable that the researcher manipulates or controls in the experiment. It is called "independent" because its variation is presumed to have a direct effect on the dependent variable. For example, in a study investigating the effect of caffeine on memory, the independent variable would be the amount of caffeine administered (e.g., high caffeine vs. low caffeine vs. placebo).

3. Dependent Variable

The dependent variable (DV) is the variable that is measured or observed to determine the effect of the independent variable. It is called "dependent" because its variation is expected to depend on the manipulation of the independent variable. In the caffeine and memory study, the dependent variable would be the participants' performance on memory tests.

4. Control Group

A control group is a group in an experiment that does not receive the experimental treatment. It serves as a baseline for comparison to assess the effect of the independent variable. The control group allows researchers to isolate the impact of the independent variable by minimizing the influence of confounding variables. For instance, in the caffeine study, the control group might receive a placebo instead of caffeine.

5. Experimental Group

An experimental group is a group in an experiment that receives the experimental treatment or manipulation of the independent variable. The experimental group is compared to the control group to evaluate the effect of the independent variable. In the caffeine study, the experimental group would receive varying levels of caffeine.

6. Random Assignment

Random assignment involves assigning participants to different experimental groups in a random manner. This helps ensure that each participant has an equal chance of being assigned to any group, minimizing the potential for bias and allowing for the comparison of groups with similar characteristics. Random assignment helps strengthen the internal validity of the experiment by reducing the influence of pre-existing differences between participants.

7. Extraneous Variables

Extraneous variables are variables other than the independent variable that could potentially influence the dependent variable and confound the results of an experiment. These variables may include participant characteristics, environmental factors, or unexpected events. Controlling extraneous variables through experimental design and procedures helps ensure that any observed effects on the dependent variable can be attributed to the manipulation of the independent variable.

8. Experimental Design

Experimental design refers to the overall plan or structure of the experiment, including how participants are assigned to groups, how the independent variable is manipulated, and how the dependent variable is measured. Well-designed experiments are characterized by clear operational definitions of variables, appropriate control of extraneous variables, and systematic manipulation of the independent variable to test the hypothesis effectively.

9. Data Collection and Analysis

Data collection involves gathering information or measurements related to the dependent variable(s) from participants in the experiment. Data analysis involves using statistical methods to analyze the collected data and determine whether the results support or refute the hypothesis. Statistical techniques such as t-tests, ANOVA (Analysis of Variance), and regression analysis are commonly used to analyze experimental data and draw conclusions.

10. Ethical Considerations

Ethical considerations are important in experimental research to ensure the rights and well-being of participants are protected. Researchers must obtain informed consent from participants, minimize potential risks, and adhere to ethical guidelines and regulations. Ethical conduct in experimental research helps maintain trust and integrity in scientific inquiry.

By carefully considering and implementing these elements, experimental researchers can design rigorous studies to investigate relationships between variables and contribute valuable insights to their respective fields of study.

SELF- CHECK EXERCISE-1

Q.1 In an experiment, the variable that the researcher manipulates is called the __________ variable.

Q.2 The group that does not receive the experimental treatment and serves as a baseline for comparison is known as the __________ group.

Q.3 The variable that is measured to assess the effect of the manipulation is the __________ variable.

6.4 METHODS OF CONTROLLING EXTRANEOUS VARIABLES:

An experiment focuses on two specific variables: the independent variable and the dependent variable. The idea is that the manipulation of the I.V will cause the response measured of the D.V. However within every experiment there are thousands of other variables that are constantly changing. For example all participants entering an experiment have different backgrounds, heights, weights, personalities etc.. Furthermore the conditions of the experiment are constantly changing such as the lighting, temperature, weather changes, people getting tired or bored and so on. All these extra variables are called extraneous variables, which cannot be avoided and therefore it is important that the researcher doesn't let these turn into confounding variables. If an extraneous variable turns into a confounding variable then it can undermine the internal validity of an experiment and potentially cause a type 1 error.

For an extraneous variable to turn into a confounding variable it must influence the dependent variable. If the extraneous variable is totally unrelated to the dependent variable then it is not a threat. For example everyone knows Milgram's obedience study, in this experiment participants would all be wearing different types of shoes (trainers, sandals, heels, flats, etc) however it is unlikely that the type of shoe one is wearing has any influence on participants obedience levels. Therefore it was not necessary to control participants shoe variable. Secondly a confounding variable must vary systematically with the independent variable. If the variable changes randomly with no relation to the independent variable then it is not a threat.

To control an extraneous variable the researcher needs to firstly identify those variables that are most likely to influence the dependent variable. This is done based on the researchers common sense, simple logical reasoning and past experience. For example it is obvious that a loud busy room can cause distractions that lower performance opposed to a quiet room, therefore by using a quite room you are stopping the extraneous variable of noise from becoming a confounding variable. Furthermore once identifying an extraneous variable they can be controlled by either holding a variable constant or matching values across treatment conditions. The extraneous variables can be hold constant by creating a standardized environment and procedure so that all variables are the same in each condition and therefore cannot be confounding. By matching the values across treatment conditions you are ensuring that the variable does not vary across the treatment conditions, for example participants are assigned so that the average age is the same for all different treatment conditions.

If the extraneous variable is not controlled then it can turn into a confounding variable which means the conclusion reached in an experiment may not be correct. For example, an experiment measuring group interaction on a playing field came to the conclusion that boys are more sociable than girls however when the girls were on the playing field the weather was rainy which may have caused them to be cold and not feel very sociable. Therefore the weather is the confounding variable and has lead the researcher to come to a false conclusion.

In conclusion it is extremely important when conducting research to stop extraneous variables from turning into confounding variables. Although it is hard to hold all other variables apart from the I.V constant there are ways around stopping most extraneous variables from becoming confounding. Further more if research has been conducted and confounding variables have been found then a popular way of getting around this is to perform a meta-analysis to adjust for confounding variables. For example research by Camma on Crohn's disease and research on alcoholic hepatitis by Christensen both use meta-analysis

Benefits and limitations of experimental research

Experimental research is generally recognized as the most appropriate method for drawing causal conclusions about instructional interventions, for example, which instructional method is most effective for which type of student under which conditions. In a careful analysis of educational research methods, Richard Shavelson and Lisa Towne concluded that "from a scientific perspective, randomized trials (we also use the term experiment to refer to causal studies that feature random assignment) are the ideal for establishing whether one or more factors caused change in an outcome because of their strong ability to enable fair comparisons" (2002, p. 110). Similarly, Richard Mayer notes: "experimental methods— which involve random assignment to treatments and control of extraneous variables—have been the gold standard for educational psychology since the field evolved in the early 1900s" (2005, p. 74). Mayer states, "when properly implemented, they allow for drawing causal conclusions, such as the conclusion that a particular instructional method causes better learning outcomes" (p. 75). Overall, if one wants to determine whether a particular instructional intervention causes an improvement in student learning, then one should use experimental research methodology.

Although experiments are widely recognized as the method of choice for determining the effects of an instructional intervention, they are subject to limitations involving method and theory. First, concerning method, the requirements for random assignment, experiment control, and appropriate measures can impose artificiality on the situation. Perfectly controlled conditions are generally not possible in authentic educational environments such as schools. Thus, there may be a tradeoff between experimental rigor and practical authenticity, in which highly controlled experiments may be too far removed from real classroom contexts. Experimental researchers should be sensitive to this limitation, by incorporating mitigating features in their experiments that maintain ecological validity.

Second, concerning theory, experimental research may be able to tell that one method of instruction is better than conventional practice, but may not be able to specify why; it may not be able to pinpoint the mechanisms that create the improvement. In these cases, it is useful to derive clear predictions from competing theories so experimental research can be used to test the specific predictions of competing theories. In addition, more focused research methods—such as naturalistic observation or in-depth interviews—may provide richer data that allows for the development of a detailed explanation for why an intervention might have a new effect. Experimental researchers should be sensitive to this limitation, by using complementary methods in addition to experiments that provide new kinds of evidence.

Experimental Designs

Three common research designs used in experimental research are between subjects, within subjects, and factorial designs. In between-subjects designs, subjects are assigned to one of two (or more) groups with each group constituting a specific treatment. For example, in a between-subjects design, students may be assigned to spend two school years in a small class or a large class. In within-subjects designs, the same subject receives two (or more) treatments. For example, students may be assigned to a small class for one year and a large class for the next year, or vice versa. Within-subjects designs are problematic when experience with one treatment may spill over and affect the subject's experience in the following treatment, as would likely be the case with the class size example. In factorial designs, groups are based on two (or more) factors, such as one factor being large or small class size and another factor being whether the subject is a boy or girl, which yields four cells (corresponding to four groups). In a factorial design it is possible to test for main effects, such as whether class size affects learning, and interactions, such as whether class size has equivalent effects for boys and girls.

SELF- CHECK EXERCISE-2

Q.1 Which method involves evenly distributing participants with varying characteristics across different experimental groups to control extraneous variables?

a) Random Assignment

b) Matching

c) Standardization

d) Blinding

Q2 . What is the purpose of using standardization in experimental research?

a) To ensure participants do not know which group they are in

b) To keep procedures consistent across all experimental conditions

c) To pair participants with similar characteristics

d) To randomly assign participants to different groups

6.5 SUMMARY

Experimental research is a methodical approach designed to establish cause-and-effect relationships between variables. Key elements include the hypothesis, which is a testable prediction about the relationship between variables; the independent variable, which is manipulated by the researcher; and the dependent variable, which is measured to assess the impact of the manipulation. The control group serves as a baseline that does not receive the treatment, while the experimental group does. Random assignment distributes participants into groups randomly to minimize bias, and controlling extraneous variables is essential to ensure that the results are valid. This is achieved through methods such as matching, which pairs participants with similar characteristics; standardization, which keeps procedures consistent across all conditions; and blinding, which ensures that participants or both participants and researchers are unaware of group assignments. These strategies help ensure that observed effects on the dependent variable are due to the independent variable, not other factors, thus enhancing the internal validity of the research. Data collection and analysis involve gathering and statistically analyzing data to draw conclusions about the hypothesis, all while adhering to ethical considerations to ensure the well-being of participants.

6.6 GLOSSARY

Extraneous Variables: These are variables other than the independent variable that could potentially influence the dependent variable and thus affect the outcome of an experiment.

6.7 ANSWERS TO SELF- CHECK EXERCISE

EXERCISE-1

Answer 1. Independent

Answer 2. Control

Answer 3. Dependent

EXERCISE-2

Answer 1. a) Random Assignment

Answer 2. b) To keep procedures consistent across all experimental conditions

6.8 REFERENCES / SUGGESTED READINGS

- Best, J.W and J.V.Kahn, Research in Education (7th Ed.) New Delhi: Prentice Hall of India Pvt Ltd.1998
- Sanswal, N.D. (2020). *Research Methodology and Applied Statistics.* (1st ed.). Shipra Publications.
- Kaul, L. (2009). *Methodology of Educational Research.* (4th ed.). Vikas Publishing House Private Limited.

6.9 TERMINAL QUESTIONS

1. What is the primary role of a control group in experimental research?

2. Explain the concept of extraneous variables in experimental research and their significance.

UNIT-7

RESEARCH DESIGN

Structure

7.1 INTRODUCTION

Research design is the systematic planning and structure that guides the implementation of a research study. It encompasses decisions about how to collect and analyze data to address specific research questions or hypotheses effectively. A well-designed research study considers factors such as the research objectives, the type of data required, ethical considerations, and practical constraints. It outlines the overall approach, methods, and procedures to ensure that the study is conducted with rigor and clarity, aiming to produce reliable and valid findings.

Randomized trials in educational research are a specific type of research design used to evaluate the effectiveness of educational interventions or programs. In randomized trials, participants (such as students, teachers, or schools) are randomly assigned to either an experimental group that receives the intervention or a control group that does not. Random assignment helps minimize biases and ensures that any differences observed between the groups can be attributed to the intervention rather than other factors. This method allows researchers to establish causal relationships between the intervention and its effects on educational outcomes, providing robust evidence to inform educational practices and policies. Randomized trials are valued for their ability to generate high-quality evidence, helping to improve educational practices and outcomes based on empirical findings.

7.2 LEARNING OBJECTIVES

After completing this Unit, the Learners will be able to;

- Understand the principles of research design to effectively structure and implement educational studies.
- identify extraneous variables in educational research to enhance the validity of findings.
- Apply research design principles to formulate effective educational study plans.
- Evaluate the significance of controlling extraneous variables in enhancing research validity in educational settings.

7.3 RESEARCH DESIGN:

A **research design** is the plan of a research study. The design of a study defines the study type (descriptive, correlational, semi-experimental, experimental, review, meta-analytic) and sub-type (e.g., descriptive-longitudinal case study), research question, hypotheses, independent and dependent variables, experimental design, and, if applicable, data collection methods and a statistical analysis plan. Research design is the framework that has been created to seek answers to research questions.

Research design refers to the overall plan or structure of a research study, outlining the methods and procedures used to collect and analyze data. It is crucial because it guides the researcher in systematically addressing the research problem or question. Research design can vary based on the nature of the study, the discipline, and the objectives.

Design types and sub-types:

There are many ways to classify research designs, but sometimes the distinction is artificial and other times different designs are combined. Nonetheless, the list below offers a number of useful distinctions between possible research designs. A research design is an arrangement of conditions or collections.

Experimental Research Design: This design involves manipulating variables to observe their effect on other variables. It typically includes random assignment of participants to different conditions or groups, and it aims to establish cause-and-effect relationship.

Quasi-Experimental Research Design: Similar to experimental design but lacks random assignment of participants to groups. It is used when random assignment is not feasible or ethical.

Descriptive Research Design: This design aims to describe characteristics of a phenomenon or population. It involves observing and describing behavior, attitudes, or conditions without influencing them.

Correlational Research Design: This design examines the relationship between two or more variables without manipulating them. It determines the degree of association between variables.

Explanatory Research Design: Also known as causal-comparative or causal-explanatory design, this type of research explores causal relationships between variables.

Cross-Sectional Research Design: This design involves collecting data from a sample of subjects at a single point in time. It provides a snapshot of the current status of a phenomenon.

Longitudinal Research Design: In contrast to cross-sectional design, longitudinal design involves collecting data from the same subjects repeatedly over a period of time. It allows researchers to study changes over time.

Sequential Research Design: This design combines elements of both cross-sectional and longitudinal designs. It involves multiple cross-sectional or longitudinal studies conducted in sequence.

Case Study Research Design: This design focuses on intensive analysis of a single individual, group, or event. It provides in-depth understanding and context-specific insights.

Ethnographic Research Design: Commonly used in anthropology and sociology, this design involves immersing oneself in a culture or social group to observe and understand their behavior and practices.

Each type of research design has its strengths and weaknesses, and the choice of design depends on the research question, objectives, and feasibility of conducting the study within certain constraints.

Sometimes a distinction is made between "fixed" and "flexible" designs. In some cases, these types coincide with quantitative and qualitative research designs respectively, though this need not be the case. In fixed designs, the design of the study is fixed before the main stage of data collection takes place. Fixed designs are normally theory-driven; otherwise, it is impossible to know in advance which variables need to be controlled and measured. Often, these variables are measured quantitatively. Flexible designs allow for more freedom during the data collection process. One reason for using a flexible research design can be that the variable of interest is not quantitatively measurable, such as culture. In other cases, theory might not be available before one starts the research.

The main weakness of this research design is the internal validity is questioned from the interaction between such variables as selection and maturation or selection and testing. In the absence of randomization, the possibility always exists that some critical difference, not reflected in the pretest, is operating to contaminate the posttest data. For example, if the experimental group consists of volunteers, they may be more highly motivated, or if they happen to have a different experience background that affects how they interact with the experimental treatment - such factors rather than X by itself, may account for the differences.

SELF- CHECK EXERCISE-1

Q.1 Research design refers to the __________ and __________ of a research study.

Q.2 A well-defined research design helps researchers __________ their hypotheses and __________ their findings.

Q.3 Control groups and random assignment are elements of research design that enhance __________ __________ by minimizing bias.

7.4 RANDOMIZED TRIALS IN EDUCATIONAL RESEARCH

Experimental research helps test and possibly provide evidence on which to base a causal relationship between factors. In the late 1940s, Ronald A. Fisher (1890–1962) of England began testing hypotheses on crops by dividing them into groups that were similar in composition and treatment to isolate certain effects on the crops. Soon he and others began refining the same principles for use in human research.

To ensure that groups are similar when testing variables, researchers began using randomization. By randomly placing subjects into groups that say, receive a treatment or receive a placebo, researchers help ensure that participants with the same features do not cluster into one group. The larger the study groups, the more likely randomization will produce groups approximately equal on relevant characteristics. Non randomized trials and smaller participant groups produce greater chance for bias in group formation. In education research, these experiments also involve randomly assigning participants to an experimental group and at least one control group.

The Elementary and Secondary Education Act (ESEA) of 2001 and the Educational Sciences Reform Act (ERSA) of 2002 both established clear policies from the federal government concerning a preference for "scientifically based research." A federal emphasis on the use of randomized trials in educational research is reflected in the fact that 70% of the studies funded by the Institute of Education Sciences in 2001 were to employ randomized designs.

The federal government and other sources say that the field of education lags behind other fields in use of randomized trials to determine effectiveness of methods. Critics of experimental research say that the time involved in designing, conducting, and publishing the trials makes them less effective than qualitative research. Frederick Erickson and Kris Gutierrez of the University of California, Los Angeles argued that comparing educational research to the medical failed to consider social facts, as well as possible side effects.

Evidence-based research aims to bring scientific authority to all specialties of behavioral and clinical medicine. However, the effectiveness of clinical trials can be marred by bias from financial interests and other biases, as evidenced in recent medical trials. In a 2002 Hastings Center Report, physicians Jason Klein and Albert Fleischman of the Albert Einstein College of Medicine argued that financial incentives to physicians should be limited. In 2007 many drug companies and physicians were under scrutiny for financial incentives and full disclosure of clinical trial results.

Comparison to other research methods:

In educational research, it is customary to distinguish between experimental and observational research methods, quantitative and qualitative measures, and applied versus basic research goals.

First, if experimental methods are preferred for testing causal hypotheses, what is the role of observational methods, in which a researcher carefully describes what happens in a natural environment? Observational methods can be used in an initial phase of research, as a way of generating more specific hypotheses to be tested in experiments, and observational methods can be used in conjunction with experiments to help provide a richer theoretical explanation for the observed effects. However, a collection of observations, such as portions of transcripts of conversations among students, is generally not sufficient for testing causal hypotheses. An important type of observational method is a correlational study, in which subjects generate scores on a variety of measures. By looking at the pattern of correlations, using a variety of statistical techniques, it is possible to see which factors tend to go together. However, controlled experiments are required in order to determine if the correlated factors are causally related.

Second, should educational research be based on quantitative measures (e.g., those involving numbers) or qualitative measures (e.g., those involving verbal descriptions)? Experiments may use either type of measure, depending on the research hypothesis being tested, but even qualitative descriptions can often be converted into quantitative measures by counting various events.

Third, should educational research be basic or applied? In a compelling answer to this question, Donald Stokes argues for “use-inspired basic research” (1997, p. 73). For example, in educational research, experimental researchers could examine basic principles of how instruction influences learning, that is, experiments aimed at the basic question of how to help people learn within the practical setting of schools.

SELF- CHECK EXERCISE-2

Q1. What is the primary purpose of using randomized trials in educational research?

a) To compare different teaching methods without controlling for biases

b) To assign students to groups based on their preferences

c) To randomly assign participants to different groups to minimize bias

d) To select participants based on their academic performance

Q2. In a randomized trial studying the effectiveness of a new math curriculum, which group would receive the new curriculum?

a) Experimental group

b) Control group

c) Both experimental and control groups

d) Neither experimental nor control groups

7.5 SUMMARY

The hallmark of the true experiment is control. The experimenter is in control of many facets of the research design. The experimenter controls the way in which a sample of participants is obtained from the population, participants are assigned to different treatment conditions, the environment is organized during testing, instructions are presented to participants, observations are made, and data are collected. As we will see, the purpose of this control is to reduce the influence of extraneous variables so that changes in the dependent variable can be attributed to the independent variable. In this chapter, we will describe random assignment, the use of control groups, and careful experimental techniques as means of reducing extraneous variability and increasing internal validity. In brief, we will look at how research should be done. Keep this principle in mind: The time to avoid random error (the largest component is individual differences) and confounding (systematic error) is during the design phase. Possible sources of confounding should be anticipated and eliminated before gathering data. After the data have been gathered, it is too late to eliminate any confounding that may exist.

7.6 GLOSSARY

Research Design: Research design refers to the overall plan, structure, and strategy devised to answer research questions or test hypotheses. It outlines the methods and procedures for collecting and analyzing data, as well as the rationale for selecting specific approaches and techniques. A well-designed research study considers factors such as the research objectives, the nature of the phenomenon being studied, ethical considerations, and the resources available. The design ensures that the study is conducted systematically and rigorously, facilitating the interpretation and generalizability of the findings.

7.7 ANSWERS TO SELF- CHECK EXERCISE

EXERCISE-1

Answer 1. structure, plan

Answer 2. test, interpret

Answer 3. internal, validity

EXERCISE-2

Answer 1. c) To randomly assign participants to different groups to minimize bias

Answer 2. a) Experimental group

7.8 REFERENCES / SUGGESTED READINGS

- Best, J.W and J.V.Kahn, Research in Education (7th Ed.) New Delhi: Prentice Hall of India Pvt Ltd.1998
- Sanswal, N.D. (2020). *Research Methodology and Applied Statistics.* (1st ed.). Shipra Publications.
- Kaul, L. (2009). *Methodology of Educational Research.* (4th ed.). Vikas Publishing House Private Limited.

7.9 TERMINAL QUESTIONS

Q.1 Discuss the ethical considerations that researchers should take into account when designing and conducting research involving human participants.

Q.2 How can ethical principles be integrated into different types of research designs to ensure participant welfare and integrity of research findings?

Q.3 Describe the purpose of descriptive research design. What types of research questions does it typically address?

UNIT-8

RESEARCH DESIGN-II

Structure

8.1 INTRODUCTION:

The posttest-only research design is a type of experimental design used in research to evaluate the effects of an intervention or treatment on a group of participants. Unlike the more common pretest-posttest design, which involves measuring participants both before and after the intervention, the posttest-only design only involves measuring participants after they have been exposed to the intervention. Here’s an explanation of its characteristics and considerations:

In a posttest-only design, participants are randomly assigned to either an experimental group or a control group. The experimental group receives the intervention or treatment being studied, while the control group does not receive the intervention and serves as a baseline for comparison. After the intervention period, both groups are measured on the outcome variable (the posttest measure).

8.2 LEARNING OBJECTIVES:

After completing this unit, the learners will be able to;

- Understand One Group Post-test Research Design
- Apply One Group Pre-test Post test Research Design
- Make use of Pretest-Posttest Control Group Design in different studies

8.3 ONE-GROUP POSTTEST ONLY RESEARCH DESIGN

The one-group posttest-only design (one-shot case study) is a type of quasi-experiment in which the outcome of interest is measured only once after exposing a non-random group of participants to a certain intervention.The objective is to evaluate the effect of that intervention which can be:

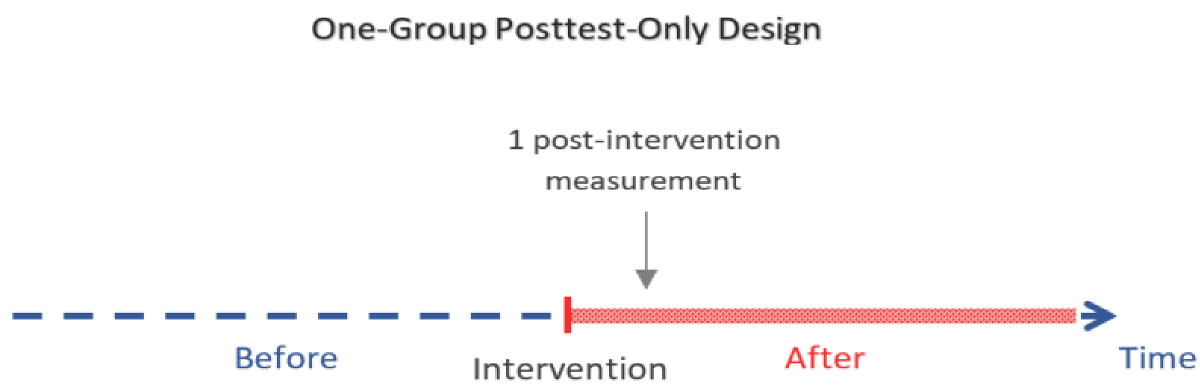
- A training program
- A policy change
- A medical treatment, etc.

This design is particularly useful in situations where conducting a pretest may introduce biases or influence participants' responses. By omitting the pretest, researchers can reduce potential sensitization effects or measurement biases that may occur due to participants becoming aware of the study’s objectives or their own performance changes over time.

However, a key consideration of the posttest-only design is the potential difficulty in establishing a baseline measure or controlling for pre-existing differences between groups. Without a pretest measure, researchers cannot ascertain whether any observed differences in outcomes are solely due to the intervention or could be influenced by other factors.

Moreover, the posttest-only design may require larger sample sizes compared to designs with pretest measures to ensure adequate statistical power and to control for variability between participants.

Despite these challenges, the posttest-only design offers advantages in terms of simplicity and practicality. It can be particularly valuable in evaluating interventions where pretests are impractical or when researchers want to avoid potential biases introduced by pretest measures. Researchers using this design must carefully consider the limitations and plan accordingly to ensure robust findings and reliable conclusions about the effectiveness of the intervention being studied.



As in other quasi-experiments, the group of participants who receive the intervention is selected in a non-random way (for example according to their choosing or that of the researcher).

The one-group posttest-only design is especially characterized by having:

- No control group
- No measurements before the intervention

It is the simplest and weakest of the quasi-experimental designs in terms of level of evidence as the measured outcome cannot be compared to a measurement before the intervention nor to a control group.

So the outcome will be compared to what we assume will happen if the intervention was not implemented. This is generally based on expert knowledge and speculation.

Next we will discuss cases where this design can be useful and its limitations in the study of a causal relationship between the intervention and the outcome.

Advantages of the one-group posttest-only design

1. Advantages related to the non-random selection of participants:

- **Ethical considerations:** Random selection of participants is considered unethical when the intervention is believed to be harmful (for example exposing people to smoking or dangerous chemicals) or on the contrary when it is believed to be so beneficial that it would be malevolent not to offer it to all participants (for example a groundbreaking treatment or medical operation).
- **Difficulty to adequately randomize subjects and locations:** In some cases where the intervention acts on a group of people at a given location, it becomes infeasible to adequately randomize subjects (ex. an intervention that reduces pollution in a given area).

2. Advantages related to the simplicity of this design:

- **Feasible with fewer resources than most designs:** The one-group posttest-only design is especially useful when the intervention must be quickly introduced and we do not have enough time to take pre-intervention measurements. Other designs may also require a larger sample size or a higher cost to account for the follow-up of a control group.
- **No temporality issue:** Since the outcome is measured after the intervention, we can be certain that it occurred after it, which is important for inferring a causal relationship between the two.

Limitations of the one-group posttest-only design

1. Selection bias:

Because participants were not chosen at random, it is certainly possible that those who volunteered are not representative of the population of interest on which we intend to draw our conclusions.

2. Limitation due to maturation:

Because we don’t have a control group nor a pre-intervention measurement of the variable of interest, the post-intervention measurement will be compared to what we believe or assume would happen was there no intervention at all.

The problem is when the outcome of interest has a natural fluctuation pattern (maturation effect) that we don’t know about.

So since certain factors are essentially hard to predict and since 1 measurement is certainly not enough to understand the natural pattern of an outcome, therefore with the one-group posttest-only design, we can hardly infer any causal relationship between intervention and outcome.

3. Limitation due to history:

The idea here is that we may have a historical event, which may also influence the outcome, occurring at the same time as the intervention.

The problem is that this event can now be an alternative explanation of the observed outcome. The only way out of this is if the effect of this event on the outcome is well-known and documented in order to account for it in our data analysis.

This is why most of the time we prefer other designs that include a control group (made of people who were exposed to the historical event but not to the intervention) as it provides us with a reference to compare to.

SELF- CHECK EXERCISE-1

Q.1 In a posttest-only research design, participants are:

A) Measured on the outcome variable before and after the intervention

B) Randomly assigned to experimental and control groups

C) Given the intervention and then measured on the outcome variable

D) Divided into homogeneous subsets before random assignment

Q.2 What is a primary advantage of using a posttest-only design compared to a pretest-posttest design?

A) It allows for stronger causal inferences

B) It reduces the risk of selection bias

C) It provides a baseline measure for comparison

D) It ensures equal distribution of participants

Q.3 Which of the following is a limitation of the posttest-only research design?

A) Difficulty in establishing a baseline measure

B) Increased likelihood of measurement biases

C) Requires larger sample sizes

D) Involves random assignment of participants

Q.4 What type of conclusions can typically be drawn from a posttest-only research design?

A) Causal relationships between variables

B) Generalizability to a broader population

C) Comparisons between different treatment conditions

D) Changes within the same group over time

Q.5 In a posttest-only design, the control group serves primarily to:

A) Provide a baseline measure

B) Randomly assign participants

C) Ensure ethical standards are met

D) Validate the intervention's effectiveness

Q.6 Which ethical consideration is particularly relevant when using a posttest-only design in research?

A) Ensuring participant confidentiality

B) Obtaining informed consent from participants

C) Minimizing researcher bias

D) Preventing participant dropout

Q.7 Which factor is important to consider when interpreting results from a posttest-only research design?

A) The diversity of participants in the sample

B) The validity of the outcome measures

C) The use of qualitative data analysis techniques

D) The cost-effectiveness of the study

Q.8 In educational research, a posttest-only design is most appropriate for:

A) Comparing the effectiveness of two different teaching methods

B) Evaluating long-term impacts of a new curriculum

C) Assessing immediate outcomes of a tutoring program

D) Observing natural behaviors in classroom settings

8.4 One-Group Pretest-Post test Design:

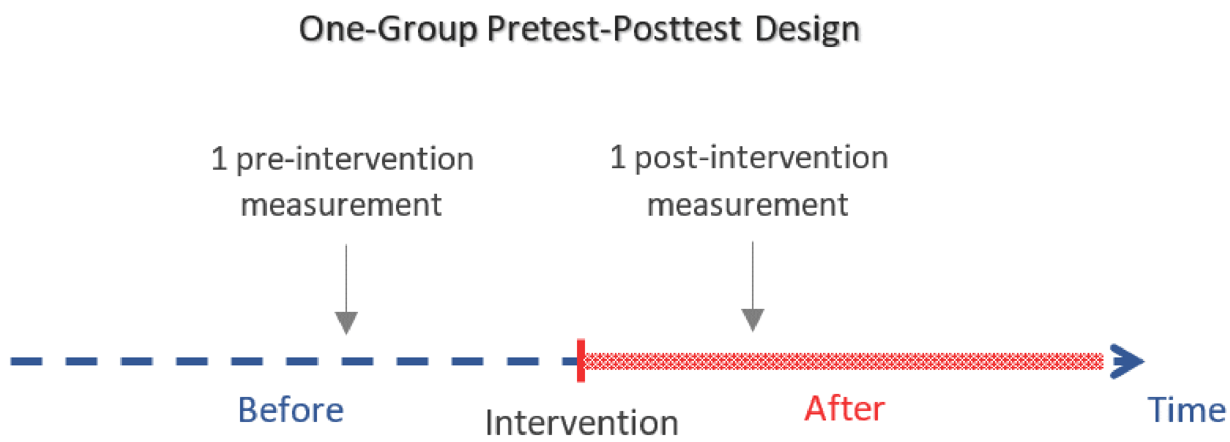
The **one-group pretest- post test design** is a type of quasi-experiment in which the outcome of interest is measured 2 times: once before and once after exposing a non-random group of participants to a certain intervention/treatment.
The objective is to evaluate the effect of that intervention which can be:

- A training program
- A policy change
- A medical treatment, etc.

The one-group pretest-post test design is a quasi-experimental research design frequently utilized to evaluate the effects of an intervention within a single group of participants. This design involves measuring participants' outcomes twice: once before they receive the intervention (pretest) and again after they have received it (post test).

The pretest serves several essential purposes in this design. First, it provides a baseline measurement of participants' initial status on the outcome variable(s) of interest. This baseline measurement helps researchers assess the extent of any initial differences or similarities among participants before they experience the intervention. Second, the pretest helps establish a basis for comparison with the post test results. By comparing changes in participants' outcomes from pretest to post test, researchers can infer whether the intervention has had a significant impact on the measured variables.

After the pretest, participants receive the intervention or treatment being studied. This could range from educational programs and therapies to policy changes or behavioral interventions. Following the intervention period, researchers administer the posttest to measure the outcomes again. Comparing the pretest and posttest scores allows researchers to determine whether there have been statistically significant changes in participants' outcomes due to the intervention.



The one-group pretest-post test design has 3 major characteristics:

1. The group of participants who receives the intervention is selected in a non-random way — which makes it a quasi-experimental design.
2. The absence of a control group against which the outcome can be compared.
3. The effect of the intervention is measured by comparing the pre- and post-intervention measurements (the null hypothesis is that the intervention has no effect, i.e. the 2 measurements are equal).

Despite its utility, the one-group pretest-post test design has inherent limitations. One major challenge is the lack of a control group for comparison. Without a control group, it becomes difficult to attribute changes observed in the outcome variables solely to the intervention. Other factors such as history, maturation, and testing effects could also influence the results, making it challenging to establish causal relationships definitively. Therefore, while this design provides valuable insights into within-group changes over time, researchers must interpret its findings cautiously and consider alternative explanations for the observed outcomes.

In conclusion, the one-group pretest-post test design is a valuable approach for evaluating interventions when random assignment to control groups is not feasible or ethical. It provides a systematic method to assess changes in participants' outcomes before and after receiving an intervention, although researchers must carefully consider its limitations and the potential for alternative explanations when interpreting the results.

Advantages of the one-group pretest-post test design

1. Feasible when random assignment of participants is considered unethical

Random assignment of participants is considered unethical when the intervention is believed to be harmful (for example exposing people to smoking or dangerous chemicals) or on the contrary when it is believed to be so beneficial that it would be malevolent not to offer it to all participants (for example a groundbreaking treatment or medical operation).

2. Feasible when randomization is impractical

In some cases, where the intervention acts on a group of people at a given location, it becomes difficult to adequately randomize subjects (eg. an intervention that reduces pollution in a given area).

3. Requires fewer resources than most designs

The one-group pretest-post test design does not require a large sample size nor a high cost to account for the follow-up of a control group.

4. No temporality issue

Since the outcome is measured after the intervention, we can be certain that it occurred after it, which is important for inferring a causal relationship between the two.

The one-group pretest-post test design is an improvement over the one-group posttest only design as it adds a pretest measurement against which we can estimate the effect of the intervention. However, it has some major limitations which will be our next topic.

Limitations of the one-group pretest-post test design

This design uses the outcome of the pretest to judge what might have happened if the intervention had not been implemented. The problem with this approach is that the difference between the outcome of the pretest and the post test might be due to factors other than the intervention.

Here is a list of factors that can bias a one-group pretest-post test study:

1. History

History refers to events (other than the intervention) that take place in time between the pretest and posttest and can affect the outcome of the posttest. The longer the time lapse is between the pretest and the posttest, the higher the risk is for history to bias the study.

Example: A commercial to help people quit smoking — the intervention — may be implemented at the same time as a new warning for cigarette packs — a co-occurring event.

2. Maturation

Maturation refers to things that vary naturally with time such as: seasonality effects, psychological factors that may change with time, worsening or improvement of a disease or condition with time, etc. These can bias the study if they affect the outcome of the posttest.

Example: People may feel overwhelmed after starting a new job, then calm down as time passes. So a one-group pretest posttest study targeting people on their first week at work may be under the influence of maturation due to the participants' varying levels of stress.

3. Testing

The testing effect is the influence of the pretest itself on the outcome of the posttest. This happens when just taking the pretest increases the experience, knowledge, or awareness of participants which changes their posttest results (this change will occur irrespective of the intervention).

Example: As one takes more IQ tests, the person becomes trained to think in a way that makes them do better on subsequent IQ tests. So, when studying the effect of a certain intervention on IQ, a pretest IQ score cannot be directly compared to a posttest IQ score as the effect of the intervention on the IQ score will be biased by the effect of testing.

Another example is when asking people about their hygiene in a pretest makes them more attentive about their hygiene and therefore affects posttest results.

4. Instrumentation

Instrumentation effect refers to changes in the measuring instrument that may account for the observed difference between pretest and posttest results. Note that sometimes the measuring instrument is the researchers themselves who are recording the outcome.

Example: Fatigue, loss of interest, or instead an increase in measuring skills of the researcher between pre- and posttest may introduce instrumentation bias.

5. Differential loss to follow-up

Loss to follow-up constitutes a problem if the group of participants who quit the study (i.e. those who did the pretest and quit before they were assessed on the posttest) differ from those who stayed until the study was over – i.e. the loss to follow-up is not random.

Example: If some participants who took the pretest were discouraged by its outcome and left the study before reaching the posttest, then the study might get biased toward proving that the intervention is better than it actually is.

6. Regression to the mean

Regression to the mean happens when the study group is selected because of its unusual scoring on a pretest (either unusually high or unusually low score), because on a subsequent test (i.e. the posttest), we would expect the scores to regress naturally toward the mean.

Example: Imagine asking a group of people "how much money did you spend today on shopping?", selecting the top 10 who spent the most, and summing up their expenditures. If we asked the same question to those 10 people again after some time, then almost certainly the sum spent on shopping the second time will be lower. This is because unusual behavior/scoring is hard to sustain.

How to deal with these limitations?

In general, we would be more confident that the observed effect is only due to the intervention if:

- The study conditions were under control.
- Participants were isolated from the outside world.
- The time interval between pretest and posttest was short.

More specifically, in order to reduce the effect of maturation and regression to the mean, we can add another pretest measure.

SELF- CHECK EXERCISE-2

Q.1 In a one-group pretest-post test design, what is the purpose of administering a pretest?

A) To measure participants' outcomes after the intervention

B) To compare different groups' responses to the intervention

C) To establish a baseline measure of participants' initial status

D) To ensure participants understand the study procedures

Q.2 Which of the following is a key advantage of using a one-group pretest-posttest design?

A) It allows for comparisons between different groups

B) It provides a strong basis for causal inferences

C) It reduces the risk of participant dropout

D) It requires a smaller sample size

Q.3 What is a potential limitation of the one-group pretest-post test design?

A) It requires random assignment of participants

B) It lacks a control group for comparison

C) It involves complex statistical analyses

D) It ensures equal distribution of participants

Q.4 Which type of conclusions can typically be drawn from a one-group pretest-post test design?

A) Causal relationships between variables

B) Generalization to a broader population

C) Comparisons between different treatment conditions

D) Changes within the same group over time

Q.5 In a one-group pretest-post test design, the intervention is typically administered:

A) Before measuring participants' outcomes

B) Between administering the pretest and post test

C) After measuring participants' outcomes

D) Without any measurement of outcomes

Q.6 Which ethical consideration is particularly relevant when using a one-group pretest-post test design in research?

A) Ensuring participant confidentiality

B) Obtaining informed consent from participants

C) Minimizing researcher bias

D) Preventing participant dropout

Q.7 Which factor is important to consider when interpreting results from a one-group pretest-post test research design?

A) The diversity of participants in the sample

B) The validity of the outcome measures

C) The use of qualitative data analysis techniques

D) The cost-effectiveness of the study

Q.8 In educational research, a one-group pretest-post test design is most appropriate for:

A) Comparing the effectiveness of two different teaching methods

B) Evaluating long-term impacts of a new curriculum

C) Assessing immediate outcomes of a tutoring program

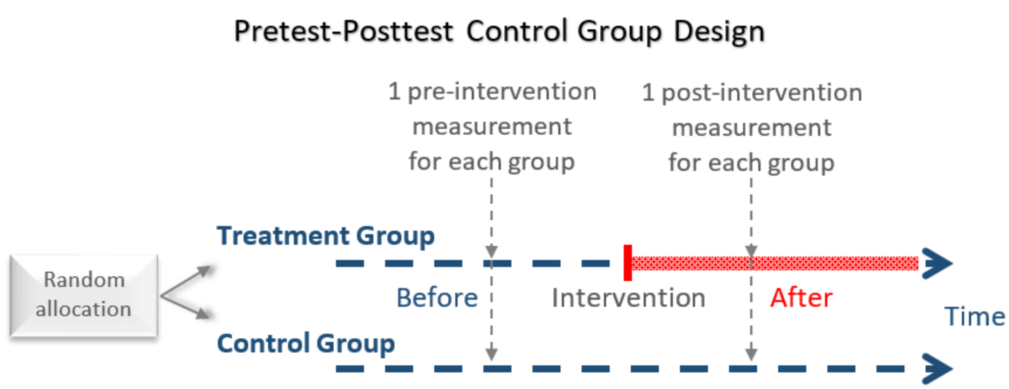
D) Observing natural behaviors in classroom settings

8.5 PRETEST-POST TEST CONTROL GROUP DESIGN: AN INTRODUCTION

The **pretest-post test control group design**, also called the **pretest-post test randomized experimental design**, is a type of experiment where participants get randomly assigned to either receive an intervention (the treatment group) or not (the control group). The outcome of interest is measured 2 times, once before the treatment group gets the intervention — the pretest — and once after it — the post test.

The objective is to measure the effect of the intervention which can be:

- A medical treatment
- An education program
- A policy change, etc.



The pretest-post test control group design has 3 major characteristics:

1. The study participants are randomly assigned to either the treatment or the control group (this random assignment can occur either before of after the pretest).
2. Both groups are exposed to the same conditions except for the intervention: the treatment group receives the intervention, whereas the control group does not.
3. The outcome is measured simultaneously for both groups at 2 points in time — the pretest and the post test.

The pretest-post test control group is the most commonly used design in randomized controlled trials.

Advantages of the pretest-post test control group design

By using a pretest, a control group, and random assignment, this design controls all internal threats to validity.

Advantage of having a pretest measurement

This design is better than the posttest-only control group design because it adds a pretest.

Adding a pretest:

1. Increases the power of the design to detect an effect.
2. Allows studying the effect of the intervention at different sublevels of the pretest.
3. Helps analyzing initial differences between groups (and therefore quantifying their effect on the study outcome).
4. Helps controlling attrition bias i.e. the unequal loss to follow-up of participants between the treatment and the control group which can affect the outcome measured at the posttest.

Advantage of using random assignment and having a control group

Random assignment and the control group will both limit the effects of:

1. **Selection bias**: Which happens when participants themselves get to choose if they receive the intervention or not. This may create unequal and incomparable study groups. Randomization allows unbiased assignment of participants to treatment options, and therefore makes the study groups comparable.
2. **Maturation**: Which is the effect of time (between the pretest and the posttest) on study participants (e.g. participants growing older, or getting tired over time) which might influence the outcome, thus becoming a rival explanation for the intervention regarding the study outcome. Participants are subject to maturation both in the treatment and the control group, therefore, any difference between the outcome of these groups will be due to the effect of the treatment alone and will not be affected by maturation.
3. **History**: Which is any event that might co-occur with the intervention and has the potential to influence the outcome. Co-occurring events affect both the treatment and the control group, and therefore any difference between the outcome of these groups will be due to the effect of the treatment alone and will not be affected by history.
4. **Testing**: Which is the effect of taking a pretest on the result of a posttest. For instance, if the pretest sensitizes participants and compels them to behave in a certain way that affects the outcome of the posttest. The presence of a control group protects against testing effects, as these will affect both groups and therefore any difference between the outcome of these groups will be due to the effect of the treatment alone and will not be affected by testing.
5. **Regression to the mean**: When pretest scores are exceptionally good by chance, the posttest scores will naturally regress toward the mean. This happens because an exceptionally good performance is hard to maintain. Regression toward the mean can be mistaken for the effect of the treatment, and therefore is a source of bias. Since participants from both groups are subject to regression, therefore, comparing the outcome of the treatment group with that of the control group will take care of this regression effect.

Limitations of the pretest-post test control group design

Participants included in any randomized study might not be typical people in the population i.e. they may not represent well the population of interest, this is because:

1. Not everyone in the population of interest is **eligible** for the experiment,
2. and not everyone who is eligible can be **recruited**,
3. and not everyone who is recruited will **give us their consent** to be included in the study,
4. and not everyone who consented will be **randomized**.

So the outcome of a randomized study may not generalize well to the population.

More specifically, this design:

- **Does not allow us to study how the effect of the treatment changes over time:** To do so, we need to add more post test measures.
- **Is susceptible for interactions between the intervention and other factors** (such as the pretest, history, instrumentation, etc.): One solution for this problem is to use the Solomon four-group design.

SELF-CHECK EXERCISE-3

Q 1 In a research study using a Pretest-Post test Control Group Design, what is the purpose of the pretest?

A) To establish baseline measurements of the dependent variable.
B) B) To compare the outcomes between experimental and control groups.
C) C) To determine the statistical significance of the results.
D) D) To analyze the effect size of the intervention.

.

Q. 2 Which of the following is a potential limitation of the Pretest-Posttest Control Group Design?

A) It requires random assignment of participants.

B) It ensures that observed changes are due to the intervention.

C) It may sensitize participants to the study's purpose.

D) It allows for comparison of outcomes before and after the intervention.

Q. 3 Which of the following best describes the control group in a Pretest-Posttest Control Group Design?

A) The group that receives the intervention being studied.

B) The group that is measured only after the intervention.

C) The group that is not exposed to the intervention.

D) The group that is not measured in the study.

Q.4 Which of the following statements best describes the Pretest-Posttest Control Group Design in experimental research?

A) Participants are randomly assigned to either the experimental or control group, and both groups are measured on the dependent variable after the intervention.

B) Participants are randomly assigned to either the experimental or control group, and both groups are measured on the dependent variable before and after the intervention.

C) Participants are not randomly assigned; instead, they self-select into either the experimental or control group, and both groups are measured on the dependent variable after the intervention.

D) Participants are assigned to either the experimental or control group based on their pre-existing characteristics, and both groups are measured on the dependent variable after the intervention.

8.6 SUMMARY

Experimental research employs various designs to evaluate interventions and treatments effectively. The Posttest-Only Design involves random assignment of participants into experimental and control groups, with outcomes measured only after the intervention, allowing for immediate assessment of intervention effects. In contrast, the Pretest-Posttest Design includes both pretest and posttest measurements, providing a baseline and enabling the comparison of changes over time due to the intervention. The Control Group Design, also employing random assignment, includes a control group that does not receive the intervention, enabling researchers to isolate and measure the specific effects of the intervention. These designs serve distinct purposes: Posttest-Only for immediate impact assessment, Pretest-Posttest for evaluating changes over time, and Control Group for establishing causality by comparing intervention effects against a baseline condition. Each design plays a crucial role in advancing knowledge and understanding in fields such as psychology, medicine, education, and social sciences by rigorously evaluating the efficacy and effectiveness of interventions.

8.7 GLOSSARY

Posttest-Only Design:A research design where participants are randomly assigned to different groups, and outcomes are measured only after the intervention or treatment has been administered to the experimental group.

Pretest-Posttest Design: A research design where participants are randomly assigned to different groups, and outcomes are measured both before (pretest) and after (posttest) the intervention or treatment has been administered to the experimental group.

Control Group Design: A research design where participants are assigned to different groups (experimental and control), with the control group typically receiving no intervention or a placebo, while the experimental group receives the intervention being studied.

8.8 ANSWERS TO SELF- CHECK EXERCISES

Exercise-1

Answer1: C) Given the intervention and then measured on the outcome variable

Answer2: A) It allows for stronger causal inferences

Answer3: A) Difficulty in establishing a baseline measure

Answer4: A) Causal relationships between variables

Answer5: A) Provide a baseline measure

Answer6: B) Obtaining informed consent from participants

Answer7: B) The validity of the outcome measuresAnswer8: C) Assessing immediate outcomes of a tutoring program

Exercise-2

Answer1: C) To establish a baseline measure of participants' initial status

Answer2: B) It provides a strong basis for causal inferences

Answer3: B) It lacks a control group for comparison

Answer4: D) Changes within the same group over time

Answer5: B) Between administering the pretest and posttest

Answer6: B) Obtaining informed consent from participants

Answer7: B) The validity of the outcome measures

Answer8: C) Assessing immediate outcomes of a tutoring program

Exercise-3

Answer1: A) To establish baseline measurements of the dependent variable

Answer2: C) It may sensitize participants to the study's purpose.

Answer3: C) The group that is not exposed to the intervention.

Answer4: B) Participants are randomly assigned to either the experimental or control group, and both groups are measured on the dependent variable before and after the intervention.

8.9 REFERENCES / SUGGESTED READINGS

- Best, J.W and J.V.Kahn, Research in Education (7th Ed.) New Delhi: Prentice Hall of India Pvt Ltd.1998

- Sanswal, N.D. (2020). *Research Methodology and Applied Statistics.* (1st ed.). Shipra Publications.
- Kaul, L. (2009). *Methodology of Educational Research.* (4th ed.). Vikas Publishing House Private Limited.
- Shadish WR, Cook TD, Campbell DT. *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. 2nd Edition. Cengage Learning; 2001.
- Campbell DT, Stanley J. *Experimental and Quasi-Experimental Designs for Research*. 1st Edition. Cengage Learning; 1963.

8.10 TERMINAL QUESTIONS:

Q1: Explain the rationale behind using a Posttest-Only Design in experimental research. How does this design differ from a Pretest-Posttest Design? Provide examples to illustrate your explanation.

Q2: Discuss the importance of a control group in experimental research. How does a Control Group Design contribute to establishing causality compared to other designs? Provide an example to illustrate your explanation.

Q3: Compare and contrast the strengths and limitations of Pretest-Posttest Design and Posttest-Only Design in experimental research. Provide specific examples where each design would be most appropriate and explain why.

UNIT-9

RESEARCH DESIGN-III

Structure

9.1 INTRODUCTION:

Randomization of subjects is a fundamental methodological practice in experimental research, designed to ensure the validity and reliability of study findings. This process involves assigning participants to different experimental or control groups in a manner that is entirely random and unbiased. By doing so, researchers aim to minimize the influence of confounding variables and potential biases that could otherwise distort results.

There are several methods of randomization, including simple randomization where each participant has an equal chance of being assigned to any group, and more sophisticated methods like stratified randomization or block randomization, which ensure balance across important variables. Additionally, blinding techniques—where participants or researchers are unaware of group assignments—further enhance the integrity of the study by preventing conscious or unconscious biases from influencing results.

9.2 LEARNING OBJECTIVES:

- After completing this unit, the learners will be able to;
- Define the concept of randomisation of subjects.
- Understand the Two Group Post Test research design

9.3 RANDOMIZATION OF SUBJECTS:

The primary importance of randomization lies in its ability to create comparable groups at the outset of an experiment. This comparability helps in establishing a cause-and-effect relationship between the independent variable (such as a new treatment or intervention) and the dependent variable (the outcome being measured). Without randomization, there is a risk that characteristics like age, gender, socioeconomic status, or other factors could disproportionately affect one group over another, leading to erroneous conclusions about the intervention's effectiveness.

Randomization of subjects is a crucial methodological technique used in research to ensure that participants are assigned to different groups in a way that minimizes biases and maximizes the validity of study findings. Here’s a comprehensive overview of randomization of subjects:

Definition:

Randomization refers to the process of assigning participants to different groups (e.g., experimental group vs. control group) in a research study randomly. The goal is to distribute potential confounding variables evenly across groups, thereby enhancing the internal validity of the study.

Key Principles:

Random Assignment: Participants are randomly assigned to groups using methods such as random number generators, coin flips, or computer-generated algorithms. This helps ensure that each participant has an equal chance of being assigned to any group.

Minimizing Bias: Randomization reduces the likelihood of systematic biases, such as selection bias or researcher bias, which could otherwise influence study results.

Equal Distribution: By distributing potential confounding variables evenly across groups, randomization strengthens the ability to attribute observed differences in outcomes to the intervention or treatment being studied.

Types of Randomization:

Simple Randomization: Participants are randomly assigned to groups without any restrictions or stratification. This is typically done using random number tables or computer-generated randomization lists.

Stratified Randomization: Participants are first divided into homogeneous subsets (strata) based on certain characteristics (e.g., age, gender, severity of condition). Random assignment is then conducted within each stratum to ensure balance across groups.

Blocked Randomization: Participants are randomized in blocks or batches. Each block contains an equal number of participants assigned to each group, ensuring balanced group sizes throughout the study.

Cluster Randomization: Randomization occurs at the level of groups or clusters rather than individual participants. This is useful when interventions are applied at the group level (e.g., schools, classrooms).

Importance in Research:

Enhancing Validity: Randomization enhances the internal validity of research by reducing the influence of confounding variables and ensuring that differences observed between groups are more likely due to the intervention rather than pre-existing differences.

Generalizability: Findings from studies with randomized samples are often more generalizable to the broader population because randomization helps create samples that are representative and unbiased.

Ethical Considerations: Randomization helps ensure fairness in assigning participants to different conditions or treatments, thereby upholding ethical standards in research.

Challenges and Considerations:

Logistical Challenges: Implementing randomization requires careful planning and coordination to ensure proper allocation of participants and adherence to randomization protocols.

Sample Size: Adequate sample size is critical to ensure that randomization leads to groups that are sufficiently balanced and representative of the population being studied.

Blinding: In some cases, blinding (masking) of participants, researchers, or assessors to group assignments may be necessary to further minimize biases.

Examples of Randomization in Research:

Clinical Trials: Randomization is commonly used in clinical trials to assign patients to different treatment arms (e.g., drug vs. placebo) to evaluate efficacy and safety.

Educational Research: Randomization ensures that students or schools are assigned to different teaching methods or interventions fairly, allowing researchers to assess the impact on learning outcomes objectively.

Psychological Studies: Researchers use randomization to assign participants to different experimental conditions (e.g., therapy vs. control) to study the effects on psychological variables.

In summary, randomization of subjects is a fundamental methodological approach in research to ensure unbiased assignment of participants to different groups. It plays a critical role in enhancing the validity, reliability, and ethical integrity of research findings across various disciplines and study contexts.

SELF- CHECK EXERCISE-1

Q.1 What is the primary goal of randomization in research studies?

A) To ensure that all participants are of similar age

B) To minimize systematic biases and ensure groups are comparable

C) To maximize the number of participants in each group

D) To select participants based on their willingness to participate

Q.2 Which type of randomization involves dividing participants into homogeneous subsets before random assignment?

A) Simple randomization

B) Stratified randomization

C) Blocked randomization

D) Cluster randomization

Q.3 In blocked randomization, participants are randomized in:

A) Equal-sized groups

B) Homogeneous subsets

C) Sequential batches

D) Geographic clusters

Q.4 What is the main advantage of using randomization in research studies?

A) It ensures that all participants receive the same treatment

B) It increases the cost-effectiveness of the study

C) It enhances the external validity of findings

D) It reduces the influence of confounding variables

Q.5 Which ethical consideration is directly addressed by randomization in research?

A) Ensuring participant confidentiality

B) Minimizing the risk of harm to participants

C) Obtaining informed consent

D) Ensuring fairness in participant assignment

Q.6 Cluster randomization is typically used when:

A) Participants are assigned to groups based on geographic location

B) Participants are randomly assigned without any grouping

C) Participants are stratified based on demographic factors

D) Participants are sequentially assigned to different conditions

Q.7 Which type of randomization involves assigning participants to groups without any restrictions or stratification?

A) Stratified randomization

B) Simple randomization

C) Blocked randomization

D) Cluster randomization

Q.8 In research, randomization helps to enhance:

A) External validity

B) Statistical power

C) Convenience sampling

D) Random selection

Answer8: B) Statistical power

Q.9 Which statement best describes the purpose of randomization in research?

A) To ensure that participants are informed about the study procedures

B) To prevent researchers from knowing the identity of participants

C) To ensure that participants are assigned to groups by chance

D) To provide incentives for participation in the study

Q.10 Randomization is particularly useful in research for:

A) Ensuring that participants are evenly distributed across age groups

B) Controlling for potential confounding variables

C) Maximizing the diversity of participants

D) Determining the eligibility criteria for participation

9.4 TWO-GROUP POST TEST-ONLY DESIGN

The simplest true experimental designs are two group designs involving one treatment group and one control group. These are ideally suited for testing the effects of a single independent variable that can be manipulated as a treatment. The two basic two-group designs are the pretest-posttest control group design and the posttest-only control group design, while variations may include covariance designs. These designs are often depicted using a standardised design notation, where represents random assignment of subjects to groups, represents the treatment administered to the treatment group, and represents pretest or posttest observations of the dependent variable (with different subscripts to distinguish between pretest and posttest observations of treatment and control groups).

Pretest-posttest control group design. In this design, subjects are randomly assigned to treatment and control groups, subjected to an initial (pretest) measurement of the dependent variables of interest, the treatment group is administered a treatment (representing the independent variable of interest), and the dependent variables measured again (posttest). The notation of this design is shown in Figure

R	O_1	X	O_2	(Treatment group)
R	O_3		O_4	(Control group)

Figure Pretest-posttest control group design

The effect of the experimental treatment in the pretest-posttest design is measured as the difference in the posttest and pretest scores between the treatment and control groups:

Statistical analysis of this design involves a simple analysis of variance (ANOVA) between the treatment and control groups. The pretest-posttest design handles several threats to internal validity, such as maturation, testing, and regression, since these threats can be expected to influence both treatment and control groups in a similar (random) manner. The selection threat is controlled via random assignment. However, additional threats to internal validity may exist. For instance, mortality can be a problem if there are differential dropout rates between the two groups, and the pretest measurement may bias the posttest measurement—especially if the pretest introduces unusual topics or content.

Posttest-only control group design. This design is a simpler version of the pretest-posttest design where pretest measurements are omitted. The design notation is shown in Figure 10.2.

R	X	O_1	(Treatment group)
R		O_2	(Control group)

Figure Posttest-only control group design

The treatment effect is measured simply as the difference in the posttest scores between the two groups:

The appropriate statistical analysis of this design is also a two-group analysis of variance (ANOVA). The simplicity of this design makes it more attractive than the pretest-posttest design in terms of internal validity. This design controls for maturation, testing, regression, selection, and pretest-posttest interaction, though the mortality threat may continue to exist.

The two-group posttest-only research design is a common experimental design used in research to compare the effects of an intervention or treatment between two distinct groups. Here’s an explanation of this design:

Description of the Two-Group Posttest-Only Design:

In the two-group posttest-only design:

- Participants are randomly assigned to either an experimental group or a control group.
- Both groups are exposed to different conditions: the experimental group receives the intervention or treatment being studied, while the control group does not receive the intervention and serves as a comparison or baseline.
- After the intervention period, both groups are measured on the outcome variable(s) of interest using a posttest measure.
- The primary comparison in this design is between the outcomes of the experimental group (which received the intervention) and the control group (which did not).

Characteristics and Uses:

1. **Random Assignment**: Random assignment of participants to groups helps ensure that any differences observed between groups at the posttest stage are less likely to be due to pre-existing differences and more likely due to the intervention itself.
2. **Causal Inference**: By comparing the posttest outcomes of the experimental and control groups, researchers can make stronger causal inferences about the effects of the intervention on the outcome variable(s).
3. **Controlled Comparison**: The presence of a control group allows researchers to control for external factors and potential confounding variables that could influence the outcomes, thereby enhancing the internal validity of the study.

4. **Statistical Analysis**: Statistical techniques such as t-tests or analysis of variance (ANOVA) are often used to analyze and compare the posttest scores between the experimental and control groups.

Advantages and Limitations:

- **Advantages**:
  - Provides strong evidence for causality by comparing outcomes between intervention and control groups.
  - Allows researchers to control for confounding variables through random assignment.
  - Enhances the ability to generalize findings to the broader population.
- **Limitations**:
  - Ethical concerns may arise if withholding treatment from the control group is deemed harmful or unfair.
  - Practical challenges in ensuring participants adhere strictly to their assigned conditions.
  - External validity might be compromised if the experimental conditions differ significantly from real-world settings.

Example in Educational Research:

In educational research, a two-group posttest-only design could be used to evaluate the effectiveness of a new teaching method. Students could be randomly assigned to either the experimental group (receiving the new teaching method) or the control group (receiving the traditional teaching method). After a semester, both groups would be assessed on their academic performance to determine if there are significant differences in learning outcomes between the two groups.

In summary, the two-group posttest-only design is a robust experimental approach for evaluating interventions or treatments by comparing outcomes between an experimental group that receives the intervention and a control group that does not. It provides valuable insights into the effectiveness of interventions while controlling for potential confounding variables, thereby contributing to evidence-based decision-making in various fields of research.

SELF-CHECK EXERCISE-2

Q.1 In a two-group posttest-only research design, participants are:

A) Measured on the outcome variable before and after the intervention

B) Randomly assigned to different treatment conditions

C) Given the intervention and then measured on the outcome variable

D) Divided into homogeneous subsets before random assignment

Q.2 What is the primary purpose of including a control group in a two-group posttest-only design?

A) To ensure ethical standards are met

B) To provide a baseline measure for comparison

C) To increase the statistical power of the study

D) To administer alternative interventions

Q.3 Which statistical analysis technique is typically used to compare the outcomes between the experimental and control groups in a two-group posttest-only design?

A) Chi-square test

B) Regression analysis

C) Analysis of variance (ANOVA)

D) Factorial design

Q.4 What type of conclusions can be drawn from a two-group posttest-only design?

A) Causal relationships between variables

B) Generalizability to a broader population

C) Comparisons between different treatment conditions

D) Changes within the same group over time

Q.5 In a two-group posttest-only design, random assignment helps to:

A) Ensure equal distribution of participants' characteristics

B) Minimize the duration of the study

C) Reduce the need for ethical approval

D) Select participants based on convenience

Q.6 Which ethical consideration is particularly relevant when using a two-group posttest-only design in research?

A) Maintaining participant confidentiality

B) Ensuring participant retention throughout the study

C) Providing debriefing sessions after the study

D) Avoiding harm to participants in the control group

Q.7 Which factor is important to consider when interpreting results from a two-group posttest-only research design?

A) The cost-effectiveness of the study

B) The use of qualitative data analysis techniques

C) The validity of the outcome measures

D) The availability of funding for future research

Q.8 In educational research, a two-group posttest-only design is most appropriate for:

A) Evaluating the long-term impact of a new teaching method

B) Comparing the effectiveness of two different curricula

C) Observing natural behaviors in classroom settings

D) Exploring student perceptions of educational resources

9.5 SUMMARY:

In conclusion, randomization is not merely a procedural step but a cornerstone of rigorous experimental design. It safeguards against biases, enhances the study's internal validity, and supports broader generalizations of findings to the population at large. By systematically assigning participants to groups without bias, randomization ensures that experimental research remains robust, credible, and capable of producing reliable insights into the effectiveness of interventions and treatments.

9.6 GLOSSARY:

Randomization: The process of assigning participants to different groups or conditions in an experiment randomly, ensuring each participant has an equal chance of being assigned to any group. Randomization helps minimize bias and ensures comparability between groups.

Experimental Research: Research conducted to investigate cause-and-effect relationships between variables. Experimental studies involve manipulating an independent variable to observe its effect on a dependent variable while controlling for other variables.

Control Group: A group in an experiment that does not receive the experimental treatment or intervention. It serves as a baseline for comparison to evaluate the effects of the intervention.

Experimental Group: The group in an experiment that receives the experimental treatment or intervention being studied. Changes in the experimental group are compared to the control group to determine the effect of the intervention.
Independent Variable: The variable that is manipulated or controlled by the researcher in an experiment. It is hypothesized to cause changes in the dependent variable.
Dependent Variable: The variable that is measured in an experiment and is expected to change in response to manipulations of the independent variable.
Posttest-Only Design: An experimental design where measurements of the dependent variable are taken only after the intervention or treatment has been administered to the experimental group, without a pretest.
Controlled Variables: Variables other than the independent variable that are kept constant or controlled to prevent them from influencing the results of an experiment.

9.7 ANSWERS TO SELF- CHECK EXERCISES:

Exercise-1

Answer1: B) To minimize systematic biases and ensure groups are comparable

Answer2: B) Stratified randomization

Answer3: C) Sequential batches

Answer4: D) It reduces the influence of confounding variables

Answer5: D) Ensuring fairness in participant assignment

Answer6: A) Participants are assigned to groups based on geographic location

Answer7: B) Simple randomization

Answer9: C) To ensure that participants are assigned to groups by chance

Answer10: B) Controlling for potential confounding variables

Exercise-2

Answer1: C) Given the intervention and then measured on the outcome variable

Answer2: B) To provide a baseline measure for comparison

Answer3: C) Analysis of variance (ANOVA)

Answer4: A) Causal relationships between variables

Answer5: A) Ensure equal distribution of participants' characteristics

Answer6: D) Avoiding harm to participants in the control group

Answer7: C) The validity of the outcome measures

Answer8: B) Comparing the effectiveness of two different curricula

9.8 REFERENCES / SUGGESTED READINGS:

- Best, J.W and J.V.Kahn, Research in Education (7th Ed.) New Delhi: Prentice Hall of India Pvt Ltd.1998
- Sanswal, N.D. (2020). *Research Methodology and Applied Statistics.* (1st ed.). Shipra Publications.
- Kaul, L. (2009). *Methodology of Educational Research.* (4th ed.). Vikas Publishing House Private Limited.
- Shadish WR, Cook TD, Campbell DT. *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. 2nd Edition. Cengage Learning; 2001.
- Campbell DT, Stanley J. *Experimental and Quasi-Experimental Designs for Research*. 1st Edition. Cengage Learning; 1963.

9.9 TERMINAL QUESTIONS:

Q.1 Discuss the importance of randomization in experimental research. How does randomization contribute to the internal validity of a study? Provide examples to illustrate your explanation.

Q.2 Discuss the key components and rationale behind using the Two-Group Posttest Design in experimental research. How does this design facilitate the assessment of causal relationships between variables? Provide examples to illustrate your explanation.

UNIT-10

RESEARCH DESIGN-IV

Structure

10.1 INTRODUCTION:

Factorial design is a statistical experimental design used to investigate the effects of two or more independent variables (factors) on a dependent variable. By manipulating the levels of the characteristics and measuring the resulting impact on the dependent variable, researchers can identify each element's unique contributions and their combined or interactive effects.

These are beneficial when investigating interactions between variables. They allow researchers to explore how one factor's effects may depend on another element's levels. This can provide valuable insights into the underlying mechanisms. It further drives the observed impacts and helps identify potential moderators or mediators of the relationship between variables.

Factorial design is a powerful and versatile experimental design used in research across various disciplines, from psychology and education to medicine and engineering. This design allows researchers to investigate the effects of two or more independent variables simultaneously, providing insights into their individual and combined influences on the dependent variable(s).

10.2 LEARNING OBJECTIVES:

After completing this unit, the learners will be able to;

- Define and explain factorial design.
- Understand the concept of 2X2 Factorial design.
- Apply 2X2 Factorial design on different comparison groups.

10.3 INTRODUCTION TO FACTORIAL DESIGN:

Definition: Factorial design involves the manipulation of two or more independent variables (factors), with each factor having multiple levels. By systematically varying these factors, researchers can examine their main effects (influence of each factor independently) and interactions (combined effects of factors) on the dependent variable(s).

Key Components:

Independent Variables (Factors): These are the variables that researchers manipulate or control in the experiment to observe their effects on the dependent variable(s). Factors can be categorical (e.g., type of treatment, gender) or continuous (e.g., dosage, time).

Levels: Each independent variable has two or more levels, representing different conditions or values of that variable. For example, a study on the effects of nutrition and exercise might have two factors: type of diet (healthy vs. unhealthy) and exercise intensity (low vs. high), each with two levels.

Dependent Variable(s): These are the outcome variables that researchers measure to assess the effects of the independent variables. Dependent variables can be behavioral, physiological, cognitive, or any other measurable outcome relevant to the research question.

Advantages of Factorial Design:

Efficiency: Factorial designs allow researchers to study multiple factors and their interactions simultaneously, reducing the number of experiments needed compared to conducting separate experiments for each factor.

Detection of Interactions: By examining interactions between factors, factorial designs provide insights into how variables may influence each other in complex ways that might not be evident from studying each variable independently.

Generalizability: Results from factorial designs can often be generalized more broadly, as they account for interactions that may occur in real-world settings where multiple variables influence outcomes simultaneously.

Types of Factorial Designs:

It can be classified into several types. Based on the number of independent variables (factors) and levels used in the experiment. Some common types of it include:

1. **2×2 factorial design**: It involves two independent variables, each with two levels. It is popular in psychological research to investigate the effects of two factors on behavior or outcome.

2. **3x2 Factorial Design:** Involves two factors, one with three levels and the other with two levels. This design extends the analysis to include interactions between a categorical factor with more than two levels and another factor.

3. **3×3 factorial design**: It involves three independent variables, each with three levels. It helps investigate the effects of multiple factors on behavior or outcome and can be particularly useful in medical research.

4. **Mixed factorial design**: This design involves at least one independent variable manipulated within subjects (i.e., each participant experiences all levels of the variable). And at least one independent variable between subjects (i.e., each participant experiences only one level of the variable).

5. **Nested factorial design:** This design involves one independent variable that is in alignment with another independent variable. For instance, a study on different types of therapy for depression might have one independent variable that represents the type of therapy (cognitive-behavioral therapy, psychoanalytic therapy, etc.) and another independent variable that represents the therapist administering the treatment.

6. **Fractional factorial design**: This design involves testing only a subset of possible combinations of levels of the independent variables. This can be useful when resources are limited or when trying all possible combinations would be impractical.

7. **Higher-order Factorial Designs:** Can involve more than two factors and multiple levels for each factor, allowing researchers to explore complex interactions and relationships among variables.

Examples

Let us understand it better with the help of some examples:

Example 1:

Suppose a study on the effects of different types of online learning environments and study strategies on academic performance in college students is carried out. The study could use a 2×2 factorial design, with two independent variables (learning environment and study strategy) and two levels of each independent variable.

The learning environments could be synchronous online learning (i.e., live classes with real-time interaction), asynchronous online learning (i.e., pre-recorded lessons with discussion boards), or a combination. The study strategies are self-regulated learning (i.e., self-paced and self-directed study), collaborative learning (i.e., group work and peer feedback), or a combination.

Participants would be assigned groups: synchronous learning with self-regulated study, asynchronous understanding with collaborative study, synchronous and asynchronous learning with self-regulated study, or synchronous and asynchronous learning with collaborative research. The dependent variable would be the participants' academic performance, measured by their grades in a specific course or course.

By manipulating the levels of the learning environment and study strategy and measuring their combined and individual effects on academic performance, this study could provide valuable insights into the most effective approaches to online learning for college students.

Example 2:

Imagine a study investigating the effects of caffeine consumption and stress level on cognitive performance in college students. Researchers employ a 2x2 factorial design, with caffeine consumption (caffeinated vs. decaffeinated) as one factor and stress level (low vs. high) as the other factor. Participants are randomly assigned to one of four groups: (1) low stress + caffeinated, (2) low stress + decaffeinated, (3) high stress + caffeinated, and (4) high stress + decaffeinated.

Independent Variables:

Factor 1: Caffeine consumption (caffeinated vs. decaffeinated).

Factor 2: Stress level (low vs. high).

Dependent Variable: Cognitive performance (e.g., memory recall, reaction time).

By measuring cognitive performance across all four groups, researchers can analyze:

- The **main effects** of caffeine consumption and stress level on cognitive performance.
- The **interaction effect** between caffeine consumption and stress level, assessing whether the effects of caffeine vary depending on stress level and vice versa.

Advantages And Disadvantages

The advantages are as follows:

1. **Ability to investigate multiple factors**: These allow researchers to investigate the effects of various independent on a dependent variable in a single experiment, which can save time and resources.
2. **Identification of main effects and interactions**: These enable researchers to identify the main products of each independent variable and any interaction effects between them, providing a more nuanced understanding of the relationships between variables.
3. **Increased statistical power**: By manipulating multiple independent variables, factorial designs can increase the statistical power of a study and improve the likelihood of detecting meaningful effects.
4. **Flexibility**: These adapt to various research questions and uses in multiple fields, including psychology, education, medicine, and engineering.

The disadvantages are as follows:

1. **Increased complexity**: Using multiple independent variables can interpret results more complexly, mainly when interaction effects are present.
2. **Increased sample size requirements**: A larger **sample size** is preferable to a more straightforward design with fewer independent variables to power such a design adequately.
3. **Potential for confounding**: The presence of interaction effects can make it challenging to determine which independent variable is responsible for observed effects, potentially confounding the results.

4. **Limited generalizability**: The specific conditions of it may not be generalizable to other contexts.

SELF-CHECK EXERCISE-1

Q.1 In factorial design, what are the independent variables called?

A) Conditions

B) Factors

C) Variables

D) Treatments

Q.2 What is a main advantage of factorial designs compared to single-factor designs?

A) They require fewer participants

B) They provide insights into interactions between variables

C) They are easier to analyze statistically

D) They control for all possible confounding variables

Q.3 Which design allows researchers to study multiple factors simultaneously and is efficient in exploring interactions?

A) Longitudinal design

B) Case study design

C) Factorial design

D) Cross-sectional design

Q.4 What is the purpose of using factorial design in experiments?

A) To reduce the number of participants required

B) To assess the effectiveness of a single variable

C) To investigate interactions between variables

D) To control for confounding variables

10.4 FACTORIAL DESIGN (2X2):

A **2×2 factorial design** is a type of experimental design that allows researchers to understand the effects of two independent variables (each with two levels) on a single dependent variable.

		Independent Variable 2	
		Level 1	Level 2
Independent Variable 1	Level 1	Dependent Variable	Dependent Variable
	Level 2	Dependent Variable	Dependent Variable

For example, suppose a botanist wants to understand the effects of sunlight (low vs. high) and watering frequency (daily vs. weekly) on the growth of a certain species of plant.

		Watering Frequency	
		Daily	Weekly
Sunlight	Low	Plant Growth	Plant Growth
	High	Plant Growth	Plant Growth

This is an example of a 2×2 factorial design because there are two independent variables, each with two levels:

Independent variable #1: Sunlight

Levels: Low, High

Independent variable #2: Watering Frequency

Levels: Daily, Weekly

And there is one dependent variable: Plant growth.

The Purpose of a 2×2 Factorial Design

A 2×2 factorial design allows you to analyze the following effects:

Main Effects: These are the effects that just one independent variable has on the dependent variable.

For example, in our previous scenario we could analyze the following main effects:

- Main effect of sunlight on plant growth.
  - We can find the mean plant growth of all plants that received low sunlight.
  - We can find the mean plant growth of all plants that received high sunlight.
- Main effect of watering frequency on plant growth.
  - We can find the mean plant growth of all plants that were watered daily.
  - We can find the mean plant growth of all plants that were watered weekly.

For example, in our previous scenario we could analyze the following interaction effects:

- Does the effect of sunlight on plant growth depend on watering frequency?

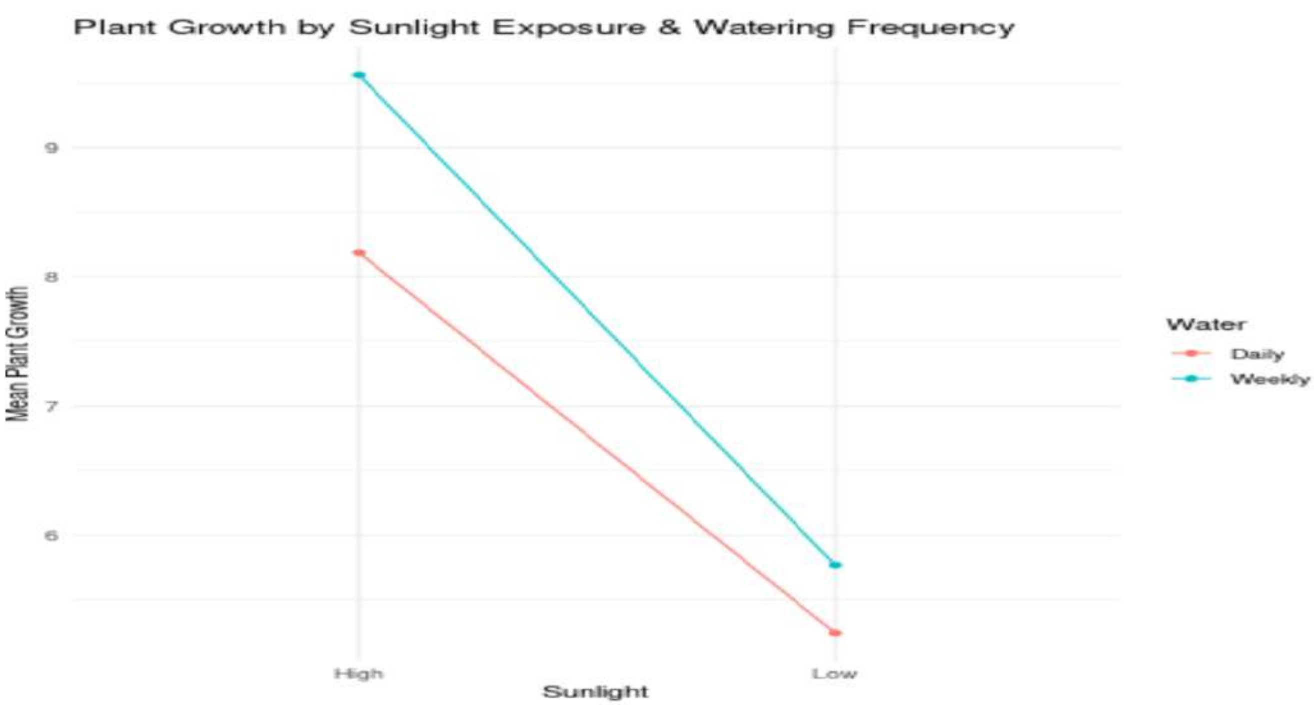
- Does the effect of watering frequency on plant growth depend on the amount of sunlight?

Visualizing Main Effects & Interaction Effects

When we use a 2×2 factorial design, we often graph the means to gain a better understanding of the effects that the independent variables have on the dependent variable.

Interaction Effects: These occur when the effect that one independent variable has on the dependent variable depends on the level of the other independent variable.

For example, consider the following plot:



Here's how to interpret the values in the plot:

- The mean growth for plants that received high sunlight and daily watering was about **8.2** inches.
- The mean growth for plants that received high sunlight and weekly watering was about **9.6** inches.

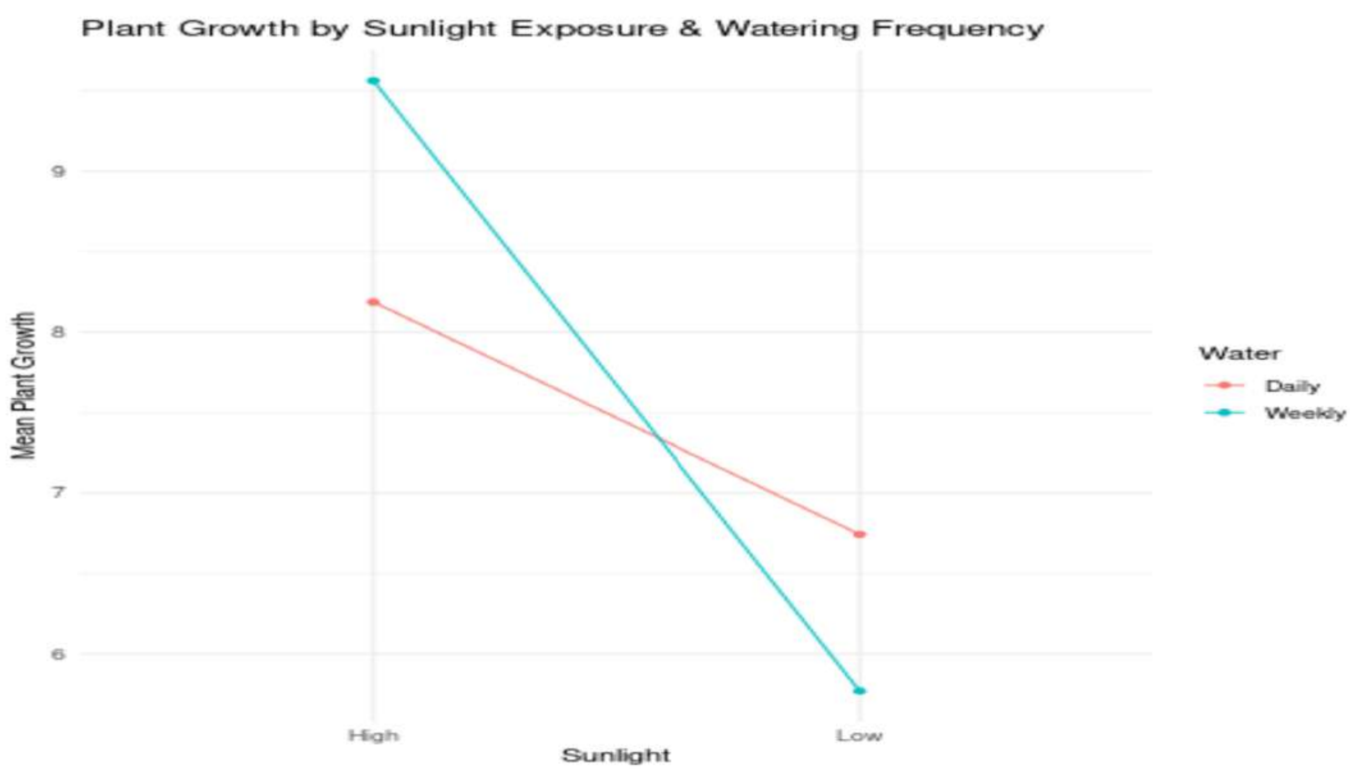
- The mean growth for plants that received low sunlight and daily watering was about **5.3** inches.
- The mean growth for plants that received low sunlight and weekly watering was about **5.8** inches.

To determine if there is an interaction effect between the two independent variables, we simply need to inspect whether or not the lines are parallel:

- If the two lines in the plot are parallel, there is no interaction effect.
- If the two lines in the plot are not parallel, there is an interaction effect.

In the previous plot, the two lines were roughly parallel so there is likely no interaction effect between watering frequency and sunlight exposure.

However, consider the following plot:



The two lines are not parallel at all (in fact, they cross!), which indicates that there is likely an interaction effect between them.

For example, this means the effect that sunlight has on plant growth depends on the watering frequency.

In other words, sunlight and watering frequency do not affect plant growth independently. Rather, there is an interaction effect between the two independent variables.

How to Analyze a 2×2 Factorial Design

Plotting the means is a visualize way to inspect the effects that the independent variables have on the dependent variable. However, we can also perform a two-way ANOVA to formally test whether or not the independent variables have a statistically significant relationship with the dependent variable.

SELF-CHECK EXERCISE-2

Q.1 A 2x2 factorial design involves:

A) Two factors with one level each

B) Two factors with two levels each

C) Two factors with three levels each

D) Two factors with four levels each

Q.2 What does a 3x2 factorial design typically include?

A) Three factors, each with two levels

B) Two factors, one with three levels and the other with two levels

C) Three factors, each with three levels

D) Two factors, one with two levels and the other with three levels

Q.3 In a 2x3 factorial design, how many treatment conditions are there?

A) 2

B) 3

C) 4

D) 6

Q.4 Which type of factorial design examines the main effects and interactions of three independent variables?

A) 3x3 factorial design

B) 3x2 factorial design

C) 2x3x2 factorial design

D) 2x2 factorial design

Q.5 Factorial designs are particularly useful for:

A) Assessing the effects of a single variable across different levels

B) Investigating interactions between multiple variables

C) Conducting studies with large sample sizes

D) Exploring longitudinal changes in behavior

Q.6 In a 2x2x2 factorial design, how many conditions or treatment combinations are there?

A) 2

B) 4

C) 6

D) 8

10.5 SUMMARY:

Factorial design is a valuable approach in experimental research for its ability to explore the effects of multiple independent variables and their interactions on dependent variables. By systematically manipulating factors and levels, researchers can uncover complex relationships and enhance understanding across diverse fields of study. Factorial designs offer researchers flexibility, efficiency, and depth in analyzing how various factors contribute to outcomes, making them a cornerstone of rigorous experimental investigations.

10.6 GLOSSARY:

Factorial Design: An experimental design in which two or more independent variables (factors) are manipulated simultaneously to assess their effects on one or more dependent variables.

Factors: The independent variables manipulated in factorial design, each with two or more levels representing different conditions or values.

Levels: The specific values or conditions of each factor in factorial design. For example, if a factor is "type of treatment," its levels could be "treatment A" and "treatment B."

Main Effects: The separate effects of each independent variable (factor) on the dependent variable(s) in factorial design, ignoring the effects of other variables.

Interactions: The combined effects of two or more independent variables on the dependent variable(s) in factorial design. Interactions indicate whether the effect of one variable depends on the level of another variable.

2x2 Factorial Design: A factorial design involving two factors, each with two levels. It allows for the assessment of two main effects and one interaction.

Cell: A specific combination of levels from each factor in a factorial design. For example, in a 2x2 design with Factor A (levels: A1, A2) and Factor B (levels: B1, B2), there are four cells: A1B1, A1B2, A2B1, and A2B2.

10.7 ANSWERS TO SELF CHECK EXERCISES:

Exercise-1

Answer1: B) Factors

Answer2: B) They provide insights into interactions between variables

Answer3: C) Factorial design

Answer4: C) To investigate interactions between variables

Exercise-2

Answer1: B) Two factors with two levels each

Answer2: D) Two factors, one with two levels and the other with three levels

Answer3: D) 6

Answer4: C) 2x3x2 factorial design

Answer5: B) Investigating interactions between multiple variables

Answer6: D) 8

10.8 REFERENCES / SUGGESTED READINGS:

- Best, J.W and J.V.Kahn, Research in Education (7th Ed.) New Delhi: Prentice Hall of India Pvt Ltd.1998
- Sanswal, N.D. (2020). *Research Methodology and Applied Statistics.* (1st ed.). Shipra Publications.
- Kaul, L. (2009). *Methodology of Educational Research.* (4th ed.). Vikas Publishing House Private Limited.
- Shadish WR, Cook TD, Campbell DT. *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. 2nd Edition. Cengage Learning; 2001.
- Campbell DT, Stanley J. *Experimental and Quasi-Experimental Designs for Research*. 1st Edition. Cengage Learning; 1963.

10.9 TERMINAL QUESTIONS:

Q.1 Explain the concept of factorial design in experimental research. Discuss the advantages and challenges of using factorial designs compared to single-factor designs. Provide examples to illustrate your discussion.

Q.2 Compare and contrast between within-subjects and between-subjects factorial designs. Provide examples to illustrate each type of design and discuss their respective strengths and limitations.

UNIT:11

QUALITATIVE AND QUNATITATIVE DATA, DIFFERENCE BETWEEN QUALITATIVE AND QUANTITATIVE DATA

11.1 Introduction

Research is a systematic process of inquiry. There are different approaches of research. In the present unit, we will learn about types of research approaches such as qualitative and quantitative. These approaches serve as fundamental pillars in understanding and interpreting information across various fields. While both types of data offer valuable insights, they differ significantly in their methodologies, applications and interpretations. Qualitative data explores the richness of human experiences whereas quantitative data employs numerical measurements.

11.2 Learning Objectives: After going through this unit, the students will be able to:

1. Explain the meaning of qualitative and quantitative research.

2. Differentiate between quantitative and qualitative data.

3. Differentiate between positivist and anti-positivist research paradigms.

4. Discuss the strategies of data collection in qualitative studies.

5. Explain the process of content analysis, logical and inductive analysis.

6. Discuss the process of analyzing and interpreting interview and observation- based data.

11.3 Quantitative and Qualitative Researches and Type of Data

QUANTITATIVE DATA: Quantitative data refers to a data set that is displayed in the form of numerical values or through the usage of numbers. Quantitative data mainly consists of quantifiable information which can be used by the researchers for various mathematical calculations and statistical analysis in order to make real – life decisions based on these numerical derivations. Quantitative data includes anything that can be counted, measured or that can be assigned a numerical value. Quantitative data is usually analyzed with the help of statistics. Quantitative data can be divided into various forms such as categorical data which consists of categories and discrete data that can be in the form of whole numbers.

QUALITATIVE DATA: Qualitative data is a type of data which represents the information and concepts that are not represented by numbers. Qualitative data are verbal and other symbolic materials. Some examples of qualitative data are the detailed descriptions of observed behaviors of people, events and situations. The responses to open ended questions of questionnaire or a schedule, first - hand information from people about their experiences, ideas, beliefs etc and selected content or excerpts from documents, personal diaries, case histories and letters are some of the other examples of qualitative data. Qualitative data provides in depth and detailed information. Such data is based on inductive approach. The Qualitative data are the product of researcher's direct or close contact with the people, situation and the phenomenon under study in which his experiences and insights play an important part in inquiry and in critical understanding of phenomenon.

SELF CHECK EXERCISE-1

1.Quantitative data consists of:

a. Quantifiable information

b. Qualitative information

c. Both Quantifiable and Qualitative information

d. None of these

2. Qualitative data is based on:

a. Deductive approach

b. Constructive approach

c. Inductive approach

d. All of these

11.4 DIFFERENCE BETWEEN QUANTITATIVE AND QUALITATIVE DATA:

Mixed methods research involves two processes i.e. collecting the data followed by analysis of both qualitative and quantitative. The information which is closed- ended encompasses quantitative data such as the information collected by using behaviour, attitude and performance instruments. The close ended information can also be gathered with the help of checklist which is also close-ended. Many times, the close- ended information is found in various documents like attendance or census records. On the other hand, qualitative data comprises of open-ended information that can be collected by interviewing participants. Usually, open ended questions are asked while conducting interviews. Qualitative data can also be gathered by observing various research sites, by gathering documents from distinct sources that can be public or private. Private sources may include diaries while the public sources may include audio-visual materials, minutes of meetings. In Quantitative research, phenomena are systematically investigated by using mathematical or statistical techniques. Quantitative research employs numerical data in the form of percentage, statistics etc. The data gathered in quantitative research yields unbiased result which can be generalized to the whole or larger population. On the other side, broad questions are asked in qualitative research. In qualitative research, the researcher looks for the themes and in turn describes information in patterns and themes. In social sciences, quantitative research is often looked as opposite of qualitative research, which excludes mathematical models. A distinction is commonly drawn both the types of research, but it is also argued that both the types of research go hand in hand. Qualitative research is usually used in generating new or to refer to phenomena. In contrast, quantitative research consists of scientific methods, such as:

a. models, theories and hypotheses

b. methods and instruments for measuring the data.

c. experimental control and manipulation of variables

d. collecting empirical data

e. modeling and analysis of data

f. evaluation of results

In quantitative research, Statistics is most commonly used branch of mathematics and it is also applicable in physical sciences, such as in statistical mechanics. "Stats" are the numbers that people use to describe things Statistics refer to data set that has numerical value. Statistics simply means the summary of scores. Statistics is a branch of science that can be used to manipulate the data. The data is analyzed to understand the characteristics of dataset. Statistical methods are usually applicable in various fields like social sciences, economics and biology Quantitative research involves collecting the data which is based on the hypothesis. Generally. a large data sample is collected which requires verification, validation and recording before the analysis. Relationships are studied by manipulating factors while controlling the other variables. Measurements are considered as the only way by which observations are expressed in numerical terms for investigating associations or causal relations. Measurements play a major role in quantitative research. Psychometrics is central in the field of quantitative research. Psychometrics is associated with the theories and techniques of gauging psychological and social attributes as well as phenomena. But the researchers should be cautious about the fact that just because a study has numbers doesn't mean it is right; it should always be read with a critical eye. Quantitative research, is the process of inspecting what does the data means to the researcher. Qualitative research is all about exploring and understanding social or cultural experiences in a rich and detailed way. Instead of focusing on numbers and statistics, it aims to paint a full picture using stories, observations, and interviews. Researchers go into real-world settings—whether it's a community, a workplace, or a cultural group—to see things firsthand and gather insights through conversations and documents.

The process of qualitative research usually involves immersing oneself in the environment, asking thoughtful questions, and carefully analyzing patterns and themes that emerge. There are several different ways to approach this kind of research, including:

1. **Case Study** – A deep dive into a single person, group, or event to understand it in detail.
2. **Focus Group** – A discussion with a small group of people to explore their opinions, experiences, or reactions.
3. **Ethnographic Research** – A long-term study of a culture or community by observing and participating in daily life.
4. **Phenomenological Research** – Examining how people personally experience a particular event or phenomenon.
5. **Grounded Theory** – Developing a new theory based on patterns found in collected data.

6. **Historical Research** – Looking at past events and documents to understand their impact on the present and future.

By using these approaches, qualitative researchers can uncover deep, meaningful insights that help us better understand human experiences.

SELF CHECK EXERCISE - 2:

1.Which of the following is not included in qualitative data?

a. Numbers

b. First - hand information

c. Open ended questions.

d. Personal diaries

2. What is the common method of data collection in quantitative research?

a. Interviews

b. Focus groups

11.5 SUMMARY: After going through this lesson, you must have understood about Qualitative data. Qualitative data involves exploring phenomena in – depth, often through the use of methods like observations interviews, and textual analysis. It aims to understand the complexity of human experiences, their perceptions and their behaviours by delving into the meanings, contexts and relationships. On the other hand, quantitative research focuses on numerical data and use of statistical analysis in order to quantify phenomena and to establish patterns or relationships by the employment of structured data collection methods such as experiments, surveys and measurements to gather empirical evidence.

11.6 GLOSSARY:

CHECKLISTS – Checklist as a means of data collection in research means creating a structured list of items or variables that need to be observed, measured or recorded during the data collection process.

INTERVIEWS – It refers to the formal or informal interaction between two or more people, where one person asks questions and the other person provide responses.

OPEN ENDED QUESTIONS- Open ended questions are questions that prompt a free form response from the respondent rather than a simple "yes" or "no" answer. These questions encourage the respondents to provide detailed and descriptive answers.

11.7 ANSWERS TO SELF CHECK EXERCISE:

SELF CHECK EXERCISE -1

Answer 1. A

Answer 2. C

SELF CHECK EXERCISE-2

Answer 1. A

Answer 2. D

11.8 REFERENCES/ SUGGESTIVE READINGS:

Anastasi, A. (1970). Psychological Testing. London: McMillan.

Best, John W. and Kahn, James V. (2004). Research in Education (7 Ed.). New Delhi: Prentice-Hall of India.

Creswell, J. W. (1994). Research designs: Qualitative and quantitative approaches. Thousand Oaks, CA: Sage.

11.9 TERMINAL QUESTIONS:

1.What is meant by quantitative data?

2.What is meant by quantitative data?

3.Write down the points of difference between Quantitative and qualitative data.

UNIT: 12

QUALITATIVE RESEARCH AND TYPES OF QUALITATIVE RESEARCH:

ETHNOGRAPHY, PHENOMENOLOGICAL INQUIRY, GROUNDED THEORY RESEARCH, FOCUS GROUP, OBSERVATIONAL RESEARCH

12.1 INTRODUCTION: Qualitative research is a type of research that explores and that provide deeper insights into the real - world problems. Qualitative research focuses on gaining insight as well as understanding of individual’s perception of circumstances and events. In this lesson, we will learn about various types of qualitative research processes.

12.2 LEARNING OBJECTIVES: After going through this unit, the students will be able to:

a. Explain the meaning of Ethnographic research strategy.

b. Understand the meaning of Phenomenological research.

c. Remember the meaning of Grounded Theory strategy.

d. Differentiate between Focus group and Observational research.

e. Explain the meaning of Observational research.

12.3 The "General" Qualitative Research Process

Qualitative research is a way of studying things by looking at the bigger picture, instead of breaking them down into small pieces. It focuses on understanding people’s experiences, behaviors, and perspectives in their natural environment. Unlike quantitative research, which relies on numbers and statistics, qualitative research gathers information through interviews, observations, and documents.

How Qualitative Research Works

1. What Defines Qualitative Research?

McMillan and Schumacher describe qualitative research as an *inductive* process, meaning researchers allow data and patterns to emerge naturally rather than forcing predetermined ideas onto the study. The goal is to uncover deeper meanings and relationships within the collected data.

2. Core Assumptions of Qualitative Research

Wiersma outlines several key principles that guide qualitative research:

- **Looking at the Whole Picture:** Instead of reducing complex issues into small parts, qualitative researchers try to understand a subject in its entirety.
- **Studying People in Their Natural Environment:** Researchers do not manipulate variables; instead, they observe and record real-life situations.
- **Seeing the World Through the Eyes of Participants:** The study reflects reality as experienced by the people involved, rather than the researcher's own biases.
- **Avoiding Premature Conclusions:** Researchers do not start with fixed conclusions. Instead, they let insights emerge naturally from the data they collect.

---

3. Common Features of Qualitative Research

Most qualitative studies share these characteristics:

A. Flexible Research Design

- Researchers have a general plan, but they adjust it based on what they learn during the study.
- The locations and participants are chosen purposefully based on the study's goals.
- The duration of the research is determined based on the depth of understanding needed.

B. Open-Ended Inquiry

- Researchers do not start with strict hypotheses. Instead, they ask broad questions and refine them as they collect more data.
- The goal is to create a full and accurate description of the subject from the perspective of those involved.

C. Data Collection Methods

- Observations
- Interviews

- Analysis of documents, records, or artifacts
- Oral histories
- Personal notes on thoughts and reflections to minimize bias

D. Data Analysis and Interpretation

- Data is collected and analyzed at the same time (an *iterative* process).
- Information is organized by **coding**, which helps identify key themes:
  - **Setting codes:** Describe the environment or situation being studied.
  - **Perception codes:** Capture how people understand and interpret their experiences.
  - **Process codes:** Track changes and developments over time.

Since real-life situations are complex, these codes often overlap. The coding system is developed as the study progresses to best capture the richness of the data.

---

4. Ensuring the Validity and Trustworthiness of the Study

Since qualitative research doesn't rely on numbers, it must be carefully structured to ensure its findings are credible.

A. Internal Validity (Accuracy of the Study's Design)

- Researchers must provide full descriptions of their study's setting, participants, and data collection methods.
- Two key ways to strengthen internal validity:
  1. **Interpretive Validity:** The study must truly reflect what the participants experience and believe.
  2. **Trustworthiness:** The study must follow systematic procedures to ensure accurate results.

B. Strategies to Increase Trustworthiness

1. **Triangulation:** Using multiple sources of data (e.g., interviews, observations, and documents) to confirm findings.
2. **Member Checking:** Asking participants to review the findings to ensure accuracy.
3. **Chain of Evidence:** Ensuring the study's process is transparent and logical so that others could reach similar conclusions.

Other techniques include:

- **Outlier Analysis:** Examining unexpected results and explaining them.
- **Pattern Matching:** Comparing expected and actual outcomes to strengthen credibility.
- **Long-Term Involvement:** Studying a phenomenon over a long period to reduce short-term influences.
- **Coding Checks:** Having multiple researchers code data independently to ensure consistency.

---

5. Reliability and Generalizability

Unlike quantitative research, which aims to generalize findings to large populations, qualitative research focuses on depth over breadth. However, researchers can strengthen reliability by:

- Using multiple observers and checking for agreement.
- Comparing findings with similar studies to ensure consistency.
- Ensuring that other researchers can understand and build upon the study's insights.

Qualitative research is an in-depth and flexible approach to studying human experiences. It allows researchers to understand the complexities of people's lives and behaviours in their natural settings. By focusing on real-world contexts, keeping an open mind, and following systematic methods, qualitative researchers uncover meaningful insights that may not be visible through numbers alone.

SELF CHECK EXERCISE-1

1.Qualitative Research is done in

a. Artificial settings

b. Natural settings

c. Laboratory settings

d. None of these

2. In Qualitative research, variables are not _________.

12.4 Qualitative Research Types

A. Ethnographic Research Strategy: Ethnographic research, often called *cultural anthropology* or *naturalistic inquiry*, originates from anthropology and focuses on studying and describing the culture of a particular group. This research method is highly flexible and context-dependent, adapting to the environment and people being studied. While ethnography has long been a tool for anthropologists, its use in education is relatively recent but growing.

---

1. Purpose: Capturing Culture and Behavior

Goetz and LeCompte define ethnography as an analytical description of social groups and their shared beliefs, practices, and behaviors. The goal is to recreate the lived experiences of a community, helping readers understand how culture influences behavior. Researchers in this field don’t just observe people—they try to uncover the deeper meanings behind their actions and interactions.

2. The Process: A Deep Dive into Everyday Life

Ethnographic research requires long-term engagement in a natural setting. It's not a quick process—it demands patience and immersion. Researchers start with broad research questions, but these evolve over time as they build trust and rapport with the people they are studying. The questions become more refined as the research progresses, often breaking into smaller, more specific inquiries.

---

3. Data Collection: Gathering Insights from Multiple Angles

To ensure their findings are well-rounded and accurate, ethnographers use three main data collection methods:

a. Participant Observation

Researchers spend time directly engaging with the group they study—sometimes as mere observers and other times as active participants. This can range from watching a classroom setting to actually teaching a class. The biggest challenge? Avoiding bias, since the researcher's own perceptions can influence their observations. To counter this, they carefully record field notes, including personal reflections, to stay as objective as possible.

b. Ethnographic Interviews

Interviews in ethnography are not rigidly structured—they're open-ended and conversational. This allows researchers to truly capture the real-life perspectives, experiences, and cultural insights of participants. The goal is not just to collect answers but to understand the way people see and interpret their own world.

c. Artifact Collection

Artifacts—such as documents, objects, or cultural symbols—offer valuable context. These can be anything from handwritten notes to classroom decorations, helping researchers piece together the broader cultural picture beyond just words and actions.

---

4. Data Analysis: Making Sense of the Findings

Unlike traditional research, where data collection and analysis happen in separate stages, ethnographers analyze data as they collect it. They look for patterns, connections, and themes by comparing new observations with previous ones. Through this ongoing process, researchers eventually develop a deeper understanding of their participants' lived experiences and realities.

---

5. Sharing the Story: Communicating Findings

Ethnographic findings are more than just raw data—they are rich narratives that bring people's experiences to life. The research is presented through:

- Detailed descriptions (vignettes) that illustrate cultural insights
- Direct quotes from participants to highlight personal perspectives
- Interpretative observations that connect individual experiences to broader themes

This approach ensures that the final work is not just factual but immersive, relatable, and deeply insightful.

In short, ethnographic research is about understanding people from their own perspective, immersing oneself in their world, and carefully documenting their stories. It's a method that values depth over speed, making it one of the most powerful tools for exploring human culture and behaviour.

SELF CHECK EXERCISE-2

1.Ethnographic research strategy is originated from

a. Philosophy

b. Phenomenology

c. Sociology

d. Anthropology

2.Which of the following device is not used for data collection in ethnographic research:

a. Surveys

b. Participant observation

c. Ethnographic Interviews

d. Artifact collection

B. Phenomenological Research

Phenomenology is originated from philosophy. Phenomenology is type of descriptive study which explains how individuals experience a phenomenon naturally. Creswell (2009) describes phenomenological research as a strategy of inquiry in which the researcher spots the elements of human experiences as described by the participant. Understanding the livid experiences marks phenomenology as a method, and a procedure that includes study of a small number of subjects.

1. Purpose: Phenomenology is all about diving into people's experiences and perspectives—how they see, feel, and understand a particular event, relationship, program, or emotion. It's about capturing the essence of their lived experiences. Often, the researcher is personally connected to the topic, bringing their own curiosity and passion into the study.

2. Process: Once the researcher chooses a phenomenon to explore, they dive into the experience much like an ethnographer would—immersing themselves in the details, observing, listening, and trying to truly understand the perspectives of those involved.

3. Data Collection: Phenomenologists usually focus on a small group of people—typically between 6 and 10—who are carefully chosen for the study. Sometimes, they might even focus on just one person. To truly understand their experiences, researchers use in-depth, semi-structured interviews, creating a space for open and meaningful conversations. Since the goal is to capture deep personal insights, the researcher and participants work closely together throughout the process.

4. Data Analysis: After conducting interviews, researchers carefully go through the transcripts, looking for key moments—small but meaningful pieces of text that capture important insights. Instead of sorting responses into rigid categories, phenomenologists focus on finding deeper themes and patterns, connecting these meaningful moments to paint a clearer picture of the overall experience.

5. Communicating Findings: Phenomenologists share their findings through rich, detailed stories that bring the experiences to life. They highlight the key themes and patterns that emerged from their analysis, making sense of the data by carefully refining it. Finally, they place these insights within the broader context, showing how they relate to similar experiences of others who have gone through the same phenomenon.

SELF CHECK EXERCISE-3

1.Phenomenology is originated from_______.

2.Phenomenology involves understanding the ______ experiences of an individual.

C. Grounded Theory Research Strategy

Grounded theory is an essential approach of qualitative research. It is originated from sociology. It refers to a strategy of inquiry where researcher derives an abstract, general theory of an action, integration or processes which are grounded in views of participants. This process involves multiple levels of data collection, refinement and interrelationship of categories of the information. The focus of grounded theory approach is on development of bottom up as well as inductive theory that is “grounded” directly in the empirical data.

,

1.Purpose: Through a natural and evolving process of gathering data and analyzing relationships, researchers develop a theory directly from the information they collect. This theory serves as the anticipated result of their investigation.

2.Process: By repeatedly collecting and analyzing data, researchers continuously identify and refine connections between concepts, allowing for the gradual development of a well-grounded theory.

3.Data Collection: Grounded theorists use the same data collection methods as other qualitative researchers. Their approach is iterative, meaning they constantly compare early data with new data to refine, modify, expand, or even discard questions, hypotheses, or conclusions as their understanding evolves.

4.Data Analysis: In grounded theory research, the process of data collection and analysis is iterative, meaning researchers continuously refine their understanding by identifying patterns of interaction among subjects (which may not always be individuals). This is done by logically linking related data categories—groups of similar topics that share a common meaning.

Strauss and Corbin (1990) outlined three key coding strategies used to analyze data in grounded theory:

1. **Open Coding** – This is the first step, where data is broken down into its simplest elements, examined for similarities, and grouped into categories.
2. **Axial Coding** – In this intermediate stage, the data is reorganized by identifying logical connections between different categories.
3. **Selective Coding** – At this final stage, researchers determine the "core" category and establish relationships between it and secondary categories. These connections are then validated, and any categories requiring further development are refined.

When two or more related categories or concepts are linked, they form the foundation of a theory, known as a *proposition.* Since a well-developed theory requires multiple interconnected concepts, grounded theories are considered to be *conceptually dense.*

5.Communicating Findings: According to Strauss and Corbin (1990), achieving *integration* involves presenting the core category (or concept) as a central storyline. This storyline serves as a guiding framework through which all other categories are analyzed. The relationships between categories are then compared against the data to confirm, refine, or eliminate them as needed.

SELF CHECK EXERCISE- 4

1.The focus of grounded theory approach is on the development of bottom up as well as _______ theory.

2.Which of the following is/are data coding strategies used in grounded theory research?

a. Open coding

b. Axial coding

c. Selective coding

d. All of these

D. Focus Groups: Focus groups bring together a small group of people—usually no more than a dozen—to discuss a specific topic under the guidance of a moderator. These discussions allow participants to share their perspectives, knowledge, and opinions within a set timeframe. Focus groups are commonly used in research, marketing, corporate, and political settings to gather insights.

Key Benefits of Focus Groups:

1. Efficient and Cost-Effective – They quickly and affordably identify the core issues related to a topic.
2. Observation of Reactions – Researchers can directly observe how participants respond to a research question or product in an open discussion.
3. Exploration of New Insights – Unexpected responses or insights can emerge, which can then be further explored in subsequent focus groups.
4. Authentic Responses with Emotional Depth – Participants express themselves in their own words, and their emotional intensity can be assessed, providing deeper qualitative insights.

SELF CHECK EXERCISE- 5

1.Focus group are panels, facilitated by a _______.

2.Focus groups are often sponsored by _______, marketing, corporate or political organizations

E. Observational Research: Observational research is useful to obtain background information for planning major investigations, however, since they have a narrow focus, they do not allow the researchers to generalize their findings for the whole population. Moreover, the results obtained are subjective rather than objective. In observational research, the steps are the same as the ones for other's descriptive research. There are certain issues that the researcher should be careful about in conducting the research of this type. The following are some suggestions given by Gay (1987):

1.The behavior to be observed should be defined in specific and clear terms.

2.Observations must be structured so that all observers will have the same criteria. For instance, Flander's interaction analysis categories (Flander, 1960) are excellent in guiding the observer.

3.Observation times may be randomly selected so that behavior at different times of the day and the week are reflected

4.It is better to record the observations as the behavior occurs by using some coding system, or a checklist

5.Recording the situations on a video tape helps the researcher to go back and observe the same situations with a more critical eye and with less bias.

6.Subjects to be observed usually feel uncomfortable, and thus, they may not demonstrate their typical behavior. For this reason, observers should be very sensitive to this issue, should make some acquaintance with the subjects prior to the observation sessions.

In non - participant observation, researcher does not participate in the observational situation. "Non-participation observation includes naturalistic observation, simulation observation, case studies, and content analysis" (Gay, 1987, p. 206). The observation is made in a naturalistic setting, or by means of simulation, where a situation is created and the subjects are asked to engage themselves in the simulated activity. In the case study, an individual, group, or institution is investigated in depth to find out the factors, and the correlation among the factors, affecting the current of the subject under study. Content analysis is done to provide a systematic and quantitative description of the composition of an object or sets of objects to decide whether they meet the criteria set up for a specific purpose. For example, in choosing teaching materials, textbooks are analyzed from different perspectives such as the readability level, vocabulary frequency etc. for students at a certain grade. The need of the students determines the criteria and the content analysis is done accordingly.

In participant observation, the researcher is directly involved in the situations to be observed. This type of observation may be conducted to test hypotheses, to derive hypotheses, or both. If the aim is to test the formulated hypotheses, then the observation needs to be more structured and guided so that the data collected will be directly involved with the issue of interest. Thus, an attempt is made not to collect irrelevant data.

Perspective	Disciplinary Roots	Central Questions
1. Ethnography	Anthropology	What is the culture of this group of people?
2. Phenomenology	Philosophy	What is the structure and essence of experience of this phenomenon for these people?
3. Ethnomethodology	Sociology	How, do people make sense of their everyday activities so as to behave in socially acceptable ways?

SELF CHECK EXERCISE- 6:

1.The results obtained by observational research are:

a. Objective

b. Theoretical

c. Subjective

d. All of these

2. Which of the following is a part of observational research?

a. Participant Observation

b. Non participant Observation

c. Both a and b

d. None of these

12.5 SUMMARY:

After going through this lesson, you must have understood about Qualitative research methods which are the approaches used to gather non numerical data, focusing on understanding human behavior, experiences, and perceptions. Some common qualitative methods include interviews, focus groups, observation, ethnography, case studies, grounded theory, mixed methods. Each method offers unique advantages.

12.6 GLOSSARY:

Validity – Validity generally refers to the extent to which a concept, conclusion or measurement is well founded and accurately represents the real - world situation.

Fieldwork – refers to the practical work conducted outside of a controlled laboratory or academic setting.

Moderator – A moderator facilitates, reviews, and guides a discussion or debate and related interactions to ensure all shared content is appropriate and follows community rules.

12.7 ANSWERS TO SELF CHECK EXERCISES:

SELF CHECK EXERCISE-1

Answer 1. B

Answer 2. Manipulated

SELF CHECK EXERCISE-2

Answer 1. D

Answer 2. A

SELF CHECK EXERCISE-3

Answer 1. Philosophy

Answer 2. Livid

SELF CHECK EXERCISE-4

Answer 1. Inductive

Answer 2. D

SELF CHECK EXERCISE-5

Answer 1. Moderator

Answer 2. Research

SELF CHECK EXERCISE-6

Answer 1. C

Answer 2. C

12.8 REFERENCES/ SUGGESTIVE READINGS:

Ebel, Robert L.(1966). Measuring Educational Achievement. New Delhi: Prentice Hall of India Pvt. Ltd. pp. 481

Gall, M. D., Borg, W. R., & Gall, J. P. (1996). Educational research: An introduction. White Plains, NY: Longman

12.9 TERMINAL QUESTIONS:

1. Write briefly about qualitative research and various forms of qualitative research.
2. Explain ethnographic research and various processes involved in ethnographic research.
3. What do you understand by Focus Group? Describe briefly.
4. Explain observational research with its types.

UNIT: 13

RESEARCH PARADIGMS (POSITIVISM AND ANTI – POSITIVISM) AND MIXED METHODS RESEARCH

13.1 INTRODUCTION:

In this lesson, we will learn about research paradigms which will throw loght on positivism (Quantitative Research Paradigm) and Anti Positivism (Qualitative Research Paradigm). In addition to this, we will study about mixed methods research which involves a blend of quantitative and qualitative approaches of research.

13.2 LEARNING OBJECTIVES: After going through this unit, the students will be able to:

a. Understand the meaning of research paradigms.

b. Explain the concepts of positivism and anti – positivism.

c. To learn in detail about mixed methods research.

13.3 Research Paradigms

The term *paradigm* refers to a loosely connected set of assumptions, concepts, and propositions that shape the way research is approached and understood (Bogdan & Biklen, 1998). The selection of a paradigm establishes the foundation for the study by defining its purpose, motivation, and anticipated outcomes. Without first identifying a paradigm, researchers lack a framework for making informed decisions about methodology, methods, literature review, or research design. While scholarly discussions present differing views on the number of research paradigms, the following provides a brief overview of the major paradigms commonly used in the social sciences and humanities.

1. Positivism or Quantitative Research Paradigm

Positivism, often called the *scientific method* or *scientific research*, is rooted in rationalist and empiricist philosophy, drawing influence from thinkers such as Aristotle, Francis Bacon, John Locke, August Comte, and Immanuel Kant. It is based on a deterministic perspective, where causes are believed to likely influence and shape outcomes or effects. Positivism is a philosophical system which relies on mathematical proof or logic and it rejects theism and metaphysics. Positivism also implies independent and self - governing existence of truth. Positivism is based on reason and measurement. Positivism also emphasizes on reason and measurement. Positivism also emphasizes on scientific methods and empirical evidences to understand the world. Positivism relies on philosophy that for acquiring knowledge, one should rely on experimentation and observation and also the phenomenon should be studied objectively by avoiding subjective biases. Positivism has gained influence in various fields like psychology, sociology, political science etc, Positivism rejects abstract theories and instead focuses on observable and concrete phenomenon. Positivism is based on the assumption that "the social world can be studied in the same way as the physical world, that there is a method for studying the social world that is value free, and that explanations of a causal nature can be provided" (Mertens, 2005).

2. Anti-Positivism or Qualitative Research Paradigm

Anti positivism is also known as non – positivism or post positivism and it emerged out of the criticism and limitations of positivism. Anti positivists threw light on subjective experiences and interpretations for understanding the social world. The anti-positivist or non-positivist paradigm emerged from Edmund Husserl's phenomenology and the interpretive tradition of hermeneutics developed by German philosophers. This perspective focuses on understanding human experiences, emphasizing that reality is socially constructed. Researchers who follow this approach are often referred to as *interpretivists* or *constructivists*.

According to Creswell (2003), interpretivist and constructivist researchers prioritize the perspectives of participants in their studies and acknowledge how their own backgrounds and experiences influence the research process. Unlike positivists, constructivists do not start with a predefined theory; instead, they develop theories or patterns of meaning inductively as the research unfolds.

SELF CHECK EXERCISE-1

1.What is another name of Positivism?

a. Philosophical Research

b. Constructivism

c. Scientific Method

d. None of these

2.The anti – positivism paradigm grew out of the philosophy of:

a. John Locke

b. Sigmund Freud

c. Jean Piaget

d. Edmund Husserl

13.4 Mixed Methods Research

Mixed methods research is a research design that integrates both philosophical assumptions and specific methods of inquiry. As a methodology, it is guided by philosophical beliefs that shape data collection, analysis, and the blending of qualitative and quantitative approaches throughout various stages of the research process. As a method, it focuses on gathering, analyzing, and combining both numerical (quantitative) and descriptive (qualitative) data within a single study or a series of studies.

The core idea behind mixed methods research is that combining qualitative and quantitative approaches leads to a deeper and more comprehensive understanding of research problems than relying on either method alone. This research paradigm acknowledges the value of both approaches, aiming not to replace them but rather to leverage their strengths while minimizing their limitations.

If we imagine research approaches as a continuum, with qualitative research on one end and quantitative research on the other, mixed methods research occupies the middle ground. Alternatively, if viewed categorically, it represents a third paradigm, positioned alongside qualitative and quantitative research. It serves as a bridge between the two, helping to resolve the longstanding divide between them.

Integration of Qualitative and Quantitative Methods

A key question in mixed methods research is whether qualitative and quantitative methods can be effectively combined and, if so, how this integration should take place. According to Mertens (2005), a researcher’s theoretical orientation influences every decision made throughout the research process, including the choice of methods. As research methodologies have evolved, mixed methods approaches have become more sophisticated, adaptable, and widely accepted.

Mixed methods research is formally defined as a research approach in which qualitative and quantitative techniques, methods, perspectives, or language are blended within a single study. Philosophically, it is considered the "third wave" or *third research movement*, offering a practical and logical alternative that moves beyond the rigid divide between paradigms. Rather than limiting researchers to one approach, mixed methods research legitimizes the use of multiple techniques to answer research questions more effectively. It is an open and creative approach that expands research possibilities rather than restricting them.

A mixed methods approach involves collecting both numerical data (e.g., through surveys or experiments) and textual data (e.g., through interviews or observations), ensuring that the final dataset includes both quantitative and qualitative information. Gorard (2004) highlights that mixed methods research is crucial for enhancing social sciences, including education research, as the use of multiple methods strengthens research outcomes. However, while mixed methods research enhances effectiveness, it is not a universal solution to all methodological challenges. Instead, it should be applied in a way that thoughtfully integrates the insights from both qualitative and quantitative approaches into a meaningful and practical solution.

Principles and Justification for Mixed Methods Research

For mixed methods research to be effective, researchers must first understand the key characteristics, strengths, and weaknesses of both qualitative and quantitative approaches. This understanding enables them to strategically combine research strategies and apply what Johnson and Turner (2003) call the *fundamental principle of mixed research.* According to this principle, researchers should collect multiple types of data using diverse strategies, approaches, and methods in a way that enhances the strengths of each while minimizing their respective weaknesses.

The effectiveness of this principle is a strong justification for mixed methods research, as the integration of different approaches results in a more robust and comprehensive study compared to single-method research. For instance, incorporating qualitative interviews into an experimental study can serve as a **manipulation check**, allowing researchers to explore participants' perspectives and meanings more deeply while addressing potential shortcomings of the experimental method.

The Expanding Potential of Mixed Methods Research

One of the most exciting aspects of mixed methods research is its potential for innovation and future exploration. By combining the strengths of both qualitative and quantitative methods, researchers can tackle complex research questions with greater depth and flexibility. The central premise of this approach is that integrating both perspectives leads to a more thorough and insightful understanding of research problems than either method alone could provide.

SELF CHECK EXERCISE-2

1.Mixed methods research is a mixture of:

a. Constructivist and Phenomenological approaches

b. Qualitative and Quantitative Approaches

c. Descriptive and Experimental Research

d. All of these

2.Mixed method research is the ______ research paradigm

a. First

b. Second

c. Third

d. Fourth

13.5 SUMMARY: In this lesson, we explored research paradigms and mixed methods research. A paradigm is a broad framework consisting of interconnected assumptions, concepts, and propositions that guide thinking and research. On the other hand, mixed methods research refers to a research approach in which qualitative and quantitative techniques, methods, perspectives, or language are integrated within a single study.

13.6 GLOSSARY:

Objectivity: Objectivity refers to the quality of being unbiased partial and free from personal opinions or feelings while analyzing or evaluating something**.**

Subjectivity: Subjectivity refers to the quality of being based on personal feelings, opinions, interpretations or experiences rather than on external or objective facts.

13.7 ANSWERS TO SELF CHECK EXERCISES

SELF CHECK EXERCISE-1

Answer 1. C

Answer 2. D

SELF CHECK EXERCISE-2

Answer 1. B

Answer 2. C

13.8 REFERENCES/SUGGESTIVE READINGS

Garrett, H. E. and Woodsworth, R. S. (1966). Statistics in Psychology and Education. Bombay Vakils, Feffer and Simons Pvt. Ltd.

Guilford, J. P. (1973). Fundamental Statistics in Psychology and Education (3rd Ed.). New York: McGraw Hill Book Co.

13.9TERMINAL QUESTIONS:

1.What do you mean by mixed method research? Explain briefly.

2.What do you understand by research paradigm?

3.What is the meaning of Positivism and Anti positivism.

UNIT: 14

QUALITATIVE DATA ANALYSIS, NATURE OF QUALITATIVE DATA ANALYSIS, RESEARCH DESIGN IN QUALITATIVE STUDIES, DATA COLLECTION TECHNIQUES IN QUALITATIVE RESEARCHES

14.1 INTRODUCTION: Qualitative data analysis involves examining non numerical data such as images, texts or videos in order to uncover patterns, themes and meanings. Qualitative data analysis is popularly used in social sciences, humanities and other fields in order to understand the phenomenon in depth.

14.2 LEARNING OBJECTIVES: After going through this unit, the students will be able to:

a. Gain an in depth understanding of qualitative data analysis.

b. Learn about the nature of qualitative data analysis.

c. Understand the research design in qualitative studies.

d. Study about various data collection techniques in qualitative research.

14.3 Qualitative Data Analysis: The Concept

Bogdan and Biklen (1982) define qualitative data analysis as "working with data, organizing it, breaking it into manageable units, synthesizing it, searching for patterns, discovering what is important and what is to be learned, and deciding what the researcher will tell others". Qualitative researchers tend to use inductive analysis of data, meaning that the critical themes emerge out of data (Patton, 1990). Qualitative mode of analysis of data provides ways of discerning, examining, comparing and contrasting, and interpreting meaningful patterns or themes. Meaningfulness is determined by particular goals and objectives of study at hand: the same data can be analyzed and synthesized from multiple angles depending on the particular research or evaluation questions being addressed. The theoretical lens from which researcher approaches the phenomenon, strategies that a researcher uses to collect or construct data, and the understandings that researcher has about what might count as relevant or important data in answering research question are all analytic processes that influence the data. Analysis also occurs as an explicit step in conceptually interpreting the data set as a whole, using specific analytic strategies to transform the raw data into a new and coherent depiction of the thing being studied. Although, there are many qualitative data analysis computer programs available today, these are essentially aids to sorting and organizing sets of qualitative data, and none are capable of the intellectual and conceptualizing processes required to transform data into meaningful findings. Qualitative data analysis requires some creativity, for the challenge is to place the raw data into logical, meaningful categories; to examine them in a holistic fashion; and to find a way to communicate this interpretation to others. In qualitative research studies, analysis frequently takes place at the same time as data collection. Many consider it a mistake to go on accumulating data without examining it from time to time to see if any major themes or patterns are emerging. If there are, these will direct future data gathering in the process known as 'progressive focusing'. If this is not done, the researcher risks becoming swamped in data that become increasingly more difficult to analyze. In order to make sense of the data, much may have to be discard - which means a lot of time and work might have been wasted, as well as a lower quality product. One of the main problems in qualitative work is having too much data rather than not enough.

NATURE OF QUALITATIVE DATA ANALYSIS

Qualitative analysis is all about working with words rather than numbers, and unlike statistical analysis, it doesn't follow a strict set of universal rules. This flexibility is both its strength and the reason it's often misunderstood. Some researchers criticize it for lacking structure, assuming that because there aren't fixed steps, it must be random or purely subjective. But that's not true—good qualitative analysis is actually very systematic and carefully thought out. While it may not be "objective" in the strict scientific sense, it is still transparent and replicable, meaning other researchers can follow the reasoning behind the conclusions.

Another key difference is timing. In quantitative research, there are clear steps: first, you design the study, then collect the data, then analyze it. But in qualitative research, data collection and analysis happen at the same time. From the moment researchers start gathering information, they're already making sense of it. The process is cyclical rather than linear, meaning researchers keep going back to the data, refining their understanding, and uncovering new insights as they go.

At its core, qualitative analysis is about making sense of collected information to answer a research question. The process often unfolds in stages: first, researchers organize and examine the data, then they start identifying patterns and forming categories, and sometimes, they take it a step further by developing theories based on their findings. Throughout this process, they ask themselves key questions:

- What themes and patterns emerge? Do they help answer the research question?

- Are there any outliers or unexpected responses? What might explain them?
- Are there any particularly interesting stories in the data that add depth to the research?
- Do the findings suggest the need for more data or adjustments to the research questions?
- How do the patterns compare to other similar studies? If there are differences, what might explain them?

In short, qualitative research may look different from quantitative research, but it's just as rigorous—just in a different way.

Research Design in Qualitative Studies:

Eisner (1991) points out that there aren't many strict guidelines for conducting qualitative research. This is because, unlike standardized methods, qualitative research relies more on the researcher's skills, intuition, and adaptability. However, Lincoln and Guba (1985) do offer a structured approach to designing naturalistic inquiry, which involves the following steps:

1. **Define the Study's Focus:** Start by setting clear boundaries for what the research will and won't include. These boundaries help guide the study but can be adjusted as new insights emerge.
2. **Match the Research Approach to the Study's Goals:** Ensure that qualitative methods align with what the study aims to accomplish. The researcher should check whether qualitative inquiry is the best fit for answering their questions.
3. **Decide Where and From Whom to Gather Data:** Identify the sources of information—this could be people, documents, or observations.
4. **Outline the Different Phases of the Study:** The research process often unfolds in stages. The first phase might involve broad, open-ended exploration, while later phases focus on more specific details.

5. **Consider Additional Tools Beyond the Researcher's Observations:** While the researcher is the primary tool for interpreting data, other instruments—such as recording devices, surveys, or software—might also be helpful.
6. **Plan How to Collect and Record Data:** This step involves determining the level of detail needed, how interviews or observations will be documented, and how accurately the data will be captured.
7. **Decide on Data Analysis Methods:** Outline the approach for making sense of the collected information—whether through thematic analysis, coding, or other qualitative techniques.
8. **Organize the Practical Aspects of Data Collection:** Plan logistics such as scheduling interviews, managing resources, and staying within budget.
9. **Ensure the Study's Trustworthiness:** Establish methods for verifying the accuracy and reliability of findings, such as triangulation, member checks, or peer reviews.

In essence, while qualitative research isn't as rigidly structured as quantitative studies, it still follows a thoughtful and organized process. Researchers must remain flexible and continuously refine their approach as they gather and analyze data.

SELF CHECK ExERCISE-1

1.Analysis of qualitative data begins almost immediately with:

a. Primary analysis

b. Secondary analysis

c. Tertiary analysis

d. All of these

2.Qualitative data analysis is:

a. Systematic

b. Undisciplined

c. Disciplined

d. Both a and c

14.4 Data Collection Techniques in Qualitative Researches

Marshall and Rossman (1989) highlight two key methods for collecting qualitative data: observation and interviewing. While there are other techniques, most qualitative research heavily relies on these two approaches—either separately or in combination—to gather meaningful insights.

1. Observations in Qualitative Research

When researchers use observation, they carefully document behaviors, events, and the surrounding context in great detail. This is different from quantitative research, where observation is often focused on counting how often something happens or measuring how long it lasts. While qualitative observations can later be converted into numerical data for analysis, the reverse—turning numerical data into rich descriptions—is not possible.

Patton's Five Dimensions of Observation

According to Patton (1990), observations can vary along five key dimensions:

1. The Role of the Observer – The researcher can be a full participant (e.g., a teacher observing their own class) or a detached outsider (e.g., a research assistant quietly sitting at the back of a room).
2. Awareness of Those Being Observed – Observations can be:
    - Covert (hidden, such as watching from behind a one-way mirror).

    - Fully open (everyone knows they are being observed).
    - Partially disclosed (only some people are aware, such as a teacher knowing but students not).
3. Level of Explanation Given – People being observed may:
    - Receive a full explanation of the research.
    - Get only partial details.
    - Receive no explanation at all.
    - Be given a false explanation.
4. Duration of Observation – Observations can last a short time or extend over months or even years, depending on the research goals.
5. Scope of Focus – Some studies have a broad focus (e.g., studying an entire school's curriculum), while others are more specific (e.g., how students respond to a substitute math teacher).

2. What Can Be Observed?

Researchers can observe many aspects of a setting, including:

- The environment (e.g., classroom layout, resources available).
- Social interactions (e.g., how students interact with teachers and peers).
- Physical activities (e.g., body language and gestures).
- Planned vs. unplanned events (e.g., scheduled lessons versus spontaneous discussions).
- Subtle clues (e.g., dusty equipment suggesting lack of use).

Interestingly, researchers must also pay attention to what does not happen but should have. For example, in a past quantitative study, researchers tracked the percentage of time students spent "on task" (actively working on an assigned activity). They found that over 40% of class time had no assigned tasks, which explained why students were engaged for less than half the period. In this case, the absence of assigned work was the most revealing finding.

In short, observation in qualitative research is a flexible and powerful tool that allows researchers to capture both what happens and what doesn't, leading to deeper insights about human behaviour and social settings.

SELF CHECK EXERCISE-2

1.A teacher observing in his or her own class would be a ______ observer.

2.Observations can be of the:

a. Physical environment

b. Social interactions

c. Non - verbal communication

d. All of these

3. A person who is engaged in the process of observation is known as:

a. Interviewer

b. Interviewee

c. Observer

d. All of these

B. Interviews

The main goal of an interview is to understand what someone else thinks, knows, or feels. As Patton explains, open-ended interviews should not be about influencing or shaping the interviewee's thoughts. Instead, they should focus on uncovering the person's genuine perspective.

One major challenge in interviews is bias. If interviewees sense what the researcher is hoping to hear, they might tailor their responses to fit those expectations rather than sharing their true thoughts. To avoid this, interviewers need to make it clear that they are open to all perspectives and do not have a fixed agenda.

Types of Interviews

Interviews can range from:

- Informal & Open-Ended: A casual conversation where the interviewer explores topics as they naturally arise.
- Structured & Formal: A standardized format where each interviewee is asked the same pre-written questions.

What Interviews Help Discover

Interviews are used to gather information about:

- Personal experiences and knowledge (e.g., what someone has been through).
- Opinions, beliefs, and emotions (e.g., what someone thinks or feels about a topic).
- Demographic details (e.g., age, background, profession).
- Past, present, and future perspectives (e.g., past experiences, current situations, or future expectations).

Recording Interviews for Accuracy

The best way to capture interview data is to audio-record the conversation, as long as the interviewee agrees. If recording isn’t possible, the interviewer should take detailed notes and expand on them immediately after the interview while everything is still fresh in their mind.

In short, interviews are a powerful tool in qualitative research—but they must be conducted carefully to ensure honest, unbiased, and insightful responses.

Analysis of qualitative data begins almost immediately, with 'primary analysis'. As interview transcripts are made, or field notes of observation compiled, or documents assembled, the researcher continuously examines the data, perhaps highlighting certain points in the text or writing comments in the margins. These might identify what seem to be important points, and note contradictions and inconsistencies, any common themes that seem to be emerging, references to related literature, comparisons and contrasts with other data and so on.. Many of these first attempts at speculative analysis will probably be discarded later, but some ideas will no doubt take shape as further data collection and analysis proceed. Much of this early activity may appear chaotic and uncoordinated, but this chaos is a prolific seedbed for ideas. ualitative analysis focuses on words and meanings rather than numbers, following fewer standardized rules than statistical methods. This flexibility allows for deeper exploration but also leads to misconceptions. Some critics argue that the lack of strict procedures makes qualitative research unstructured, undisciplined, or overly subjective. However, while it differs significantly from quantitative analysis in both method and purpose, good qualitative research is highly systematic and rigorously conducted.

Although qualitative analysis may not be "objective" in the strictest scientific sense, it can still be replicable—meaning other researchers can follow the analyst’s thought process and assumptions.

How Qualitative Analysis Works

One major distinction between qualitative and quantitative research is timing. In quantitative studies, research follows clear steps:

1. Designing the study
2. Collecting data
3. Processing data
4. Analyzing results

In contrast, qualitative research does not separate data collection and analysis into distinct phases. Instead, analysis begins immediately as the first pieces of data are gathered. Researchers continually revisit and refine their interpretations, uncovering new connections and deeper meanings along the way. This iterative process—where insights develop over multiple rounds of data review—defines qualitative research.

At its core, qualitative analysis involves making sense of collected information to answer research questions. The data are often more complex and embedded within context, making them harder to reduce into simple numbers. The research process typically unfolds in three possible stages:

1. Initial Data Examination – Identifying how the collected information addresses the research question.
2. Category & Concept Formation – Organizing findings into meaningful themes.
3. Theory Development (if applicable) – Using insights to build broader explanations.

Key Questions in Qualitative Analysis

Throughout the process, researchers continually ask:

- What patterns and themes emerge? How do they relate to the research question?
- Are there exceptions or unusual responses? What might explain them?
- Are there compelling narratives within the data? How do they contribute to understanding the topic?
- Does the data suggest gaps or new questions? Should additional information be gathered?
- Do the findings align with other qualitative studies? If not, what could explain the differences?

In summary, qualitative research is not random or unstructured—it follows a logical, evolving process that allows for deeper understanding. While it may not have rigid formulas, it remains a disciplined and systematic approach to exploring human experiences.

SELF CHECK EXERCISE-3

1.A person who is being interviewed is known as ____.

2.The purpose of interviewing someone is to find out:

a. What is in or on someone else's mind.

b. To quantify variables

c. Both a and b

d. None of these

14.5 SUMMARY

In this lesson we have learnt about the concept of Qualitative data analysis, its nature, research designs in Qualitative studies and various data collection techniques in Qualitative Researches such as Observation and Interviews.

14.6 GLOSSARY:

Analysis – Analysis refers to the process of examining something methodically and in detail to understand its nature, structure and components.

Interviewee - An interviewee is an individual who is being interviewed, typically in a formal or structured setting.

14.7 ANSWERS TO SELF CHECK EXERCISES

SELF CHECK EXERCISE-1:

Answer 1. A

Answer 2. D

SELF CHECK EXERCISE -2

Answer 1. Participant

Answer 2. D

Answer 3. C

SELF CHECK EXERCISE-3

Answer 1. Interviewee

Answer 2. A

14.8REFERENCES/SUGGESTIVE READINGS:

Koul, Lokesh (1988). Methodology of Educational Research. New Delhi. Vikas Publishing House Pvt. Ltd.

McMillan, J. H. & Schumacher, S. (1993). Research in education: A conceptual understanding. New York: Harper Collins.

14.9TERMINAL QUESTIONS:

1.Write briefly about the concept of Qualitative Data Analysis.

2.Write about the nature of Qualitative Data Analysis.

3.What are the data collection techniques in Qualitative Researches. Explain in detail.

UNIT: 15

PROCESSES IN QUALITATIVE DATA ANALYSIS (DOCUMENT OR CONTENT ANALYSIS, INDUCTIVE ANALYSIS, LOGICAL ANALYSIS)

15.1 INTRODUCTION: In this process we will study in detail about various processes involved in qualitative data analysis which includes document or content analysis, inductive analysis and logical analysis. Qualitative data analysis make use of non - numerical data such as images, texts or observations.

15.2 LEARNING OBJECTIVES: After going through this unit, the students will be able to:

a. Understand the meaning of Document analysis.

b. Explain the concept of Inductive analysis.

c. Explain the concept of Logical analysis.

d. Differentiate between Inductive analysis and Logical analysis.

15.3 Processes in Qualitative Data Analysis

Processes in Qualitative Data Analysis are designed to uncover themes, patterns or insights within data. These processes play an important role in interpreting, organizing as well as synthesizing qualitative data in order to derive useful insights and meaningful conclusions.

The processes in qualitative data analysis are discussed as follows.

1. **Document or Content Analysis:** Documents play a crucial role in many types of research, offering valuable insights much like historical studies. However, there is one key difference: while historians focus solely on past events, document analysis in other research areas may examine both past and present issues. This type of analysis helps researchers understand the current state of a phenomenon or track how it has evolved over time. It is especially useful for expanding knowledge and explaining social events, including those in education and other fields.

A wide range of materials can serve as data in document analysis, including:

Official records and reports

Letters, autobiographies, and diaries

Student work, such as essays and compositions

Books, journals, and newspapers

Syllabi, court decisions, and policy documents

Visual materials like photos, films, and cartoons

Ensuring Document Trustworthiness

One important thing to remember is that not everything in print is reliable. Just because a document exists doesn't mean its information is accurate or unbiased. That's why researchers must carefully evaluate their sources, just as historians do. This means checking:

1.Authenticity – Is the document real and legitimate?

2.Validity – Is the information accurate, unbiased, and trustworthy?

Ultimately, researchers have a responsibility to verify the credibility of all documentary sources before using them as evidence in their studies.

SELF CHECK EXERCISE-1

1.Which of the following is not used as a source of data in documentary analysis?

a. Themes

b. Books

c. Syllabi

d. Interviews

2.Document Analysis is also known as:

a. Content Analysis

b. Logical Analysis

c. Inductive Analysis

d. All of these

2. Inductive analysis

Inductive analysis is a research approach where patterns, themes, and categories naturally emerge from the data rather than being imposed beforehand. Instead of forcing information into predefined structures, researchers observe variations and allow insights to develop organically.

According to Patton, when evaluators use inductive analysis, they pay close attention to how programs work, how processes unfold, and how participants react to and are influenced by a program.

There are two main ways to represent patterns in the data:

1. Using existing categories – Researchers can organize findings based on terms and categories already used by the people involved in the study.
2. Creating new categories – Sometimes, researchers notice patterns that participants themselves have not named. In such cases, new terms and labels are developed to describe these emerging insights.

In short, inductive analysis is about letting the data speak for itself rather than fitting it into predetermined boxes. This method helps researchers uncover unexpected patterns and deeper meanings in their studies.

SELF CHECK EXERCISE-2

1.In Inductive analysis, the researcher looks for______ variables in the data.

2.Inductive analysis means that _______, themes and categories of analysis emerge out of the data.

3. Logical Analysis

When analyzing data, researchers often look for patterns. Individual analysis helps identify these patterns by categorizing them based on either participants' own perspectives or the evaluator's interpretations. One way to deepen this analysis is by cross-classifying different dimensions, which can reveal new insights that may not have been obvious during the initial inductive analysis.

Logical analysis takes this a step further by combining different categories (or typologies) to form new classifications. According to Patton, this process involves:

Crossing one set of categories with another to create a matrix of possible patterns.

Comparing this logical structure with the actual data, adjusting as necessary.

Refining the categories based on what the data truly reflects.

This back-and-forth process helps researchers discover relationships and new ways of organizing information. However, not all parts of the matrix will always be represented in the real data—some categories may remain purely theoretical.

While logical analysis is a powerful tool, researchers must use it carefully. They should:

a. Avoid forcing data into artificial categories that don't actually exist.
b. Be aware of overlooked behaviors or activities that could affect the analysis.
c. Remain open to the possibility that certain logical categories may exist in theory but not in practice.

In short, logical analysis is a structured way to explore and refine data patterns, but it requires thoughtful interpretation and sensitivity to what the data truly reveals.

SELF CHECK EXERCISE-3

1.Which of the following is an exercise in logic?

a. Manipulation of data

b. Manipulation of variable

c. Creating cross – classification matrices

d. None of these

Qualitative researchers have identified common processes for analyzing data, and one widely used framework comes from Miles and Huberman (1994). They describe three key phases of qualitative data analysis: data reduction, data display, and conclusion drawing & verification.

---

1. Data Reduction: Organizing and Simplifying the Information

The first challenge in qualitative research is dealing with the huge amount of raw data collected through interviews, observations, and documents. Researchers need to organize, focus, and refine this data to make it manageable and meaningful.

Miles and Huberman call this process "data reduction," which involves:

- Selecting the most relevant pieces of data
- Simplifying and summarizing complex information
- Abstracting key themes from raw notes and transcripts

Many beginners mistakenly believe that data should "speak for itself," but qualitative research requires active decision-making about which data to highlight or minimize. This process usually combines both deductive analysis (using pre-set categories) and inductive analysis (allowing new themes to emerge from the data).

---

2. Data Display: Organizing Data Visually for Deeper Insights

Once the data is reduced, the next step is data display, where information is presented in a way that makes patterns and connections easier to see. Instead of leaving everything in long text form, researchers use visual tools like:

- Diagrams, charts, and matrices to structure key insights
- Flow charts to map decision-making processes or event sequences

This step goes beyond simple organization—it helps researchers see new relationships and refine their findings. At this stage, they may identify higher-level themes that weren't obvious during data reduction.

For example, in a study comparing multiple schools, researchers might create a flow chart for one school, then compare it with others. This allows them to either:

1. Modify the original flow chart based on new data.
2. Create independent flow charts for each school.
3. Develop a single chart for common trends and separate charts for unique cases.

---

3. Conclusion Drawing & Verification: Making Sense of the Findings

The final stage is interpreting the data and checking conclusions for accuracy. At this point, researchers ask:

- What do these findings mean?
- How do they answer the research questions?
- Are they consistent, reliable, and defensible?

Unlike in quantitative research, where validity refers to how well a measure captures a concept, in qualitative research, validity means credibility—do the conclusions make sense and hold up to scrutiny?

To ensure trustworthiness, researchers:

- Go back to the data repeatedly to verify their conclusions.

- Consider multiple perspectives rather than forcing one "correct" answer.
- Analyze contradictions and unexpected findings.

One of the strengths of qualitative research is that it embraces outliers and exceptions rather than ignoring them. If something unexpected appears in the data, rather than dismissing it, researchers take it as an opportunity for deeper investigation.

Miles and Huberman refer to this as "following up surprises"—sometimes, a single unusual case can reveal new insights that reshape the entire analysis.

Practical Tips for Conducting Qualitative Analysis

1. Keep detailed notes: Always document thoughts, patterns, and reflections throughout the research process.
2. Work collaboratively: Having more than one analyst can improve reliability by offering multiple viewpoints and preventing bias. If a full team isn't possible, a second reviewer can still help by analyzing a portion of the data.
3. Plan for extra time and effort: Qualitative research takes longer than expected—analyzing and writing up findings is a complex process that requires careful thought. Be sure to allocate enough time and resources.

15.4 SUMMARY:

After going through this lesson, you must have understood the processes in Qualitative data analysis. This lesson also threw light on Document analysis which is also known as Content analysis, Inductive analysis and Logical analysis.

15.5 GLOSSARY:

Autobiography – An autobiography is a written account of a person's life, which is written by that person itself.

Films- Films are also known as movies or motion pictures which typically consist of a series of moving images, often accompanied by sound.

Reports- Reports typically refer to documents that provide information, analysis findings or recommendations on a specific topic, issue or events.

15.6 ANSWERS TO SELF CHECK EXERCISES:

SELF CHECK EXERCISE-1

Answer 1. D

Answer 2. A

SELF CHECK EXERCISE-2

Answer 1. Natural

Answer 2. Patterns

SELF CHECK EXERCISE-3

Answer 1. C

15.7REFERENCES:

Miles, M.B. and Huberman, AM. (1994). Qualitative data analysis. 10-12 Newbury Park, CA: Sage.

Patton, M. Q. (1990). Qualitative evaluation and research methods (2nd ed.) Newbury Park, CA: Sage.

Strauss, Anselm L and Corbin, Juliet (1990). Basics of qualitative research: Grounded theory procedures and techniques. London: Sage.

15.8TERMINAL QUESTIONS:

1.Name the processes involved in Qualitative Data Analysis.

2.What do you mean by Inductive analysis?

3.What do you mean by logical analysis?

UNIT: 16

QUANTITATIVE DATA, NATURE OF QUANTITAIVE DATA AND SCALES OF MEASUREMENT

16.1 Introduction

In this unit, we will explore the fundamentals of quantitative data, including its characteristics, nature, and different scales of measurement. Quantitative data refers to information that can be measured and represented numerically, allowing researchers to apply statistical analysis and draw meaningful conclusions based on the data.

16.2 LEARNING OBJECTIVES: After going through this unit, the students will be able to:

1. Understand the meaning of quantitative data and nature of quantitative data.

2. Define the concept of different scales of measurement.

3. Differentiate between different scales of measurement.

16.3 Quantitative Data, Nature of Quantitative data and scales of measurement:

Quantification is the process of using numerical methods to describe observations of materials or characteristics. By establishing a specific portion of the material or characteristic as a measurement standard, researchers can ensure a valid and precise approach to data description.

NATURE OF QUANTITATIVE DATA:

Measurement is the most accepted method used in quantitative approach. Quantitative data includes numerical values that can be counted as well as measured. Quantitative data deals with amounts and quantities which involves the use of mathematical calculations and the use of statistical analysis. Examples of quantitative data are: Temperature, Height, Weight, Income etc. Quantitative data is mostly used in the field of physics, economics and psychology.

There are three properties of Quantitative data which are listed below:

a. The property of order

b. The property of identity

c. The property of additivity

A Nominal Scale: The nominal scale is the most basic form of measurement and the least precise method of quantification. It is used to categorize objects or entities based on qualitative differences rather than numerical values. In other words, a nominal scale groups items into distinct categories without any inherent ranking or order. For example, academic titles such as professor, associate professor, assistant professor, instructor, and lecturer, or classifications like male and female, are all examples of nominal data.

In statistics and research, nominal scales are used to classify data without implying any hierarchy among categories. Unlike other measurement scales, nominal data do not follow a specific order. Instead, they serve the purpose of differentiation.

Nominal data consist of counted data, meaning each individual belongs to only one category within a set, and all members of that set share the same defining characteristic. Examples include nationality, gender, socio-economic status, race, occupation, and religious affiliation. Although nominal scales lack an inherent order, in some cases, simple classification and counting provide a sufficient basis for statistical analysis.

SELF CHECK EXERCISE-1

1.Nominal data are ___________ data.

2.A nominal scale is a type of scale where data is classified into:

a. Numbers

b. Ranks

c. Categories

d. All of the above

An Ordinal Scale: An ordinal scale is a type of measurement scale where data is ranked based on magnitude or intensity, but the gaps between ranks may not be equal. Unlike nominal scales, which only classify data into categories, ordinal scales establish a hierarchy or order among the categories.

Ordinal scales follow a serial arrangement, meaning they not only indicate differences between items but also suggest that these differences exist in varying degrees. This allows researchers to rank individuals or items from highest to lowest based on a particular criterion. The ranking is expressed in terms of relative position within a group, such as 1st, 2nd, 3rd, 4th, 5th, and so on.

However, ordinal measurements do not have absolute values, and the actual differences between adjacent ranks are not necessarily equal. Although rankings appear evenly spaced, the true gaps between them may vary. This limitation is best understood through specific examples that illustrate how ordinal scales function in real-world scenarios.The following example illustrates this limitation:

Subject	**Height In inches**	**Difference in inches**	**Rank**
Rahul	76		1st
Surinder	68	8	2nd
Bhanu	66	2	3rd
Pyare Lal	59	7	4th
Arun	58	1	5th

Some other examples of ordinal scale are:

Rankings in competition (1st, 2nd, 3rd)

Likert scales in surveys (e.g. Strongly Agree, Agree, Neutral, Strongly Disagree, Disagree)

Rating Scales (Poor, Fair, Good, Excellent)

SELF CHECK EXERCISE-2

1.Ordinal scale is a _____________ scale.

2.Ordinal scale establishes a ____________ among the categories.

An Interval Scale: An interval scale is a quantitative measurement scale that maintains both order and equal intervals between values. It uses a standardized unit of measurement to indicate how much of a characteristic is present. For example, the difference between scores of 90 and 91 is the same as the difference between 60 and 61, ensuring consistency in measurement. Many psychological tests and inventories are based on interval scales.

With an interval scale, addition and subtraction are valid operations, but multiplication and division are not applicable because the scale lacks a true zero point. Unlike ratio scales, interval scales do not measure the complete absence of a trait. This means that a score of 90 does not indicate twice as much of a characteristic as a score of 45.

Despite this limitation, the interval scale offers a significant advantage over nominal and ordinal scales because it allows researchers to quantify the relative amount of a characteristic rather than simply ranking or categorizing data.

SELF EXERCISE-3

1. Interval scale consists of:

a. Unequal intervals between two variables

b. Equal intervals between two variables

c. Both a and b

d. None of these

RATIO SCALE: Ratio scales represent the highest level of measurement, offering the most precise way to quantify variables. Unlike other measurement scales, ratio scales allow all four mathematical operations: addition, subtraction, multiplication, and division.

A ratio scale shares the equal interval properties of an interval scale but has two additional features:

1. A true zero point – This means a variable can be completely absent. For example, zero length or zero height indicates a total lack of that characteristic.
2. Real-number properties – Numbers on a ratio scale can be added, subtracted, multiplied, divided, and expressed in ratio relationships. For instance:
    - 5 grams is half of 10 grams
    - 15 grams is three times 5 grams
    - On a weighing scale, two 1-gram weights balance a 2-gram weight

One key advantage in physical sciences is that many variables, such as weight, height, and temperature (in Kelvin), can be measured using ratio scales. In contrast, behavioral sciences often rely on interval scales, which are less precise because many psychological and social traits cannot be measured with a true zero.

From Nominal to Ratio Scales: Increasing Precision

Measurement scales progress in precision from nominal (least precise) to ratio (most precise). Researchers should aim to use the most accurate and detailed scale available for their variables.

Challenges in Behavioral Research

In behavioral sciences, many important qualities—such as intelligence, motivation, or personality—are abstract concepts that cannot be directly observed. Instead, researchers must define them based on observable behaviors. For example, intelligence might be measured using scores on an IQ test, but this is only an operational definition—not intelligence itself.

Operational definitions come with limitations:

- They can be subjective, leading to disagreements among experts about their validity.
- Quantification does not guarantee accuracy—even when data is numerical, it can still contain ambiguities and inconsistencies.

Some critics argue that an overemphasis on quantification in behavioral research can lead to superficial studies. The desire to imitate the precision of physical sciences may push researchers to measure small, easily quantifiable aspects of behavior, sometimes missing the bigger picture of real human experiences.

The Role of Quantitative Methods in Scientific Progress

Despite these challenges, quantitative research remains essential. Over time, researchers continue to improve operational definitions and observation techniques, making measurement more valid and reliable. Quantification is indispensable in most fields of research, playing a crucial role in science's evolution from philosophical speculation to empirical, verifiable knowledge.

SELF CHECK EXERCISE-4

1.Which of the following scales of measurement possesses a true zero point?

a. Interval scale

b. Ordinal scale

c. Nominal scale

d. Ratio scale

16.4 SUMMARY: In this lesson we have learnt about quantitative data, nature of quantitative data and scales of measurement. Scales of measurement play an important role in quantitative data and these scales provide a framework which in turn is useful for analyzing data and classification of data.

16.5 GLOSSARY

Arrangement – Arrangement refers to the organization or placement of items, ideas or events in a particular order or pattern.

Properties - Properties refer to the characteristics or attributes that define an object, substance or concept**.**

Statistical Analysis- Statistical analysis is the process of collecting, processing, analyzing and interpreting nume4rical data to uncover patterns, trends, relationships or insights within a dataset.

16.6 ANSWERS TO SELF CHECK EXERCISES

SELF CHECK EXERCISE-1

Answer 1. Counted

Answer 2. Categories.

SELF CHECK EXERCISE-2

Answer 1. Measurement

Answer 2. Hierarchy/order

SELF CHECK EXERCISE-3

Answer 1. B

SELF CHECK EXERCISE-4

Answer 1. D

16.7REFERENCES/ SUGGESTIVE READINGS:

Anastasi, A (1970) Psychological Testing London McMillan

Best, John W. and Kahn, James V. (2004). Research in Education (7 Ed) New Delhi Prentice-Hall of India

16.8TERMINAL QUESTIONS:

1.Describe the meaning of quantitative data.

2.Explain different types of scale of measurements with examples.

3. Write in detail about the nature of quantitative data?

UNIT :17

ORGANIZATION AND GRAPHICAL REPRESENTATION OF DATA

17.1 INTRODUCTION: In today's data driven world, the ability to organiz4e and effectively present data is paramount. Whether in business, social trends or scientific findings, the way data is structured can profoundly impact the decision - making process and understanding.

17.2 LEARNING OBJECTIVES: After going through this unit, the students will be able to:

1**.** Study about organization of data.

2. Understand the graphical representation of data.

17.3 Organization and Graphical representation of data

In educational research, various tests are administered from time to time with a view to establishing individual differences, ascertaining relative status of students in a group and assessing significant group trends pertinent to the specific objectives of the project, based on surveys or experimental observations (which are made use of) for building up the scientific body of knowledge or for solving the immediate problems. In either case, investigator or classroom teacher comes across a mass of data comprising individual scores. This mass of unordered data is known as raw data and alt statistical investigations start with this type of fundamental information Classification and description of this data is needed for its interpretation and meaningful presentation. The classification leads the investigator to understand basic features of the data. A frequency distribution of data represents its arrangement in an orderly manner so as to indicate the frequency of occurrence of the different values of variables falling within arbitrarily defined intervals of the variable Its meaning will be made dear in the present lesson along with its graphical representation.

Scores by themselves have no meaning, 55 out of 100 may be a good or a bad score depending on a variety of factors such as the difficulty of the test, the ability of the class, and the standard of marking by the examiner. Therefore, 55 out of 100 may mean average or poor or high score. We can not interpret the score of a student unless we know about the scores of other students who appeared in the same examination.

For example, 53% may be a good score in one case and poor in another.

Set-A: 30, 40, 45, 50, 53, 55 Mean = 45.5

Set B: 50, 60, 53, 70, 75, 80 Mean = 64.67

In set -A, score 53 is above the average score (45.5) and can be considered as a good score but in set-. B, it is below the average score (64.67) and therefore, here it is- a poor score. Hence to judge where a score is good or poor, reference must be made to the average score of the group.

Even in two sets of scores with the same average, some scores may have different meanings. Consider the following two sets of scores.

Set C: 15, 25, 35, 45, 55, 65, 75, 85, 95. Mean = 55.

Set-D: 35, 40, 45, 50, 60, 65, 70, 75.   Mean = 55.

In both the sets of scores the average of scores is 55, here the score 75 has a different meaning in each. In set-C, 75 is the third best score, where as in set-D, it is the best score. Thus, we observe that one must also know something about a particular score.

Hence, the scores of two sets should not be compared unless the averages of the scores of the two tests and their distributions are similar.

Example -1: Arrange the given scores in a frequency distribution

8, 6, 2, 5, 10, 9, 3, 2, 1, 5, 4, 5, 7, 6, 5, 3, 4, 7, 0, 7

2, 5, 6, 7, 4, 3, 4, 6, 8, 5, 7, 4, 3, 5, 3, 4, 9, 6, 1, 7

It is difficult to see from the above list how the scores are distributed. Inspection of these scores, however, shows that many scores occurred more than once.

We observed that there are two 9s, two 8s, six 7s, and so on. This suggests that we may arrange the data in columns, as shown in Table-1. In first column we may arrange the possible scores in descending or ascending order, and in the other we record by tallies (opposite to the respective marks) the number of students scored these scores. When we have to record five tallies, we mark four tallies, thus III and the fifth is made across the four

thus III.

The tallies are then totaled in the next column. This column thus, lists the number of times each score occurred. Such an arrangement of data is known as frequency distribution and the number of times a particular score value occurs is known as frequency of that score. The value of score is generally represented by the symbol X and its frequency by the symbol 'f. The total number of frequencies is denoted by 'N' or Σf

Scores	**Tallies**	**Frequencies**
10	I	1
9	II	2
8	II	2
7	IIII I	6
6	IIII	5
5	IIII III	8
4	IIII I	6
3	IIII	5
2	III	3
1	II	2
0	I	1
Total		N = 40

Arrangement in Table 1 is known as frequency array. The data have been classified in as many classes as there are score values within the total range of the variables. In the above example, the maximum score was 10 and the maximum possible score was 0. In this way we had only 11 classes. But when the range (the interval between the highest and lowest score) of scores is large, we shall have large number of classes if we classify in as many classes as there are score values.

If the classes are more than twenty in number, it becomes difficult to handle them Therefore, in such cases we reduce the number of classes by arranging the data in arbitrarily defined sub-groups. Consider the following scores of data in arbitrarily defined classes, A range of values which incorporates a set of items is called a class. For example, 5-10, 10-15 or 5-9, 10-14 are the classes in a frequency distribution.

We will understand this with another example

Example: 2: Arrange the given scores in a frequency distribution

9, 7, 6, 3, 4, 9, 3, 1, 2, 7, 4, 2, 3, 9, 10,

10, 2, 8, 5, 5, 3, 1, 0, 10, 2, 9, 7, 8, 5, 0

SCORES	TALLIES	FREQUENCIES
10	III	3
9	IIII	4
8	II	2
7	III	3
6	I	1
5	III	3
4	II	2
3	IIII	4
2	IIII	4
1	II	2
0	II	2
TOTAL		N = 30

In first column we may arrange the possible scores in descending or ascending order, and in the other we record by tallies (opposite to the respective marks) the number of students scored these scores.

The tallies are then totaled in the next column. This column thus, lists the number of times each score occurred. Such an arrangement of data is known as frequency distribution and the number of times a particular score value occurs is known as frequency of that score. The value of score is generally represented by the symbol X and its frequency by the symbol 'f'. The total number of frequencies is denoted by 'N'.

Example: Consider the following scores of 50 students and arrange them in a frequency distribution.

85	66	76	45	66	91	77	64	71	74
47	78	76	42	70	58	71	67	80	78
73	48	68	87	71	72	65	69	73	84
75	56	58	87	56	72	62	93	73	83
97	81	51	61	53	72	62	79	88	79

It is shown that the highest score is 97 and lowest score is 42. so the range is 55 (i.e. 97-42) Therefore, the distribution of scores can be conveniently arranged by dividing the range of 55 into ten or more classes if the class is taken to be of 5 points each and we take starting point 40, then the scores within the range 40 to 44 that is, all the given scores with the values 40, 41, 42, 43 and 44 will be grouped together to form the lowest class. All scores from 45 to 49 i.e., 45, 46, 47, 48 and 49 will form the next class. Similarly we shall group all scores within the classes 50 to 54, 55 to 59, 60 to 64 and so on. The highest class will be 95-99.

In Table-2, these classes have been arranged serially from the smallest at the bottom to the largest at the top. Each class covers 5 scores. For each score we have marked tallies against the corresponding class. The first score of 85 is represented be a tally placed opposite- the class 85-89. The second score of 47 by tally placed opposite to class 45-49 and the third score 73 by a tally placed opposite to 85-89 The remaining scores have been listed the total number of tallies in each class i.e., the frequency being written in the next column 'f'. The total of 'fs' gives the number of scores (here 50) and are denoted by N. You should note that the beginning score of the lowest class was taken as 40 and not 42, which was the actual lowest score.

Theoretically, classes of 42 to 46, 47 to 51, 52 to 56 etc., are as good as classes of 40 to 44, 45 to 49, 50 to 54 etc., but the second set is easier to handle from the point of view of tabulation as well as computations which will come later. Such a distribution is called grouped series. There are five kinds of continuous series: (i) Exclusive series (ii) Inclusive series (iii) Open end series (iv) Cumulative frequency series and (v) Mid-value series.

Table - 2

Class Intervals	**Tallies**	**Frequencies**
95-99	I	1
90-94	I I	2
85-89	IIII	4
80-84	𝍸	5
75-79	𝍸 III	8
70-74	𝍸 𝍸	10
65-69	𝍸 I	6
60-64	IIII	4
55-59	IIII	4
50-54	II	2
45-49	III	3
40-44	I	1
		N = 50

Conventions regarding the Formation of Class Intervals:

In the frequency distribution as shown in Table-1, the original observations have been retained and we can reconstruct the data from the frequency distribution without loss. When the interval is of more than 1, as in the above example, it is of 5, some loss of information regarding individual observations is incurred. In such cases the original observations cannot be reproduced exactly from the frequency distribution.

If the class interval is large in relation to the total range or the set of observations, this loss of information may be appreciable if the class interval is small, we shall have a large number of classes and there shall be very little gain in convenience over the utilization of the original data. Therefore, we choose such a class interval which is neither very small nor very large.The following conventions are generally used in the selection of class intervals:

(i)The class interval should be well defined and should not overlap. Class intervals of 0-4, 5-9, etc. should be used in preference to 0-5, 5-10, etc.

(ii)The class interval should be of such a size that with such class intervals the total range of observations is covered by 10 to 20 intervals.

(iii)Start the class interval with a value which is a multiple of the size of the interval or a zero. For example, with a class interval of 5, the interval should start with the values of 0, 5, 10, 15, etc., while with a class interval of 2, the intervals should start with the values 0, 2, 4, 6, etc.

(iv)The class intervals should be of uniform size and commonly of 3, 5 or 10, rarely of 7 and 20.

SELF CHECK EXERCISE-1

1.What do we call the mass of unordered data?

a.Qualitative data

b.Raw data

c.Quantitative data

d.All of the above

2. Frequency distribution indicates:

a. Frequency of occurrence

b. Statistical analysis of data

c. Both a and b

d. None of these

17.4 Steps in Construction of a Frequency Distribution Table:

1.Determine range of the scores.

Range = Highest score - Lowest score

2.Decide on how many categories of step intervals are required. Normally, the number of intervals used is not less than 10 and donot exceeds than 20.

3.Divide the range by total number of intervals giving the actual size of each step interval. If the size of the interval used does not work out to be a whole number. Usually, the class intervals are taken to be equal to 3, 5 or 10.

4.Construct the class interval column starting with the highest score or a convenient score. Subtract the class interval size from this score to get the lower score of the class. Repeat this procedure until the class interval column includes an interval into which the lowest score can be placed.

5.Mark a tally for each individual score against the class interval in which it falls.

6.Total up the tallies within each class interval and place them in the frequency column.

Exact Limits of the Class Intervals:

Where the variable under consideration is continuous and not discrete, we select a unit of measurement and record our observation on as discrete. For example, like in statistical measurement we measure the achievement of a child and award full scores of 26 or 80 instead of fractions series is discrete, though achievement is a continuous variable. When we record an observation in discrete form and the variable is a continuous one, (like the one we have just quoted), we

$$69.5\ (70-74)/\text{"}Class\ Interval\text{"}\ \ 74.5$$

Have just quoted), we imply that the value recorded-represents a value falling within certain limits, usually one-half unit above and below the value reported. Hence, a score of 44 on a continuous variable will represent a class interval 43.5 to 44.5 (e.g., all values greater than or equal to 43.5 and less than 44.5). These are called the exact limits of a class interval or class boundaries or end value. Similarly, the class interval "70-74" in the previous example will include all values greater than or equal to 69.5 (the lower Limit of 70) and below 74.5 (the upper limit of 74). i.e., it covers all values between 69.5 and 74.5.

Cumulative Frequency Distribution:

Sometimes we are not with the frequencies within the class intervals themselves, but rather with the number of percentage of values 'greater than or less than a specified value. This can be obtained by adding successively the individual frequencies. The new frequencies obtained by adding individual frequencies of class intervals are called cumulative class frequencies. If we denote individual class frequencies of the successive class intervals by f_1, f_2, f_3, ... f_k, the cumulative frequencies will f_1; $f_1 + f_2$, $f_1 + f_2 + f_3$ and so on.

Table 3 shows how from the frequency distribution given in Table 2. we can get cumulative frequencies and cumulative percentages for the distribution.

Table 4

Exact Limits of Class Intervals	**Class Intervals**	**Midpoints**	**Frequency (f)**	**Cumulative frequency (cf)**	**Cumulative Percentage Frequency (c%f)**
94.5-99.5	95-99	97	1	49 + 1 = 50	100.0
89.5-94.5	90-94	92	2	47 + 2 = 49	98.0
84.5-89.5	85-89	87	4	43 + 4 = 47	94.0
79.5-84.5	80-84	82	5	38 + 5 = 43	86.0
74.5-79.5	75-79	77	8	30 + 8 = 38	76.0

69.5-74.5	70-74	72	10	20 + 10 = 30	60.0
64.5-69.5	65-69	67	6	14 + 6 = 20	40.0
59.5-64.5	60-64	62	4	10 + 4 = 14	28.0
54.5-59.5	55-59	57	4	6 + 4 = 10	20.0
49.5-54.5	50-54	52	2	4 + 2 = 6	12.0
44.5-49.5	45-49	47	3	1 + 3 = 4	8.0
39.5-44.5	40-44	42	1	1 + 0 = 1	2.0
			N = 50		

SELF CHECK EXERCISE-2

1.Arrange the following steps of construction of a frequency distribution table in sequence:

a. Construct the class interval column.

b. Total up the tallies.

c. Determine the range of the scores

d. Mark a tally for each individual score against the class interval.

e. Decide how many categories of intervals are required

f. Divide the range by the number of intervals.

Choose the correct option from the following options:

1.a, b, c, d, e, f

2.d, b, a, c, f, e

3.e, f, b, a, d, c

4.c, e, f, a, d, b

2.Which of the following is not continuous data?

a. A person's weight

b. Volume of water in a bottle

c. Bikes manufactured in a factory in a day

d. None of these

17.5 SUMMARY: In this lesson, we have learnt about organization and graphical representation of data. We have learnt that mass of unordered data is known as raw data and all statistical investigations start with this type of fundamental information.

17.6 GLOSSARY:

Interval - An interval is a set of real numbers with the property that any number that lies is also included in the set.

Tallies – Tallies are a simple and visual way to represent numerical data and are commonly used for counting and recording of data.

17.7 ANSWERS TO SELF CHECK EXERCISES

SELF CHECK EXERCISE:1

Answer 1. B

Answer 2. A

SELF CHECK EXERCISE-2

Answer 1. D

Answer 2. C

17.8 REFERENCES/SUGGESTIVE RERADINGS:

Ebel, Robert L (1966). Measuring Educational Achievement. New Delhi: Prentice Hall of India Pvt. Ltd pp. 481.

Garrett, H. E. and Woodsworth, R. S. (1966). Statistics in Psychology and Education Bombay Vakils, Feffer and Simons Pvt. Ltd.

17.9 TERMINAL QUESTIONS

1. What do you understand by frequency distribution?

2.Write down the steps in construction of Frequency distribution table.

3.Take scores of 100 students in any subject of your interest. Convert raw scores into frequency distribution.

UNIT:18

GRAPHIC REPRESENTATION OF FREQUENCY DISTRIBUTION

18.1 INTRODUCTION: In this lesson we will learn about graphical representation of data, drawing of a graph, drawing of histogram, drawing of frequency polygon, drawing of a smoothed frequency polygon, drawing of cumulated frequency curve and also drawing up of a cumulative percentage curve which is also known as Ogive.

18.2LEARNING OBJECTIVES: After going through this unit, the students will be able to:

1. Study about histogram.

2. Understand the concept of Frequency Polygon.

3. Study about Smoothed frequency polygon.

4. Learn about Cumulated frequency curve.

5. Learn about Cumulated percentage curve.

18.3 Graphic Representation of Frequency Distribution:

Graphic representation leads to the understanding of a data set. If the graph is well drawn, it is pretty easier to read and interpret from the table. We shall consider here only those graphs which are useful in visualizing the important properties of frequency distributions. These will be of great help in enabling us to comprehend the important features of frequency distributions and in comparing one frequency distribution with another. Four methods of graphic representation of frequency distribution are in general use.

(i) Histograms

(ii) Frequency Polygons

(iii) Cumulative Frequency Curve

(iv) Cumulative Percentage Curve or Ogive.

Before proceeding to discuss the methods of representation of tabular data graphically, I would like to discuss some of the general conventions for the construction of graph and certain basic ideas in drawing of graph.

Drawing of a Graph

Before considering the procedure of constructing a frequency polygon or histogram, I would like to discuss with you the simple algebraic principles applicable to any graphic representation. Graphing or presentation of any distribution on a graph paper is done with reference to two lines i.e., co-ordinate axes. One, the vertical line or Y-axis and the other, the horizontal or X-axis Usually, these two lines are taken perpendicular to each other and their point of intersection is called origin 'O' This is the point of reference for both the axes.

Some Conventions for the Construction of Graph:

1.In a frequency distribution graph, it is customary to let the horizontal axis represent scores and the vertical axis the frequencies.

2. The arrangement of the graph should proceed from left to right. The low or small numbers on the scale should be on the left, and the low numbers on the vertical scale should be at the bottom.

3.The distance along either axis selected to serve as a unit is arbitrary and affects the appearance of the graph. Some writers suggest that the units should be so selected that the ratio of height to length should be roughly 3:5. This procedure has some aesthetic advantages.

4.The vertical scale should be so selected that the zero point must fall at the point of intersection of the axes. When data start with a zero, it is customary to designate the point of intersection at the zero point and make a small break-off in the vertical line A similar procedure is to be followed for the horizontal line.

5.Both the horizontal and vertical axes should be appropriately labeled.

6. Every graph should be assigned a descriptive title which states precisely what it is about

7. The scale of measurement (or units selected) should always be mentioned on the graph.

Now let us go to the procedure of drawing a graph.

Drawing of a Histogram:

A histogram is a graph, where the frequencies are represented in the form of rectangular bars. The height of such rectangular bars is the frequency and the width of such bars is the length of respective class intervals (taking into consideration, the exact limits).

Example: Draw a histogram of the following distribution in Table 4.

Table - 4

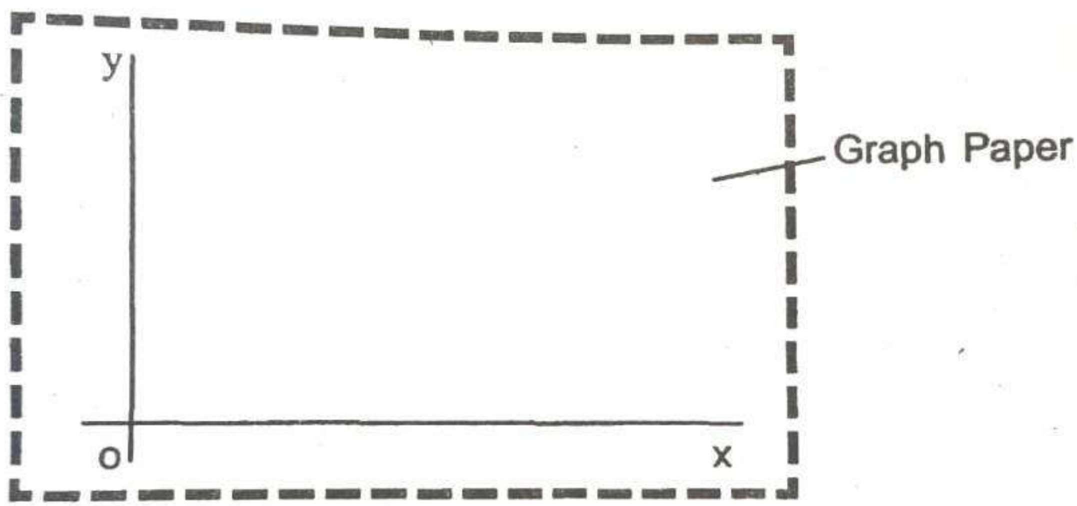
Class Interval	**Exact Limits**	**Frequency (f)**
88-90	87.5-90.5	1
85-87	84.5-87.5	1
82-84	81.5-84.5	2
79-81	78.5-81.5	2
76-78	75.5-78.5	5
73-75	72.5-75.5	2
70-72	69.5-72.5	5
67-69	66.5-69.5	6
64-66	63.5-66.5	8
61-63	60.5-63.5	4
58-60	57.5-60.5	4
55-57	54.5-57.5	3
52-54	51.0-54.5	4
49-51	48.5-51.5	2
46-48	45.5-48.5	1
		N = 50

Solution:

Step 1-Draw two straight lines perpendicular to each other, the vertical line near the left side of the graph paper and the horizontal line near the bottom of it.

Step 2 - Label the vertical line (the Y-axis) OY, and the horizontal line (the X-axis) OX Put the 0 (origin) where the two lines interest.

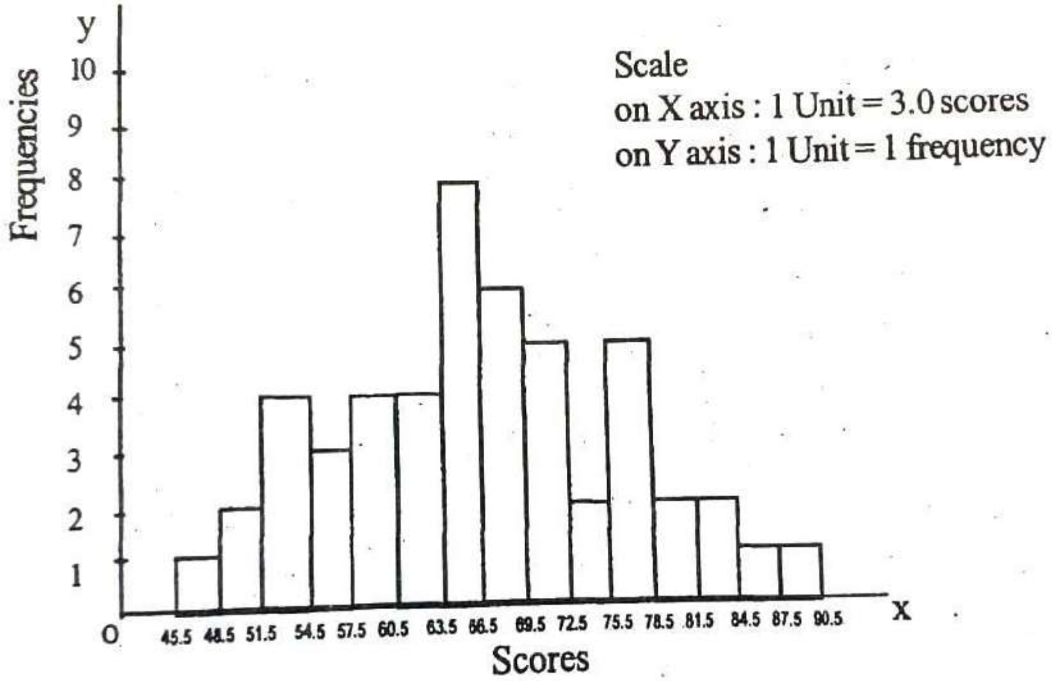
Step 3- Lay off the scores (or C) of the frequency distribution at regular distances along X-axis. The exact lower limits of the scores (or C1) are to be taken. Select X unit such that it will allow all the scores (or C.) to be represented easily on the graph.



Step 4- Mark on the Y-axis successive units to represent the frequencies of the different intervals Choose a Y scale which will make the largest frequency (the height) of the histogram approximately 60% to 80% (or roughly 75%) of the width of the figure.

Step 5-Draw rectangles

Note: Units are mentioned on the upper right corner of the graph



Exercise: Draw a histogram of the following distribution:

Table-5

C.I.	Exact Limits	Frequencies (f)
53-57	52.5-57.5	1
48-52	47.5-52.5	1
43-47	42.5-47.5	6
38-42	37.5-42.5	4
33-37	32.5-37.5	3
28-32	27.5-32.5	14
23-27	22.5-27.5	19
18-22	17.5-22.5	22
13-17	12.5-17.5	2

Now follow the steps 1 to 5 of the previous example and get the histogram. Hint: Length on X-axis is 9 x 5= 45 divisions.

Maximum height should be about 45 x 3/4 = '33.7, division which when divided by the maximum number (frequency 22) gives approximately 1.5 div. This is a suitable, but not rigid unit on Y-axis.

SELF CHECK EXERCISE -1

1.In the construction of graph, the arrangement of graph should proceed from:

a. Left to Right

b. Right to Left

c. Horizontal to Vertical

d. Vertical to Horizontal

2.In a frequency distribution graphs, the horizontal axis represents ______ and the vertical axis represents the________.

3. In histogram, the frequencies are represented in the form of ________bars.

18.4 Drawing of a Frequency Polygon:

A frequency polygon is a closed figure where the frequencies are represented by the height of the perpendicular from the mid-values of each class interval.

In the construction of a frequency polygon, after the usual steps in the drawing of any graph, points plotted are above the midpoints of the intervals on the X-axis. Frequencies are represented in each case by a dot. When all the points are located, they are joined by a sense of short lines to form a frequency curve. In order to complete the polygon, additional intervals at the high and low ends of the distribution are included on the X-axis. The frequencies on each of these additional intervals is naturally Zero. The polygon is closed by joining the mid-points of these two extreme intervals on the X- axis.

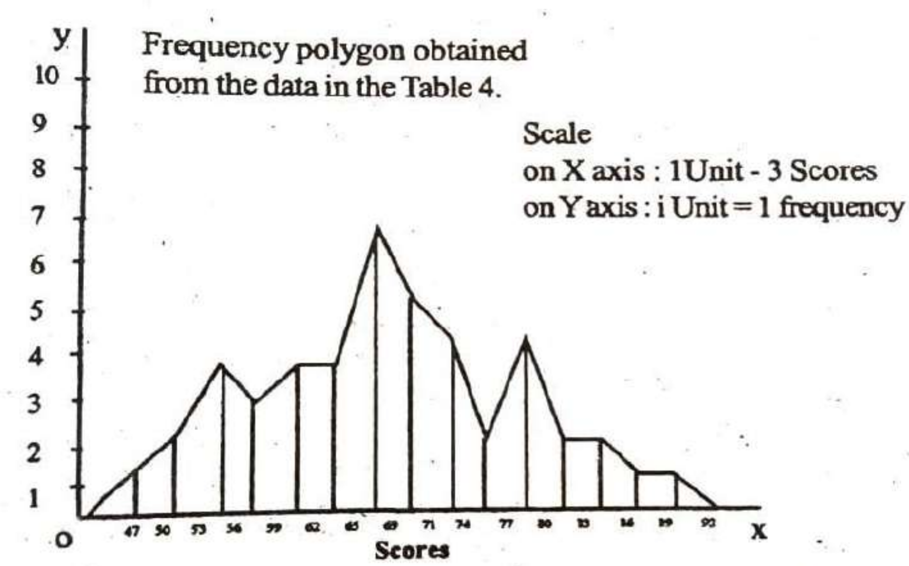
Example: Represent the frequency distribution in Table 4 as a frequency polygon.

Solution: Follow the steps 1 to 4 of histogram, except for step 3, instead of taking the exact limits of scores, take the mid-points of the class intervals. These mid points are to be marked off on the X-axis

5.From the midpoint of each interval on the X-axis, go up in the Y direction at a distance equal to the number of frequencies of the intervals. Place points at all these locations

6.Join all the points with straight lines to each other to get the frequency polygon.

Notice that the end points of the polygon have been positioned on the X-axis at the mid-points of the intervals on either side of the two extreme intervals.



Exercise: Represent the frequency distribution in Table-5 in a frequency polygon.

Drawing of a Smoothed Frequency Polygon:

Sometimes the researcher wishes to know what sort of frequency distribution he would have obtained the data had been collected from a larger sample, He can get this idea to some extent by smoothing the original polygon.

Smoothing a frequency polygon requires the calculation of averaged frequencies for all intervals. The average frequency for any interval is calculated by adding the frequency of that interval to the frequencies of two adjacent intervals, and dividing the total by 3

For example, in Table-6 the averaged frequency for the interval 49-51 is the frequency of the interval (2) added to the frequency of the interval 46-48(1) and the frequency of the interval 52-54(4) divided by 3.

$(2 + 1 + "4")/3$= 2.3

This procedure is repeated for all of the class intervals, when an interval has only an adjacent interval, then missing interval is given a frequency of 0.

For example, the averaged frequency for the interval 46-48 is

$(0 + 1 + "2")/3$ = 1.0

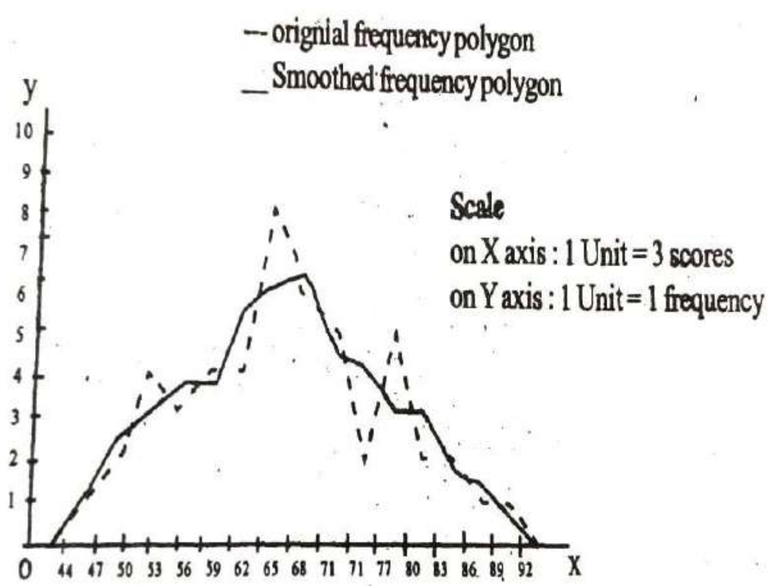
Table-6 shows the frequency distribution with averaged frequency for the of the class intervals. The smoothed frequencies are plotted for the polygon. If this is super imposed over the original frequency polygon, then comparison can be made as to the shape of the curves.

Table 6

Frequency distribution (Smoothed Frequencies)

Class Interval	**Midpoints (X)**	**Frequencies**	**Averaged or Smoothed Frequencies**
88-90	89	1	0.6
85-87	86	1	1.3
82-84	83	2	1.6
79-81	80	2	3.0
76-78	77	5	3.0
73-75	74	2	4.0
70-72	71	5	4.3
67-69	68	6	6.3

64-66	65	8	6.0
61-63	82	4	5.3
58-60	59	4	3.6
55-57	56	3	3.6
52-54	53	4	3.0
49-51	50	2	2.3
46-48	47	1	1.0



SELF CHECK EXERCISE-2

1.A frequency polygon is a __________ figure.

a. Open

b. Closed

c. Unlocked

d. None of these

18.5 Drawing of a Cumulative Frequency Curve:

A curve representing accumulated frequency is usually termed as Accumulative frequency curve or graph A cumulative frequency is defined as frequencies accumulated progressively from the bottom of the distribution to upwards. To illustrate, we can take the help of Table-3, then.

We can plot the graph with the help of these added frequencies. The cumulative frequencies (cf) are plotted vertically at the upper exact limit of each class interval (or scores) because cumulative frequencies are cumulated through each interval rather than their mid values. Once the points are plotted, they are connected by straight lines (free hand) beginning with zero at the lower limit of the lowest interval and ending with upper exact limit of the interval at the upper end of the X-axis.

Example: Plot a cumulative frequency graph of the distribution given in Table-7.

Table-7

Cumulative Frequency Distribution

Class Interval (Scores)	Class Interval (Exact Limits)	Frequency (f)	Cumulative Frequency (f)
88-90	87.5-90.5	1	50
85-87	84.5-87.5	1	49
82-84	81.5-84.5	2	48
79-81	78.5-81.5	2	46
76-78	75.5-78.5	5	44
73-75	72.5-75.5	2	39
70-72	69.5-72.5	5	37
67-69	66.5-69.5	6	32
64-66	63.5-66.5	8	26
61-63	60.5-63.5	4	18
58-60	57.5-60.5	4	14
55-57	54.5-57.5	3	10
52-54	51.5-54.5	4	7
49-51	48.5-51.5	2	3
46-48	45.5-48.5	1	1

The procedure for plotting a cumulative frequency curve is the same as for frequency polygons except that of the cumulative frequencies are plotted on the upper exact limits of each of the class interval instead of midpoints, as explained earlier.

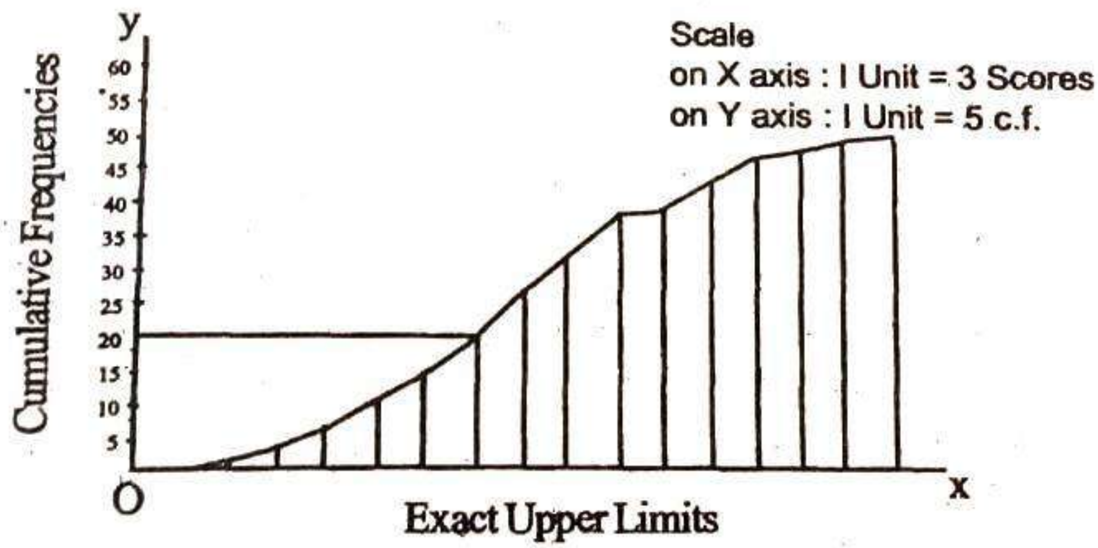
Summary of the steps is given below:

1.Draw the axes.

2.Mark off upper exact limits of each of the class interval on X-axis and cumulative frequencies on the Y-axis, by selecting appropriate units.

3.Plot cumulative frequencies for each class interval on the upper exact limit of that interval.

4.Join the points to get the cumulative frequency curve. Cumulative frequency curve can be smoothed in the same manner in which frequency polygon can be smoothed



Drawing of a Cumulative Percentage Curve or Ogive:

The cumulative percentage curve or Ogive differs from cumulative frequency curve. In it, frequencies are expressed as cumulative percents of frequency on the X- axis In Table-8 cumulative frequencies have been converted into cumulative percents.

The procedure of plotting an Ogive is exactly the same as that of plotting cumulative frequency curves except that instead of cumulative frequencies, the percentage of cumulative frequencies are plotted on the upper exact limits of each class interval

Example: Plot an Ogive of the distribution given in Table-8.

Table-8

Cumulative Percentages

Class Intervals	Upper exact limit	Individual frequencies (f)	Cumulative frequency (cf)	Cumulative Percentage Frequency (c%f)
41-43	43.5	1	86	100.0
38-40	40.5	4	85	98.8
35-37	37.5	5	81	94.2
32-34	34.5	8	76	8.4
29-31	31.5	14	68	79.1
26-28	28.5	17	54	72.8
23-25	25.5	9	37	43.0
20-22	22.2	13	28	32.6
17-19	19.5	8	1	17.4
14-16	16.5	3	7	8.1
11-13	13.5	4	4	4.7
8-10	10.5	0	0	0.0

Step 1- Find out the exact upper limit of each class interval

Step 2-Accumulate the successive frequencies.

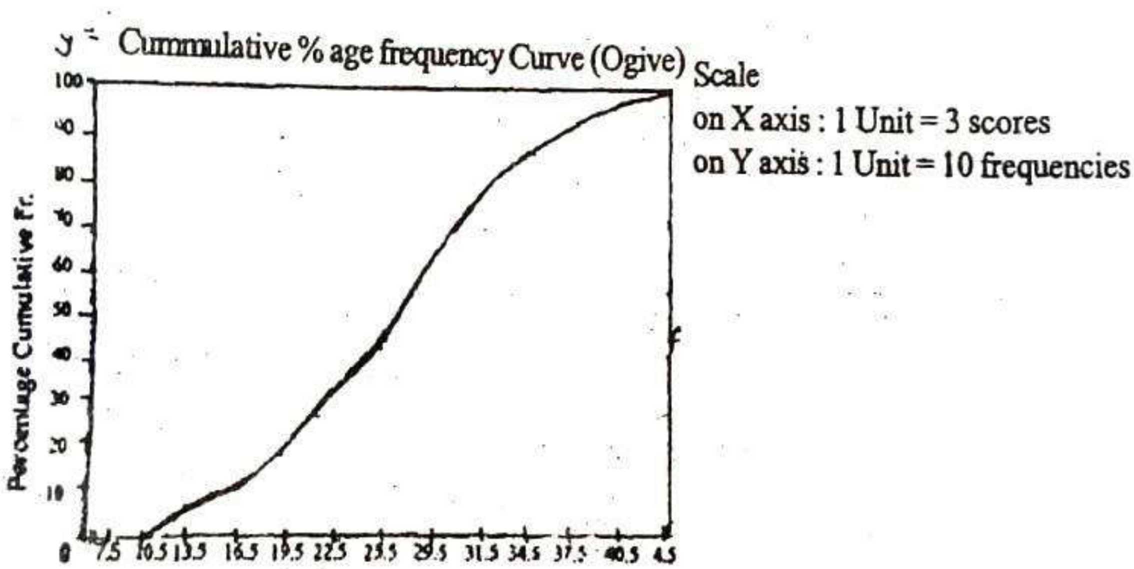
Step 3- Convert these cumulated frequencies into percentages to obtain cumulative percentage frequencies

Step 4- Plot these cumulative percentages on the upper exact limits of the class intervals in the same manner as

we have done in the case plotting of a cumulative frequency curve. The only difference is that on the Y-axis,

instead of cumulative frequencies, cumulative percentage frequencies are marked off from 0 to 100.

Step 5-Join the points smoothly to get Ogive



Exercise: Plot Ogive for the given frequency distribution

	II	III	IV	V
C.I.	Exact limits	F	Cf	Cf%
53-57	53-57	1		
48-52	48-52	1		
43-47	43-47	6		
38-42	38-42	4		
33-32	33-32	8		

28-32	28-32	14		
23-22	23-22	10		
18-22	18-22	4		
13-17	13-17	2		

When to use the Frequency Polygon and Histogram:

The frequency polygon is less precise than the histogram. Because it does not represent accurately in terms of area the frequency in each interval. In comparing two or more graphs plotted on the same axis, the frequency polygon is likely to be more useful.

SELF CHECK EXERCISE-3

1.Accumulated frequency curve represents:

a. Undistributed frequency

b. Distributed frequency

c. Accumulated frequency

d. All of these

2.A cumulative frequency is defined as:

a. Frequencies accumulated from upwards to bottom

b. Frequencies accumulated from bottom of distribution to upwards

c. Both a and b

d. None of these

18.6 Summary:

After going through this lesson, we have learnt about different histograms, polygons, Cumulative frequency curve and Ogive curve. These were understood by us in terms of their representation.

18.7 GLOSSARY:

Horizontal axis: A horizontal axis runs horizontally from left to right on a graph or chart.

Vertical axis: A vertical axis runs vertically from bottom to top on a graph or chart.

Percentage: Percentage is a way of expressing a proportion or a fraction of a whole in terms of hundredths.

18.8 ANSWERS TO SELF CHECK EXERCISES:

SELF CHECK EXERCISE- 1

Answer 1. A

Answer 2. Scores, Frequencies

Answer 3. Rectangular

SELF CHECK EXERCISE-2

Answer1. B

SELF CHECK EXERCISE-3

Answer 1. C

Answer 2. B

18.9 REFERENCES/SUGGESTIVE READINGS:

Sanswal, N.D. (2020). *Research Methodology and Applied Statistics.* (1st ed.). Shipra Publications.

Kaul, L. (2009). *Methodology of Educational Research.* (4th ed.). Vikas Publishing House Private Limited.

Best, John W. and Kahn, James V. (2004). Research in Education (7 Ed.). New Delhi: Prentice-Hall of India.

18.10TERMINAL QUESTIONS:

1.Take scores of 100 students in any subject of your interest. Convert raw scores into frequency distribution and draw a Histogram.

UNIT: 19

MEASURES OF CENTRAL TENDENCY (MEAN, MEDIAN, MODE)

19.1 INTRODUCTION: In this unit, we will learn about measures of central tendency which includes mean, median and mode. In the field of statistics, central tendency can be referred to as a central value for any probability distribution. Measures of central tendency are the statistical measures which are used to describe the center of a data set. These measures provide a single value that represents the central value around which the data tend to cluster. They help in understanding the central or average value of a data distribution, aiding in data analysis and interpretation.

19.2 LEARNING OBJECTIVES: After going through this unit, the students will be able to:

1. Define the concepts of mean, median and mode.

2. Identify the conditions when different measures of central tendency should be used.

3. Compute mean, median and mode for given data

19.3 Measures of Central Tendency:

Statistical methods provide a variety of measures to describe a distribution. The most often used descriptive measure is one which determines the 'central tendency' of the distribution or a set of data. A more popular term for a measure of central tendency is an average. People generally talk about the average price, average height, average score etc. What do we mean by an average? Usually we mean some measure which, in some sense, summarizes a set of data. For example, if we are told that the average IQ of a group of students is 118, this single figure leads us to think of this group as generally bright. We know that not all the students in the group have an I.Q. of 118. Some have a lower 1,Q. for the group which permits us to gain a general impress of the intelligence level of the group of students as a whole.

Types of Statistical Averages:

For the sake of simplicity of our study, various averages may be divided as follows:

Mathematical Average: (i) Arithmetical Mean, (ii) Geometric Mean, (iii) Harmonic Mean

Positional Average: (i) Median, (ii) Mode

The following three measures of central tendency are commonly used in Education:

(a) The Arithmetic Mean or Simple Mean, (b) The Median, (c) The Mode.

1.The Arithmetic Mean

The 'Arithmetic Mean' is perhaps the most familiar and most frequently used measure of central tendency. Moreover, it is relatively easy to calculate and is widely used in statistical research. Generally, when the term mean is used without a modifier (adjective) the arithmetic mean is implied. The arithmetic mean represents the typical value of the dataset by distributing the total value equally across all observations. The mean is sensitive to extreme values, often reflecting the central tendency when the data is normally distributed.

The arithmetic mean or simply the mean of a set of observations is obtained by adding all the values and dividing the total by the number of the values. If 'X' denotes measurements x in question, then the mean is always denoted by ' ' (read xbar) or 'M',

and 'N' stands for the n of the values and symbol 'Σ' (Sigma) denotes the sum of all the terms following it, we have the formula:

M or (∓) = $(0+1+"1")/3$ = 0.67

i.e. Mean = $"sum\ of\ the\ scores\ or\ values"\ /"number\ of\ the\ scores\ or\ values"$

Example 1: The following are the ungrouped scores of 12 students 17, 25, 44, 16, 20, 15, 10, 30, 19, 22, 31, 11

Calculate mean score for the given set of scores.

Sol. By definition of the mean

Mean = $\Sigma X/N$

X = "17+ 25+ 44+ 16+ 20+ 15+ 10+ 30+ 19+ 22+ 31+11" /12 = 260/12 = 21.6

Example 2: The following are the ungrouped scores of 10 students 47, 52, 51, 50, 52, 53, 51, 51, 49, 55.

Calculate mean score for the given set of scores.

Sol. By definition of the mean

Mean = $\Sigma X/N$

X = $("47 " + " 52 " + " 51 " + " 5" 0 + " 52 " + " 53 " + " 51 " + " 51 " + " 49 " + " 55")/10$

= $511/10$ = 51.1

Deviation:

Deviation of any X value from its mean is its difference from the mean. In example 2, the deviation of 53 from its mean 51.1 is 1.9 i.e., 53-51.1 and similarly the deviation of 47 from its mean is -4.1 i.e. (47 – 51.1 = -41).

Here, we can say that

Deviation (Score-Mean) or x = (X - M).

Where: x denotes deviation of score X from its true mean.

1.Short-Cut Method of Calculating the Mean

In this method we first take an arbitrary (assumed) working mean and calculate the mean of the deviations of the observations from this working mean. If 'x' denotes deviation of any 'X' value from assumed mean (A.M.) then:

Mean or (x) A.M. + $\Sigma X/N$ (1)

Now we can solve example-1, by taking the assumed mean (A.M.) equal to 50

Serial No.	X	X' = X - A.M.
1	47	-3
2	52	2
3	51	1
4	50	0

5	52	2
6	53	3
7	51	1
8	51	1
9	49	-1
10	55	-5
		Σx =11

Mean or (x) =A.M. + $\Sigma X/N$ = 50 + $11/10$ = 50+ 1.1 + 51.1

As regards the final result, any assumed mean will do, but in order to keep the computation to the minimum, care

should be taken to select an assumed mean as close as possible to the actual mean, as far as one can judge.

(II) The Arithmetic Mean of Grouped Data:

One simple method to calculate the mean of grouped data is given below.

Mean or (x) = $\Sigma fX/N$

Where ΣfX is the sum of product of frequency (f) and the midpoints (X) of class

intervals

Step-1. Find out the mid-point of each class interval by finding out the average of upper and lower scores of the

class.

Step-2. Multiply each mid-point value (X) by the frequency (f) in that class to get the value of fx.

Step-3. Add all values of fx to obtain ΣfX

Step-4. Apply the following formula to get the value of mean.

Mean or (x) = $\Sigma fX/N$

Example-2: From the given frequency distribution, calculate the value of Mean

Score	F
30-34	2
25-29	2
20-24	5
15-19	6
10-14	4
5-9	1

Solution:

Score (C.I.)	**Midpoints intervals (X)**	**F**	**fx**
30-34	32	2	64
25-29	27	2	54
20-24	22	5	110
15-19	17	6	102
10-14	12	4	48
5-9	7	1	7
		N = 20	ΣfX = 385

Mean or ($\bar{x}$) = $\Sigma fX/N$ = $385/20$ = 19.25

Example-3: From the given frequency distribution, calculate the value of Mean

Score	F
80- 84	5
75 – 79	1
70 – 74	2
65 – 69	4
60 – 64	3
55 – 59	7

Solution:

Score (C.I.)	**Midpoints intervals (X)**	**F**	**fx**
80-84	82	5	410
75-79	77	1	77
70-74	72	2	144
65-69	67	4	268
60-64	62	3	186
55-59	57	7	399
		N = 22	ΣfX= 1484

Mean = $\Sigma fX/N$ = 1484/22 = 67.45

(III) The Arithmetic Mean from Group Data: (short method).

The steps in the process of computing a mean from a frequency distribution according to the short-cut method are as follows:

Step 1. Arrange the data in a frequency distribution to get the total number of items, i.e. N- Σ f, and the width of class intervals, i.e., (i)

Step 2. By mere inspection estimate the interval in the distribution which is most likely to contain the mean. The midpoint of this interval will be designated as AM (Assumed Mean).

Step-3. In the fourth column, Le, the column next to that of frequencies, mark the deviation 'x' of the midpoint of the interval from the assumed mean in steps, i.e. in terms of interval. Those that are greater than the assumed mean are designed plus (+) and the small are designed minus (-)

Step-4. The next operation is to multiply each frequency (f) by its corresponding deviation (x'). The products (fx') are written in the fifth column. Care should be taken to observe signs.

Step-5. Find the algebraic sum of fx' i.e. (Σfx') from fifth column.

Step-6. Divide Σfx' by N. Sometimes Σfx' will be positive and sometimes negative. This sign depends on the position of the assumed mean.

Step-7. Multiply $\Sigma f X'/N$by the site of the class interval (i) of the class interval is

also called the width of the class interval and is equal to the difference between lower or upper limits of two consecutive class intervals.

Step-8. The final step is to calculate the mean by applying the following formula.

Mean or ($\bar{x}$) = A.M. + $\Sigma f X'/N$ x i

Remember that the above formula is only when all classes are of equal width.

Example -3: Calculate mean of the following distribution.

Class Interval (C.I.)	Frequency (f)
53-57	1
48-52	1
43-47	2
38-42	3
33-32	5
28-32	4
23-22	2
18-22	1
13-17	1

Solution:

Step-1 Adding up all the frequencies, we get N (Total)or Σf=20

Step-2 As we need mid-points of the class intervals so we re-write the frequency distribution, taking the mid-point of each of the C.I in column II

Step-3 Let us take mid-point 30 of class interval 28-32 as our assumed mean (A.M. = 30).

Step-4 Since A.M. 30 (deviation of midpoint in C.1. units) corresponding to 28-32 is zero, and that for class interval 23-27 is-l' for, class interval 18-22 is - 2 and soon. Similarly for Class Interval 33-37 value for 'x 'is + 1' and that for 38-42 is + 2' and so on. In the forth column we note the values of x'.

Step-5 Calculate the products 'fx', i.e. product of frequency and corresponding deviation x' and write the values in the 5^{th} column fx. In the CI. 53-57, f= I and x +5, hence fx + 5. In C. 48-52, f= 1, x = +4 and so on. The particular sign of '+' or should not be ignored.

(I) C.I	(II) Mid-point	(III) (f)	(IV) (x')	(V) f x'
53-57	55	1	+5	+5
48-52	50	1	+4	+4
43-47	45	2	+3	+6
38-42	40	3	+2	+6
33-37	35	5	+1	+5
28-32	30 AM	4	0	+0
23-27	25	2	-1	-2
18-22	20	1	-2	-2
13-17	15	1	-3	-3

N = 20 $\vdash$ █$(\& + 26@\& - 7)]\sum fx' = 19$

Step-6 Find the algebraic sum of the 5^{th} column, (first add all the '+' values and then add the '-' values, the algebraic sum will be the value of Σfx'.

Step-7 Calculate mean by applying the following formula.

x =A.M. + $(\sum fX')/N\ xi$

Step-8 Put the respective values of A.M. = 30 (assumed mean)

ΣfX' = 19 (calculated in 5th column)

1 = 5 (size of C.I.)

N=20 (Total number of frequencies)

Step-9 Mean = 30 + $19/20$ x 5 = 30 + $95/20$= 30 + 4.75 + 34.75

The Mean from Combined Groups.

If there are 'n' groups whose means and number of cases in each group (N) are known, we can compute their weighted mean using the following formula

M_{comb} = $(N\_1\, M\_1 + N\_2\, M\_2.........+N\_n\, M\_n)/(N\_1 + N\_2+...........N\_n\,)$

Example-4: Compute the M_{comb} for the table given below:

Group	Mean (M)	N
I	20	10
II	15	20
III	25	30

Solution:

M_{comb} = $(N\_1\, M\_1 + N\_2\, M\_2 + N\_3\, M\_3)/(N\_1 + N\_2 + N\_3\,)$

= $(10 \times 20 + 20 \times 15 + 30 \times 25)/(10 + 20 + 30) = 1250/60 = 20.83$

Some Properties of Arithmetic Mean - Following are the important properties

of Arithmetic mean are-

1.The sum of the deviations of all the measurements in a set from their arithmetic mean is zero. If $\bar{x}$ or M is the mean then (X-) =0.x

2. The sum of squares of deviations about the arithmetic mean is less than the sum of squares of deviations about any other value. The deviations of scores 2, 8, 16,

4, 6 and 0 form their mean 6 are -4, 2, 10-2, 0 and -6. The squares of these deviations are 16, 4, 100, 4, 0, 36. The sum of these squared deviations is 160. If we take deviations from some other value, say 8, the deviations are -6, 0, 8, -4, -2, -8 squaring these we have 36, 0, 64, 16, 4, 64 the sum of these is 184, which is greater than the sum of squared deviations from the mean. Selection of any other value will demonstrate the same result.

SELF CHECK EXERCISE-1

1.Sum of scores divided by number of scores is the formula of:

a. Mean

b. Mode

c. Median

d. None of these

2. Median and Mode comes under the category of:

a. Mathematical average

b. Positional average

c. Both a and b

d. None of the above

2. The Median

For most purposes arithmetic mean is used to summarize the general character of collection of data. But if collection of data contains extreme values, which markedly affect the arithmetic mean, the simple mean is inappropriate or even misleading. For example, if a sample of five values is 45, 57, 65, 90, 98, its arithmetic mean is 71.0. This value is not a true representative of the sample and misleads us. In such cases another value called the 'Median' is used.

Median is the middle value in a dataset which is in ascending or descending order. If there is an even number of values, the median is the average of two middle values. Median of a set of data is that point below and above which 50% of the values lie. In other words, it is the half way mark when the data are ranked (arranged in order of magnitude). In the above example, values are in ascending order and the middle value is 65. Therefore, the median is 65. Median does not take into consideration the absolute difference in successive pairs or values. The median is often called positional average. In the arithmetic mean each value contributes to the final result according to its magnitude. In median only the middle value represents the whole data.

In a series consisting of an odd number of values, the median is the middle most value. If a series is arranged in numerical order i.e., it is the arithmetic mean of the two middle values. For example median of 31, 32, 35, 36, 38 and 42

is $((35 + 36))/2 = 35.5$

(I) Calculation of Median from Grouped Data

In case of grouped data, ie, frequency distribution, we first prepare the cumulative frequency distribution and then the formula for calculation of the median is:

Mdn = l + $((N/2 - F))/f \times i$

Where: Mdn is median, (I) is the exact lower limit of the interval which contains the median, the point below which half the number of cases lie (i) is the width of the class interval in which the median falls (f) is the frequency of the same interval and (F) is the cumulative frequency of the preceding classes or intervals.

Example 1 - Calculate the median from the data given below.

Class Interval	Frequency

40-44	2
35-39	2
30-24	4
25-29	6
20-24	10
15-19	15
10-14	6
5-9	5
	N = 50

Solution:

Step-1 We first add the frequencies and get N or Σf = 50

Step-2 We have the following working formula for the median

Mdn = l + $((N/2 - F))/f \times i$

We need the exact lower limit of the median class and F (the cumulative frequency, i.e., sum of the frequencies of

the preceding classes).

Step-3 We take the exact limits and prepare a cumulative frequency distribution.

Step-4 Here N= 50. Therefore: $N/2 = 50/2 = 25$

The cumulative 'fs' are required to decide about the median interval. Hence the median class (class in which the median lies) is 15-19. Because in this interval we are getting the required number (25) of cumulative frequencies

Step-5Calculate median by applying the formula

Mdn = 1 +$((N/2-F))/f \times i$

C.I.	Limit	f	cf
40-44	39.5-44.5	2	50
35-39	34.5-39.5	2	48
30-34	29.5-34.4	4	46
25-29	24.5-29.5	6	42
20-24	19.5-24.5	10	36
15-19	14.5-19.5	15	26
10-14	9.5-14.5	6	11
5-9	4.5-9.5	5	5

Here: 1 14 5, (the exact lower limit of the C 1. 15-19 is 14.5)

F= 11 (cumulative frequencies preceding the median class interval 15-19) f=15 (frequency in the Mdn class), and i= 5 (size of the class interval)

Putting the values in the above formula

Mdn = 14.5 +$(50/2-11)/15 \times 5 = 14.5 + (25-11)/15 \times 5$

= 14.5 + $14/(15\_3) \times 5$ = 14.5 + $14/3$ = 14.5 + 4.67 = 19.17

Example 2 - Calculate the median from the data given below.

Class Interval	Frequency
185-205	4

165-184	8
145-164	14
125-144	20
105-124	13
85-104	5
65-84	4
	N = 68

Solution:

Step-1 We first add the frequencies and get N or Σf = 68

Step-2 We have the following working formula for the median

Mdn = l + $((N/2 - F))/f \times i$

We need the exact lower limit of the median class and F (the cumulative frequency, i.e., sum of the frequencies of the preceding classes).

Step-3 We take the exact limits and prepare a cumulative frequency distribution.

Step-4 Here N= 68. Therefore: N/2 = 68/2 = 34

The cumulative 'fs' are required to decide about the median interval. Hence the median class (class in which the median lies) is 125-145. Because in this interval we are getting the required number (34) of cumulative frequencies

Step-5 Calculate median by applying the formula

Mdn = 1 + ((N/2-F))/ f x i

C.I.	Limit	F	cf
185- 204	184.5-204.5	4	68

165-184	164.5-184.5	8	64
145-164	144.5-164.5	14	56
125 – 144	124.5-144.5	20	42
105-124	104.5-124.5	13	22
85-104	84.5-104.5	5	9
65-84	64.5-84.5	4	4

Here: 124.5, is the exact lower limit of the class interval 125- 145

F= 20 (cumulative frequencies preceding the median class interval 125-145) f=15 (frequency in the Mdn class), and i= 20 (size of the class interval)

Putting the values in the above formula

Mdn = 124.5 + (34-22) / 20 x 20 = 124.5 + 22/20 x 20

= 124.5 + 34-22

= 124.5 + 12 = 136.5

(II) Special Case: When the frequency of Median interval is zero (0).

Calculation of Median when: (a) the frequency distribution contains gaps; and (b) the first or last interval has

indeterminate limits.

(a)Difficulty arises when there are gaps or zero frequency which Mdn falls. We can take the following example.

C.I.	F	Cf

20-21	2	16
18-19	2	14
16-17	4	12
14-15	0	8
12-13	0	8
10-11	4	8
8-9	4	4

As N=16, N/2 = 8; which is the of in both the Ci (12-13) and (14-15) giving two values of median, if the ordinary method is applied median may either be 13.5 or 15.5. Similarly we can get cases where more than two such values are obtained (if there are many zero frequencies. There are many ways of adjustment in such cases. One of the easiest way is to take the mean of the exact lower limit of the first and the upper limit of next class interval in which cumulative frequency is N/2. In this case cf N/2, in 12-13 and 14-15, the mean of II.5 and 15.5 is 13.5. Hence here median is 13.5.

(b) The mean of grouped data cannot be calculated if the distribution is open ended (e.g. 80 and above, at the higher end or 20 and below, on the lowest end, but the median is readily computed since each score is simply counted as one frequency whether accurately classified or not, provided that the class in which median falls is defined.

The calculation of median will be discussed in detail during P.C.P.

SELF CHECK EXERCISE-2

1.Median is the _______ value in a dataset.

a. First

b. Second

c. Middle

d. Last

2.Median of a set of data is that point below and above which _____ of the values lie.

a. 50%

b. 25%

c. 75%

d. 40%

1.The Mode

Mode is the number that occurs with highest frequency. If no number repeats, the dataset is said to have no mode or it can have multiple modes if two or more numbers occur with the same highest frequency.

The mode is the value of the variate that occurs most commonly i.e., that value of variate for which frequency is maximum. If there is only one value which occurs the maximum number of times, then the distribution is said to have one mode or to be unimodal. On the other hand, if more than one value is repeated most and the same number of time the distribution is said to be multimodal.

In a sense, mode is the most representative of observations because it tells us which value is most common. But certain difficulties arise in the calculation and use of this value in case value of the variate has same frequency (rectangular or uniform distribution) the mode has no meaning. It is greatly, moreover, as mentioned earlier a distribution may have more than one mode.

If the distribution is unimodal there is hardly any difficulty in its calculation. We simply have to see from the data which of the observations occurs most.

Example - Find the mode of the given observations: 1,2,3,4,5,6,5,6,5

Solution:

We observe that the distribution is unimodal and 5 occurs maximum number of times i.e. 3 times. Therefore, the mode is 5.

(I) Calculation of Mode from Grouped Data -

In case of grouped data, the crude mode is the mid- point of the class interval with maximum (f) while true mode is calculated by the following formula

Mode = 3 Median—2 Mean

This formula is applicable only when the values of mean and median are equal or almost equal I.e., difference should not be more than 0.5. If the difference is more than 0.5 then the value of mode will get affected accordingly.

Example: Compute the mode for the following frequency distribution.

CI	F
50-53	1
46-49	1
42-45	3
38-41	2
34-37	2
30-33	1

Solution: For computing the mode, we have to compute mean and median first.

(i) Calculation of Mean : Assume 43.5 as assumed mean (the mid-value of the interval 42-45).

CI	F	X	fx'
50-53	1	+2	+2
46-49	1	+1	+1
42-45	3	0	0
38-41	2	-1	-1
34-37	2	-2	-4
30-33	1	-3	-3
	N=10		Σfx' = -5

Here:

A.M. = 43.5, Σ*f*x' = -5, N=10 and I = 4.

Put these values in the following formula

Mean A.M. + $(\sum fX')/N$x i EJx'

= 43.5 + $(-5)/10$ x 4 = 43.5 $(-20)/10$= 43.5 - 2.00 = 41.50

(ii) Calculation of Median

Class intervals	**F**	**Cf**
50-53	1	10
46-49	1	9
42-45	3	8

38-41	2	5
34-37	2	3
30-33	1	1

Here: $\boldsymbol{N/2 = 10/2 = 5}$ The interval in which we get cumulative frequencies is the median interval

Thus: 38-41 is the median interval with lower limit 37.5

I = 37.5, F = 3, f = 2 and i = 4 (Now put these values in the formula of median)

Mdn =I+$((N/2 - F))/f\ xi$

= 37.5 + $((10/2 - 3))/2$x 4 = 37.5 + 1 x 4 = 37.5 + 4 + 41.5 Ans.

Mode = 3 median - 2 mean: (This formula is applicable when the values of mean and median are equal almost

equal) i.e. the difference between mean and median value is less than 5.

=3(41.50) - 2, (41.50) = 124.50 - 83.00 = 41 Ans

II. Calculation of Mode Directly:

Mode can also be calculated directly by applying the following formula

Z or M_0 = I+ $(f\_m - f\_1)/(2f\_m - f\_1 - f\_2)\ xi$

In the formula:

1 = exact lower limit of the modal class

f_m = Frequency of the modal class

f_l = Frequency of the class preceding the modal class

f_2 = Frequency of the class succeeding the modal class

$_i$ = Size of the class interval

Example: Calculate mode from the following frequency distribution

Class interval	F
35-39	1
30-34	2
25-29	4
20-24	6
15-19	1
10-14	1

Solution:

The first step is to identify the modal class, i.e., the class having the highest frequency. Through inspection, mode lies in the class interval 20- 24. The second step is to apply the formula.

Here: 1 = 19.5, exact lower limit of the class interval 20-24

f_m = 6, frequency of the class interval 20-24.

f_1 = frequency of the proceeding interval 1.e., 15-19.

f_2 = 4, frequency of the succeeding interval i.e., 25-29.

i = 5, the, size of the class interval 20-25

Now put these values in the following formula

M0 = I+ $(f\_m - f\_1)/(2f\_m - f\_1 - f\_2)\ xi$

Mode = 19.5 + $(6 - 1)/(2 \times 6 - 1 - 4) \times 5$ = 19.5 + $5/(12 - 5) \times 5$

19.5 + $25/7$= 19.5 + 3.57 = 23.0

The Characteristics of Arithmetic Mean:

1. The mean is best known and well understood measure of central tendency.

2. The value of the arithmetic mean is determined by every score in the distribution.

3. It is greatly affected by extreme values.

4. The sum of deviations about the arithmetic mean is zero. ie., $\Sigma(X—M) = 0$

5. The sum of squares of the deviations from the arithmetic mean is less than those computed about any other point.

6. In every case it has a determinate value.

7. The standard error is minimum (Will be discussed later).

The Advantages of Arithmetic Mean:

1. The mean is the most commonly known and used measure of central tendency.

2. Its calculation is not difficult.

3. Its standard error is lowest.

4. Mean can be manipulated algebraically.

The Limitations of Arithmetic Mean:

1. The value of arithmetic mean, maybe greatly distorted by extreme values and therefore, in such cases it may not be a typical value

2. It cannot be calculated from open ended distributions.

The Characteristics of Median:

1. The Median is a central position.

2. It is affected by number of values, not by the size of extreme values.

3. The sum of the deviations about the median, signs ignored (all considered positive), will be less than the total about any other point.

4. It is most typical when the central values of the data are closely grouped.

The Advantages of Median:

1. It is easy to calculate median.
2. It is not distorted by extreme values.
3. It is more typical measure of central tendency, because it does not depend upon quantity of the values.
4. It may be calculated even when the distribution is open ended.
5. Median is resistant to outliers. This makes it more reliable when dealing with skewed or asymmetric databases.

The Limitations of Median:

1. The median is not so widely used as the arithmetic mean.
2. The items must be arranged according to the values of the variate (in ascending or descending order) before the median can be computed.
3. The median is less reliable than the mean because it has large standard error than that of arithmetic mean (will be considered later).
4. The median cannot be manipulated algebraically i.e. we cannot find the median of a combined group if medians of sub-groups are known.
5. Median does not take into account actual values of the dataset beyond the middle point.

The Characteristics of Mode:

1. The mode has not most usual value.
2. Mode is entirely independent of extreme values.
3. It represents the value that occurs most frequently in a dataset.
4. Unlike the mean, mode is not influenced by extreme values or outliers in the data. It simply reflects the value that appears most often.

The Advantages of Mode:

1. It is most typical and therefore the most descriptive value.
2. It is simple to find mode by observation when there are a small number of items.
3. It is not necessary to arrange the values if they are a few in number.
4. Since extreme values are few in number, the mode is not affected by extreme values.

The Limitations of Mode:

1. There may be multimodal distributions.
2. Its significance is limited when a large number of values is not available.
3. In a small number of items the mode may tint exist, for none of the values may be repeated.

Selection of An Appropriate Measure of Central Tendency:

We observe that no one central value can be said to be good for all types of enquiries and under all conditions. In

selection of a central value consideration must be given to the characteristics and limitations of various central

tendencies. Each has its own field of importance and usefulness. In actual practice two or three values of a series

maybe required for a proper understanding of the given data.

In most of the cases, arithmetic mean would be found to be an ideal value, but if a very large number of items ma series have small values and only on or two items a big value, the arithmetic mean would give a fallacious conclusion, In such cases other values would give better results than the arithmetic mean If the purpose of enquiry is to study phenomena which are incapable of direct advantages in measurement, like intelligence etc, median has a distinct advantage If the enquiry relates, to say, "typical size or form' or 'average size of readymade clothes' or 'average outputs' then mode is the best value.

SELF CHECK EXERCIS- 3

1.Which of the following is included in measures of central tendency?

a. Average deviation

b. Mode

c. Standard deviation

d. None of these

2.Mode is the number that occurs with:

a. Highest frequency

b. Lowest frequency

c. Medium Frequency

d. All of the above

3. 3Median – 2 Mean is the formula of:

a. Average

b. Median

c. Mean

d. Mode

19.4 SUMMARY – In this chapter, we have learned about various measures of central tendencies (mean, median, mode) with their characteristics, advantages and limitations. We have also learned the process of computing the measures of central tendencies.

19.5 GLOSSARY-

Grouped data: Grouped data refers to a set of data that has been organized into groups or intervals rather than listing individual values. Grouped data is commonly used in statistical analysis to simplify large datasets and identify patterns or trends.

Ungrouped data: Ungrouped data refers to set of raw, individual data points that are not organized into groups or intervals. Ungrouped data is typically used when the individual values are important for analysis or when the dataset is relatively small and manageable without the need for grouping.

Frequency: Frequency refers to the number of times a particular value occurs within a dataset or a specific category.

19.6 ANSWERS TO SELF CHECK EXERCISES

SELF CHECK EXERCISE -1

Answer 1. A

Answer 2. B

SELF CHECK EXERCISE- 2

Answer 1. C

Answer 2 – A

SELF CHECK EXERCISE-3

Answer 1 – B

Answer 2 – A

Answer 3 – D

19.7REFERENCES/ SUGGESTIVE READINGS:

Best, J.W and J.V.Kahn, Research in Education (7th Ed.) New Delhi: Prentice Hall of India Pvt Ltd.1998

Sanswal, N.D. (2020). *Research Methodology and Applied Statistics.* (1st ed.). Shipra Publications

19.8TERMINAL QUESTIONS:

1.What are the various modes of central tendency? Explain briefly.

2.What are the limitations of mode?

3.What are the characteristics of mean?

4.What are the advantages of median?

5.Compute mean, median and mode for the following set of data.

Class Intervals	Frequencies (f)
41-43	1
38-40	4
35-27	5
32-34	8
29-31	14
26-28	17
23-25	9
20-22	13
17-19	8
14-16	3
11-13	4
8-10	0

UNIT: 20

MEASURES OF VARIABILITY (RANGE, QUARTILE DEVIATION, STANDARD DEVIATION AND VARIANCE)

20.1 INTRODUCTION: This chapter will delve into the fundamental concepts that quantify the dispersion or spread of data within a dataset. Understanding variability is crucial in statistical analysis as it provides insight into the distribution and reliability of datapoints. This chapter explores various measures that capture different aspects of variability, including range, variance, standard deviation, inter quartile range, mean, absolute deviation and coefficient of variation. Through clear explanations, this chapter aims to equip readers with the tools necessary to effectively interpret and analyze variability within datasets, enabling informed decision making and robust statistical inference.

20.2 LEARNING OBJECTIVES: After going through this unit, the students will be able to:

1. Identify the conditions when different measures of variability should be used.

2. Compute standard deviation for given data.

20.3 Measures of Variability or Dispersion

Central tendencies are central values around which the individual observations lie. They give us an idea of location of the distribution, but tell us nothing as to how the individual scores are scattered. Thus, each of the following six series, has 5 as the mean, though the patterns of individual measurements are different in all the series.

(i)	5.5, 5, 5, 5, 5	(iv)	0, 9, 2, 2, 2, 3, 4, 12, 6. 10.
(ii)	3, 4, 5, 6, 7	(v)	1.9, 10, 3, 7.0
(iii)	2, 3, 4, 5, 6, 7, 8	(vi)	6, 5, 5, 5, 5, 4

Thus, we observe that measurement of central tendency alone is not enough, we should also know how the individual scores are clustered around or scattered away from the central value. This characteristic of distribution is called variability. Dispersion or the spread is the degree to which the numerical data tends to spread about the average value of that data.

Measures of variability are statistical measures that describe the spread or dispersion of a set of datapoints. Measures of variability refer to statistical tools used to quantify the extent of spread or dispersion within a dataset. They provide insight into how the individual datapoints are distributed around a central tendency such as the mean or median. These measures help to characterize the diversity or consistency of data points, which is essential for drawing meaningful conclusions and make accurate predictions in statistical analysis.

The following are the main measures of variability or dispersion of the individual observations in the population.

Range - The range of a distribution is the difference between the maximum and the minimum values of the variate. It is easily calculated. The ranges of the above six series are 0, 4, 6, 12, 9 and 2 respectively. It is readily understood and gives us some idea of the amount of dispersion present, but it is a crude and unstable measure of variability since it depends on two extreme values in the series and indicates virtually nothing about the general form of the series. Therefore, quite frequently, range misleads regarding dispersion of the distribution.

Range= Maximum value – Minimum value

EXAMPLE 1

Let's calculate range for the given set of data:

74, 80, 92, 64, 70, 99, 82

Here, Maximum value = 99

Minimum value = 64

Range = Maximum value – Minimum value

= 99 – 64

= 35

MERITS OF RANGE:

It is simple to understand.

It is easy to calculate.

It is widely used in statistical quality control.

DEMERITS OF RANGE:

It cannot be calculated in case of open- ended series.

It is not based on all observations.

It is affected by extreme values in series.

SELF CHECK EXERCISE-1

1.Measure of variability helps to characterize:

a. Diversity of data points.

b. Similarity of data points

c. Both diversity and similarity of data points

d. None of the above

2. The formula Maximum value – Minimum value signifies:

a. Mean

b. Median

c. Average

d. Range

Quartile Range - Another way of describing the dispersion of a distribution is in terms of Quartile Range In determining this measure 25 percent of lowest values and 25 per cent of the upper values are disregarded. If Q_1 is first quartile and Q_3 is third quartile, then Quartile Range is Q_3 - Q_1. Half of this range is termed as semi-inter quartile range or quartile deviation (Q.D. or simple Q).

Quartiles are the values that divide the data into 4 equal parts.

Q1 is known as Lower Quartile

Q2 is known as Middle Quartile or Median

Q3 is known as Upper Quartile

Let's understand this with the help of an example:

Example: Find the quartile deviation of the following set of data

62, 18, 22,11, 40, 41,70

Rearrange data into ascending or descending order

11, 18, 22, 40, 41, 62, 70

We can find Q1 by using the formula ¼ (n+1)th term

$Q1 = \frac{1}{4}(7+1)$

$= \frac{1}{4}(8)$

$= 8/4$

$= 2^{nd}$ term i.e. 18

Hence, Q1 = 18

Similarly, we will find Q2 by using the following formula

$Q2 = \frac{1}{2}(n+1)$th term

$= \frac{1}{2}(7+1)$th term

$= 1/2\ (8)$

$= 8/2$

$= 4^{th}$ term i.e. 40

So, Q2= 40

Now, we will find Q3 by using the formula

$Q3 = \frac{3}{4}(n+1)$th term

$= \frac{3}{4}(7+1)$th term

$= \frac{3}{4}(8)$th term

$= 6^{th}$ term which is 62

So, we will compute quartile Range by using the formula

$Q3-Q1 = 62-18$

$= 44$

The range and the quartile range both do not take into consideration the value of each individual item of the distribution and therefore, both lack in descriptive value. A good measure of dispersion should depend upon the amount by which the scores deviate from the measure of central tendency, say mean, the next measure depends upon deviation of each individual item from the mean.

Merits of Quartile Deviation

1.It is easy to calculate.

2.It is not very much affected by the extreme values of a series.

Limitations of Quartile Deviation

1.It is a positional measure based on only 25^{th} and 75^{th} percentile.

SELF CHECK EXERCISE -2

1.In Quartile Range, data is divided into ____ equal parts

a. Three

b. Four

c. Two

d. Five

2.Q2 in Quartile Range is known as:

a. Lower Quartile

b. Upper Quartile

c. Middle Quartile or mean

d. None of the above

1.AVERAGE DEVIATION AND STANDARD DEVIATION

Average Deviation (A.D.) - Average deviation (A.D.) tells us how much, on average, each data point in a set differs from the overall average (mean). It’s like asking, *"On a typical day, how far is each number from the center?"*

To find it, we:

1. Work out the mean (average) of the numbers.
2. Find how far each number is from that mean (ignoring negative signs).
3. Take the average of all those distances.

A

The formula to compute A.D. is:

$$\text{A.D.} = (\sum|x|)/N$$

Where:

Σ|x| indicates magnitude of deviation by ignoring—ve sign. We calculate X-M = x for all the scores and get |x| by disregarding its proper sign (+or-). To calculate A.D. add all the |x| and divide the sum by N.

Example - Calculate A.D. of the following values of X = 9,7,5,11,1,5,7,3

Solution

X	x = X – M	|x|
9	+3	3
7	+1	1
5	-1	1
11	+5	5
1	-5	5
5	-1	1
7	+1	1
3	-3	3
Σx = 48	Σx = 0	Σ|x| = 20

Here : $\Sigma x = 48$, $N = 8$, Mean = 6 and $\Sigma|x| = 20$

Therefore: A.D. = $(\sum|x|)/N = 20/8 = 2.5$

A. D. from Grouped Data:

The A.D. from grouped data can be calculated after calculating its mean. The deviations of the mid-points of the class intervals are calculated and multiplied by their respective frequencies. The sum (ignoring the signs) divided by N gives us the required A.D. value

The formula is A.D = $(\sum f|x|)/(\sum f)$

The A.D. is rarely used in modern statistics, but is often found in the old experimental literature.

Let's understand this with an example

Compute Average Deviation from the following set of Grouped Data

CLASS INTERVAL	FREQUENCY
195-199	1
190-194	2
185-189	4
180-184	5
175-179	8
170-174	10
165-169	6
160-164	4

155-159	4
150-154	2
145-149	1
140-144	1

CLASS INTERVAL	MID POINT (X)	FREQUENCY (f)	fX	x	Fx
195-199	197	1	197	26.2	26.2
190-194	192	2	384	21.2	42.4
185-189	187	4	743	16.2	64.8
180-184	182	5	910	11.2	56
175-179	177	8	1416	6.2	49.6
170-174	172	10	1720	1.2	12
165-169	167	6	1002	-3.8	-22.8
160-164	162	4	648	-8.8	-35.2
155-159	157	4	628	-13.8	-55.2
150-154	152	2	304	-18.8	-37.6
145-149	147	1	441	-23.8	-71.4

140-144	142	1	142	-28.8	-28.8
		N=50	Sum=8540		

Average Deviation= $(\sum f|x|)/(\sum f)$ where x= X-M x is Deviation of scores from mean

M= 8540/50

=170.8

X is Midpoint

M is Mean

A.D.= $(\sum f|x|)/(\sum f)$

= 502/50

= 10.04

Merits of Average Deviation

1. It is easy to calculate.
2. Average Deviation reflects the variability or spread of the data.
3. Calculating Average Deviation involves straightforward arithmetic operations.

Limitations of Average Deviation

Average deviation is sensitive to changes in sample size.

Standard Deviation: (S.D. OR σ)

The standard deviation is the most widely used measure of dispersion. It is positive square root of the mean of the squares of the deviations from the arithmetic mean and is denoted by a Greek letter a (sigma) and in short it is called S.D.

SD or σ = $\sqrt{((\sum(X-M)^2)/N)}$ or $(\sum d^2)/N$

Where:

σ: stands for standard deviation, X: is the value of variate

M: is the arithmetic mean of the data, N: is the number of items

d: is the deviation of mean from any score

When the data are grouped in the form of frequency distribution, the above formula takes the following from.

σ = $\sqrt{((\sum f(X-M)^2)/N)}$ or $1/N \sqrt{([(N\sum fd^2) - (\sum fd^2)^2])}$

I. Calculation of Standard Deviation:

The standard deviation is seldom calculated from the above formula because it is too time consuming. Unless the mean (M) is around number, the deviations (X-M) will be in fractional values, the squaring of which results in a prohibitive amount of calculation. The standard deviation, therefore, is generally calculated with the help of the following formula:

σ = $1/N \sqrt{([(N\sum fd^2) - (\sum fd^2)^2])}$

Where:

'x deviation of the score (mid point) from the assumed mean (AM) in Gil units.

f = frequency of different intervals or scores.

N = number of cases Le sum (20) of all the frequencies or scores.

i = size of the class intervals of the distribution.

Example-1 Calculate the SD of the following values of X : 9,7,5,11,1,5,7,3

Solution: Taking score 5 as assumed mean, we obtain the following table:

X	x^1 = X-5	x'^2
9	4	16
7	2	4
5	0	0
11	6	36
1	-4	16
5	0	0
7	2	4
3	-2	4
N=8 Scores	Σx'=+8	Σx'2=80

Here: $\Sigma x' = 8$, $\Sigma x^2 = 80$ and $N = 8$

$\sigma = 1/N \sqrt{([(N\sum x'^2) - (\sum x')^2])}$ Put the different values in this formula.

$= \frac{1}{8}\sqrt{([8(80) - (8)^2])} = 1/8\sqrt{([640 - 64])} = \frac{1}{8}\sqrt{576} = 1/8 \times 24 = 3$

Note: Here size of the class interval is not to be used as we have only ungrouped observations.

II. Calculation of S.D. from Frequency Distribution or Grouped Data.

When the data have been arranged in a frequency then the standard deviation is computed by the use of formula:

$\sigma = 1/N \sqrt{([(N\sum fx'^2) - (\sum fx')^2])}$

In the above formula:

i - represents size of the class interval

x' - represents step deviations from the assumed mean in terms of class interval and N = Σf

The steps required in the process of computing standard deviation from the distribution are outlined below:

Step-1 Arrange the data in a frequency distribution table and add up all the frequencies to get N. i.e., Σf and find size of the class interval.

Step-2 Complete the x' and fx' column to get Σfx' and $\Sigma fx'^2$.

Step-3 Multiplying each f x' by the x' and write the result in the next column headed by fx'^2. Add the products of this column to get to get $\Sigma f x'^2$.

Stop-4 Make use of the formula for σ

Example -2. Calculate S.D. for the following distribution:

X	F
48-52	2
53-57	3
58-62	5
63-67	9
68-72	10
73-77	12
78-82	7

83-87	2
88-92	3
93-97	1

Solution: First, we can arrange the data as per our usual order. Assure 70 as assumed mean, which is the mid-

point of 68-72 class interval.

(1) C.I.	(2) f	(3) x'	(4) f x'	(5) fx'^2
93-97	1	+5	+5	25
88-92	3	+4	+12	48
83-87	2	+3	= 6	18
79-82	7	+2	+14	28
73-77	12	+1	+12	12
68-72	10	0	0	0
63-67	9	-1	-9	9
58-62	5	-2	-10	20
53-57	3	-3	-9	27
48-52	2	-4	-8	32
	$\Sigma f = 54$		+48 13 -36	$\Sigma fx'^2 = 219$

			$\Sigma fx' = 13$	

Here :

$\Sigma fx^1 = 13$. $\Sigma fx^2 = 219$ and $\Sigma f = 54$.

Step-1. From column (1) i = 53-48 or 57-52 = 5

Step-2. Taking mid-point of interval 68-72 as assumed mean and completing column (4), i.e. $\Sigma fx' = 13$.

Step-3. Multiplying each number in the column (4) or 'fx' by the corresponding number in the column (3) or 'x' we get column (5) of fx^2. Adding column (5) we get $\Sigma fx^2 = + 219$

Step - 4. Put the required values in the formula.

$$\sigma = 1/N \sqrt{([(N\Sigma fx'^2) - (\Sigma fx')^2])}$$

$$\sigma = 5/54 \sqrt{([(54 \times 219) - (13)^2])} = 9.99 \text{ Ans.}$$

We should remember that the measures of dispersion are expressed in the same units of measurement (such as inches, cm, grams, pounds etc. in which the observations themselves are measured. Exercise: Find out the SD of the following table

Table-a

C.I.	F
20-21	2
18-19	2
16-17	4
14-15	0
12-13	4

Table-b

C.I.	F
40-44	2
35-39	3
30-34	6
25-29	10
20-14	15

10-11	0
8-9	4
	N=16

15-19	20
10-14	16
5-9	12
0-4	8
	N = 92

Effect on the Standard Deviation of Adding or Multiplying by a Constant:

(a) If a constant (positive or negative) is added to all the observations of a sample the same constant is added to the mean but the standard deviation remains uncharged. Let 'X' be the variable and constant 'C' is added to each value of 'X'. If 'M' denotes the mean of original values of X then the mean would be equal to (X+C) or (X-C) which is clearly equal to X-M. This is the same as the deviations of the original variable from the mean. It proves that addition of the constant does not change the deviations The SD will remain the same

Example- Let us consider small sets of 4 values, say 3.4.7, 10 and of 5, 6, 9, 12 The mean of the new set is '8'. The deviations from the mean in both the sets from their means are the same, which are -3, -2, -1 and 4 Therefore, the SD of both the sets is the same.

(b) If each score in a frequency distribution is multiplied or divided by a constant then the SD of the resultant distribution is also multiplied or divided to the same extent, as the individual scores are multiplied or divided by a constant. You should multiply the values in the preceding example and verify the above property.

The standard deviation is the most commonly used measure of dispersion. The range and quartile range, though simple in calculation, are based on only two out of the whole bulk of observations Moreover, the range of a small sample will not agree with the range of the distribution from which it measures and is rigidly defined. In some applications of statistics, range is useful as in quality control. But in education, range and quartile range are seldom used. In fact, none of the measures of dispersion is as useful as the SD Most of the methods of statistical analysis have been evolved around the SD and its square.

We use the standard deviation in the greatest dependability of the measures is required

Variance: The term variance is used to denote the square of the standard deviation.

Variance or σ^2 = $(\Sigma(X - M)^2)/N$ or i^2/N^2 [$N\Sigma f x'^2 - (\Sigma EX')^2$] in case of grouped data.

4.7.1 Uses of Measures of Variability

(1) Uses of Range:

- (i) When the data are too scant or too scattered to justify the computation of a more precise measure of variability.
- (ii) When knowledge of extreme scores or of total spread is all that is wanted.
- (iii) Further calculations that depend upon it are likely to be needed.
- (iv) Interpretations related to normal distribution curve are to be done.

(2) Uses of Quartile Deviation

- (i) When the median is the measure of central tendency.
- (ii) When there are extreme scores which have disproportionate influence on S.D.
- (iii) When the concentration around the median is of primary interest (I.e. mid cases).
- (iv) When the upper and lower class intervals are open

(3) Uses of A.D

- (i) When it is desired to weigh all deviations from the mean according to their size.
- (ii) When extreme deviations would influence the SD. unduly.

(4) Uses of S.D.

(i) When the statistic having the greatest stability is sought.

(ii) When the extreme deviations should exercise a proportionally great effect upon the variability.

(iii) When coefficients of correlation and other statistics are subsequently to be computed

SELF CHECK EXERCISE- 3

1.Standard Deviation is denoted by

a. Alpha

b. Sigma

c. Rho

d. None of these

2. Positive square root of the mean of the squares of deviations from the arithmetic mean is the formula of:

a. Average Deviation

b. Mode

c. Standard Deviation

d. Quartile Deviation

20.4 SUMMARY: In this lesson we have learnt about measures of variability and how to compute the measures of variability. Measures of variability refer to statistical tools used to quantify the extent of spread or dispersion within a dataset. They provide insight into how the individual datapoints are distributed around a central tendency such as the mean or median.

20.5 GLOSSARY:

Deviation: Deviation refers to the act of departing or diverging from a standard, norm or expected course of action.

Range: Range typically refers to the difference between the highest and lowest values in a set of data or the extent or variation between limits.

20.6 ANSWERS TO SELF CHECK EXERCISES:

SELF CHECK EXERCISE-1

Answer 1. A

Answer 2. D

SELF CHECK EXERCISE-2

Answer1. B

Answer 2. C

SELF CHECK EXERCISE-3

Answer 1. B

Answer 2. C

20.7REFERENCES/SUGGESTIVE READINGS:

Guilford. J. P. (1973). Fundamental Statistics in Psychology and Education (3 Ed). New York McGraw Hill Book Co

Koul, Lokesh (1988) Methodology of Educational Research New Delhi: Vikas Publishing House Pvt. Ltd.

20.8 TERMINAL QUESTIONS:

1.What are the various measures of variability? Explain briefly.

2.Compute Average deviation for the given data sets:

Class Intervals (Scores)	Frequencies (f)	Class Intervals (Scores)	Frequencies (f)

88-90	1	70-72	5
85-87	1	67-69	6
82-84	2	64-66	8
79-81	2	61-63	4
76-81	5	58-60	4
73-75	2		

*****