B. Ed. Spl. Ed. (M. R. / H. I. / V. I)-
ODL Programme

AREA - D

D - 19 : BASIC RESEARCH AND STATISTICS

A COLLABORATIVE PROGRAMME OF
NETAJI SUBHAS OPEN UNIVERSITY
AND
REHABILITATION COUNCIL OF INDIA

AREA - D
DISABILITY SPECIALIZATION
COURSE CODE - D-19
BASIC RESEARCH AND STATISTICS

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The Self Instructional Material (SIM) is prepared keeping conformity with the B.Ed.Spl. Edn.(MR/HI/VI) Programme as prepared and circulated by the Rehabilitation Council of India, New Delhi and adopted by NSOU on and from the 2015-2017 academic session.

Mohan Kumar Chattopadhyay
Registrar

Netaji Subhas Open University

From the Vice-Chancellor's Desk

Dear Students, from this Academic Session (2015-17) the Curriculum and Course Structure of B. Ed.- Special Education have been thoroughly revised as per the stipulations which featured in the Memorandum of Understanding (MoU) between the Rehabilitation Council of India (RCI) and the National Council for Teacher Education (NCTE). The newly designed course structure and syllabus is comprehensive and futuristic has, therefore, been contextualized and adopted by NSOU from the present academic session, following the directives of the aforesaid national statutory authorities.

Consequent upon the introduction of new syllabus the revision of Self Instructional Material (SIM) becomes imperative. The new syllabus was circulated by RCI for introduction in the month of June, 2015 while the new session begins in the month of July. So the difficulties of preparing the SIMs within such a short time can easily be understood. However, the School of Education of NSOU took up the challenge and put the best minds together in preparing SIM without compromising the standard and quality of such an academic package. It required many rigorous steps before printing and circulation of the entire academic package to our dear learners. Every intervening step was meticulously and methodically followed for ensuring quality in such a time bound manner.

The SIMs are prepared by eminent subject experts and edited by the senior members of the faculty specializing in the discipline concerned. Printing of the SIMs has been done with utmost care and attention. Students are the primary beneficiaries of these materials so developed. Therefore, you must go through the contents seriously and take your queries, if any, to the Counselors during Personal Contact Programs (PCPs) for clarifications. In comparison to F2F mode, the onus is on the learners in the ODL mode. So please change your mind accordingly and shrug off your old mindset of teacher dependence and spoon feeding habits immediately.

I would further urge you to go for other Open Educational Resources (OERs) - available on websites, for better understanding and gaining comprehensive mastery over the subject. From this year NSOU is also providing ICT enabled support services to the students enrolled under this University. So, in addition to the printed SIMs, the e-contents are also provided to the students to facilitate the usage and ensure more flexibility at the user end. The other ICT based support systems will be there for the benefit of the learners.

So please make the most of it and do your best in the examinations. However, any suggestion or constructive criticism regarding the SIMs and its improvement is welcome. 1 must acknowledge the contribution of all the content writers, editors and background minds at the SoE, NSOU for their respective efforts, expertise and hard work in producing the SIMs within a very short time.

Professor (Dr.) Subha Sankar Sarkar
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D-19 ❐ BASIC RESEARCH AND STATISTICS

Unit - 1 ❐ Introduction to Research

Structure:

1.1. Introduction

In the field of research in disabilities many different methods and procedures have been adopted to aid in the acquisition of fruitful result. The scientific method in research on disability studies is important and effective. There are systematic and specific steps that are followed by the researcher to conduct the research as characterized by scientific method of research. Similarly, methods like the case study, ethnographic study, observation technique, longitudinal method, rating scale, attitude scale are mostly found to be used in the field of research on disabilities. In this unit, the concept of scientific method, concept and definition of research, application of scientific method in research, purpose of research and research in education and special education will be discussed.

1.2. Objectives

After completion of the unit the learner will be able to:-

- discuss the concept of scientific method;
- enumerate the concept and definition of research;
- explain the application of scientific method in research;
- elucidate the purpose of research;
- discuss research in education and special education;

1.3. Scientific Method

The method adopted by sciences for the acquisition of knowledge exploring truth and solving problem is known as scientific method. Merriam- Webster's Seventh New Collegiate Dictionary (1970:771) defines the term scientific method as "principles and

procedures for the systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of hypothesis".

Wiersma (1986:8): The scientific method is usually describe as series of steps, beginning with the identification of some problem and proceeding to the final step of drawing conclusion.

Swain (2007:3): the scientific method involves collection of empirical evidences and observation of experimental results and in the process tests opinions and impressions through logical considerations of stable conclusions. (Mangal & Mangal, 2015:12)

1.3.1. The Nature and Meaning of Scientific Method

Scientific method is an approach or method used for discovering of facts and solving the problems of employing a series of logical, objective and systematic steps.

The term science is now thought of as a method or attitude rather than a field of subject matter. It is describe as a method of enquiry that permits man to examine the phenomena of interest to him.

Hence, we can conclude about the meaning, nature and purposes of scientific method as under:

1. Scientific method provides quite exact and efficient means in terms of the utilization of proper tools, and thinking for the acquisition of the desire knowledge.
2. Scientific method is used in all kinds of study made in different types and branches of sciences.
3. Scientific method lays emphasis on a systematic and careful study.
4. In this method, all information, data and facts are collected by accurate observation, experimentation and testing for providing empirical evidences in research for the truth or proper solution to the problem in consideration.
5. Here the collected information and data are properly organized and classified. These are then subjected to careful analysis for deriving useful results.
6. The result so obtained are further verified and then, finally, definite principles and laws are framed in the light of these generalized and verified, giving way to scientific theory for the generalized application to its users.

7. For carrying out all its functions cited above, scientific method is processed through a series of well organized and sequential steps known as steps of scientific method, especially in terms of arriving at some appropriate solution of the felt problem.

From the meaning and nature of the term scientific method gained from the above discussion, we may think of the scientific method as a systematic and organized attempt carried out through some carefully planned sequential steps in answering a question raised or felt problem in a most objective way for arriving at the sufficiently reliable, valid and satisfying conclusion capable of bearing the testimony of any verification and generality for being helpful in the building of the treasure of scientific facts, laws and theory.(Mangal & Mangal, 2015:13)

1.3.2. Characteristics of Scientific Method

A scientific method has its uniqueness and specific among all other methods used for the acquisition of knowledge or discovery of the facts or truth. By its very nature, mode of its procedure and the results arrived at through its use; it may be well distinguished and recognised in terms of its unique features as summarized below.

1. **Objectivity:** scientific method is quite objective in its approach and is almost free from biases, prejudices and subjectivity.
2. **Definiteness:** scientific method is characterized by definiteness in its process as well as product.
3. **Verifiability:** scientific method lays emphasis on the proper verification of the collected information, data or facts. Here nothing is accepted and derived unless verified through adequate observation, tests and experimentation.
4. **Generality:** The conclusions or results derived from the scientific method show a marked characteristic of generality.
5. **Predictability:** the results obtained through scientific method are characterized with the ability of predicting the future outcomes of the things or events.
6. **Modifiability and dynamicity:** the conclusions reached or results obtained through scientific method are never final, absolute or static. They are always open to verification, observation and experimentation. (Mangal & Mangal, 2015:13-14).

1.3.3. Steps of Scientific Method

Following are the steps of scientific method.

1. **Identification and definition of the problem:**

   This is the first step in the use of scientific method. A scientific inquiry starts with the identification of a problem that is in need of solution. The problem identified must be defined in such a manner that observation or experimentation in the natural world can provide a solution.

2. **Understanding the problem:**

   In this step, attempts are made to have a closer look into the nature of the problem through a careful study and analysis from all possible angels.

3. **Formulation of hypothesis:**

   Once the problem is defined, the next step is to formulate the hypothesis, which provides an intelligent guess for the solution of the problem. It requires a critical review of the knowledge or information related to the problem.

4. **Testing hypothesis (collection, organization and analysis of data):**

   Here in this step, attempts are made for testing the hypothesis under consideration by (i) collecting the relevant information, data or experimental evidences for the testing of the selected hypothesis, (ii) organizing the collected information, data in a proper way and then (iii) putting this organized data under proper scrutiny and analysis for arriving at some useful results or conclusions helpful in the solution to the problem.

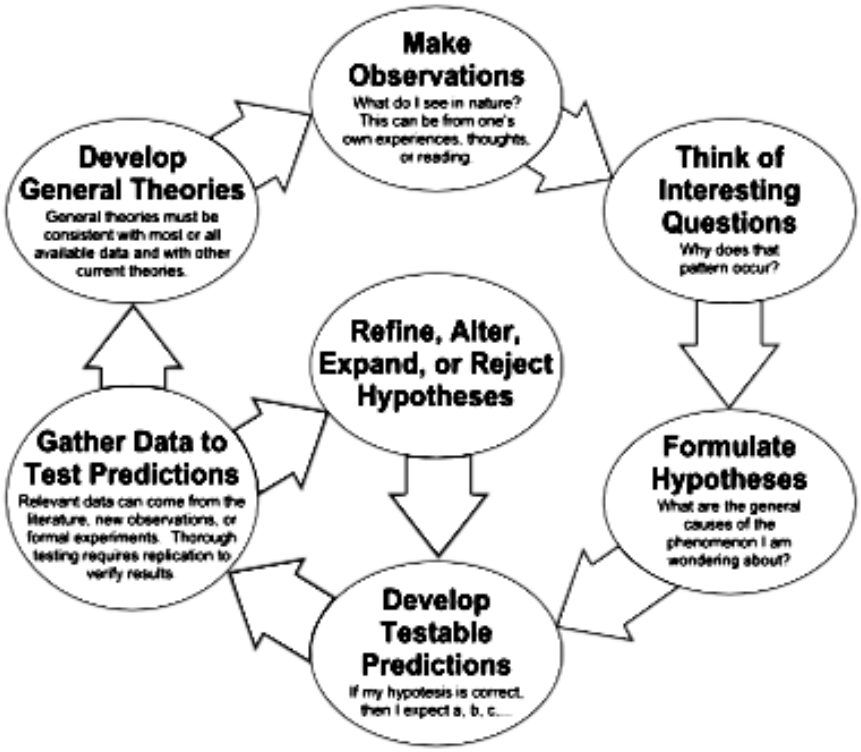
5. **Deriving appropriate inferences or conclusions:**

   Here in this step, attempts are made to draw appropriate and valid inferences or conclusions based on the efforts made for testing hypothesis. In the light of these derived inferences or conclusions, the decision is taken for the acceptance or rejection of the hypothesis in consideration

6. **Verification, rejection, or modification of hypothesis:**

   Once the evidence has been collected and analyzed, the results are analyzed in order to verify whether the evidence support the hypothesis. It may be noted that the characteristic of scientific method is not to prove the hypothesis in terms of

The Scientific Method as an Ongoing Process



absolute truth but to conclude that the evidence does or does not support the hypothesis (Mangal & Mangal, 2015:14-16).

1.3.4. The Scientific Method through Cyclical Process:

The scientific method is a continuous process that begins with observations about the natural world. People are naturally inquisitive, so they often come up with questions about things they see or hear, and they often develop ideas or hypothesis about why things are the way they are. The best hypotheses lead to predictions that can be tested in various ways. The strongest tests of hypotheses come from carefully controlled experiments that gather empirical data. Depending on how well additional tests match the predictions, the original hypothesis may require refinement, alteration, expansion or even rejection. If a particular hypothesis becomes very well supported, a general theory may be developed.

(Source: https://en.wikipediaorg/wiki/Scientific_method)

1.4. Research: Concept and Definition

The word 'research' means searching again, or to search for something new or to modify the existing ones. In this sense the word research signifies knowing something new or getting more knowledge about it. The general meaning of the word 'research' may emerge before us when we find people finding answer in the situation like below.

1. A housewife may try to know what combinations of sugar, salt or food contents make a dish more testy and presentable.
2. A coach may try to find out the best possible way to provide coaching to his hockey team.
3. A worker may try to find out technique of getting better output from the machines.

All the above persons are trying to find out solutions to their problems. In other words, it may be said that they are engaged in the task of research in their own ways. But so far as the real meaning of the term research is concerned here, it is quite possible that none of the above persons may be carrying out 'research' in its true sense. They may seek solutions to their problems or answers to their questions from some experts in their respective fields, or may acquire the desired knowledge from the reading of the books or literature, or get it through a mere chance trial.

Hence, let us look at some well definitions of research

Young (1966:15): Research is "the systematic method of discovering new facts or verifying the old facts, their sequences, interrelationships, casual explanations and the natural laws which govern him"

Kothari (1999:20): "The term research refers to the systematic method consisting of enunciating the problem, formulating a hypothesis, collecting the facts or data, analysing the facts and reaching certain conclusions either in the form of solutions towards the problem concerned or in certain generalizations for some theoretical formulations."

Best and Kahn (2006:25): "Research may be defined as the systematic and objective analysis and recording of controlled observations that may lead to the development of generalizations, principles, or theories, resulting in prediction and possibly ultimate control of events."

From the definitions and discussion it may conclude that the research is a systematic attempt to obtain answers to meaningful questions about phenomena or events through the application of scientific procedures. It is an objective, impartial, empirical and

logical analysis and recording or controlled observations that may lead to the development of generalizations, principles or theories, resulting, to some extent in prediction and control of events that may be consequences or causes of specific phenomena. Research is scientific and such, is not satisfied with isolated facts, but seeks to integrate and systematize its finding. It is concerned with the objective verification of generalizations. Such verification requires logical analysis of problems and devising of appropriate methodologies for obtaining evidence.

1.4.1. Research Design

The research design is the detailed plan of the investigation. In fact, it is the blue print of the detailed procedures of testing the hypotheses and analysing the obtained data. The research design, thus, may be defined as the sequence of those steps taken ahead of time to ensure that the relevant data will be collected in a way that permits objective analysis of the different hypotheses formulated with respect to the research problems. Thus, the research design helps the researcher in testing the hypotheses by reaching valid and objective conclusions regarding relationship between independent and dependent variables. The purpose of any research design is to provide a maximum amount of information relevant to the problem under investigation at a minimum cost. (A.K. Singh, 2004:375)

1.4.2. Methods of Research

There are three basic methods of research: 1) survey, 2) observation, and 3) experiment. Each method has its advantages and disadvantages.

Survey:

The survey is the most common method of gathering information in the social sciences. It can be a face-to-face interview, telephone, mail, e-mail, or web survey. A personal interview is one of the best methods obtaining personal, detailed, or in-depth information. It usually involves a lengthy questionnaire that the interviewer fills out while asking questions. It allows for extensive probing by the interviewer and gives respondents the ability to elaborate their answers. In the present times, email and web surveys are the most cost effective and fastest methods. Survey methods describe and specify the properties of educational phenomena. They include: social survey, school survey, college survey, public opinion survey etc.

Characteristics of Survey Method:

- Surveys ask questions about the nature, incident or distribution of educational variables.

- They are non-experimental, for they deal with relationships between non-manipulated variable in a natural, rather than an artificial setting.
- They use the logical method of inducative deductive reasoning to arrive at generalizations.
- They use techniques of observation, description and analysis.

Stapes of Survey Method:

1. Statement of the problem.
2. Identification of information needed to solve the problem.
3. Selection or development of instrument for gathering data.
4. Identification of target population and determination of any necessary sampling procedure.
5. Design of the procedure for data collection.
6. Collection of data.
7. Analysis of data.
8. Preparation of the report.

Observation method:

From the earliest history of scientific activity, observation has been the prevailing method of inquiry. Observation of natural phenomena, aided by systematic classification and measurement, led to the development of theories and laws of nature's forces. Observation continues to characterize all research: experimental, descriptive, and qualitative. For example, one may study the characteristics of a school building by observing and recording aspects such as materials of construction, number of rooms for various purposes, size of rooms, amount of furniture and equipment, presence or absence of certain facilities, and other relevant aspects. Adequacy could then be determined by comparing these facilities with reasonable standards previously determined by expert judgment and research.

Observation research monitors respondents' actions without directly interacting with them. It has been used for many years by A.C. Nielsen to monitor television viewing habits. Psychologists often use one-way mirrors to study behaviour. Anthropologists and social scientists often study societal and group behaviours by simply observing them. The fastest growing form of observation research has been made possible by the

bar code scanners at cash registers, where purchasing habits of consumers can now be automatically monitored and summarized. This method is very effective in the area of research conducted for special education.

Experimental method:

In an experiment, you test an idea (or practice or procedure) to determine whether it influences an outcome or dependent variable. You first decide on an idea with which to "experiment" assign individuals to experience it (and have some individuals experience something different), and then determine whether those who experienced the idea (or practice or procedure) performed better on some outcome than those who did not experience it.

You use an experiment when you want to establish possible cause and effect between independent and dependent variables. This means that you attempt to control all variables that influence the outcome except for the independent variable. Then, when the independent variable influences the dependent variable, we can say the independent variable "caused" or "probably caused" the dependent variable. Because experiments are controlled, they are the best of the quantitative designs to use to establish probable cause and effect. Four essential characteristics of experimental research: control, manipulation, observation and replication.

1.4.3. Sampling

For studying any problem, it is difficult to study the whole population or universe. Studying the entire universe is not only viable in many ways. It is therefore convenient to pick up a sample out of the universe proposed to be covered by the study. So let us define the term population, sample and sampling.

Population:

By population we mean the aggregate or totality of objects or individuals regarding which inferences are to be made in a sampling study. It means all those people or documents, etc. who are proposed to be covered under the scheme of study. A population is any group of individuals that have one or more characteristics in common that are of interest to the researcher.

A population is a group of individual who have same characteristic. For example, all teachers would make up the population of teachers, and all high school administrators in a school district would comprise the population of administrators. As these examples illustrate, population can be small or large. You need to decide what group you would like to study.

Sample:

A sample is a small proportion of a population selected for observation and analysis. It is a collection consisting of a part or subset of the objects or individuals of population which is selected for the express purpose of representing the population. By observing the characteristics of the sample, one can make certain inferences about the characteristics of the population from which it is drawn.

For instance, if we want to study the income pattern of professors in west Bengal and there are 10000 professors, then we may take a random sample of only 1000 professors out of this entire population of 10000 for the purpose of our study. Then this number of 1000 professors constitutes a sample.

Sampling:

Sampling is the process of selecting a sample from the population. It is technically and economically not feasible to take the entire population for analysis. So we must take a representative sample out of this population for the purpose of such analysis. A sample is a part of the whole, selected in such a manner as to be representing the whole.

Parameter:

When representative values such as mean, median, and standard deviation, calculated directly from the population, are termed parameters. A parameter is a population fact which depends upon or is a function of the scores for all the population units. It is the population value representing any trait or characteristics of the population as a whole.

Statistics:

A statistics is a sample fact which depends upon the scores of the particular sampling units comprising a sample. It is the sample value representing any trait or characteristics of the members of the sampling. (K.S. Sidhu, 2014: 253)

Sampling methods are classified as either probability or non probability. In probability samples, each member of the population has a known non-zero probability of being selected. Probability methods include random sampling, systematic sampling, and stratified sampling. In non probability sampling, members are selected from the population in some non random manner. These include convenience sampling, judgment sampling, quota sampling, and snowball sampling. The advantage of probability sampling is that sampling error can be calculated. Sampling error is the

degree to which a sample might differ from the population. When inferring to the population, results are reported plus or minus the sampling error. In non probability sampling, the degree to which the sample differs from the population remains unknown.

1.4.4. Data Collection

There are very few hard and fast rules to define the task of data collection. Each research project uses a data collection technique appropriate to the particular research methodology. The two primary goals for both quantitative and qualitative studies are to maximize response and maximize accuracy.

When using an outside data collection service, researchers often validate the data collection process by contacting a percentage of the respondents to verify that they were actually interviewed. Data editing and cleaning involves the process of checking for inadvertent errors in the data. This usually entails using a computer to check for out-of-bounds data.

Quantitative studies employ deductive logic, where the researcher starts with a hypothesis, and then collects data to confirm or refute the hypothesis. Qualitative studies use inductive logic, where the researcher first designs a study and then develops a hypothesis or theory to explain the results of the analysis.

Quantitative analysis is generally fast and inexpensive. A wide assortment of statistical techniques is available to the researcher. Computer software is readily available to provide both basic and advanced multivariate analysis. The researcher simply follows the pre-planned analysis process, without making subjective decisions about the data. For this reason, quantitative studies are usually easier to execute than qualitative studies.

Qualitative studies nearly always involve in-person interviews, and are therefore very labour intensive and costly. They rely heavily on a researcher's ability to exclude personal biases. The interpretation of qualitative data is often highly subjective, and different researchers can reach different conclusions from the same data. However, the goal of qualitative research is to develop a hypothesis--not to test one. Qualitative studies have merit in that they provide broad, general theories that can be examined in future research.

1.4.5. Reporting the Results

The most important consideration in preparing any research report is the nature of the audience. The purpose is to communicate information, and therefore, the report should be prepared specifically for the readers of the report. Sometimes the format for the report will be defined for the researcher (e.g., a thesis or dissertation), while other times,

the researcher will have complete latitude regarding the structure of the report. At a minimum, the report should contain an abstract, problem statement, methods section, results section, discussion of the results, and a list of references. (A.K. Singh, 2004: 460)

1.4.6. Validity

Validity refers to the appropriate or accuracy or truthfulness interpretations made from test scores and other evaluates with regard to particular usage. e.g., if a test is to be conducted to describe pupil's achievement, one should be able to interpret the scores as a relevant sample of the achievement to be measured. Basically validity is concerned with the specific use of the results and the sound interpretations based on definite premises. Are we measuring what we think we are? This is a simple concept, but in reality, it is extremely difficult to determine if a measure is valid.

Face validity is based solely on the judgment of the researcher. Each question is scrutinized and modified until the researcher is satisfied that it is an accurate measure of the desired construct. The determination of face validity is based on the subjective opinion of the researcher.

Content validity is similar to face validity in that it relies on the judgment of the researcher. However, where face validity only evaluates the individual items on an instrument, content validity goes further in that it attempts to determine if an instrument provides adequate coverage of a topic. Expert opinions, literature searches, and open-ended pre-test questions help to establish content validity.

Criterion-related validity can be either predictive or concurrent. When a dependent/ independent relationship has been established between two or more variables, criterion-related validity can be assessed. A mathematical model is developed to be able to predict the dependent variable from the independent variable. Predictive validity refers to the ability of an independent variable (or group of variables) to predict a future value of the dependent variable. Concurrent validity is concerned with the relationship between two or more variables at the same point in time.

Construct validity refers to the theoretical foundations underlying a particular scale or measurement. It looks at the underlying theories or constructs that explain phenomena. This is also quite subjective and depends heavily on the understanding, opinions, and biases of the researcher.

1.4.7. Reliability

Reliability is synonymous with repeatability. A measurement that yields consistent

results over time is said to be reliable. Whenever anything is measured, whether in the physical, biological, or behavioural sciences, there is some possibility of chance error or measurement error. This is true for educational or psychological tests as well.

According to Anastasi (1968) "Reliability means consistency of scores obtained by same individual when re-examined whit the test on different sets of equivalent items or under other variable examining conditions."

Characteristics of reliability:

- It is consistency of a test scores.
- It is the measure of variable error or chance error or measurement error.
- It is refers to the stability of a certain population.
- It is the coefficient of stability.
- It is the reproducibility of the scores.

There are three basic methods to test reliability: test-retest, equivalent form, and internal consistency.

A test-retest measure of reliability can be obtained by administering the same instrument to the same group of people at two different points in time. The degree to which both administrations are in agreement is a measure of the reliability of the instrument. This technique for assessing reliability suffers two possible drawbacks. First, a person may have changed between the first and second measurement. Second, the initial administration of an instrument might in itself induce a person to answer differently on the second administration.

The second method of determining reliability is called the equivalent-form technique. The researcher creates two different instruments designed to measure identical constructs. The degree of correlation between the instruments is a measure of equivalent-form reliability. The difficulty in using this method is that it may be very difficult (and/or prohibitively expensive) to create a totally equivalent instrument.

The most popular methods of estimating reliability use measures of internal consistency. When an instrument includes a series of questions designed to examine the same construct, the questions can be arbitrarily split into two groups. The correlation between the two subsets of questions is called the split-half reliability. The problem is that this measure of reliability changes depending on how the questions are split. A better statistic, known as Cronbach's alpha, is based on the mean (absolute value) inter item

correlation for all possible variable pairs. It provides a conservative estimate of reliability, and generally represents the lower bound to the reliability of a scale of items. For dichotomous nominal data, the KR-20 (Kuder-Richardson) is used instead of Cronbach's alpha.

1.4.8. Systematic and Random Error

Most research is an attempt to understand and explain variability. When a measurement lacks variability, no statistical tests can be (or need be) performed. Variability refers to the dispersion of scores.

Ideally, when a researcher finds differences between respondents, they are due to true difference on the variable being measured. However, the combination of systematic and random errors can dilute the accuracy of a measurement. Systematic error is introduced through a constant bias in a measurement. It can usually be traced to a fault in the sampling procedure or in the design of a questionnaire. Random error does not occur in any consistent pattern, and it is not controllable by the researcher.

1.4.9. Formulating Hypotheses from Research Questions

The word 'hypothesis' is composed of two different words- hypo and thesis. Hypo means something less or little and thesis means a derived conclusion or theory. In this sense, we can term hypothesis in the chain of our efforts to arrive at some valid conclusion to our finding as something less than formulating a theory. There are basically two kinds of research questions: testable and non-testable. Neither is better than the other, and both have a place in applied research.

Examples of non-testable questions are:

How do managers feel about the reorganization?

What do residents feel are the most important problems facing the community?

Respondents' answers to these questions could be summarized in descriptive tables and the results might be extremely valuable to administrators and planners. Business and social science researchers often ask non-testable research questions. The shortcoming with these types of questions is that they do not provide objective cut-off points for decision-makers.

In order to overcome this problem, researchers often seek to answer one or more testable research questions. Nearly all testable research questions begin with one of the following two phrases:

Is there a significant difference between...?

Is there a significant relationship between...?

For example: Is there a significant relationship between the age of learners and their attitudes towards the teachers?

Is there a significant difference between majority and minority residents with respect to what they feel are the most important problems facing the community?

A research hypothesis is a testable statement of opinion. It is created from the research question by replacing the words "Is there" with the words "There is", and also replacing the question mark with a period. The hypotheses for the two sample research questions would be:

There is a significant relationship between the age of learners and their attitudes towards the teachers.

There is a significant difference between majority and minority residents with respect to what they feel are the most important problems facing the community.

It is not possible to test a hypothesis directly. Instead, you must turn the hypothesis into a null hypothesis. The null hypothesis is created from the hypothesis by adding the words "no" or "not" to the statement. For example, the null hypotheses for the two examples would be:

There is no significant relationship between the age of learners and their attitudes towards the teachers.

There is no significant difference between majority and minority residents with respect to what they feel are the most important problems facing the community.

All statistical testing is done on the null hypothesis...never the hypothesis. The result of a statistical test will enable you to either 1) reject the null hypothesis, or 2) fail to reject the null hypothesis. Never use the words "accept the null hypothesis".

1.4.10. Type I and Type II Errors

There are two types of hypothesis testing errors. The first one is called a Type I error. This is a very serious error where you wrongly reject the null hypothesis. It means rejection of a hypothesis, which should have been accepted. It is denoted by a (alpha) and is also known as alpha error.

A Type II error is less serious, in this type of error where you are supposed to accept a null hypothesis, which should have been rejected. It is denoted by (beta) and is also

known as beta error. Usually, the consequences of a Type II error will be less serious than a Type I error.

Type I error - Rejecting H0 when H0 is true.

Type II error - Accepting H0 when H0 is false.

1.4.11. Types of Data

One of the most important concepts in statistical testing is to understand the four basic types of data: nominal, ordinal, interval, and ratio. The kinds of statistical tests that can be performed depend upon the type of data you have. Different statistical tests are used for different types of data.

Nominal and ordinal data are nonparametric (non-continuous or categorical). Interval and ratio scales are called parametric (continuous). Some statistical tests are called parametric tests because they use parametric data. Others are called nonparametric tests because they use nonparametric data. All statistical tests are designed to be used with a specific kind of data, and may only be performed when you have that kind of data.

Nominal data

In nominal data, numbers or symbols are used to identify an object, person or group and its characteristics. Nominal data is characterized by non-ordered response categories.

Examples of nominal data

What is your sex? ____ Male ____ Female

Do you have health insurance? ___ Yes ___ No ___ don't know

Ordinal data

In ordinal data, various group of population are divided according to a certain order or serial keeping in view properties being measured. Ordinal data is characterized by ordered response categories.

Examples of ordinal data

What is your highest level of education ___ primary ___ secondary ___ higher secondary ___ graduate ___ post graduate

How would you rate your progress? ___ Excellent___ Good ___ Fair___ Poor

Interval data

Measures with order and establishes numerically equal distances on the scale

Examples

Temperature, Attitudinal scale (Thurstone scale)

Ratio data

It has a fix starting point, e.g. a zero point.

Examples

What is your age? _____

How many units have you completed? (Circle) 0 1 2 3 (Mangal & Mangal, 2015:305-310)

1.4.12. Test of Significance

Test of significance means that there is a good chance that we are right in finding that a relationship exists between two variables. But statistical significance is not the same as practical significance. We can have a statistically significant finding may have no practical application. The researcher must always examine both the statistical and the practical significance of any research finding, often times, when difference are small but statistically significant, it is due to a very large sample size. In a sample of a smaller size, the differences would not be enough to be statistically significant.

Level of significance

The rejection or acceptance of a null hypothesis is based on some level of significant as a criterion.

Rejecting a null hypothesis at the 5% (0.05) level indicates that a difference in mean as large as that found between the experimental and control groups would have resulted from sampling error is less than 5 out of 100 replications of the experiment. This suggests a 95% probability that the difference was due to the experimental treatment rather than to sampling error.

A more rigorous test of significance is the 1 %(0.01) level. Rejecting a null hypothesis at the 0.01 level would suggest that a difference in means as large as that found between the experimental and control groups would have resulted from sampling error is less than 1 out of 100 replications of the experiment. This suggests a 99% probability that the difference was due to the experimental treatment rather than to sampling error.

Procedure for Significance Testing

Whenever we perform a significance test, it involves comparing a test value that we

have calculated to some critical value for the statistic. It doesn't matter what type of statistic we are calculating (e.g., a t-statistic, a chi-square statistic, an F-statistic, etc.), the procedure to test for significance is the same.

1. Decide on the critical alpha level you will use (i.e., the error rate you are willing to accept).
2. Conduct the research.
3. Calculate the statistic.
4. Compare the statistic to a critical value obtained from a table or compares the probability of the statistic to the critical alpha level.

If your statistic is higher than the critical value from the table or the probability of the statistic is less than the critical alpha level:

- Your finding is significant.
- You reject the null hypothesis.
- The probability is small that the difference or relationship happened by chance, and p is less than the critical alpha level (P < alpha).

If your statistic is lower than the critical value from the table or the probability of the statistic is higher than the critical alpha level:

- Your finding is not significant.
- You fail to reject the null hypothesis.
- The probability is high that the difference or relationship happened by chance, and p is greater than the critical alpha level (P > alpha).

Modern computer software can calculate exact probabilities for most test statistics. When Stat Pac (or other software) gives you an exact probability, simply compare it to your critical alpha level. If the exact probability is less than the critical alpha level, your finding is significant, and if the exact probability is greater than your critical alpha level, your finding is not significant. Using a table is not necessary when you have the exact probability for a statistic.

1.4.13. One-Tailed and Two-Tailed Tests

In statistical significance testing, a one-tailed test or two-tailed test are alternative ways of computing the statistical significance of a data set in terms of a test statistic, depending on whether only one direction is considered extreme or both directions are

considered extreme. Alternative aims are one sided and two sided tests; the term 'tail' is because the extremes of distribution are often small as in the normal distribution.

We apply two-tailed test or non-directional test for determining the significance of the difference between two obtain means, we do not care for the direction of such a difference, whether positive or negative. For example, a null hypothesis was set up that there are no difference between the mean achievement scores of boys and girls.

In one-tailed test, when we are hypothesising a direction of difference in a definite term, rather than the mere existence of a difference like as positive or negative, higher or lower, we make use of one -tailed test or directional test. For example, a null hypothesis was set up that boys have higher achievement than girls; then this hypothesis indicates a direction of the difference.

1.4.14. Central Tendency

The best known measures of central tendency are the mean and median. The mean average is found by adding the values for all the cases and dividing by the number of cases. For example, to find the mean age of all your friends, add all their ages together and divide by the number of friends. The mean average can present a distorted picture of central tendency if the sample is skewed in any way.

For example, let's say five people take a test. Their scores are 10, 12, 14, 18, and 94. (The last person is a genius.) The mean would be the sums of the scores 10+12+14+18+94 divided by 5. In this example, a mean of 29.6 is not a good measure of how well people did on the test in general. When analyzing data, be careful of using only the mean average when the sample has a few very high or very low scores. These scores tend to skew the shape of the distribution and will distort the mean.

When you have sampled from the population, the mean of the sample is also your best estimate of the mean of the population. The actual mean of the population is unknown, but the mean of the sample is as good an estimate as we can get.

The median provides a measure of central tendency such that half the sample will be above it and half the sample will be below it. For skewed distributions this is a better measure of central tendency. In the previous example, 14 would be the median for the sample of five people. If there is no middle value (i.e., there are an even number of data points), the median is the value midway between the two middle values.

The distribution of many variables follows that of a bell-shaped curve. This is called a "normal distribution". One must assume that data is approximately normally distributed for many statistical analyses to be valid. When a distribution is normal, the

mean and median will be equal to each other. If they are not equal, the distribution is distorted in some way.

1.4.15. Variability

Variability is synonymous with diversity. The more diversity there is in a set of data, the greater the variability. One simple measure of diversity is the range (maximum value minus the minimum value). The range is generally not a good measure of variability because it can be severely affected by a single very low or high value in the data. A better method of describing the amount of variability is to talk about the dispersion of scores away from the mean.

The variance and standard deviation are useful statistics that measure the dispersion of scores around the mean. The standard deviation is simply the square root of the variance. Both statistics measure the amount of diversity in the data, the higher the statistics, the greater the diversity.

1.4.16. Degrees of Freedom (df)

Degrees of freedom literally refer to the number of data values that are free to vary. The number of degrees of freedom in a distribution is the number of observations or values that are independent of each other that can be deduced from each other. Estimates of statistical parameters can be based upon different amounts of information or data. The number of independent pieces of information that go into the estimates of a parameter is called the degree of freedom. The concept of degrees of freedom is highly important in small sample statistics. For example, suppose we have to select any five numbers. We have complete freedom of choice as to what the numbers are. So, we have five degree of freedom. Suppose, however, we are then told that the five numbers must have a total value of 25. We will have complete freedom of choice to select four numbers but the fifth will be dependent on the other four. Let's say that the first four numbers we select are 2,3,5 and 6, which total 16, then, if the total value of five number must be 9. Then, 2+3+5+6+9=25, so only four numbers are free to vary; the fifth has lost its freedom. In our example, then, df =4, that is N-1=5-1=4.

Calculation of the variance and the standard deviation will be based on N-1 independent observations or N-1 degree of freedom, as the co-efficient of correlation (r) depends on the deviations from two means, so number of degrees of freedom is N-2. (B.K.Sahu, 2004: 177)

1.5. Application of Scientific Method in Research

Scientific method is very important in the field of research. It guides the research to be very specific to wind up the entire process of the research work. However it suggests the structure begin with problem and end with the concrete result as well as outcome.

Research originates with a question or problem:

In the field of disability studies there are numerous problems such as teaching learning of special children, rehabilitation of differently able, socialization of disable children etc. can be the thought of research. In this regard, the world is filled with unanswered questions, unresolved problems. Everywhere we look, we observe things that cause us to wonder, to speculate, and to ask questions: why? What's the cause of that? What does it all mean? These are everyday questions. With question like this, research begins and by asking questions, we strike the first spark igniting a chain reaction that terminates in the research process. An inquisitive mind is the beginning of research.

Research requires a clear articulation of goal:

Scientific method helps researcher to select a goal for further investigation and exploration. It is very difficult to investigate with variety of goals. However, goal must be defined and clear. This goal is an exercise in intellectual honesty. This is basic and is required for the success of any research undertaking.

Researcher requires a specific plan of procedure:

Scientific method help researcher with a specific plan of procedure to conduct a research. Research is not an excursion into happy expectation. It is instead, a carefully planned attack, a search and discovers mission explicitly planned in advance. The overall research effort must be explicit planned and logically designed. Researcher plan their overall research design and specific research methods in a purposeful way --- that is, to yield data relevant to their particular research problem.

Research usually divides the principal problem into more manageable sub problems:

Scientific method helps researcher to divide the principal problem into sub problems. If researchers do not take the time or trouble to isolate the lesser problems within the major problem, their research project becomes cumbersome and unwieldy.

Research is guided by the specific research problems, question, or hypothesis:

Having stated the problem and the attendant sub problems, each sub problem is then

viewed through a construct called hypothesis. A hypothesis is a logical supposition, a reasonable guess, and an educated conjecture. It may direct your thinking to the possible source of information that will aid in resolving the research problem through the resolution of each attendant sub problem.

Research accepts certain critical assumptions:

In research assumption is a condition that is taken for granted, without which the research situation would be impossible.

Research requires the collection and interpretation of data in attempting to resolve the problem that initiated the research:

Having now isolated the problem, divided it into appropriate sub problems, frame reasonable questions or hypothesis, and recognized the assumptions that are basic to the entire effort, the next step is to collect whatever data seem appropriate and to organize them in meaningful ways so that they can be interpreted.

1.6. Purpose of research

Research is a systematic inquiry that uses disciplined method to answer questions or solve problems. It indicates that research is more formal aspects. Research has drawn its pattern and spirit from the physical sciences and has represented a rigorous, structured type of analysis. The goal of research is the development of theories by the discovery of broad generalizations or principles.

1.7. Research in Education and Special Education

Research in education as in the other fields is essential for providing useful and dependable knowledge through which the process of education can be made more effective. There are various considerations, which emphasize need for research in education.

Educational research refers to a systematic attempt to gain a better understanding of the educational process, generally with a view to improving its efficiency. It is an application of scientific method to the study of educational problems. Travers (1958) states: educational research represents an activity directed towards the development of an organized body of scientific knowledge about the events with which educators are concerned.

According to the Report of the First International Conference on Educational research, "Research is literally speaking a kind of human behaviour, an activity in which people

engage".

In education and special education, teachers, administrators, scholars or others engage in educational research, when they systematically assemble information about schools, school children and special children, the social matrix in which a school system is determined, the characteristics of the learner or the interaction or the interaction between the school and the pupils.

From the above discussion it may be stated that:

- A scientific body of knowledge about education should enable the educators to determine just what teaching and other learning condition to provide in order to produce desired aspects of learned behaviour among young people who attended school.
- Since education is a behavioural science, the major concern of educational research is to understand, explain and to some degree predict and control human behaviour. It is an activity directed towards the development of organized and useful body of scientific knowledge about the events with which educators are concerned.
- Education and special education have strong roots in the fields like philosophy, history, economics, psychology and sociology. It is however based on conceptual frame of theory. It is through an intensive process of scientific enquiry about the philosophical, historical, economic, psychological and sociological impact on various aspects of education that sound theories can be established.
- Research in education is not only meant for specialist. Any teacher with common sense, intelligence and insight can undertake this type of research, but in the beginning, such persons need some guidance and training from an expert.
- Research in education may admit varying paradigms of world view about the reality; hence it may be either of quantitative, qualitative or mixed type.
- The uses of action research have shown great interest in the field of education and special education. Because it focused on immediate application, not on the development of theory or on generalization of applications. It has placed its emphasis on a problem here and now in a local setting.

1.8. Let us sum up

Research is a very important and critical task that anyone anywhere cannot do it without

knowing its proper methods or procedures. For conducting any research the knowledge of the scientific methods is very essential because, it helps researcher to conduct his/her research in a systematic manner. Along with the scientific methods, the concept and definition of research also help us to know about various activities related with the research work such as research design, method of research, sampling procedures, procedure of data collection, validity, reliability, test of significance and how to write a research report. Like other fields, in the field of education and special education conducting research is an indispensable aspect as there are constant changes in the area of learner attitude, subject content, way of teaching and the instructional objectives.

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1.10. Check Your Progress

1. Define research.
2. What is meant by scientific method of research?
3. What is meant by identification of a research problem?
4. What is hypothesis?
5. Write any one nature of scientific method.
6. Define population.
7. What is the difference between sample and sampling?
8. Define degree of freedom with example.

Unit-2 ❑ Types & Process of Research

2.1: Introduction:

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 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 in every time or place.

2.2: Objectives:

Upon Completion of the Unit, you will be able to

- distinguish between different types of research
- delineate the different processes of research
- identify various tools of research
- develop the concept of action research in teaching-learning environment
- understand the requisites of professional competencies for research

2.3: Types 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 the data which 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 Survey Research
- Experimental Research
- Single - Subject Research
- Causal - Comparative Research
- Correlational Research

- Meta-analysis

Combination methods

There also exists a new school of thought that these derivatives of the scientific method are far too reductionist in nature. Since educational research includes other disciplines such as psychology, sociology, anthropology, science, and philosophy and refers to work done in a wide variety of contexts it is proposed that researchers should use "multiple research approaches and theoretical constructs". This could mean using a combination of qualitative and quantitative methods as well as common methodology from the fields mentioned above. In social research this phenomenon is referred to as triangulation (social science). This idea is well summarized by the work of Barrow, 1975 in his text -"An introduction to philosophy of education":

"Since educational issues are of many different kinds and logical types, it is to be expected that quite different types of research should be brought into play on different occasions. The question therefore is not whether research into teaching should be conducted by means of quantitative measures (on some such grounds as that they are more 'objective') or qualitative measures (on some such grounds as that they are more 'insightful'), but what kind of research can sensibly be utilized to look into this particular aspect of teaching as opposed to that."

The main differences between qualitative and quantitative research methods can be summarized in the following points:

1. the concepts in quantitative research methods are usually expressed in the forms of variables, while the concepts in qualitative research methods are expressed in motives and generalizations.
2. quantitative research methods and measures are usually universal, like formulas for finding mean, median and mode for a set of data, whereas, in qualitative research each research is approached individually and individual measures are developed to interpret the primary data taking into account the unique characteristics of the research.
3. data in quantitative research appears in the forms of numbers and specific measurements and in qualitative research data can be in forms of words, images, transcripts, etc.
4. research findings in quantitative research can be illustrated in the forms of tables, graphs and pie-charts, whereas, research findings in qualitative studies is usually presented in analysis by mainly using words.

Characteristic	Quantitative research	Qualitative research
Type of data	Phenomena are described numerically	Phenomena are described in a narrative fashion
Analysis	Descriptive and inferential statistics	Identification of major schemes
Scope of inquiry	Specific questions or hypotheses	Broad, thematic concerns
Primary advantage	Large sample, statistical validity, accurately reflects the population	Rich, in-depth, narrative description of sample
Primary disadvantage	Superficial understanding of participants' thoughts and feelings	Small sample, not generalizable to the population at large

The following table presents the main differences between qualitative and quantitative research methods:

Fig: Qualitative and Quantitative Research Methods

After discussing the two prime types of researches, we now narrow our discussion to various types of research in this subunit. This classification is based on objectives of research. They are:

1. Basic/Fundamental research

Basic research advances fundamental knowledge about the world. It focuses on supporting theories that explain observed phenomena. Pure research is the source of newest scientific ideas and ways of thinking about the world. It can be exploratory, descriptive, or explanatory; however, explanatory research is the most common.

Basic research generates new ideas, principles, and theories, which may not be immediately utilized but nonetheless form the basis of progress and development in

different fields. Today's computers, for example, could not exist without research in pure mathematics conducted over a century ago, for which there was no known practical application at the time. Basic research rarely helps practitioners directly with their everyday concerns; nevertheless, it stimulates new ways of thinking that have the potential to revolutionize and dramatically improve how practitioners deal with a problem in the future. It can be clubbed together into the following befitting points

a. Also called as the fundamental or the theoretical research.

b. Is basic and original.

c. Can lead to the discovery of a new theory.

d. Can result in the development or refinement of a theory that already exists.

e. Helps in getting knowledge without thinking formally of implementing it in practice based on the honesty, love and integrity of the researcher for discovering the truth.

2. Applied research

a. Based on the concept of the pure research.

b. Is problem oriented.

c. Helps in finding results or solutions for real life problems.

d. Provides evidence of usefulness to society.

e. Helps in testing empirical content of a theory.

f. Utilizes and helps in developing the techniques that can be used for basic research.

g. Helps in testing the validity of a theory but under some conditions.

h. Provides data that can lead to the acceleration of the process of generalization.

3. Action research

The Process by which practitioners attempt to study their problems scientifically in order to guide, correct and evaluate their decision and action is called action research. The details of it are dealt in the subsequent subunit-2.6

4. Exploratory research

a. Involves exploring a general aspect.

b. Includes studying of a problem, about which nothing or a very little is known.

c. Follows a very formal approach of research.

d. Helps in exploring new ideas.

e. Helps in gathering information to study a specific problem very minutely.

f. Helps in knowing the feasibility in attempting a study.

5. Descriptive research

a. Common form of research.

b. More specific in nature and working than exploratory research.

c. It involves a mutual effort.

d. Helps in identifying various features of a problem.

e. Restricted to the problems that are describable and not arguable and the problems in which valid standards can be developed for standards.

f. Existing theories can be easily put under test by empirical observations.

g. Underlines factors that may lead to experimental research.

h. It consumes a lot of time.

i. It is not directed by hypothesis.

6. Diagnostic study

a. Quite similar to the descriptive research.

b. Identifies the causes of the problems and then solutions for these problems.

c. Related to causal relations.

d. It is directed by hypothesis.

e. Can be done only where knowledge is advanced.

7. Evaluation study

a. Form of applied research.

b. Studies the development project.

c. Gives access to social or economicalprogrammes.

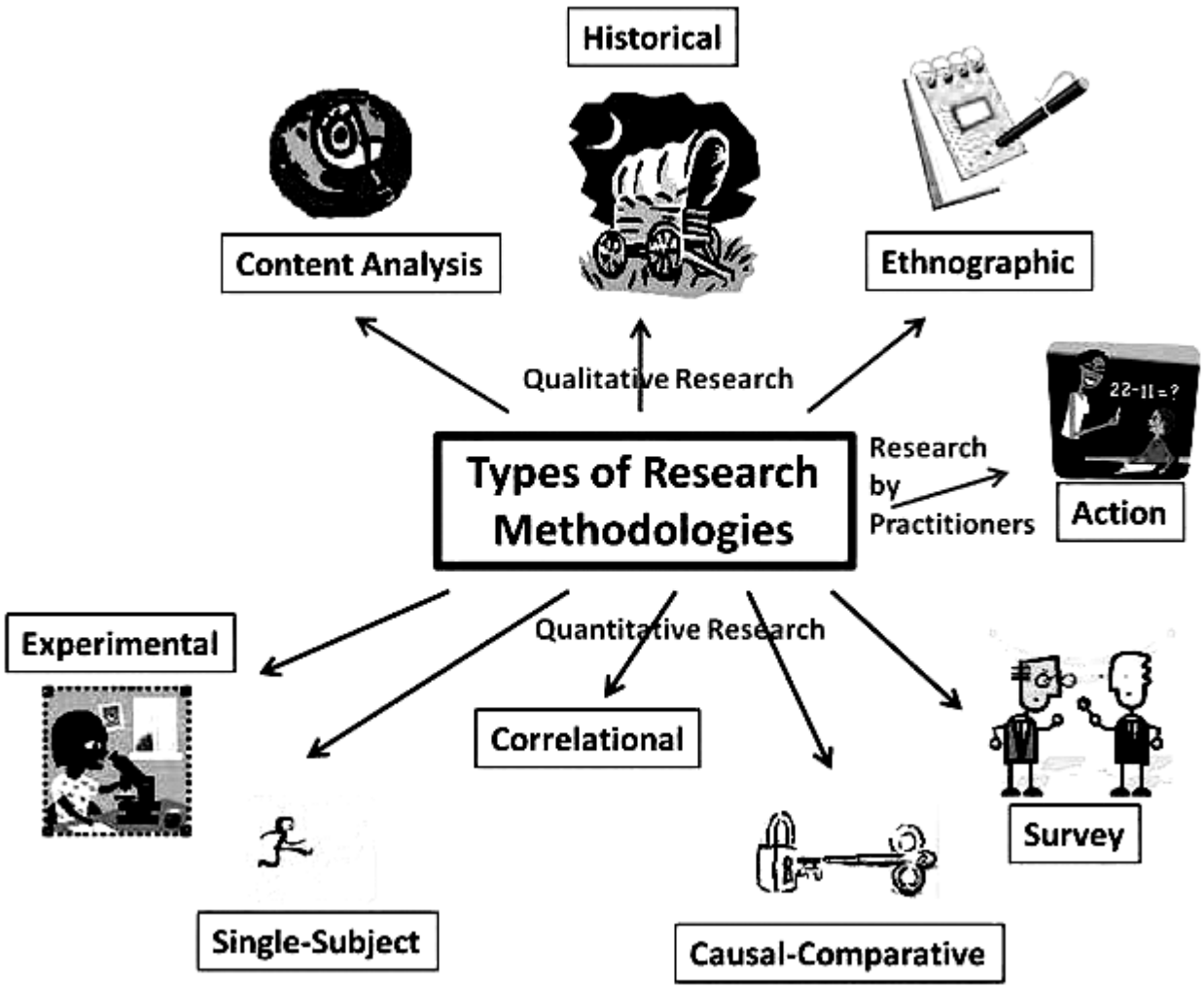

Fig: Educational Research: In a nutshell

Image Courtesy: http://researchbasics.education.uconn.edu/types-of-research/

2.4: Process of Research

The following steps are involved in the process of educational Research-

A. Selection of a Problem

B. Survey of the past experiences in the selected field of study (Review of Related Literature)

C. Formulation of Hypotheses/Research Questions

D. Deciding on the objectives

E. Collection of data/evidences

F. Analysis of data and summarization

G. Generalizations/ conclusions

H. Suggestions for further Study

Let us now discuss each step of the process of research-

A. Selection of a Problem-The following steps are to be followed in selection of a research problem-

a) Determining the field of research in which the researcher is keen to do the research work.

b) Developing the mastery on the area chosen

c) Should review the researches/studies conducted in area to know the recent trend

d) On the basis of the review, one should consider the priority field of the study

e) Locating the problem by the help of supervisor/guide/mentor/own expertise

f) One should pin point specific aspect of the problem which is to be investigated

Criteria for selection of the Problem-It involves the following tasks-

a) Novelty and avoidance of unnecessary duplications.

b) Importance for the field represented and implementation

c) Interests, intellectual curiosity and drive

d) Training and personal qualifications

e) Availability of data and method

f) Special equipment and wor4king conditions

g) Approachability of the sample

h) Sponsorship and administrative cooperation

i) Hazards, penalties and handicaps

j) Cost and returns

k) Time factor

Hildreth H McAshan (1963), has proposed few objective guides for judging the merits of a selected problem-

a) Is the problem really important?

b) Is it interesting to others?

c) Will I learn something new from this problem?

d) Am I really concerned with finding the solutions?

e) Does the problem display originality and creativeness? Etc

B. Survey of the past experiences in the selected field of study (Review of Related Literature)

This step ensures avoidance of unnecessary duplication of the problem. Detailed information regarding appropriate use of library guides and ICT and get an illustrative review of related literature. The researcher/investigator is obligated to make critical examinations of such related studies. Literature may come up with guided hypotheses, suggestive methods of research and comparative data useful in the interpretation of results. A brief summary of previous research should be given so that the researcher and reader may be familiar with what is still unknown and untested. The effective research is based upon past knowledge. A review of related literature should conclude with a comment of area of agreement and disagreement in findings.

C. Formulation of Hypotheses- A research/study is based on hypotheses. It clearly establishes the nature of the problem and logic underlying the investigation. The hypothesis indicates the expected outcomes of the investigation. The formulation of hypotheses in advance of the data gathering process is necessary for an unbiased investigation. The hypotheses should be stated first in positive or substantive form. In every investigation hypothesis cannot be formulated but objectives of the study can be written to indicate the direction of the research work.

D. Deciding on the Objectives- Objectives are always framed in order to give direction and shape to the study/research/investigation taken for consideration.The objectives of the work, i.e. the overall purpose of the study, should be clearly and concisely defined. They are broad statements of desired

outcomes, or the general intentions of the research, which 'paint a picture' of your research project. It emphasizes what is to be accomplished (not how it is to be accomplished). A specific result that a person or system aims to achieve within a time frame and with available resources. In general, objectives are more specific and easier to measure than goals. Objectives are basic tools that underlie all planning and strategic activities. It would state the overall aim of the project, which is to take us closer to solving the larger research problem, and the overall objective, which is to carry out the research project. Also, there is a sentence that states why the research problem is important and which may also introduce the specific aims.

Use the **S.M.A.R.T.** method of writing your objectives. **Specific, Measurable, Attainable, Realistic, and Time-bound.**

Keep the following in mind when preparing your objectives:

- State your objectives in quantifiable terms.
- State your objectives in terms of outcomes, not process.
- Objectives should specify the result of an activity.
- Objectives should identify the target audience or community being served.
- Objectives need to be realistic and capable of being accomplished within the grant period.

Tips for writing good goals and objectives:

- Tie your goals and objectives directly to your need statement.
- Include all relevant groups and individuals in your target population.
- Always allow plenty of time to accomplish the objectives.
- Do not confuse your outcome objectives for methods.
- Figure out how you will measure the change projected in each objective. If there is no way to measure an objective, it's not measurable and should be rewritten.
- Don't forget to plan for the evaluation (measurement) of your objectives.

Methodology and Procedure of the Study- This includes the three points of process of research. They are: E) Collection of data/evidences, F)Analysis of data and summarization, G)Generalizations/ conclusions, H) Suggestions for further research. These are discussed in the following section:

E. Collection of Data- Data means observations or evidences.Research tools are administered on the sample subjects for collecting evidences or data. Most educational research leads to the gathering of data by means of some standardized test or self-constructed research tools. It should provide objective data for interpretation of results achieved in the study. The data may be obtained by administering questionnaires, testing, personal observations, interviews and many other techniques of collecting quantitative and qualitative evidence.

The researcher/investigator must know how much and what kind of data collection will take place and when. S/he must also be sure that the types of data obtainable from the selected instruments will be usable in any statistical model s/he will use later to bring out the significance of the study. The data collection is the accumulation of specific evidence that will enable the researcher to properly analyse the results of all activities by her/his research design and procedures. The main purpose of data collection is to verify the research hypotheses. It provides a solid foundation for any educational research.

F. Analysis of Data and Summarization- A prime responsibility of an educational researcher is that of being able to make either a probability or logical reference covering the tenability of the testable hypotheses/ objectives taken into consideration. The acceptance or rejection of these hypotheses will ultimately determine what contribution the study makes to the social/cultural (or the like) development of a particular area. This is actually carried out/tried in the analysis for interpretation of data.

Analysis of data means studying the tabulated material in order to determine inherent facts or meanings. It involves breaking down existing complex factors into simpler parts and putting the parts together in new arrangements for the purpose of interpretation. Barr and Scates suggest four helpful modes while analyzing the

Analysis of data includes comparison of the outcomes of the various treatments upon the several groups and ultimately arriving at a decision as to the achievement of the aims/objectives of the study/research. Analysis may be quantitative or qualitative or both depending on the objectives set/hypotheses framed to test the objectives.Analysis is an important phase of the classification and summation of data into a summary.

G. Generalizations/ Conclusions:

It is the final aspect of data analysis plan of any research/investigation. This is

the final stage for the researcher to look back over all the decisions and choices that have been made to identify the final set of assumptions required for the investigation/research/study to be sensible and the limitations to the conclusions which will hold if the present plans for the investigation/research/study are implemented.Having stated the assumptions and limitations and researcher should scan them as a total set and review them with one thought in mind. This part of the research/study/investigation should have the critical analysis/ appreciation with the objectives stated and hypotheses framed for testing/ verification. The generalization of facts needs to be verified in terms of cross reference and opinions and remarks put forward by the related studies.

H. Suggestions for Further/Future Research:

The Future Research section is often combined with the Research Limitations section. This is because your future research suggestions generally arise out of the research limitations you have identified in your own work/study/ investigation/research. These include:

i. building on a particular finding in your research;

ii. addressing any imperfection in your research;

iii. examining in case of qualitative research design or testing a theory, framework or model in case of quantitative research design in a new context, location and/ or culture;

iv. re-evaluating and

v. expanding a theory (framework or model).

This will help you think about the potential types of future research suggestion that you may want to include at the end of your work/study/investigation/ research.

2.5 Tools of Research

In every research work, it is essential to collect factual material or data unknown or untapped so far. They can be obtained from many sources, direct or indirect. It is necessary to adopt a systematic procedure to collect essential data. Relevant data, adequate in quantity and quality should be collected. They should be sufficient, reliable and valid.

For checking new, unknown data required for the study of any problem you may use various devices, instruments, apparatus and appliances. For each and every type of research we need certain instruments to gather new facts or to explore new fields. The instruments thus employed as means for collecting data are called tools. The selection of suitable instruments or tools is of vital importance for successful research. Different tools are suitable for collecting various kinds of information for various purposes. The research worker may use one or more of the tools in combination for his purpose. Research students should therefore familiarise themselves with the varieties of tools with their nature, merits and limitations.

They should also know how to construct and use them effectively. The systematic way and procedure by which a complex or scientific task is accomplished is known as the technique. Technique is the practical method, skill or art applied to a particulate task. So, as a researcher we should aware of both the tools and techniques of research. The major tools of research ineducation can be classified:

1. Tests- Among the most useful and most frequently employed tools of educational research psychological tests and Achievement tests occupy a very significant position. Psychological tests are described to describe and measure a sample of certain aspects of human behaviour or inner qualities. They yield objective descriptions of some psychological aspects of an individual's personality and translate them inquantitative terms. For Example, 'Aptitude tests' and 'attitude Tests'. Below given are some important tests used in Educational Research:

- Achievement Test
- Aptitude Test
- Intelligence Test
- Interest inventory
- Personality measures etc.

In this unit some of them will be discussed in details.

Aptitude Tests: "Aptitude tests attempt to predict the capacities or the degree of achievement that may be expectedfrom individuals in a particular activity". Aptitude is a means by which one can find the relative knowledge of a person in terms of his intelligence and also his knowledge in general.

Purpose:

The purpose of aptitude test is to test a candidate's profile. Aptitude test helps to check one's knowledge and filters the good candidates. The ability of creativity and intelligence is proved by the aptitude test. It always checks the intelligence and fastness of the person in performance

Uses of Aptitude Test:

Aptitude tests are valuablein making programme and curricula decisions. In general, they have three major uses:

a. **Instructional:**

   Teacher can use aptitude test results to adopt their curricula to match the level of students or to design assignments for students who differ widely.

b. **Administrative:**

   Result of Aptitude tests help in determining the programmes for college onthe basis of aptitude level of high-school. It can also be used identifying students to be accelerated or given extra attention, for exampling and in predicting job training performance.

c. **Guidance:**

   Result of aptitude tests help counsellors to help parents and students. Parents develop realistic expectations for their Child's performance and students understand their own strength and weaknesses.

(N.B: Intelligence tests are also a kind of aptitude test as they describe and measure the general ability which enters into the performance of every activity and thus predict the degree of achievement that may be expected from individuals in various

Activities).

Aptitude test, however haveproved of great value for research in educational and vocational guidance, for research in selection of candidates for particularcourse of study or professional training and for research of the complex causal relationship type.

Another form of tests widely used in Educational research is Achievement Test. Achievement test is an important tool in school evaluation and has great significance in measuring instructional progress and progress of the students in the subject area. Achievement means one's learning attainments, accomplishments, proficiencies, etc. It is directly related to the pupil's growth and development in educational situations. Tests should give an accurate picture of students' knowledge and skills in the subject area or domain being tested. Accurate achievement data are very important for planning curriculum and instruction and for program evaluation. Test scores that overestimate or underestimate students' actual knowledge and skills cannot serve these important purposes.

Objectives

- Identify and explain reasons for performing tests.
- Understand testing terminology to communicate clearly with students and colleagues.
- Evaluate a test's validity and reliability.
- Select appropriate tests.
- Administer test protocols properly and safely.

Functions of test

- It provides basis for promotion to the next grade.
- To find out where each student stands in various academic areas.
- It helps in determination about the placement of the students in a particular section.
- To motivate the students before a new assignment has taken up.
- To know effectively the student is performing in theory as well as in clinical areas.
- To expose pupil's difficulties which the teacher can help them to solve.

Characteristics of a good test

Test preparation activities which promote quality, long-term learning are appropriate, even essential. Good test-taking skills and appropriate content learning can reduce the likelihood that extraneous factors will influence students' test scores. The various characteristics of a good test are:

- It can be tried out and selected on the basis of its difficulty level and discriminating power.
- Directly related to the educational objectives.
- It should possess description of measure behavior in realistic and practical terms.
- Contains a sufficient number of test items for each measured behavior; concerned with important and useful matter; comprehensive, brief, precise and clear.
- It should be divided into different knowledge and skills according to behavior to be measured.
- Standardized the items and made instructions clear so that different users can utilize it.
- Rules and norms have to be developed so that various age groups can use at various levels.
- It provides equivalent and comparable forms of the test.
- A test manual has to be prepared, which can act as a guide for administering and scoring.

Achievement Tests are of two types: Norm-referenced tests and Criterion-referenced tests. Follow the given table to get a better understanding of NRT and CRT.

Table: NRT Vs CRT

	Quantitative research	**Qualitative research**
Definition	Norm-Referenced Norm-Referenced tests measure the performance of one group of test takers against another group of test takers.	Criterion-Referenced tests measure the performance of test takers against the criteria covered in the curriculum.
Purpose	To measure how much a test taker knows compared to another student.	To measure how much the test taker known before and after the instruction is finished.
Content	Norm-Referenced tests measure broad skill areas taken from a variety of textbooks and syllabi.	Criterion-Referenced tests measure the skills the test taker has acquired on finishing a curriculum.
Item characteristics	Each skill is tested by less than four items. The items vary in difficulty.	Each skill is tested by at least four items to obtain an adequate sample of the student.
Administration	Norm-Referenced tests must be administered in a standardized format.	Criterion-Referenced tests need not be administered in a standardized format.
Score reporting	Norm-Referenced test scores are reported in a percentile rank.	Criterion-Reference test scores are reported in categories or percentage.
Score interpretation	In Norm-Referenced tests, if a test taker ranks 95%, it implies that he/she has performed better than 95% of the other test takers.	In Criterion-Reference, the score determines how much of the curriculum is understood by the test taker.

Fig: Educational Research: In a nutshell Source: noodle.org, ehow.com

1. **Questionnaire-** A questionnaire is a form prepared and distributed to secure responses to certain questions. It is a device for securing answers to questions by using a form which the respondent fills by himself. It is a systematic compilation of questions that are submitted to a sampling of population from which information is desired.

Questionnaire rely on written information supplied directly by people in response to questions. The information from questionnaires tends to fall into two broad categories - 'facts' and 'opinions'. It is worth stressing that, in practice, questionnaires are very likely to include questionsabout both facts and opinions.

Purpose:

The purpose of the questionnaire is to gather information from widely scattered sources. It is mostly used in uses in cases where one can not readily see personally all of the people from whom he desires responses. It is also used where there is no particular reason to see them personality.

Types:

Questionnaire can be of varioustype on the basis of it's preparation. They are like:

- Structured v/sNon Structured
- Closed v/s Open
- Fact v/s Opinion

Characteristics of A Good Questionnaire:

- Questionnaire should deal with important or significant topic to create interest among respondents.
- It should seek only that data which cannot be obtained from other sources.
- It should be as short as possible but should be comprehensive.
- It should be attractive.
- Directions should be clear and complete.
- It should be represented in good Psychological order proceeding from general to more specific responses.
- Double negatives in questions should be avoided.

- Putting two questions in one question also should be avoided.
- It should avoid annoying or embarrassing questions.
- It should be designed to collect information which can be used subsequently as data for analysis.
- It should consist of a written list of questions.
- The questionnaire should alsobe used appropriately.

Use of Questionnaire:

Different methods are better suited to different circumstances and questionnaire are no exception to it. Questionnaire are used at their most productive:

- When used with large numbers of respondents.
- When what is required tends tobe fairly straight forward information.
- When there is a need for standardize data from identical information.
- When time is allowing for delays.
- When resources allow for the cast of printing and postage.
- When respondents can be expected to be able to read and understand the questions.

Background Information about The Questionnaire:

Both from ethical and practical point of view, the researcher needs to provide sufficient background information about the research and the questionnaire. Each questionnaire should have a cover page, on which some information appears about:

- The sponsor
- The purpose
- Return address and date
- Confidentiality
- Voluntary responses and
- Thanks

2. **Checklist-** A checklist, is a type of informational job aid used to reduce failure by compensating for potential limits of human memory and attention. It helps to ensure consisting and completeness in carrying out a task. A basic example is 'to

do list'. A more advanced checklist which lays out tasks to bedone according to time of a day or other factors. The checklist consists of a list of items with a place to check, or to mark yes or no.

Purpose:

The main purpose of checklist is to call attention to various aspects of an object or situation,

to see that nothing of importance is overlooked. For Example, if you have to go for outing for a week, you have to list what things you have to take with you. Before leaving home, if you will check your baggage with the least there will be less chance of forgetting totake any important things, like toothbrush etc. it ensures the completeness of details of the data. Responses to the checklist items are largely a matter of fact, not of judgment. It is an important toolin gathering facts for educational surveys.

Uses:

Checklists are used for various purposes. As it is useful in over daily life, itis also useful in educational field in the following way.

- To collect acts for educational surveys.
- To record behaviour in observational studies.
- To use in educational appraisal, studies - of school buildings, property, plan, textbooks, instructional procedures and outcomes etc.
- To rate the personality.
- To know the interest of the subjects also. Kuder's interest inventory and Strong's InterestBlank are also checklists.

Hints on Constructing Checklist:

- oItems in the checklist may be continuous or divided into groups of related items.
- Items should be arranged in categories and the categories in a logical or psychological order.
- Terms used in the items should be clearly defined.
- Checklist should be continuousand comprehensive in nature.
- A pilot study should be taken to make it standardized.
- Checklist can be constructed in four different ways by arranging items differently.

3. **Rating Scale-** Rating scale is one of the enquiry form. Form is a term applied to expression or judgment regarding some situation, object or character. Opinions are usually expressed on a scale of values. Rating techniques are devices by which such judgments may be quantified. Rating scale is a very useful device in assessing quality, especially when quality is difficult to measure objectively. For Example, "How good was the performance?" is a question which can hardly be answered objectively. Rating scales record judgment or opinions and indicates the degree or amount of different degrees of quality which are arranged along a line is the scale.

For example: How good was the performance?

Excellent, Very good, Good, Average, Below average, Poor, Very poor

This is the most commonly used instrument for making appraisals. It has a large variety of forms and uses. Typically, they direct attention to a number of aspects or traits of the thing to be rated and provide a scale for assigningvalues to each of the aspects selected. They try to measure the nature or degree of certain aspects or characteristics of a person orphenomenon through the use of a series of numbers, qualitative terms or verbal descriptions.

Purpose of Rating Scale: Rating scales have been successfully utilized for measuring the following:

oTeacher Performance/Effectiveness

- Personality, anxiety, stress, emotional intelligence etc.
- School appraisal including appraisal of courses, practices and programmes.

Useful hints on Construction of Rating Scale- A rating scale includes three factors like:

i) The subjects or the phenomena to be rated.

ii) The continuum along which they will be rated and

iii) The judges who will do the rating.

All taken three factors should be carefully taken care by you when you construct the rating scale.

Use of Rating Scale:

Rating scales are used for testing the validity of many objective instruments like paper pencil inventories of personality.

They are also advantages in the following fields like:

- Helpful in writing reports to parents
- Helpful in filling out admission blanks for colleges
- Helpful in finding out student needs
- Making recommendations to employers.
- Supplementing other sources of understanding about the child
- Stimulating effect upon the individuals who are rated.

2.6: Action Research in Teaching Learning Environment

Steps of Action Research

Preparation of Research

1. Identification of Problem

A teacher should be sensitive towards job activities. The problem is isolated from the broad field. The investigation must realize the seriousness of the problem.

2. Defining and Delimiting the Problem

After identifying the problem, it should be defined so that action and goal may be specified. The delimitation means to localize the problem in terms of class subject, group and period in which a teacher perceives the problem.

3. Analyzing Causes of the Problem

The causes of the problem are analyzed with the help of some evidences. The nature of the causes is also analyzed whether it is under the control or beyond the control of the investigator. This helps in formulating the action hypothesis.

4. Formulating the Action Hypotheses

The bases for the formulation action - hypotheses are the causes of the problem which are under the approach of the investigator. The statement of action - hypothesis consists of the two aspects: action and goal. It indicates that the action should be taken for achieving the goal.

5. Design for Testing the Action Hypothesis

A design is developed for testing the most important action-hypothesis. Some

actions may be taken and their results are observed. If the hypothesis is not accepted second design is developed for testing another hypothesis. In action - research one hypothesis is tested at a time. The design of action - research is flexible and can be changed at any time according to the convenience of the researcher.

6. Conclusion of Action Research Project

The accepting or rejecting the action - hypothesis leads to draw some conclusions. The statement of conclusion indicates some prescription for the practical problem of school or classroom. The conclusions are useful in modifying and improving the current practices of school and classroom teaching.

The National Council of Research and Training has been taken interest in the action research projects. The extension departments of NCERT have been conducting seminars and workshops for in service teachers for imparting knowledge and skill of action research projects. It has developed its own paradigm of action I research projects.

A. Paradigm of Action Research Projects

The steps and sub-steps are proposed by NCERT for conducting action research projects:

1. Topic of the Project.
2. Objective of the Project.
3. The system of the project work.
4. Evaluation of the project.
5. Estimation of expenditure for the project.
6. Name of the institution, number of students enrolled with sections.
7. Number of teachers in different subjects.
8. The available facilities in school for the project work.

   a) Background for the project work.

   b) The importance of the project for the school.

   c) Identification of problem.

   d) Defining and delimiting the problem.

e) Formulation of action hypotheses.

f) Testing the action hypotheses.

g) Conclusions of the project work.

h) Remarks by the investigator.

On these lines the teacher plans an experimental project, after conducting the experiment he writes a report of his project work.

Comments of the Investigator

After testing the hypothesis teacher may improve the teaching techniques and instructional procedure.

Suggestions for Action Research Project

In developing an action research project, the following suggestions should be kept in mind:

1. The nature of the project should be decided whether it is development project or experimental project.
2. The investigator must be directly associated with the problem to be studied.
3. The form of problem should be real.
4. The project should be so planned that it should not intervene the functioning of other school working.
5. The project should be concerned directly with qualitative improvement and level of performance of the students.
6. The project should be evaluated objectively by employing reliable and valid tools.
7. The action hypothesis should be formulated by considering the causes of the problem which are under the approach of the investigator.
8. The design of action research project should be economical from money, time and energy of view.
9. The problem should be selected objectively and studied scientifically.
10. The causes of the problem should be isolated objectively on the basis of some evidences.

2.7 Professional Competencies for Research

Competencies comprise of skills, attitudes and knowledge. It is often described with its related term 'Capacity, which means the ability to do certain thing. Professional Competency is a pivotal aspect of carrying out any research work. It is important due to the following aspects: Rigor, Genuineness, Authenticity and Utility pertaining to any research endeavor. Research competencies are mapped:

i. Before the topic is finalized-critical review of literature is a pre requisite. Use of effective search strategies and evaluation of the related literature. Concept mapping of the work and framing research questions are equally important in this arena.

ii. Before conducting the actual Research-Use of sound and consistent methods for appropriateness in a given study and data gathering activities. Development of appropriate instruments for effective investigation/research work. Another feature of an effective research skill comprises of identifying the points of triangulations in data collection.

iii. During data Collection-Document related competencies with primary data collection including activities relating to data coding and data entry. Other general competencies include data management, interpersonal skills and project management.

iv. During Data Analysis-utilizing appropriate data analysis techniques consistent with the purpose and design of the study. Interpret and synthesize the findings in the light of the existing literature and theoretical framework. Apart from these, it is desirable to identify relevance for practice and future research/investigation.

v. During report Writing-Maintaining internal consistency through all the chapters of the research/investigation/project work/study. To be capable for writing for publications.

vi. During defending the research work-The researcher/investigator should have a wholesome knowledge of his/her research work. S/he should be honest, fair, responsible and capable of judging his/her work.

Certain special competencies in case of collaborative, qualitative and mixed method designed researches are also required. These are:

i. Creating a vision and setting goals

ii. Delegating responsibilities

iii. Reading between the lines

iv. Deal with words

v. Visual literacy

vi. Merging of data

vii. Identify the points of explanation and expansion

2.8 Let us sum up

This unit systematically dealt with the different types of research used in Behavioral Sciences/ Social Sciences. Education being a multidisciplinary subject shares a combination of different types of researches used in behavioral sciences/social sciences. Next comes the way of doing research. This is called the process of research. One of the significant type of Research- Action Research in Teaching-Learning environment has been dispensed in minute particulars for aspiring teachers. This will help as a practical guide for the teachers to conduct such research in his/her class teaching. This unit systematically portrays the different sequential steps involved in the process of research. Another important aspect of research is the tools of research. Tools like questionnaire, checklist, rating scale and tests are dealt intensely in this unit. In order to conduct an effective and purposeful research/investigation one has to have requisite professional competencies-before, during research work. This aspect has been also dealt with future reflections.

2.9 Check your Progress

1. Mention the two broad types of research in Education. List their characteristics.
2. Give at least five differences between fundamental and applied research in Education.
3. What is a questionnaire? Give two Characteristics of it.
4. Describe the outline of Action Research.
5. List some professional competencies for research

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Unit – 3 ❑ Measurement and Analysis of Data

Structure

3.1 Introduction

In daily life we use measurement for various purposes. Measurement is the process of assigning numerals to the attributes of objects according to some rules. It

is the basis of biological and behavioural sciences. In Psychology and Education also measurement is very important. Data are collected through measurement and then these data are arranged in a meaningful way. After that they are analysed properly using many statistical techniques to find out the results and to draw conclusion from it. In this unit we will discuss about the different scales of measurement; the arrangement of data in tables and also their presentation in graphs. Here it is also discussed that how the central tendencies and dispersion can be measured.

3.2 Objectives

After Completion of this unit the learners will able to :

(i) Define different Scales of measurements.

(ii) Define 'organisation of data' and construct frequency distribution table.

(iii) Define mean, median and mode, standard deviation & quartile deviation.

(iv) Calculate different central tendencies from frequency distribution.

(v) Calculate coefficient of correlation between two sets of Scores using rank difference methods and product moment method.

(vi) Draw bar graph, histogram, frequency polygon & ogive.

3.3. Scales for Measurement :

In everyday life, measurement is used for various purposes. 'Measurement' refers to the process of assigning numearls to events, objects etc, according to certain rules. Tyler (1963) defines measurement as "assignment of numerals, according to rules." According to Nunnally (1970), "measurement consists of rules for assigning numbers to objects in such a way as to represent quantities of attributes."

Measurement is the root of both biological and behavioural sciences. In biological science, measurement has a long history, but the history of Psychological and educational measurement dates back only to 1850. In recent years much emphasis is being placed upon the methodology of development and use of mesurenment in almost all branches of Psychology.

We know that measurment is the process of assigning numerals to the attributes of objects according to some rules. Various scales are employed in the field of measurement. Stevens (1951) has recognized four types of scales. These scales are nominal, ordinal, interval and ratio.

3.3.1. Nominal Scale :

Nominal scale is the most simplest type of scale of measurement. It is used for labeling variables. In nominal measurement numbers are used to name, identify or classify persons, groups, objects etc. For example, every student is assigned a roll number in his class, a player is identified as a player of a particular team by the type of dress he wears and also by the number of his jercy. These numbers or symbols constitute a nominal scale. We can notice that all of these scales are mutually exclusive i.e. no overlap none of them have any numerical significance. Thus in the nominal scale, numbering or classification is always made according to similarity or difference observeed with respect to some characteristic or property.

We can take another example of nominal scale. A sample of persons being Studied may be classified according to thier hair colour as : Black, brown, blonde, gray and other, or they may be classified on the basis of sex (Male/Female/ transgender), or they may be classified as rural-urban variable etc. In nominal measurement, members of any two groups are never equivalent but all members of any group are always equivalent.

In nominal measurment, the numerals or symbols are assigned to represent classes or individuals and the purpose of it is to classify or identify objects or individuals but not to tell us about the quality of the object or individual. That is why we can not say that the player wearing jercy number 01 is better than the player wearing jercy number 02.

In case of nominal measurement addition, substraction, multiplication and division one not possible because the identifying numerals themselves cannot be ligitimately added, Subtractred, multiplied or divided. The admissible statistical operations in nominal data are counting or frequency, percentage, mode and coefficient of contingency.

3.3.2. Ordinal Scale

This scale of measurement is the second level of measurement. We have seen that in nominal scale numbers serve as lables to identify the individuals or objects, but in ordinal scale the numbers denote the rank order of the objects or individuals. In this scale the numbers are arranged from highest to lowest or from lowest to highest. The measurements in oridnal scale reflect which person or object is larger or smaller, heavier or lighter, harder or softer, brighter or duller etc, than the others. We can take an example of ordinal measurement.Students of a class may be ranked 1st, 2nd, 3rd, 4th....etc interms of their academic achievement. This is an example of ordinal measurment. Similarly, individuals competing in a contest maybe fortunate to achieve first, second or third place. First, Second and Third place represent ordinal data.

Measurement of non-numeric concepts like satisfaction, happiness, discomfort etc. are also ordinal data. From the above discussion it is clear that in ordinal scale 'Order' is the key to remember because in this scale the date represent the order of the individual or object in respect to some quality, property or performance.

In oridnal measurement the order of the values is important and significant but the differences between each one is not equal. It is because of the fact that ordinal measures are not absolute quantities and are not equal-interval measurment. For example, the difference in the achievement scores between the 1st and 2nd merit position holders in a class is not necessarily equal to the difference between the 2nd and 3rd position holders. We can take another example. In an intelligence test three persons A, B and C scored 60, 50 and 30. So the persons A, B and C may be ranked as 1st, 2nd and 3rd according to their scores in the test. But the difference between A's score and B's score is 60 – 50 = 10 and that between B's score and C's score is 50 – 30 = 20. But both these deifferences are equally spaced interns of ranks. So,it is the drawback of ordinal measurement. In Psychology and education sometimes the measurement is done in ordinal scale. The Permissible Statistical Operations in ordinal measurement are median, percentiles and rank correelation coefficients, plus all those which are permissible for nominal measurment.

3.3.3. Interval Scale :

Interval scale of measurement includes all the characteristics of the nominal and oridnal measurement but the extra feature of this scale is that numerically equal distance on the scale indicate equal distances in the properties of the objects being measured. Thus in interval scale the unit of measurment is constant and equal. So, this scale may be defined as a sale which represents quantity and has equal units but for which zero represents simply an additional point of measurement. Interval scale has no absolute zero, but an arbitrary zero.

For example, Fahrenheit scale of measuring temperature is an interval scale. 80ºF, 60ºF, 40ºF are interval data. Differnece between 80ºF & 60ºF is same that between 40ºF and 20ºF, but we can't say that 80ºF is doubly hot than 40ºF. Because here the arbitrary zero in Fahrenheit scale is 32º. Other examples of interval scale are scores on intelligence tests, aptitude tests, Centigrade thermometers, Time etc.

In interval measurement, the numbers are after equal intervals, they can ligitimately be added and subtracted from each other. But here the process of addivity cannot be carried out in the absolute sense because insuch a measruement zero point is not true but rather arbitrary. Zero point in interval scale does not tell the real absence of the property being measured. Arbitrary zero is selected only for some convenience in the measurement.

In interval measurement the statistical calculations which generally performed

are arithmetic mean, standard deivation, pearson coefficient of correlation, and other statistics based upon them.

3.3.4. Ratio Scale :

Ratio scale is the highest level of measurement and has all the properties of nominal, ordinal and interval scales plus a true zero point. The main characteristics of the ratio scale is that the ratio of any two numbers is independent of the unit of measurement and therefore, it can meaningfully be equated. Physical measures like height, weight, width, length etc. represent ratio data. Thus ratio scale is common among physical sciences rather than among social sciences. The fundamental difference between interval scale and ratio scale is that interval scale has arbitrary zero point but ratio scale has true zero point. We can take an example of ratio scale. Suppose two persons A and B have height 6'8" and 3'4" respectively. Here the ratio between the numerical values of heights of A & B is 2 : 1 and in real sense also we can say thet A's height is double than that of B. It is possible because here the scale of height has true zero that means 6′8″ is actually 6′8″-0. .

All statistical calculations can be performed from ratio data. But in Psychology and education, the mesurement in ratio scale is not common. Ratio data is very common is Physical Science.

We have discussed four types of scales of measurement. The table below will present the summary of the characteristics of these scales :

Scale of Measurement	Indicates difference	Indicates direction of difference	Indicates amount of difference	Absolute Zero
Nominal	✓			
Ordinal	✓	✓		
Interval	✓	✓	✓	
Ratio	✓	✓	✓	

3.4 Organisation of Data ` Arranging Groups Distribution

Data is a Set of values of qualitative or quantitative variables. In psychology and Education we get data from different tests, experiments & Surveys. These data are mainly numerical. When thse data are collected in original form, they have little meaning for the investigator. For interpretation of the data so collected and for deriving conclusion data, have to be organized or arranged in a Systematic way. There are many ways for the organisation of data. For example :

(i) Organization of data in the form of rank order.

(ii) Organization of data in the form of frequency distribution.

3.4.1 Rank order

We obtain data from tests, experiments, Survey Studies in education and psychology and these data are mostly in numerical sores. These original raw scores can be successfully arranged in an ascending or descending series exhibiting an order with respect to the rank or merit position. For clarification of this procedure let us take an example.

Example : The achievements scores of 50 Students of Class IX are as follows :

174, 170, 165, 176, 190, 166, 137, 172, 165, 180, 178, 181, 167, 171, 157, 169, 140, 176, 177, 137, 184, 175, 169, 165, 172, 181, 182, 168, 148, 135, 183, 175, 192, 162, 172, 155, 187, 158, 156, 142, 179, 187, 179, 160, 176, 152, 156, 150, 180, 145.

If we tabulate this data in the form of a rank order (from highest scores to lowest scores i.e. in descending order) then it will look like below:

SI. no.	Scores	SI. no.	Scores	SI. no.	Scores
1	192	18	176	36	160
2	190	19	175	37	158
3	187	20	175	38	157
4	187	21	174	39	156
5	184	22	172	40	156
6	183	23	172	41	155
7	182	24	172	42	152
8	181	25	171	43	150
9	181	26	170	44	148
10	180	27	169	45	145
11	180	28	169	46	142
12	179	29	168	47	140
13	179	30	167	48	137
14	178	31	166	49	137
15	177	32	165	50	135
16	176	33	165		
17	176	34	165		
		35	162		

3.4.2 Frequency Distribution

When we organise data in the form of rank order it does not tell us the number of times the score is repeated (which we call 'frequency') in the given Series. When we handle large number of data then it needs to be adequately Summarized for proper presentation and interpretation. For Summarization of large number of data it is very much esential to group the data into some arbitrary classes or groups and to find out the frequencies of the groups. Such type of organization of data is called frequency distribution.

Frequency distribution of data is carried out through systematic steps. To understand the Steps clearly let us take the data of achievement sources of 50 Students of class IX (already discussed in the Section of rank order).

Step I : Finding the range :

Range is the difference between the highest score and the lowest score in a distribution. In the achievement score of the Students higher score is 192 and the lowest score is 135.

$\therefore$ Here, range = 192–135 = 57

Step II : Determining Class interval

Class interval is the size of the class. To organize the data in a frequency distribution, we have to desire the number of class or groups. It is generally done by knowing the range of data. Thus,

$$\text{Class interval (i)} = \frac{\text{Range}}{\text{No. of Class desired}}$$

Generally the class interval is taken as 2, 3, 5 or 10. In the Present data if we take class interval as 5, then the number of classes will be $\frac{57}{5}$ = 11.4 i.e. the nearest whole number = 12.

So, if we form 12 number of classes with class interval 5, then the desired classes will be 135–139, 140–144, 145–149, 150–154, 155–159, 160–164, 165–169, 170–174, 175–179, 180–184, 185–189 and 190–194.

Step III : Construction of the frequency distribution table

In this step a table is constructed having three columns. In the first column, all

classes of the distribution is written down. In the 2nd column, the tally marks of each class is written. Tally marks is nothing but the number of times occuring a score in the given class. For example, in the class 135-139, the number of scores is 3. So the tally mark will be III.

In the 3rd column of the table, the frequencies of each class is written.

This step will be understood better from the following frequency distribution table.

Table : Frequency distribution table

Classes of Scores	Tallies	frequencies
190–194	II	2
185–189	II	2
180–184	𝍸 II	7
175-179	𝍸 IIII	9
170-174	𝍸 I	6
165–169	𝍸 III	8
160–164	II	2
155–159	𝍸	5
150–154	II	2
145–149	II	2
140–144	II	2
135–139	III	3
		N = 50

3.5. Measures of Central Tendency & Dispersion :

Measure of central tendency is also known as statisitical average. It tells upon the point about which items have a tendency to cluster. It is also considered as the most representative figure for the entire mass of data. Mean, median and mode are the most common measures of central tendencies.

3.5.1. Mean :

Mean is the average of the scores under study. It is also known as arithmetic mean. A simple example of mean is like this :

In a class, the marks of Geography of five students are 35, 68, 85, 32 and 50. Then the average mark obtained by the students is (35 + 68 + 85 + 32 + 50)/5 = 54.

So, Mean =

If x_1, x_2, x_3, x_4,....x_N are the values of N items, then their mean (M) is given by the following formula :

M = $= \frac{\Sigma x}{N}$

The above formula is used for calculation of mean in the case of ungrouped data.

● **Calculation of Mean for grouped data :**

a. General Method :

Mean for the grouped data can be calculated with the help of following formula.

M = $\frac{\text{Sum of all scores}}{\text{No. of scores}} = \frac{x_1 + x_2 + x_3 + x_4 + ... + x_N}{N}$

Where X is the mid-point of the class interval, *f* its respective frequency and N is the total of all frequencies.

The use of this formula can be easily understood by taking the following example.

Example :

Scores	***f***	**Mid-point (X)**	***fx***
70-74	2	72	144
65-69	4	67	268
60-64	5	62	310
55-59	6	57	342
50-54	7	52	364
45-49	11	47	517

40-44	9	42	378
35-39	3	37	111
30-34	2	32	64
25-29	1	27	27
	N = 50		$\Sigma fx = 2525$

$\therefore$ M = = = 50.5

b. Short-Cut Method :

There is a short-cut method for calculation of mean for the grouped data. The formula used for this method is given below :

M = A + × i

Where, A = Assumed Mean

f = Respective frequency of the mid-values of the class intervals

N = Total frequency

i = Class interval

and $x' =$ (as discussed earlier, X is the mid-value of the class)

The short-cut method can be easily explained by taking the following frequency distribution.

Example :

Scores	***f***	**X**	**A**	**$x' = (X - A)/i$**	***fx'***
		(Mid Point)	**(Assumed Mean)**		
70-74	2	72		+5	10
65-69	4	67		+4	16
60-64	5	62		+3	15
55-59	6	57		+2	12
50-54	7	52		+1	7

45-49	11	47	47	0	0
40-44	9	42		–1	–9
35-39	3	37		–2	–6
30-34	2	32		–3	–6
25-29	1	27		–4	–4
	N = 50				$\Sigma fx^1 = 35$

Here, A = 47

N = 50

i = 5

$\Sigma fx' = 35$

$\therefore$ Mean, $M = A + \frac{\Sigma fx'}{N} \times i$

$= 47 + \frac{35}{50} \times 5 = 47 + 3.5 = 50.5$

Here it is to be noted that the mean of the same frequency distribution is calculated using two methods separately. But the result is same.

Characteristics of Mean : (i) Mean is computed on the basis of all observations. (ii) It is highly affected by the extreme values. (iii) Its value is always definite for a given distribution.

3.5.2. Median

Median is the measure or value of the middle point of a distribution of scores when the distribution is arranged in ascending or descending order. So, it can be said that median of a distribution is the point on the score below which 50% of the scores fall. In other words, median is the value of that central item which divides the series into two equal parts.

● **Calculation of Median :**

a. For ungrouped data :

For ungrouped data, two cases may arise :

(i) When no. of items in a series (N) is odd :

In this case, the median is the value of th item.

Example :

Let the scroes of 9 students in English be 28, 25, 46, 43, 56, 60, 37, 15, 52. To find out the median of these scroes, we have to arrange the scores in ascending or descending order. If we arrange the scroes inascending order then the series becomes :

15, 25, 28, 37, 43, 46, 52, 56, 60

Here N = 9 ∴ = = 5

So, the median will be the 5th item of the series = 43

(ii) When no. of items in a series (N) is even :

In this case median is calculated by the following formula.

Median = $\frac{\text{value of } \frac{N}{2}\text{th item} + \text{value of } \left(\frac{N}{2}+1\right)\text{th item}}{2}$

Example :

Let the scores of 10 students in History be 65, 30, 40, 25, 50, 48, 56, 35, 60, 49.

If we arrange this series in ascending order, then the series becomes :

25, 30, 35, 40, 48, 49, 50, 56, 60, 65.

Here N = 10

∴ $\frac{N}{2}$th i.e. 5th item is 48 and th i.e. 6th item is 49.

So, Median = $\frac{48+49}{2}$ = 48.5

b. Meidan for grouped data :

If the data are available in the form of continuous frequency distribution, then

we have to locate the class in which th (Where N = total frequency) cumulative frequency lies. This class is known as median class. After locating the median class, the median of the distribution may be calculated with the help of following formula :

Median = L + × i

where L = Exact lower limit of the median class.
F = Total of all frequencies before the median class.
f = frequency of the median class.
i = Class interval.
N = Total of all the frequencies.

The application of the above formula for calculating the median of grouped data can be easily understood by the following example.

Examples :

Scores	f	**Cumulative freq. (cf)**	$\left[\frac{N}{2}=\frac{50}{2}=25\right]$
70-74	2	50	
65-69	4	48	
60-64	5	44	
55-59	6	39	
50-54	7	33	
45-49	11	26	→ Median class
40-44	9	15	
35-39	3	6	
30-34	2	3	
25-29	1	1	

N = 50

Calculation of the Median :

Here N = 50

$\therefore \frac{N}{2} = \quad = 25$

So, from the table it is seen that the class interval designated as 45–49 is to be labelled as median class.

Now, L = 44.5 (exact lower limit of the median class)

F = 15

f = 11

i = 5

$$\therefore \text{Median} = L + \quad \times i \quad = 44.5 + \left(\frac{\frac{50}{2} - 15}{11}\right) \times 5$$

$$= 44.5 + \frac{10}{11} \times 5 = 44.5 + 4.55 = 49.05$$

Characteristics of Median :

(i) The computation of median is not based on all the observations.

(ii) Median is not affected by the extreme values.

(iii) It indicates the value of the middle item in the distribution.

3.5.3. Mode :

Mode is defined as the score which occurs most frequently in a distribution. In other words, mode is the point on the score scale that corresponds to the maximum frequency of the distribution.

a. Mode for ungrouped data :

To find out the mode for ungrouped data one has to find out the score which is repeated maximum number of times.

Examples :

Let, the score of an achievement test of 10 students are as follows :

30, 35,25, 40, 35, 45, 40, 35, 28, 34.

Here, the score 35 is repeated maximum number of times. So, the value of the mode of the above distribution is 35.

b. Mode for grouped data :

For grouped data, mode can be calculated by using the following formula :

$$\text{Mode} = L + \qquad \times i$$

Where, L = lower limit of the modal class [Modal class is the class in which mode maybe supposed to lie]

f_S = frequency of the class succeeding the modal class.

f_P = frequency of the class preceding the modal class

i = class interval.

Let us illustrate the use of this formula by taking the frequency distribution as given below :

Examples :

Scores	f	
70-74	2	$\frac{f_S}{f_P + f_S}$
65-69	4	
60-64	5	
55-59	6	
50-54	7	
45-49	11	$\rightarrow$ modal class
40-44	9	
35-39	3	
30-34	2	
25-29	1	

N = 50

If we look at the frequency distribution, the crude mode may be supposed to lie within the class interval 45–49. Hence, the modal class is 45–49.

Now, L = 44.5

$f_S = 7$

$f_P = 9$

$i = 5$

$\therefore$ Mode = L + $\times\, i$ = 44.5 + $\times$ 5 = 44.5 + $\times$ 5 = 44.5 + 2.19 = 46.09

C. Crude Mode for grouped data :

For grouped data, mode can be calculated indirectly with the help of following formula :

Mode = 3 × Median – 2 × Mean

If we calculate the mean & median of a given frequency distribution, then the crude mode can easily be estimated using the above formula.

Example :

We have calculated the mean and median of the same frequency distribution as discussed earlier.

It is found that, Mean = 50.5

Median = 49.05

$\therefore$ Mode = 3 × 49.05 – 2 × 50.5 = 147.15 – 101 = 46.15

Characteristics of Mode :

(i) Mode is not well defined.

(ii) It is not unduly affected by the extreme values.

(iii) Its computation is not based on all the variates.

(iv) It maybe unrepresentative in many cases.

■ Uses of Mean, Median and Mode :

● Use of Mean :

(i) When accurate and reliable measure of central tendency is needed, then mean is computed because mean has the greatest stability of the samples drawn from the same population.

(ii) When we need to compute S.D., Coefficient of correlation etc. then mean is computed for the given data.

(iii) Every item in a series is given equal weightage in the calculation of mean. When extreme items in a series seriously affect the position of the mean, then it is not proper to calculate mean as central trendency.

● **Use of Median :**

(i) Median is computed when the exact mid-point of the distribution is required.

(ii) As median is not affected by the extreme scroes in a series, then for a series which has extreme scores median is calculated as the reliable central tendency.

(iii) In case of an open end distribution median is calculated as the reliable central tendency.

(iv) Median can be computed graphically, but mean cannot.

(v) When data are not precisely measured in quantities, then median is calculated.

● **Use of Mode :**

(i) Mode is computed for quick and approximate measure of central tendency.

(ii) Mode is most important for the large scale manufacturing consumer goods, as the value of mode gives the most occuring item in the series.

(iii) Mode can be computed fom frequency curves. So, when we have a graphical representation, then mode is calculated.

3.5.4. Measures of Dispersion :

Generally, Mean, Median and Mode are the measures of central tendencies. They provide us the central value of a set of scroes as a whole. They donot show how the individual scores are spread out and provide insufficient base for the comparison of two or more frequency distributions. This can be easily understood with the following example :

Let us consider two sets of scroes, obtained by two groups of students :

Group 1 : 5, 10, 15, 20, 25

Group 2 : 11, 13, 15, 17, 19

In both Cases Mean = 15 and Median = 15.

So in respect to mean & median there is no difference in the performance of the two groups. But two set of scores are not identical. The score of Group 1 ranges from 5 to 25, where as that of Group 2 is 11 to 19. So, individual's in Group 2 are less variable than those in Group 1. We may conclude that there is a tendency for data tobe dispersed or to show variability around the average. The tendency of the scores to deviate from average value is known as dispersion or variability.

There are mainly four measures of dispersion or variability.

(i) Range (ii) Quartile deviation (iii) Average deviation (iv) Standard deviation.

3.5.4.1 Quartile Deviation :

A quartile is the point on the scores scale below which a given quarter of the cases lie. Quartiles for a given score series may be four in number. These are 1st quartile (Q_1), 2nd quartile (Q_2), 3rd quartile (Q_3) and fourth quartile (Q_4).

From the definition of quartile we can say that Q_1 is the point on the score scale below which 25% of the cases lie; Q_2 is the point on the score scale below which 50% of the cases lie; and so on. It is clear that Q_2 is the median of the distribution.

Now, Quartile deviation is computed by the formula : $\frac{Q_3 - Q_1}{2}$

$$Q =$$

Where Q_1 = 1st quartile of the distribution

Q_3 = 3rd quartile of the distribution

Q_1 is calculated by the following formula :

$$Q_1 = L_1 + \frac{\frac{N}{4} - F_1}{f_1} \times i$$

Where, L_1 = exact lower limit of the class interval which contains Q_1.

F_1 = Total of the frequencies before the class interval which contains Q_1.

f_1 = frequency of the 1st quartile class.

i = class interval

N = Total of all frequencies.

Q_3 is calculated by the following formula :

$$Q_3 = L_3 + \qquad \times i$$

Where, L_3 = exact lower limit of the class interval which contains Q_3.

F_3 = Total of the frequencies before the class interval which contains Q_3.

f_3 = freqeuncy of the 3rd quartile class.

i = class interval

N = Total of all frequencies.

Computation of quartile deviation (Q) can be understood from the following example :

Example :

Scores	f	**Cumlative frequency**	$\frac{\frac{3N}{4} - F_3}{f_3}$
70-74	2	50	
65-69	4	48	
60-64	5	44	
55-59	6	39	→ 3rd quartile class
50-54	7	33	
45-49	11	26	
40-44	9	15	→ 1st quartile class
35-39	3	6	
30-34	2	3	
25-29	1	1	

N = 50

Calculation of Q_1 :

N = 50

$$\therefore \frac{N}{4} = 12.5$$

So, the 1st quartile class is 40 – 44

Now, $L_1 = 39.5$

$F_1 = 6$

$f_1 = 9$

$i = 5$

$$Q_1 = L_1 + \qquad \times i = 39.5 + \frac{12.5-6}{9} \times 5 = 39.5 + \qquad = 43.11$$

Calculation of Q_3 :

$$= \qquad = 37.5$$

So, the 3rd quartile class is 55 – 59.

Now, $L_3 = 54.5$

$F_3 = 33$

$f_3 = 6$

$i = 5$

$$Q_3 = L_3 + \qquad \times i = 54.5 + \left(\frac{37.5-33}{6}\right) \times 5 = 54.5 + \frac{4.5\times5}{6} = 58.25$$

Calculations of quartile deviation (Q) :

We know, $Q = \qquad = \frac{58.25-43.11}{2} = \frac{15.14}{2} = 7.57$

3.5.4.2 Standard Deviation :

Standard deviation (σ) is the most reliable and stable mesure of dispersion as

it employs the mean for its computation. Standard deviation of a set of scores can be calculated from the following formula :

$$\sigma = \qquad = \sqrt{\frac{\Sigma x^2}{N}}$$

Where X = Individual score

M = Mean of the given set of scores

N = Total number of the scores

x = deviation of each score from the mean.

a. Standard deviation for ungrouped data :

Let us considet that 5 students have obtained the following merks is an achievement test :

30, 40, 35, 45, 30.

To find out the standard deviation of the set of scores we have to first calculate the mean of the given scores.

Now, M = $\frac{30+40+35+45+30}{5}$ = 36 $\sqrt{\frac{\Sigma(X-M)^2}{N}}$

Scores (x)	**x = X – M**	**x^2**
30	–6	36
40	+4	16
35	–1	01
45	+9	81
30	–6	36

$\Sigma x^2 = 170$

$\therefore \sigma =$ $=$ $=$ $=$ 5.83

b. Calculation of standard deviation for grouped data :

SD (σ) in case of grouped data can be calculated using the following formula :

$$\sigma =$$

Where $x = X - M$; M = Mean

X = Mid Point of class.

The use of this formula can be explained by taking the following example :

Example :

Scores	f	**Mid-point (X)**	$\left(=\frac{\Sigma f x}{N}\right)$	$x = X - M$	x^2	fx^2
70-74	2	72	50.5	21.5	462.5	924.50
65-69	4	67	50.5	16.5	272.25	1089.00
60-64	5	62	50.5	11.5	132.25	661.25
55-59	6	57	50.5	6.5	42.25	253.50
50-54	7	52	50.5	1.5	2.25	15.75
45-49	11	47	50.5	–3.5	12.25	134.75
40-44	9	42	50.5	–8.5	72.25	650.25
35-39	3	37	50.5	–13.5	182.25	546.75
30-34	2	32	50.5	–18.5	342.25	684.50
25-29	1	27	50.5	–23.5	552.25	552.25

N = 50 $\Sigma fx^2 = 5512.50$

Standard deviation, $\sigma = \sqrt{\frac{\Sigma f x^2}{N}} = \sqrt{\frac{5512.50}{50}} =$ $= 10.5$

C. Short-cut Method for Calculation of SD form grouped data :

SD from grouped data can also be calculated by the following formula :

$$\sigma = i \times \sqrt{\frac{\sum f x^{1^2}}{N} - \left(\frac{\sum f x^1}{N}\right)^2}$$

Where $x^1 = (X - A)/i$; X = Mid Point of the class
A = Assumed mean
f = frequency of that class
i = class interval
N = Total no.of frequencies.

Use of the above formula can be easily understood by taking the following example :

Scores	f	**Mid-point (X)**	**A (Assumed mean)**	$x^1 = (X - A)/i$	fx^1	fx^{1^2}
70-74	2	72		+5	10	50
65-69	4	67		+4	16	64
60-64	5	62		+3	15	45
55-59	6	57		+2	12	24
50-54	7	52		+1	7	7
45-49	11	47	47	0	0	0
40-44	9	42		–1	–9	9
35-39	3	37		–2	–6	12
30-34	2	32		–3	–6	18
25-29	1	27		–4	–9	16
	N = 50			$\Sigma fx^1 = 35$		$\Sigma fx^{1^2} = 245$

Standard deviation, $\sigma = 5 \times \sqrt{\frac{245}{50} - \left(\frac{35}{50}\right)^2} = 5 \times \sqrt{4.9 - (0.7)^2} = 5 \times \sqrt{4.41} = 5 \times 2.1 = 10.5$

It can be noted that SD Calculated by two methods for same frequency distribution is same.

3.6. Correlation: Product moments and Rank order correlation

In education and Psychology, many situations arise that involve two or more variables. In case the change in one variable appears to be accompanied by a change in other variable, the two variables are said to be correlated and this inter-dependence is called correlation.

There are many types of correlation, like linear, biserial, partial or multiple corrleation.Here our aim is to provide an elementary knowldege of statistical methods. So, we confine ourselves here, to the method of linear correlation. When the relationship between two sets of scores or variables can be represented graphically by a straight line, it is known as linerar correlation. If there is an increase (or decrease) in one variable and this leads to an increase (or decrease) in another variable, it is known as ***Positive Correlation***.

For example, increase in age of a child leads to increase of his weight. Here age and height have positive correlation.

In there is an increase (or decrease) in one variable and this leads to a decrease (or increase) in another, it is known as ***Negative Correlation.***

For example, more intelligent children take lesser time to solve a problem. Here intelligence and time required have negative correlation.

The third type of correlation is zero correlation. If there exists no relationships between two variables, then it is known as ***Zero Correlation***.

● **Coefficient of Correlation :**

Coefficient of correlation is a statistical measure of the degree to which changes to the value of one variable predict change to the value of another. It is used to express the degree of relationship quatitatively between two sets of measure or variables. The value of coefficient of correlation ranges from + 1.0 to –1.0. When the value of this coefficient is close to +1.0 then the two variables have a very strong

positive correlation and if the value is close to –1.0 then they have a very strong negative correlation. If the value of this coefficient in zero, then the two variables have zero correlation.

Computation of Coefficient of Correlation :

For computing the coefficient of linear correlation, we generally use two different methods :

(i) Rank Difference Method. (ii) Product Moment Method.

3.6.1. Rank Difference Correlation Method :

We face many situations where it is not possible to make definite measurements on the variables. For example, the evaluation of the school students on the basis of their social adjustment and personality. In such cases, the students are ranked and arranged in order of merit. On the basis of their ranks, the coefficient of correlation between two variables is measured. This type of coefficient of correlation is known as rank correlation coefficient. The rank correlation coefficient is computed if we don't have scores and have to work with data in which differences between the individuals can be expressed only by ranks. If we have usual data given in raw scores, then also the rank correlation coefficent is computed. In that case, the individual scores are converted in to ranks.

Rank correlation coefficient is also known as Spearman's Coefficient of correlation.

The formula for finding the rank correlation coefficient (ρ) is given by,

$$\rho = 1 -$$

Where d is the difference between paired ranks and N is the total number of Paired Observations.

Use of the above formula for determining the coefficent of correlation can be understood easily with the help of following example :

Example :

Let us suppose 10 students of class VII have scored the following marks in

science and mathematics.

Students :	A	B	C	D	E	F	G	H	I	J
Marks in Science :	50	65	35	40	45	62	48	52	38	68
Marks in Mathematics :	59	72	45	58	55	70	60	65	48	69

Now, we have to calculate the coefficient of correlation by Rank difference method.

First, we have to assign ranks of the students in science and also in mathemaitcs on the basis of their respective marks. It is done in the following table.

Students	**Marks in Science**	**Marks in Mathematics**	**Rank in Science (R_1)**	**Rank in Mathematics (R_2)**	**$d=R_1-R_2$**	**d^2**
A	50	59	5	6	1	1
B	65	72	2	1	1	1
C	35	45	10	10	0	0
D	40	58	8	7	1	1
E	45	55	7	8	1	1
F	62	70	3	2	1	1
G	48	60	6	5	1	1
H	52	65	4	4	0	0
I	38	48	9	9	0	0
J	68	69	1	3	2	4

N = 10 $\Sigma d^2 = 10$

Coeff. of correlation, $\rho = 1 - \qquad = 1 - \qquad = 1 - \qquad = 1 - 0.06 = 0.94$

$\therefore$ Rank Correlation Coeff. = 0.94

Which means the achievenment of the students in science of mathe is highly correlated.

● **Rank Correlation Coefficient for Tied Tanks :**

When two individuals are ranked as equal,then it is called tied rank. Let us consider eight students have scored the following marks in a test : 21, 15, 23, 21, 25, 29, 26, 24. If we replace these marks by ranks then we find that 21 occurs twice. In this case we assign the average rank which the tied observations occupy. Then the ranks showed be as follows :

Score	Rank
29	1
26	2
25	3
24	4
23	5
21	6.5
21	6.5
15	8

Here the score 21 occupies the 6th of 7th positions and thus the average rank = 6.5 is assigned to the score 21. This idea will be more clear by the following example :

Example :

Students	Marks in X	Marks in Y	Rank in X (R_1)	Rank in Y (R_2)	$d = \lvert R_1 - R_1 \rvert$	d^2
A	82	76	2	1	1	1
B	80	70	3	3	0	0
C	60	68	7.5	5	2.5	6.25
D	65	58	5	7	2	4
E	60	50	7.5	10.5	3	9
F	78	70	4	3	1	1
G	55	49	9.5	12	2.5	6.25
H	50	55	12	9	3	9
I	62	57	[illegible]	8	2	4
J	55	59	9.5	6	3.5	12.25
K	52	50	11	10.5	0.5	0.25
L	87	70	1	3	2	4

N = 12 $\quad\quad$ $\Sigma d^2 = 57$

Coeff.of Correlation = 1 –

= 1 – = 1 – = 1 – 0.199 = 0.801

So, the rank correlation coeff. = 0.801

3.6.2. Product Moment Method :

It is another method to find out the correlation coefficiet. The coefficient of correlation computed by this method is known as the product moment coefficient of correlation or Pearson's Correlation Coefficient (Υ).

The formula used in the computation of this coefficient of correlation is

$$\Upsilon = \frac{\Sigma xy}{N\sigma_x\sigma_y}$$

Where x = deviation of any X-score from the mean in test X

y = deviation of the corresponding Y score from the mean in test Y

Σxy = Sum of all the products of deviation

σ_x = standard deviation of the distribution of scores in test X

σ_y = Standard deviation of the distribution of scores in test Y

N = Total no. of scores. $\frac{\sqrt{\Sigma xy}}{\sqrt{N\sigma_N\sigma_y}}$

● **Computation of *r* from ungrouped data :**

Case I : When deviations are taken from the mean of the scores :

We know Υ =

Now, σ_x = and $\sigma_y = \sqrt{\frac{\Sigma y^2}{N}}$

$$\therefore \Upsilon = \frac{\Sigma xy}{N\times\sqrt{\frac{\Sigma x^2}{N}}\times\sqrt{\frac{\Sigma y^2}{N}}} = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \Sigma y^2}}$$

The use of the above formula may be illustrated through the following example :

Example :

Students	Scores in test X	Scores in test Y	Mean of X (M_x)	Mean of (M_y)Y	x	y	xy	x^2	y^2
A	20	26			0	2	0	0	4
B	25	20			5	–4	–20	25	16
C	15	24	20	24	–5	0	0	25	0
D	22	30			2	6	12	4	36
E	28	26			8	2	16	64	4
F	10	18			–10	–6	60	100	36

Here, $x = X - M_x$ $\quad \Sigma xy = 68 \Sigma x^2 = 218$

and $y = Y - M_y$ $\quad \Sigma y^2 = 96$

$$\text{Now, } \Upsilon = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \Sigma y^2}} = \frac{68}{\sqrt{218 \times 96}} = \frac{68}{144.67} = 0.47$$

Case II. Computation of ϒ directly from raw scores when deviations are taken from zero :

The product moment coeff.of correlation (ϒ) can be calculated directly from raw scores without calculating deviation from the means.

The formula used in this case is

$$\Upsilon = \frac{N\Sigma xy - \Sigma x \Sigma y}{\sqrt{\left[N\Sigma x^2 - (\Sigma x)^2\right]\left[N\Sigma y^2 - (\Sigma y)^2\right]}}$$

Where, X and Y = Raw scroes in the test X and Y respectively.

Σxy = Sum of the products of each X score multiplied with its corresponding Y scroes.

N = total no.of cases or scroes.

The use of this formula may be illustrated transfer the following example.

Example :

Students	Scores in test X	Scores in test Y	XY	X^2	Y^2
A	2	10	20	4	100
B	4	11	44	16	121
C	3	9	27	9	81
D	6	12	72	36	144
E	8	15	120	64	225
N = 5	$\Sigma X = 23$	$\Sigma Y = 57$	$\Sigma XY = 283$	$\Sigma X^2 = 129$	$\Sigma Y^2 = 671$

Now, r =

$$= \frac{5\times283-23\times57}{\sqrt{\left[5\times129-23^2\right]\left[5\times671-57^2\right]}}$$

$$= \frac{N\sum xy-\sum x\sum y}{\sqrt{\left[N\sum x^2-(\sum x)^2\right]\left[N\sum y^2-(\sum y)^2\right]}}$$

$$= \frac{1415-1311}{\sqrt{(645-529)(3355-3249)}} = \frac{104}{\sqrt{120\times106}} = \frac{104}{112.78} = 0.92$$

3.7 Graphical Representation of Data

We know that presentation of data is very important. In earlier section we have discussed about the organisation of data and Presentation of them by tables. We will now discuss about the graphical representation of data. A graphical representation of date is the geometrical picture of a Set of data. It is well said that one picture is better than a thousand words because graphic representation of data is quite effective for understanding and interpretation of the data.

3.7.1 Graphical representation of ungrouped data

Ungrouped data are the data in the form of raw scores and grouped data are those when they are organized into a frequency distribution.

For ungrouped data generally following graphical representations are used.

(a) Bargraph or bar diagram

(b) Pie diagram or circle graph

(c) Pictogram

(d) Line graph

Bar graph or bar diagram :

In this graph the data is represented by bars. The bars are drawn either vertically or horizontally. The bars are rectangles having small width. The length or height of the bar is Propartional to the amount of variables. The space between two bars remains same. We can understand the bar graph clearly through an example.

Example : The number Students in different classes of a School is given below.

Class	No. of Students
VI	160
VII	120
VIII	100
IX	80
X	60

If we represent the above data though a bar graph then it will look like this :

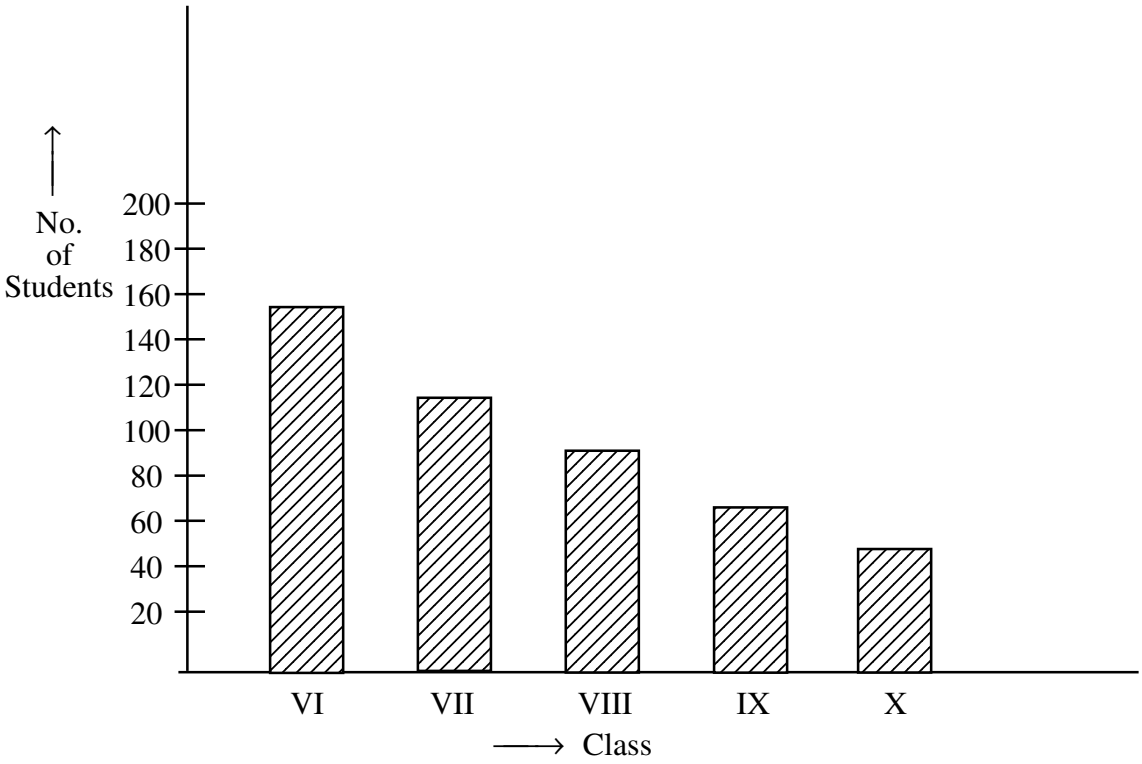

Figure : Bar graph

Here we have drawn the bars vertically. But Some times we draw the bars horizontally.

Pie diagram or Circle Graph :

In circle graph or pie diagram, data are represented by the Sections or portions of a circle. We know that the total angle Subtended by a circle at its centre is 2π or 360^o. This total angle 360^0 is divided among the variables according to their amounts. After determining these angles, the required Sectors in the circles are drawn.

For illustration of pie diagram or circle gaph let us take an example.

Example : Given below are the Seats won by different political parties in the Polling outcome of a state assembly elections.

Political party :	A	B	C
No. of Seats won :	90	30	60

To draw the pie diagram of the above data we have to first determine the angle of the circle occupied by each datum.

Political Party	Seats won	Angle of the Circle
A	90 $\xrightarrow{\frac{\cancel{60}}{\cancel{180}}}$	$\frac{90}{180} \times 360^o = 180^o$
B	30 $\longrightarrow$	$\times 360^o = 60^o$
C	60 $\longrightarrow$	$\times 360^o = 120^o$
	Total 180	Total 360^o

Now the pie diagram of the above data will look like this :

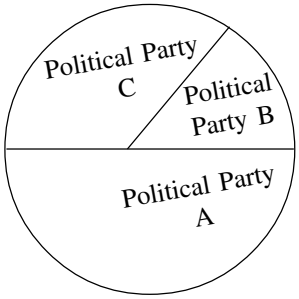

Figure : Pie diagram

3.7.2 Graphical representation of grouped data

When data are organized in to a frequency distribution, then its called grouped data.

Generally following methods are used for representation of frequency distribution graphically.

(a) The Histogram

(b) The frequency Polygon

(c) The Cumulative frequency Polygon

(d) The Cumulative frequency Percentage curve or ogive.

Histogram :

Histogram is a bar graph of frequency distribution. While constructing the histogram the scores in the form of actual class limits are taken. Two extra intervals one below and the other above the given grouped interval with zero frequency are taken. Let us take an example for illustration.

Example :

Scores	frequency
70-74	2
65-69	4
60-64	5
55-59	6
50-54	7
45-49	11
40-44	9
35-39	3
30-34	2
25-29	1

Here the actual class limits are 24.5–29.5, 29.5–34.5 and So on. We can take two extra classes 19.5–24.5 in the lower side and 74.5–79.5 in the upper side with zero frequencies.

Now the actual lower lower limits of all the class intervals are Plotted on the X-axis and the respective frequencies are plotted on the Y-axis. The base of each rectangle is the width of the class interval (i) and the hight is the respective frequency of that class. The units along X axis and Y axis are so chosen that the height of the figure is approximately 75% of its width. (It is a general rule).

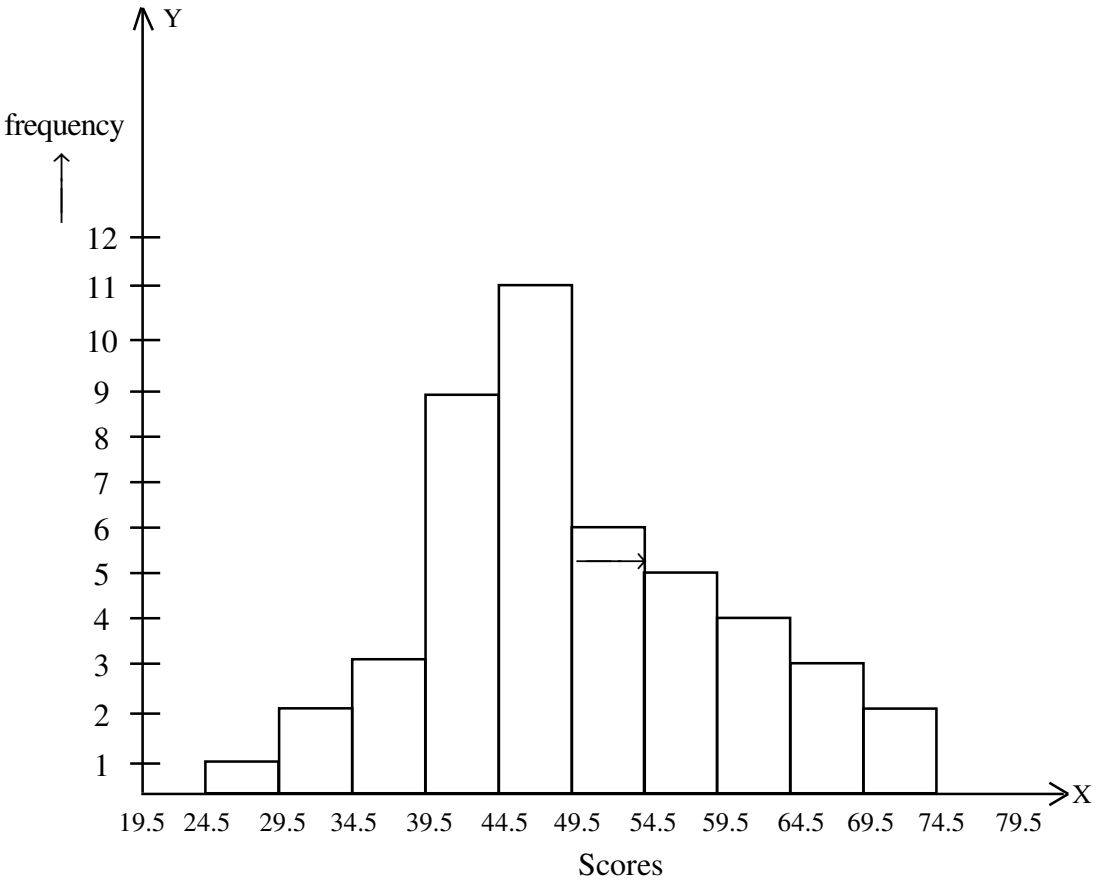

Figure : Histogram of frequency distribution

Frequency Polygon :

We have seen than a histogram is a bar graph; but a frequency polygon is a line graph for the graphical representation of the frequency distribution. To construct a frequency Polygon we have to follow the following steps :

(i) Two extra classes, one below and one above the given intervals are taken (as in the case of histogram).

(ii) The mid points of all classes are calculated and marked along the X-axis

(iii) The Corresponding frequencies are Plotted along Y-axis

(iv) The Points thus obtained by Plotting the midpoints and the corresponding frequencies are joined by straight lines. This gives the required frequency polygon.

Here also the scales of X-axis and Y-axis should be chosen in such a way that the height of the polygon is approximately equal to the 75% of the width.

We can have the frequency polygon from a histogram. Here we have to connect the midpoints of the upper bases of the rectangles by straight lines.

In the next Section a frequency polygon is constructed directly from a frequency distribution. We will take the same frequency distribution as taken in case of histogram. In this frequency distribution the midpoints are 22, 27, 32, 37, 42, 47, 52, 57, 62, 67, 72 & 77. The corresponding frequencies are 0, 1, 2, 3, 9, 11, 7, 6, 5, 4 2 & 0

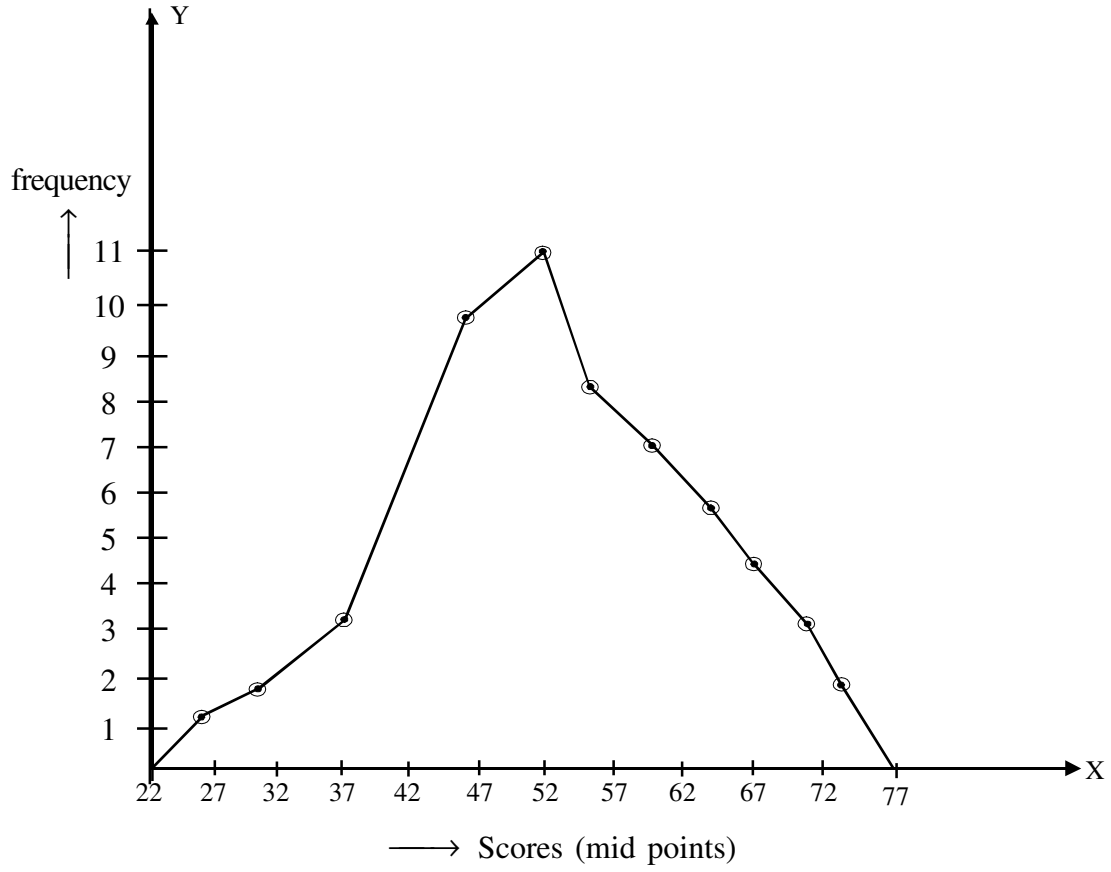

Figure : Frequency polygon of frequency distribution

Cumulative frequency graph

Cumulative frequency graph is also a line graph like frequency polygon. But in this case the data organized in the form of cumulative frequency distribution is Plotted. The actual upper limits of the class intervals are Plotted on the X-axis and the respective cumulative frequencies are plotted on the Y-axis. All the plotted points are then joined through a Successive chain of Straight lines which results a line graph. Here also it is customary to take one extra class interval with zero cumulative frequency to plot the origin of the curve on the X-axis. Let us take an example of frequency distribution to plot the cumulative frequency graph. Here we take the same frequency distribution as taken for plotting histogram or frequency polygon.

Example :

Scores	actual upper limit	frequency	comulative frequency	cumulative percentage frequency
70-74	74.5	2	50	100
65-69	69.5	4	48	96
60-64	64.5	5	44	88
55-59	59.5	6	39	78
50-54	54.5	7	33	66
45-49	49.5	11	26	52
40-44	44.5	9	15	30
35-39	39.5	3	6	12
30-34	34.5	2	3	6
25-29	29.5	1	1	2
20-24	24.5	0	0	0

To Plot origin of the curve we take an extra class interval 20-24 with zero frequency.

So in the above example we plot first the actual upper limits 24.5, 29.5, 34.5, 39.5, 44.5, 49.5, 54.5, 59.5, 64.5, 69.5 and 74.5 on the X-axis and then the corresponding cumulative frequencies o, 1, 3, 6, 15, 26, 33, 39, 44, 48 and 50 along Y-axis.

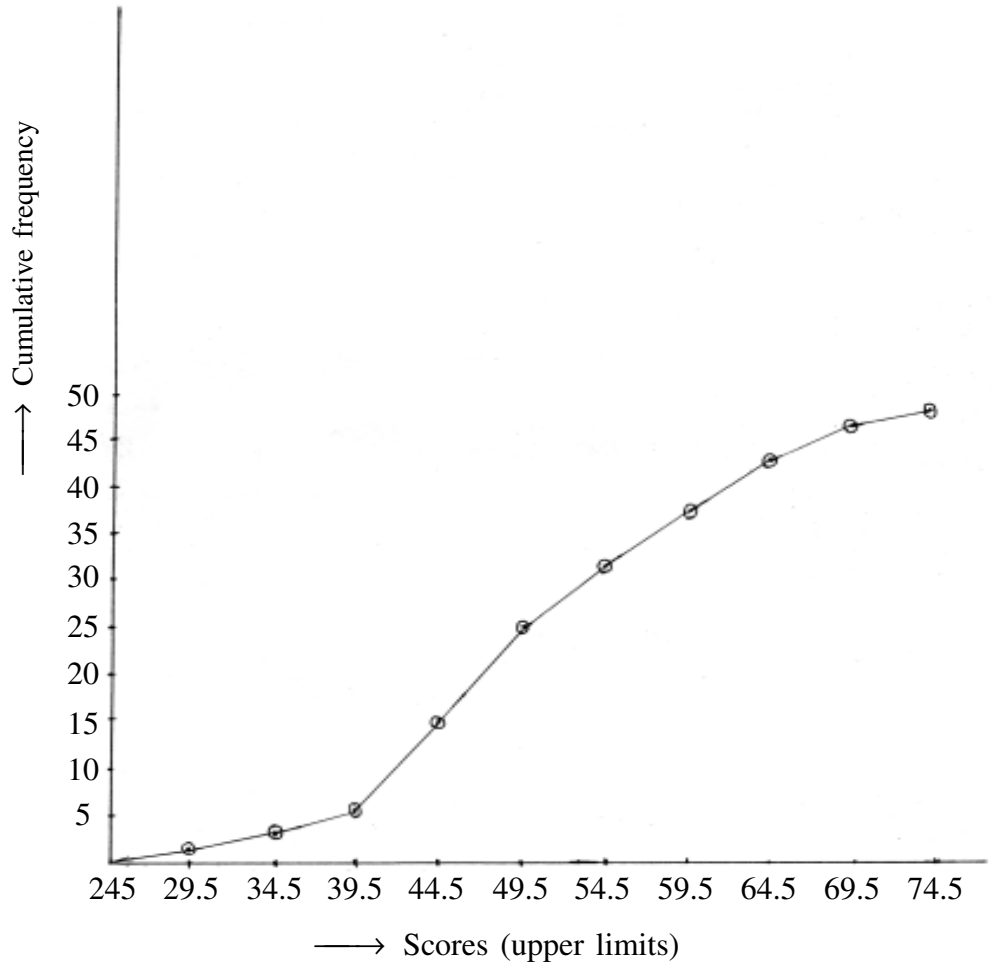

Figure : Cumulative frequency curve.

Cumulative Percentage frequency curve or Ogive

Cumulative Percentage frequency curve or Ogive is another way of graphical representation of frequency distribution. As in the case of cumulative frequency curve here also the actual upper limits of the class intervals are plotted on the X-axis and to take the origin of the X-axis here also we consider another class interval with zero frequency. The respective cumulative percentage frequencies are plotted along Y-axis. The general rule for consideration of Scales of X-axis and Y-axis is same i.e. scales are so chosen that height of the curve is approximately 75% of the width of the curve.

If we consider the same frequency distribution as taken for plotting the cumulative frequency curve, then we see that the upper class limits are 24.5, 29.5, 34.5, 39.5, 44.5, 49.5, 54.5, 59.5, 64.5, 69.5 and 74.5 and the corresponding cumulative percentage

frequencies are 0, 2, 6, 12, 30, 52, 66, 78, 88, 96 and 100. The ogive of this frequency distribution will be as follows :

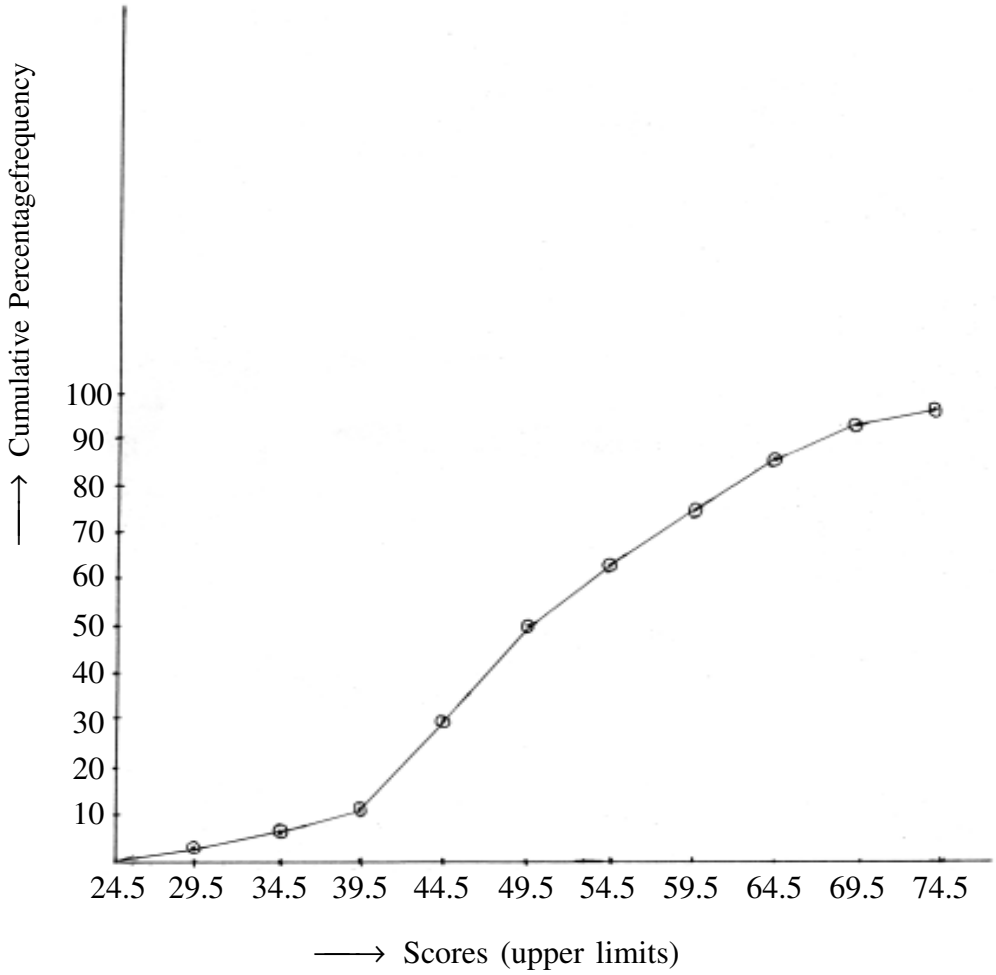

Figure : Ogive or Cumulative Percentage frequency curve

It is to be noted that Ogive or Cumulative Percentage frequency curve is very useful in Statistics. We can determine median, quartile, quartile deviations, deciles, percentiles, percentile ranks very accurately and fairly from ogive. Ogive can also be used for over all comparison of two or more frequency distributions by plotting the curves on the same Co-ordinate axes. Another important point is to be mentioned that ogive or other frequency curves sometimes need to be Smoothed. One of the methods of Smoothing a frequency distribution is the method of ‘‘running average’’. The formula for this method is as follows :

Smoothed frequency of a class interval

$= \frac{1}{3}$ [Frequency of the given class interval + frequencies of the two andjacent class intervals].

3.8 Let Us Sum Up

This unit deals with measurement and analysis of educational data. There are four scales of measurement e.g. nominal, ordinal, interval and ratio. Ratio scale is the highest level of measurement whereas nominal scale is the simplest type of scale of measurement. Interval scale has no true zero and the data collected in many experiments of education fall under this scale. Data in the field of education and psychology are mostly numerical and for interpretation of the data their organisation is necessary. Data can be organised in many ways like rank order, frequency distribution etc. Graphical representation of data is also helpful for their interpretation. Ungrouped data may be represented through a bar graph, circle graph, pictograph and line graph. Grouped data i.e. frequency distribution may be represented graphically by histogram, frequency polygon, cumulative frequency graph and ogive. For the interpretation of data we have to know the central tendency of data. For this purpose we measure mean, median and mode. These central tendencies provide us a central value of a set of scores as a whole but do not show how the individual scores are spread out. The tendency of the scores to deviate from average value is known as dispersion. There are mainly four measures of dispersion namely range, average deviation, quartile deviation and standard deviation. In education we need to know whether there exists any relationship among the different attributes and this need can be fulfilled by the technique of correlation. Linear correlation is the simplest type of correlation and it reveals how a change in one variable is accompanied by a change in the other. The degree of relationship is known by measuring the coefficient of correlation. The methods of computing coefficient of linear correlation are Rank difference method and Product moment method.

3.9 Check Your Progress

1. Explain with Suitable examples different scales of measurement.
2. Differentiate between Interval scales of measurement and Ratio scale of measurement.

3. What do you mean by organisation of data?

4. Construct a frequency distribution table with the following scores :

   86, 84, 90, 58, 60, 61, 74, 76, 85, 95, 45, 68, 72, 57, 84, 86, 71, 55, 48, 49, 52, 59, 66, 67, 72, 86, 92, 94, 96, 51, 57, 46, 66, 70, 75, 77, 79, 62, 49, 50, 64, 72, 68, 85, 83, 81, 51, 59, 69, 47.

   (N = 50)

   Take i = 5 and No. of classes = 10

5. Compute the mean, median and mode for the following frequency distributions :

Scores →	80–84	75–79	70–74	65–69	60–64	55–59	50–54	45–49
freq. →	7	8	9	13	16	11	6	5

6. Find out mean, median and SD of the following distribution.

Scores →	90–94	85–89	80–84	75–79	70–74	65–69	60–64	55–59	50–54
freq →	5	3	7	5	12	6	5	4	3

7. Calculate the quartile deviation and standard deviation for the following frequency distributions :

Scores →	45–49	40–44	35–39	30–34	25–29	20–24	15–19	10–14	5–9
freq →	3	4	3	18	30	21	14	4	3

8. Mention the important Properties of mean.

9. Write two advantages using mean.

10. Write down the important properties of median.

11. Explain in what condition median is better measure of central tendency than mean.

12. What is Coefficient of correlation? Discuss in brief the two important methods of computing coefficient of liner correlation.

13. What is Rank difference method of computing coefficient of correlation?

14. What is Pearson's Product moment method of computing correlation?

15. Find rank correlation coefficient from the following data and interpret the results.

(i)

Individuals :	A	B	C	D	E	F	G	H
Marks in History :	55	60	45	40	52	39	38	65
Marks in Geography :	62	53	55	48	45	50	42	54

(ii)

Individuals :	A	B	C	D	E	F	G	H
Marks in English :	50	52	65	52	60	50	45	57
Marks in Bebgali :	45	60	60	58	50	47	60	55

16. Find the coefficient of correlation between the following two sets of scores using the product moment method.

Individuals :	A	B	C	D	E	F	G	H	I	J	K	L
Variable X :	12	14	16	18	20	19	18	14	16	22	24	20
Variable Y :	40	38	42	35	38	40	42	36	38	40	45	50

17. What do you mean by 'graphical representation of data'? What are the advantages of it?

18. What is histogram? How does it differ from a frequency polygon?

19. Draw an ogive of the following distribution.

Scores :	37–39	34–36	31–33	28–30	25–27	22–27	19–21	16–18	13–15	10–12
freq. :	1	8	14	8	7	5	3	2	1	1

20. Draw histogram, frequency polygon and cumulative freq. polygon Separately for the following distribution :

Scores :	0–9	10–19	20–29	30–39	40–49	50–59	60–69	70–79	80–89
freq. :	2	3	4	6	10	8	4	2	1

3.10 References :

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Notes