SYLLABUS

PSYCHOLOGY
SEMESTER V

Examination to be held in the year 2019 & onwards

Course No. PY-501 (Theory) **Title : Measurement and Statistics in Psychology**

Duration of Exam : 3 Hrs **Total Marks : 100**

Theory Examination : 80

Internal Assessment : 20

4 Credits

Objectives : This course is designed to make students familiar with the concepts and methods used in statistical analysis.

UNIT - I

Statistics : Meaning and its role in psychological research. Scores frequency, continuous and discrete series. Graphical Representation - historgram, frequency polygon and ogives.

UNIT - II

Measures of Central Tendency : Mean, Median and Mode.

UNIT - III

Measures of Variability : Range, MD, SD, QD (grouped data). Percentile

and Percentile rank.

Correlation : Meaning, Uses, Product moment & Rank diffeence method.

UNIT - IV

Psychological Testing : Definition, Uses and Criteria of a good test.

Reliability & Validity : Concept & Types.

Concept of Population : Samples and its Types. Design and control of experiments. Formulation of Hypothesis. Independent and dependent Variables. Control and Experimental groups.

UNIT - V

Measurement Scales : Nominal, Ordinal, Interval and Ratio Scales. Sources of error in measurement.

Scaling Techniques : Rating Scales, Method of Paired comparisons. Differential Scales (Thurstone) Summated Scales (Likert).

BOOKS RECOMMENDED

Howitt, D., & Cramer. D. (2011), Introduction to Research Methods in Psychology. 3/e. U.K. : Person Education Limited.

Kaltenbach, H-M. (2012) *A Concise Guide to Statistics. New York : Springer.*

Kerlinger, F.N. *(1983). Foundations of Behavioural Research. New Delhi : Surjeet Publication.*

Kothari, C.R. (2004). Research Methodology : *Methods and Techniques. New Delhi : New Age International (P) Ltd., Publishers.*

Verma, L. K. & Sharma, N. K. (2000). Advanced Statistics in Education and Psychology. Jalandhar : Narendra Publishing House.

NOTE FOR QUESTION PAPER SETTING

The question paper would contain two types of questions, that is, **Long Answer Type Questions and Short Answer Types Questions.**

There would be **two long answer type questions,** set from each unit; out of which one question will have to be attempted by the students, **unitwise.**

Similarly, there would be **two short answer type qustions,** set from each unit. The student will have to attempt **one short answer question** from each unit. In all, students will have to attempt **five long answer type questions** and **five short Answer Type questions** out of five units.

Long answer type questions would carry **Sixty marks (12 marks, each question)** and Short answer type questions would carry **Twenty marks** for five questions **(4 marks, each question)**. These questions would be set **unitwise** in the question paper, separately.

Internal Assessment (Total 20 Marks)

Distribution of Internal Assessment is as under :-

i) Two Written Assignments : (10 marks each)

MEASUREMENT AND STATISTICS IN PSYCHOLOGY

B.A. III **CONTENTS** **PAPER–A**

MEASUREMENT AND STATISTICS IN PSYCHOLOGY

B.A. III **CONTENTS** **PAPER–A**

LESSON: 1 **UNIT-I**

MEANING OF STATISTICS

STRUCTURE:

1.0 INTRODUCTION :

The purpose of the lesson is to familiarise the students with the meaning of Statistics and its role in psychological Research. The chapter also has a brief overview of some psychological measurents.

Statistics is the independent field of study or Academic Discipline. It has wide Application in behaviour sciences and social sciences.

1.1 OBJECTIVES :

After going through this lesson the student should:

(i) be able to understand the meaning of statistics.

(ii) be able to define statistics.

(iii) be able to understand role of statistics in psychological research.

(iv) be able to understand different psychological measurement like score, frequency, continuous and discrete series.

1.2 MEANING OF STATISTICS:

The word "statistics" is derived from the Latin word "Status" or the word "Statista" of the Italian language. Both these words mean political status. In old times, statistics meant the political situation of the state. For example: collecting valuable statistics concerning the birth rate, death rate, income, the expenditure and the output of agricultural field etc. According to W.G. Sutcliffe "Statistics comprises the collection, tabulation, presentation and analysis of an aggregate of facts, collected in a methodological manner, without bias and related to a predetermined purpose.

Statistics can best be defined as the collection, classification, analysis and interpretation of numerical data with a definite purpose in view. In psychology, statistics is used for above purpose such as construction and standardization of psychological tests, prediction of future progress of students and guidance.

Statistics is concerned with scientific methods for collecting, organizing, summarizing, presenting and analyzing data, as well as drawing valid conclusions and making reasonable decisions on the basis of such analysis.

Check your progress exercise-1

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

(1) The word 'statistics' has been derived from:

_____

_____

_____

(2) W.G. Sutcliffe defined statistics:

_____

(3) Statistics can be best defined as:

1.3 ROLE OF STATISTICS IN PSYCHOLOGICAL RESEARCH :

(1) In the collection of facts.

(2) To present facts in a definite and unambiguous form.

(3) To simplify unwieldy and complex data so as to make them understandable.

(4) Statistics is a technique of making comparison.

(5) Statistics helps in correlating data how changes in one phenomenon lead to changes in another phenomenon.

(6) Statistics helps in formulating and testing hypothesis. Different hypothesis or laws in all fields of human efforts can be formulated and tested with the help of statistics.

(7) Statistics helps in the construction and standardization of various tests and measures like achievement tests in various subjects, Intelligence tests, Aptitude tests, Interest Inventories, Attitude scales and various other measures of personality assessment.

(8) Statistics helps in making use of the results of various tests and measures. Scores obtained from various tests and measures are always relative and not absolute. Statistical methods help in their proper presentation, comparison and interpretation. Thus it helps to know individual differences of students.

(9) Statistical methods are used in educational and vocational guidance programmes.

(10) Statistical methods help in making successful predictions regarding future progress of students.

Check your progress exercise-2

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

(1) 'The role of statistics in psychology for collection of facts', give an example:

_____

_____

_____

(2) 'The role of statistics in making comparison', give an example:

_____

_____

_____

(3) 'The role of statistics in hypothesis testing', give an example:

_____

_____

_____

(4) 'The role of statistics in predictions', give an example:

_____

_____

_____

(5) 'The role of statistics in the construction and standardization of tests and measures', give an example.

_____

_____

_____

1.4 PSYCHOLOGICAL MEASUREMENT

Scores, frequency, continuous series and discrete series

Scores

Scores are also known as measures. A number or other quantitative value used to representing measurable acts of a subject. For example; age, score, grade score. Measurement of individual performance by means of tests is usually expressed as a score. Scores may be in terms of time taken to complete a task or amount done in a given time. Some time scores are expressed in terms of difficulty of the task or excellence of result. Mental test scores vary with performance, and changes in scores are expressed in equal units they constitute an interval scale. Standardized psychological tests are usually interval scales, as they have equal units but they do not possess a true zero.

Check your progress exercise-3

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

(1) Score can be defined as :

_____

_____

_____

(2) Some examples of score can be :

_____

_____

_____

(3) Can scores are expressed in equal units :

_____

_____

_____

(4) Characteristics of an interval scale :

_____

_____

_____

Frequency

The number of times a particular value is repeated is called frequency of that class. For example: In a class of 30 students, 67% marks in mathematics obtained by 20 students. Here the 67% frequency is 20. In order to facilitate counting generally a column of 'tally bars' used. Tally bar (vertical lines) is put opposite to particular value to which it relates. Frequency refers to the number of scores, or values or cases that are present in a class interval.

Frequency Distribution

Frequency distribution is a statistical table shows the set of all distinct values of the variable arranged in order of magnitude, either individually or in group with their corresponding frequencises side by side. In order to facilitate counting generally a column of "tally bars" is prepared. It is represented by (f).

Frequency refers to the number of scores, or values or cases that are present in class interval. There is no definite rule for forming class interval may be 2,3,4,5,10 or 15. Whatever the length, all class-intervals in a certain distribution table should be of equal length.

STEPS IN THE GROUPING OF DATA INTO FREQUENCY DISTRIBUTION :

Problem:—The marks obtained by 64 students in an intelligence test are given below :

70, 71, 67, 90, 51, 70, 90, 67, 79, 81, 81, 58, 76, 72, 51, 76, 76, 90, 71, 72, 62, 89, 90, 76, 71, 88, 66, 81, 91, 71, 65, 63, 65, 76, 79, 80, 71, 76, 54, 80, 72, 63, 87, 91,

90, 45, 69, 66, 80, 79, 71, 75, 58, 50, 47, 67, 67, 52, 64, 88, 54, 80, 80, 92.

Steps for grouping data into Frequency Distribution:—

1. **Finding Range:** The first step is to determine the range. The range is to be found by highest score minus the lowest score.

   Range = Highest score - Lowest score. In the present problem the range of the distribution is (92-45). Therefore the range is 47.

2. **Determine the length of class-interval:** the second step is to decide about the number of class intervals in which all the scores will spread. The length of class interval may vary from situation to situation and its length is determined according to our convenience. These are some guiding principles for deciding the class interval.

$$\textbf{Class Interval} = \frac{\textbf{Range}}{\textbf{Number of classes desired}}$$

If the series contains less than about 50 items, the classes should not be more than 10. If the series contains from about 50 to 100 items, 10 to 15 classes tend to be appropriate. Ordinarily, not less than 10 classes or more than 20 are used.

If by dividing range by number of classes, we do not get a whole number, the nearest, appropriate number is taken as class interval.

Another rule is usually the class intervals 2,3,5 or 10 units in length are used. The class interval of 5 should be preferred because the mid-points so yielded will be in whole number. An even class-interval yields mid point in decimal fractions.

3. **Writing the classes of frequency distribution:** For this purpose, first the lowest class is settled down and after wards other subsequent classes are written down. In the present problem (45-49) can be taken as the lowest class-interval.

The next task is to tally the scores. For this purpose we take all the scores one by one and record to the right of relevant class by making a tally mark (/). Then we combine the tallies in the column under a heading "f" which stands for frequencies. Where there are

no tallies, enter a zero (0) in f column. Then find the sum of the frequencies and write it at the bottom. The sum is shown by N or Sf (sum of all the frequencies).

Class-interval	Tallies	f (frequency)
90-94	⧸⧸⧸⧸ III	8
85-89	III	4
80-84	⧸⧸⧸⧸ III	8
75-79	⧸⧸⧸⧸ ⧸⧸⧸⧸	10
70-74	⧸⧸⧸⧸ ⧸⧸⧸⧸ I	11
65-69	⧸⧸⧸⧸ IIII	9
60-64	IIII	4
55-59	II	2
50-54	⧸⧸⧸⧸ I	6
45-49	II	2
		N = 64

4. **Checking Tallies:** The total of frequencies should be equal to the number of individuals whose scores have been tabulated.

5. **The midpoint of a class in a Frequency Distribution:** In a frequency distribution classes are sometimes indicated by their mid values. Whenever we wish to represent all the scores of any class interval in a frequency distribution by a single value, a midpoint is the only choice. The formula of determining the mid-point of a class is :

$$\textbf{Midpoint} = \textbf{Lower Limit of class interval} + \frac{\textbf{(Upper limit-Lower limit)}}{\textbf{2}}$$

For class interval 45-49, the mid point

$$\text{Is} = 45 + \frac{(49-45)}{2}$$

$$4$$

or = $45 + \frac{\quad}{2}$

or $45 + 2 = 47$

A discrete frequency distribution is formed by the items, which are capable of exact measurements. In such cases units are not divisible. For example, the number of Ph.D. students in psychology, the number of student in locality.

A continuous frequency distribution are the series which can be described by a continuous variable. For example: Intelligence score, time.

The commulative frequencies against values of the variable systematically arranged in increasing or decreasing order is known as "Commulative frequency distribution". The commulative frequencies are derived by the cummulation of the frequencies of the successive individual class intervals.

Check your progress exercise - 4

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

(1) What is frequency in statistics?

_____

_____

_____

(2) What is 'tally bars'? Give an example?

_____

_____

_____

(3) What is frequency distribution?

_____

(4) What are the steps for grouping data in to frequency distribution?

(5) Make a frequency distribution table by creating hypothetical data.

Continuous and Discrete series

The term 'variable' refers to the characteristic that varies in amount or magnitude in a frequency distribution. A variable may be either continuous or discrete. A continuous variable is capable of manifesting every conceivable fractional value within the range of possibilities, such as the height, weight, IQ, time, distance etc. IQ might be 100 or even 100.98 physical measures as well as mental test scores fall in to continuous series.

Height	**No. of persons**
100-110 cm	19
110-120 cm	11
120-130 cm	25
130-140 cm	20
140-150 cm	25
	100

Series which exhibit real gaps are called discrete. It cannot manifest every conceivable fractional value. For instance; number of children the number of rooms in a house, can be expressed in 1, 2 or 3 etc. Generally speaking, continuous data are obtained through measurements, while discontinuous data are derived by counting :

No. of children	No. of families
0	20
1	50
2	70
3	100
4	120
5	150

Although the theoretical distinction between continuous and discrete variation is clear and precise, in practical statistical work it is only an approximation. The reason is that even the most precise instruments of measurement can be used only to a finite number of places. Thus every theoretically continuous series can never be expected to flow continuously with one measurement touching another without any break in actual observations.

Check your progress exercise - 5

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

(1) Define continuous series?

_____

_____

_____

(2) Gaps in a truly continuous series can be attributed to failure to get enough data or to crudity of the measuring instrument, explain it by giving an example?

(3) Define discrete series?

(4) Give some examples of continuous and discrete series?

1.5 LET US SUM UP

Statistics can be best defined as the collection, classification, analysis and interpretation of numerical data with a definite purpose in view. The role of statistic in psychological research are collection of facts, simplify complex data, making comparison, hypothesis testing and predictions. A score refer to a number or other quantitative value used to represent any measurable acts of a subject. Frequency is number of times a particular value is repeated is called frequency of that class. The continuous series reflect every conceivable fractional value within the range of possibilities. Discrete series exhibit real gaps.

1.6 LESSON END EXERCISE

Long Answer :

Q1. What do you mean by statistics discuss its role in psychological research.

Q2. What is Frequency distribution. Make a frequency distribution Table from the give data.

- A class consists of 20 students, whose English test series are as follows :

  24, 28, 39, 38, 22, 28, 34, 20, 222, 30, 28, 24, 28, 30, 34, 38, 30, 24, 22, 24.

Short Answer :

Q1. Define Frequency

Q2. Explain the terms : Continuous and discrete series.

1.7 SUGGESTED READINGS

1. Garrett, H.E. & Woodworth, R.S. (1981). Statistics in psychology and education. David Mckay & Longman Group Ltd. New York.
2. Best, J.W., & Kahn, J.V. (1995) Research in Education. Prentice Hall of India Pvt. Ltd.
3. Guilford, J.P., & Fruchter, B. (1978). Fundamental Statistics in Psychology and Education (6th ed.) New York: McGraw. Hill.
4. Kothari, C.R. (2004). Research Methodology : *Methods and Techniques New Delhi : New Age International (P) Ltd., Publishers.*
5. *Verma, L. K. & Sharma, N. K. (2000). Advanced Statistics in Education and Psychology. Jalandhar : Narendra Publishing House.*

LESSON NO. 2 **UNIT–I**

GRAPHICAL REPRESENTATION, DRAWING UP FREQUENCY DISTRIBUTION, HISTOGRAM, FREQUENCY POLYGON AND OGIVE

Structure

2.0 INTRODUCTION

In this lesson, Graphical Representation of data will be discussed. How to construct frequency. Polygon, Histogram and Ogive will also discussed.

2.1 OBJECTIVES :

After going through this lesson the student should be able to :

— understand the need and basic procedure of constructing graphs.

— arrange the scores obtained into frequency distribution.

— learn to construct polygon, histogram and ogive.

2.2 GRAPHICAL REPRESENTATION :

The main function of statistical techniques is to present the data in a way which makes the raw-data meaningful or communicable. Graphical representation of data helps us in getting a quick overview of the same. It gives a mathematical picture of the whole data. A graph is the geometrical image of a frequency distribution. Frequency distributions are converted into visual models to facilitate understanding.

There are different kinds of graphs. The most commonly employed methods of graphical representation are :

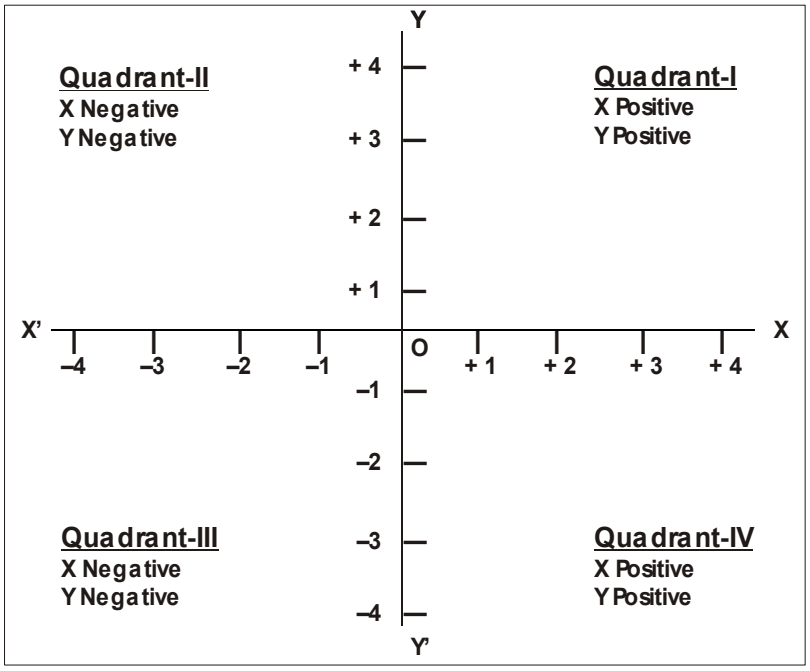
1. Frequency polygon.
2. Histogram.
3. Cumulative Percentage Curve or Ogive.

Basic procedure of Constructing Graphs :

The presentation is done on graph paper which has large squares and smaller squares of one millimetre and centimetres. Two simple lines are first drawn which intersect each other at right angles. The lines are known as co-ordinate axis. The point of intersection is known as point of origin or the Zero point. The horizontal line is called the axis of X or 'Abscissa' and the vertical line, the axis of Y or 'Ordinate'. The abscissa and ordinate are together known as axis. In the diagram O – is the point of origin, XOX' – is the axis of X or abscissa and YOY'–is the axis of Y or ordinate. Both positive as well as negative values can be shown on the graph. The whole area is divided into four quadrants. The positive values are measured along the X-axis to the right of origin (O), and negative values are on its left i.e. X-axis.

Similarly, the positive values of second dimension are measured along the Y-ordinate to the up side of origin and negative values are to the down side of it.

In order to give symmetry and balance to the graphical representation, care must be taken to select unit distance to represent the intervals on the X and Y axis. An appropriate rule is to select X and Y units which will make height of the figure approximately 75% of the width. However, the ratio of height to width may very from 60–80% but in no case it should be less than 50%. The arrangement of graph should proceed from left to right. The low numbers on the horizontal axis should be on the left and the low numbers on the vertical axis should be on the bottom. Both horizontal and vertical axis should be labelled and every graph should be assigned a title which precisely states what it is about.



CHECK YOUR PROGRESS EXERCISE NO. 1

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. Indicate the need and importance of graphic devices in statistical treatment.

_____

_____

_____

2. The space for graphical representation of data is divided into_____ quadrants.

3. Explain the following :

(a) Co-ordinate axis_____

_____

(b) Abscissa_____

_____

(c) Ordinate_____

_____

(d) Origin_____

_____

2.3 FREQUENCY DISTRIBUTION PREPARATION :

Frequency distribution is an arrangement of the data that shows the frequency of each score. It is a tally of the number of times each score value (or interval of score values) occurs in a group of scores.

The result of scientific observations is usually a collection of measurements and known as data. To make it understandable the data is to be grouped. The number of cases falling in each interval of scores has to be calculated which will depict the distribution of frequencies.

(A) Raw Scores on a statistical test :

12, 12, 14, 14, 13, 10, 11, 12, 13, 11

(B) Preparation of an Array

Step 1.—Arrange Scores in decreasing order.

14, 14, 13, 13, 12, 12, 12, 11, 11, 10.

Step 2.—Putting tally marks and frequencies.

Score X	Tally	Frequency f
14	II	2
13	II	2
12	II	3
11	II	2
10	I	1
		N = 10

Drawing up frequency distribution of ungrouped score :

Score

70	71	67	90	51	70	90
67	79	81	81	58	76	72
51	76	76	90	71	72	62
89	90	76	71	88	66	81
91	71	65	63	65	76	
79	80	71	76	54	80	
72	63	87	91	90	45	
69	66	80	79	71	75	
58	50	47	67	67	52	
64	88	54	80	60	92	

1. Find the lowest and highest scores in the set of scores. In the scores presented above, the lowest and highest scores are 45 and 92 respectively. The range in the scores is 92 – 45 = 47.
2. Create between 10 to 20 class intervals and the class interval depends upon the interval width chosen. Interval width is mostly keept at an odd number so that the mid point representing the class interval is an even number. The class interval is taken as 5 for above data.
3. The starting point is the starting point of the bottom class interval. The lowest score is 45, thus the class interval is 5 i.e. 45–49.
4. Tally the raw scores one by one against the class intervals. Then convert the tallies into frequencies (f) as shown in table below (Table 1).

Table 1

Class intervals	Tallies	Frequency (F)
90–94	𝍸	8
85–89	IIII	4
80–84	𝍸 II	7
75–79	𝍸 𝍸	10
70–74	𝍸 𝍸 1	11
65–69	𝍸 IIII	9
60–64	𝍸	5
55–59	II	2
50–54	𝍸 I	6
45–49	II	2
		Σ f or N = 64

The total of f is equal to N.

The class intervals as a convention are written in a descending order, keeping the highest class interval at the top and the lowest at the bottom. They should also form a continuous series and not the broken ones.

Exact Limits and Mid-points of the Class Intervals :

In the case of continuous variables, recording of observations or scores as discrete values like 10, 11, 12, 13 etc. is based on the assumption that the value recorded represents a value falling within certain limits. These limits are usually taken as one-half or 0.5 unit above and below the value reported. A score of 50 on a test would imply that if a more accurate form of measurement had been used, this value would fall within the limits 49.5 and 50.5. The limits of lower value are 49.5 and upper value are 50.5. The total range which the interval is expected to cover is 49.5 to 54.5 in the class interval 50–54 as shown in Table 1. In more precise terms, these limits are 49.5 to 54.499 in which the latter value has a recurring decimal and for convenience the limits are written as 49.5 to 54.5. These limits are often known as **exact limits** of the class interval.

Whenever we want to represent all the scores of any class interval in a frequency distribution by a single value, mid point is the only choice. For example, in the class interval 50–54, the mid point is 52. The **mid point** of any class interval is halfway between the exact limits of the interval. It is calculated as :

$$\text{Midpoint} = \text{Lower limit of Class interval} + \frac{\text{Upper Limit} - \text{Lower Limit}}{2}$$

For class interval 50–54, the mid point

$$\text{is} = 50 + \frac{54 - 50}{2}$$

$$= \quad 50 \quad + \quad \frac{4}{2}$$

$$= \quad 50 \quad + \quad 2 \quad = \quad 52$$

CHECK YOUR PROGRESS EXERCISE 2

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. What is a frequency distribution ? What are its uses in statistical analysis ?

_____

_____

_____

2. From the scores given below construct a frequency distribution.

   22, 12, 18, 23, 10, 9, 8, 50, 18, 17, 16, 30, 32, 33, 28, 21, 24, 30, 40, 42, 44, 46, 19, 10, 11, 15, 16, 31, 37, 36, 24, 25, 26, 28, 23, 21, 22, 8, 7, 6, 5, 7, 6, 9, 11, 30, 26, 27, 25, 26.

_____

_____

_____

3. What do you mean by :

(a) Mid Point_____

_____

(b) Class Internal_____

_____

2.4 FREQUENCY POLYGON :

A frequency polygon is a line graph of frequency distribution. A polygon is a many sided closed figure consisting of a series of points. A frequency polygon is used for graphically representing test scores on continuous data. The frequency polygon is a series of connected points above the mid point of each class interval. Each point is at a height equal to the frequency (f) of scores in that interval. The steps involved in constructing a polygon are :

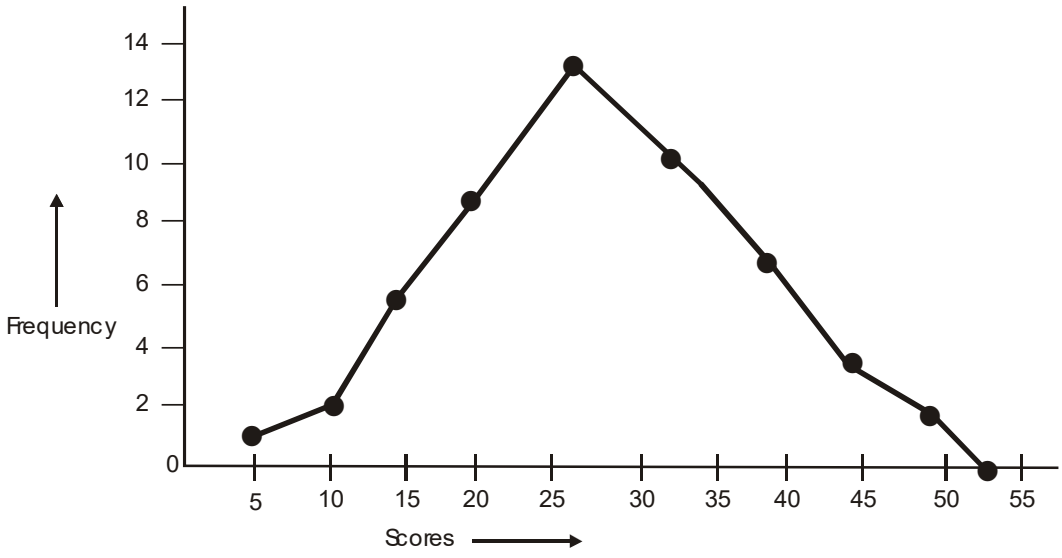
1. Set up two axis i.e. horizontal or X-axis and vertical or Y-axis.
2. The mid points of all class intervals are calculated by taking sum of upper and lower scores of a class interval and divided by 2.
3. Lay down mid points directly on the X-axis and frequencies on the Y-axis.
4. Add two empty intervals with zero frequencies above and below the class intervals so that the curve could be made to touch the base line on either side.
5. Double slash marks (//) are used to indicate breaks in the sequence of numbers between scores and/or frequencies and zero points.
6. Care should be taken to balance the ratio between horizontal and vertical axis.
7. The frequencies are plotted above the corresponding mid points of the class intervals.
8. The various points obtained by plotting mid points and frequencies are joined by straight lines. The line that connects the joints of the graph intersects the abscissa at the mid point of these empty intervals thus closing the polygon.

Example

Table 2

Class interval	*Exact limits*	*Frequency (f)*
45–49	44.5–49.5	2
40–44	39.5–44.5	3
35–39	34.5–39.5	6
30–34	29.5–34.5	9
25–29	24.5–29.5	13
20–24	19.5–24.5	8
15–19	14.5–19.5	6
10–14	0.9.5–14.5	2
05–09	04.5–09.5	1
		N = 50

Frequency Polygon for the data in Table



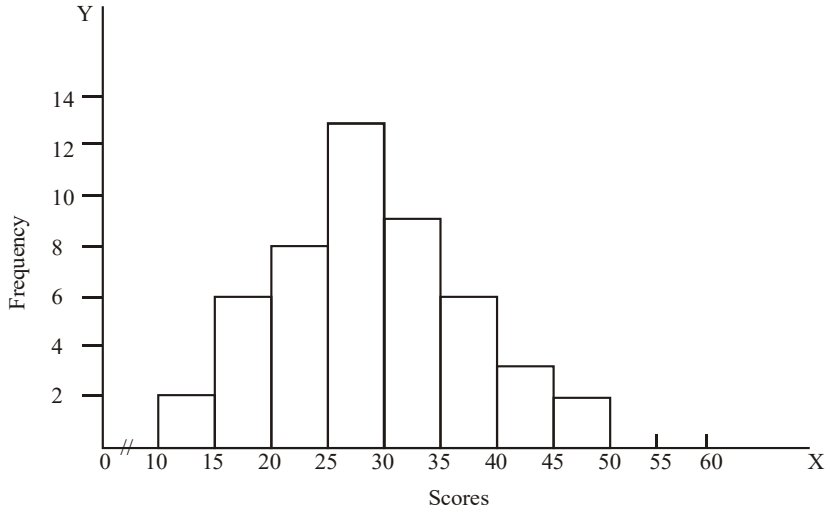
2.5 HISTOGRAM :

A histogram is a set of vertical bars with equal base but different heights. Therefore, it is also know as **bar-graph.** It is known as **frequency histogram** also. It is a type of bar or column graph which represents a frequency distribution. Unlike the frequency polygon, in histogram the actual scores are dealt with which are spread over the entire class interval. Within each interval of histogram, the frequency is shown by a rectangle the base of which is shown by length of interval and height of which is equal to number of scores in the interval. The interpretation of bar graph is simple. The higher the column the greater is the number of scores falling in that interval. The lower the column, the lesser the number of scores falling in that interval.

Steps of preparation of histogram :

1. Set up X-axis on the base line and Y-axis on the vertical side.
2. Lay down the actual class limits as upper and lower limits of each class interval i.e. 4.5-9.5 and onwards on the X-axis. The frequencies are marked on the Y-axis
3. Double slash (//) should be marked on the x-axis to indicate that the first point may be marked from any place.
4. It is prepared by placing a point on the lower and upper limits adjacent to corresponding frequencies and then joined to make a rectangle. There should be no space between bars.

Using the data in Table 2, a histogram is shown below :



In Histogram above, the two frequencies in the class interval 10-14 are represented by a bar or column or rectangle, the base of which is the length of the interval and height of which is two units upon the Y-axis. The highest rectangle is on the class interval 25-29 which has 13 frequencies, the largest f, as its height

The histogram is composed of rectangles with different heights. It is not necessary to project the sides of rectangles down to the base. The rise and fall of the boundary lines shows the increase and decrease in number of scores from interval to interval

2.6 OGIVE

Ogive is also known as cumulative percentage curve. There are occasions when cumulative frequencies become more meaningful and convenient when converted into cumulative percentages. This process makes a comparison of two or more distributions possible, when N differs. This leads to a standardization of N at 100.

In constructing an Ogive the ratio of Y-axis to X-axis is kept as 2:3. The frequencies in this are expressed as cumulative percents of N. The

cumulative frequencies are converted into cumulative percentages using the formula :

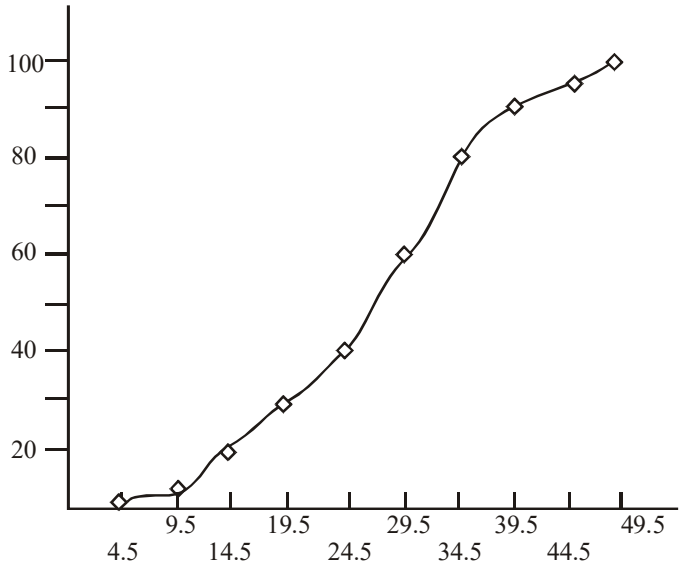
$$\text{Cumulative percentage} = \frac{\text{Cum F}}{\text{N}} \text{ x } 100$$

The cumulative percentages are laid off on the Y-axis and upper limits of each interval are placed on the X-axis

Construction of an Ogive

Class Interval	Exact Limits	Frequency	Cumulative Frequency	Cumulative Percentage Frequency
45-49	44.5-49.5	2	50	100.00
40-44	39.5-44.5	3	48	96.00
35-39	34.5-39.5	6	45	90.00
30-34	29.5-34.5	9	39	78.00
25-29	24.5-29.5	13	30	60.00
20-24	19.5-24.5	8	17	34.00
15-19	14.5-19.5	6	9	18.00
10-14	9.5-14.5	2	3	6.00
5-9	4.5-9.5	1	1	2.00

A cumulative percentage curve or Ogive based on the above date is given below :



CHECK YOUR PROGRESS - EXERCISE 3

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. What are the steps used in making a frequency polygon ?

   _____

   _____

   _____

2. Draw a histogram from the following scores.

Scores	**Frequency**
90-99	2
80-89	3
70-79	5

60-69	7
50-59	9
40-49	12
30-39	5
20-29	3
10-19	1

3. How is cumulative percentage calculated ?

_____

_____

_____

4. Draw an Ogive from the data in Q2 given above.

2.7 LET US SUM UP

Graphical Representation of date provides a Mathematical picture of the whole data. Different types of Graphs include Frequency Polygon, Histogram and Ogives.

2.8 LESSON END EXERCISE

Long Answer

Q1. Draw a Frequency Polygon of the given date of 50 students.

85	66	76	45	66	91	77	64	71	74
47	78	76	42	70	58	71	67	80	78
73	48	68	87	81	72	65	69	73	84
75	56	58	87	56	72	62	93	73	83
97	81	51	61	53	72	62	79	88	79

2.9 SUGGESTED READINGS

1. Sharma, R. A. (2008). Advanced Statistics in Education and Psychology. U. P : R. Lall Book Depot.
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LESSON NO. 3 **UNIT–II**

MEASURES OF CENTRAL TENDENCY, COMPUTING MEAN, MEDIAN AND MODE, THEIR MERITS AND DEMERITS

Structure

3.0 INTRODUCTION :

This Lesson starts with the Introduction of Measures of Central tendency. Calculation of Meen, Median and Mode for ungrouped and grouped Data will be discussed.

3.1 OBJECTIVES :

After going through this lesson the student should be able to :

— know the meaning of average.

— understand the meaning and computation of mean.

— calculate median.

— calculate mode.

— understand the advantages and limitations of mean, mode and median.

3.2 MEASURES OF CENTRAL TENDENCY :

One of the most important objective of statistical analysis is to provide a single summary figure that describes the characteristic of the entire data. Such a value is called the 'Central Value' or an 'average'. An average is a central value which is usually close to the point of greatest concentration of measurement or the expected value of the variable. The average is sometimes described as a number which is typical of the whole group.

Croxton defined an average as a single value within the range of the data that is used to represent all the values in the series. It is a single value that represents a group of values. Such a value is of great significance because it depicts the characteristic of the whole group. Since an average represents the entire data, its value lies somewhere in between the two extremes i.e. the largest and the smallest item. For this reason an average is frequently referred to as a measure of central tendency.

A measure of central tendency helps simplify comparison of two or more groups. The three commonly used measures of central tendency employed commonly in Psychology are : Arithmetic Mean, Median. and Mode.

CHECK YOUR PROGRESS EXERCISE 1

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. What is meant by average ?

_____

_____

_____

2. Define average :

_____

_____

_____

3. Why is average referred to as a measure of central tendency ?

_____

_____

_____

3.3 MEAN :

The mean or arithmetic mean is one of the most widely used measure of central tendency. The mean is actually the arithmetic average of a set of data. It is more stable index and is a single value which is a true representative of group performance. It is a score obtained by adding all the measurements and divided by the number of measurements.

Its value is calculated in two ways :

(i) Calculation through ungrouped data, and

(ii) Calculation through grouped data.

Upgrouped data :

The arithmetic mean is a score which is obtained by adding all the scores and dividing by number of scores. For example, 31, 35, 36, 38 and 40 are some measurements. The sum is 180 and dividing 180 by the number of score i.e. 5 gives mean score which is equal to 36.

$$\text{Mean} = \frac{\text{Sum of Scores}}{\text{Number of Scores}}$$

Expressed as a formula

$$\overline{X} = \frac{x_1 + x_2 + x_3 \ldots\ldots x_n}{N} = \frac{\Sigma x}{N}$$

$\overline{X}$ (x bar) devotes arithmetic mean

X = test score

N = Number of scores.

Σ = The sum of or summation (Greek letter Sigma).

Illustration :

The average of six scores 8, 5, 10, 8, 8, 9 is computed as follows :

$$\overline{X} = \frac{\Sigma x}{N}$$

$$\overline{X} = \frac{x_1 + x_2 + x_3 + x_4 + x_5 + x_6}{N}$$

$$\overline{X} = \frac{8 + 5 + 10 + 8 + 8 + 9}{6}$$

$$\overline{X} = \frac{48}{6}$$

$$\overline{X} = 8$$

Thus the average is 8.

Grouped data :

When there are many values of X scores then it becomes cumbersome to calculate the value of arithmetic mean by the method detailed above. In this type of situation the scores are grouped into different class intervals and frequency of each score in its interval is found out. The frequency distribution for a large data is prepared and Mean is calculated by two methods (i) Long Method and (ii) Short Method.

(i) Long Method or Direct Method

The arithmetic mean in this method is calculated with the help of mid-points. The formula for computing Mean through this method is :

$$\overline{X} = \frac{\Sigma fx}{N}$$

Where x = mid point of various classes.

f = frequency of each classes.

N = the total frequency.

Steps :

1. Obtain the mid point of each class and denote it by x. Mid point can be obtained by the formula.

   $$\frac{L + U}{2}$$

   Where L stands for lower limit of the class interval.

   U stands for upper limit of the class interval.

2. Multiply these mid-points by the respective frequency of each class and denote it by fx.
3. Add the scores on fx and obtain Σfx.
4. Divide the total i.e. Σfx by the sum of frequency i.e. N.

Illustration :

Calculation of Mean from Grouped data.

I **Scores**	**II** **Mid point X**	**III** **Frequency f**	**IV** **Products of f×x (fx)**
40–44	42	1	42
35–39	37	2	74
30–34	32	4	128

25–29	27	7	189
20–24	22	5	110
15–19	17	3	51
10–14	12	2	24
		N = 24	Σfx = 618

$$\text{Mean or } \bar{X} = \frac{\Sigma fx}{N}$$

$$= \frac{618}{24}$$

$$= 25.75$$

(ii) Short Method or Assumed Mean :

The long method involves more time and tedious calculations and to avoid these, short method or assumed mean method has been devised to obtain the value of mean. In this, the value of mean is assumed in the beginning and later apply a correction to the assumed value in order to get the real value of mean. The formula for obtaining mean by short method is :

$$\bar{X} = \text{A. M.} + \frac{\Sigma fx'}{N} \times i$$

where

A.M. = Assumed Mean

Σfx' = Sum of the products of frequency and deviation from the A.M.

N = Size of the sample

i = Size of the class interval.

Steps :

(1) The class interval are written in the first column.

(2) Write the frequency against the respective class interval.

(3) Find out the mid point (x) of each class interval.

(4) Assume the mid point (A. M.) at an interval which has the largest frequency.

(5) Find out the deviation (x') of each class interval. x' can be obtained by subtracting mid points from Assumed Mean i.e. (x – A.M.). The deviation above the mean will have positive sign and below deviation will always have negative sign.

(6) Multiply the respective frequencies of each class by those deviations and find fx'.

(7) Find the sum of fx' by taking into account the algebraic signs and denote it as Σfx'.

(8) Divide Σfx' by N and multiply it with the length of class interval. Add the result to Assumed mean.

Illustration :

Calculation of mean by Short Method.

Score	Mid points	f	x'	fx'	
40–44	42	1	+3	3	
35–39	37	2	+2	4	+11
30–34	32	4	+1	4	
25–29	27	A.M.	7	0	0
20–24	22	5	–1	–5	
15–19	17	3	–2	–6	–17
10–14	12	2	–3	–6	
		N = 24		Sfx' = –6	

$$\text{Formula } \overline{X} = \text{A. M.} + \frac{\Sigma fx'}{N} \times i$$

$$= 27 + \frac{-6}{24} \times 5$$

$$= 27 + \frac{-30}{24}$$

$$= 27 - 1.25$$

$$= 25.75$$

The mean obtained is 25.75

The value of mean came out to be the same when calculated either by long method or by short method.

Merits of Mean :

(1) It is the most commonly used average.

(2) It can be easily computed.

(3) It is based on all scores in data.

(4) If the mean of the sub-groups is known, the mean of the total group can be easily computed and *vice-versa*.

(5) It is least affected by the fluctuations of sampling and hence most stable average.

(6) It can be used for further algebraic treatment.

(7) It is relatively reliable in the sense that it does not vary too much.

(8) It is rigidly defined and is a definite value.

(9) It is defined by a rigid formula with the result that everyone who computes the average gets the same answer.

(10) It is a calculated value and not based on position in series.

(11) It conveys an understandable idea about the other members of the group.

Demerits of Mean :

(1) It can not be computed by mere inspection of data.

(2) It may not be an actual item in series. It can be a value which does not exist in the data.

(3) Its value can be greatly destroyed by extreme observations.

(4) It cannot be obtained if a single observation is missing or is illegible.

(5) It can not be located graphically.

(6) It can not be used in case of open-ended class intervals.

(7) It is not a suitable measure in skewed distributions.

(8) It can not be used with qualitative characteristics.

CHECK YOUR PROGRESS EXERCISE 2

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. What do you understand by the term Mean ?

_____

_____

_____

2. Calculate mean for the following scores :

10, 12, 14, 16, 18, 20.

_____

_____

_____

3. Calculate mean for the following scores by long method.

Scores	***f***
47–50	1
43–46	2
39–42	3
35–38	5
31–34	8
27–30	4
23–26	3
19–22	2
15–18	1

4. Calculate mean by short method for the following scores.

Scores	***f***
44–48	2
39–43	3
34–38	2
29–33	8
24–28	6
19–23	5

5. Give merits and demerits of mean :

_____

_____

_____

3.4 MEDIAN :

The median, symbolized by Md, is the point that divides the distribution into two parts such that an exactly equal number of scores fall above and below the point. It means that 50 percent of the scores will be above the median and the remaining 50 per cent below it.

Calculation of Median from Ungrouped data.

When the scores are not grouped into class intervals in a tabular form, the scores are arranged in the ascending order as given below :

1, 3, 5, 6, 8, 10, 11.

When the n is an odd number, the middle score becomes the median. In the above illustration 6 is the median. The score has an equal number of scores below and above it.

When the *n* is even number of scores, there is no middle score, so the median is taken as the point halfway between the two scores. For example, the scores are :

0, 3, 5, 6, 7, 10, 11, 12.

The medium in the above example is the average of the two middle scores 6 and 7 $(6+^{7}/_{2}) = 6.5$.

Calculation of Median through grouped data

The median in grouped scores is said to be the point of distribution below which and above which lie 50% of the scores. The formula for calculating the median when the data are grouped in class interval is :

$$Md = l + \frac{n/_2 - cfb}{fm} i$$

where

l = exact lower limit of the class interval within which median lies.

$n/_2$ = one half of the total number of scores.

cfb = cumulative frequency below the interval containing the median.

fm = frequency within the interval upon which the median falls.

i = size of class interval.

Steps

(1) Determine the particular class in which the value of median lies. Use N/2 as the rank of the median. This will enable to locate the median class.

(2) Compute the cumulative frequency for each class interval.

(3) Find the class interval in which median or value of N/2 falls.

(4) Find the cumulative frequency below the interval containing median.

(5) Divide the difference between the value of N/2 and cumulative frequency below by the frequency of the class in which median falls.

(6) Multiply the difference obtained by the size of class interval.

(7) Add the product to the lower limit of the interval containing median.

Illustration

Scores	*frequency (f)*	*Cumulative frequency (cf)*
40–44	1	24
35–39	2	23
30–34	4	21
25–29	7	17

20–24	5	10
15–19	3	5
10–14	2	2

N = 24

$$\text{Md} = 24.5 + \left[\frac{24/_2 - 10}{7}\right] 5$$

$$= 24.5 + \left[\frac{12 - 10}{7}\right] 5$$

$$= 24.5 + \left(\frac{2}{7}\right) 5$$

$$= 24.5 + 0.29 \times 5$$

$$= 24.5 + 1.45$$

$$= 25.95$$

Merits of Median

(1) It is rigidly defined.

(2) It is easy to compute.

(3) It is not affected by extreme observations.

(4) It is sometimes located by making a simple observations

(5) It can be used with qualitative characteristics which cannot be measured quantitatively.

(6) The value of median can be determined graphically.

(7) It is not affected if any of extreme values is missing provided total number of values is known.

(8) It can be computed while dealing with a distribution of open ended class

intervals.

(9) In skewed distribution, the median is the most useful.

(10) It is used when exact mid point of distribution is desired.

Demerits of Median

(1) It is less stable than mean.

(2) It is not suitable for further mathematical treatment.

(3) It is affected by sampling fluctuations.

(4) It is erratic if the number of scores is small.

(5) It can not be used in those situations where maximum weights are given to extreme scores.

CHECK YOUR PROGRESS EXERCISE 3

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. Define Median.

_____

_____

_____

2. Give merits and demerits of the Median.

_____

_____

_____

3. Compute median for the following scores

Scores	*f*
44–48	1
39–43	2
34–38	3
29–33	0
24–28	4
19–23	5
14–18	0
09–13	3
04–08	1
	19

3.5 MODE :

The mode (Mo) is the score value which occurs most frequently in a set of scores and around which the other scores cluster densely. It is value at a point around which the scores tend to be heavily concentrated. It is a score which occurs with greatest frequency.

Ungrouped Data : In an ungrouped data the mode is that single score which occurs in a distribution of scores most frequently e.g. 4, 5, 6, 7, 8, 4, 10, 4. In this series, 4 occurs thrice and hence, it can be taken as mode.

Grouped Data : When scores are grouped into frequency distribution the crude mode is the midpoint of the interval containing the maximum frequency. In grouped data the true mode can be obtained by calculating its value with the help of formula given below :

$$\text{Mode} = L + \frac{i\,(f_1 - f_o)}{2f_1 - f_o - f_2}$$

where

L is the lower limit of the modal class.

f_1 is the frequency of modal class.

f_0 is the frequency of class preceeding the modal class.

f_2 is the frequency of succeeding class interval.

i is the size of the class interval.

Steps :

(1) Find out the modal class from the series. Modal class is the class interval which has the highest frequency.

(2) Find out the frequency of the modal class.

(3) Find the frequency preceeding the model class.

(4) Multiply the difference between step 2 and step 3 by the size of class interval.

(5) Find the frequency succeeding the modal class.

(6) Multiply the frequency of the modal class by 2.

(7) Add step 3 and step 5.

(8) Subtract sum of step 3 and step 5 from the product of step 6.

(9) Divide product of step 4 by the result of step 8.

(10) Add the result of step 8 to lower limit of the modal class.

Illustration :

Scores	***f***
40–44	1
35–39	2
30–34	4
25–29	7
20–24	5
15–19	3
10–14	2

$$\text{Mode} = L + \frac{i\,(f_1 - f_o)}{2f_1 - f_o - f_2}$$

where $L = 24.5$

$f_0 = 5$ (succeeding class)

$f_1 = 7$ (Modal class)

$f_2 = 4$ (Preceeding class)

$i = 5.$

$$\text{Mode} = 24.5 + \frac{5\,(7 - 5)}{(2\times7) - 5 - 4}$$

$$= 24.5 + \frac{10}{14-9}$$

$$= 24.5 + \frac{10}{5}$$

$$= 24.5 + 2.0$$

$$= 26.5$$

There is another simple Formula for approximating the mode of a symmetrical or at least not badly skewed frequency distribution. The formula is :

$$\text{Mode} = 3\ \text{Median} - 2\ \text{Mean}$$

Merits of Mode

(1) It is easy to calculate the value of mode.

(2) It is easy to understand.

(3) It is not affected by extreme observations.

(4) It is not essential to know all the items for calculating the value of mode.

(5) It is the quickest approximate method.

(6) It can be calculated by mere observation also.

(7) It can be calculated graphically.

(8) It is useful for qualitative data.

Demerits of Mode

(1) It is not rigidly defined.

(2) It is not stable for further mathematical treatment.

(3) It is affected by fluctuations of sampling.

(4) It is very unstable.

(5) It is of limited practical value.

(6) In same cases no single well defined mode exists.

(7) It has little meaning unless the number of measurements under consideration is fairly large.

CHECK YOUR PROGRESS EXERCISE 4

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. Define Mode.

_____

_____

_____

2. Give merits and demerits of Mode.

_____

_____

_____

3.6 LET US SUM UP :

Mean is the arithmetic average of a set of data, median is the point which divides the distrubiton into two parts. Mode is the score that occurs most frequently in a set of scores. All these three i.e. Mean, Median, and Mode are the measures of Central Tendency.

3.7 LESSON END EXERCISE :

Long Answer :

Q1. Calculate the Mean from the below data :

C. I.	f
40 - 44	2
35 - 39	3
30 - 34	5
25 - 29	10

20 - 24	8
15 - 19	5
10 - 14	3

N = 36

Q2. What do you mean by measures of central Tendency. Discuss the merits and demerits of mean.

Short Answer

Q1. Define Mode. Describe its merits and demerits.

Q2. Define Median Discuss its merits and demerits.

3.8 SUGGESTED READINGS

1. Sharma, R. A. (2008). Advanced Statistics in Education and Psychology. U.P. : R. Lall Book Depot.
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LESSON NO. 4 **UNIT– III**

MEASURES OF VARIABILITY : COMPUTING MEAN DEVIATION, STANDARD DEVIATION

Structure

4.0 INTRODUCTION :

This lesson starts with the introduction of measures of variability. Calculation of Range, Mean Deviation, Standard. Deviation will be discussed. Merits and Demerits of all the Measures of variability will also be discussed.

4.1 OBJECTIVES :

After going through this lesson the student shall be able to :

— know the meaning and significance of measures of variability.

— compute Range

— compute Mean Deviation

— compute Standard Deviation

— Compute Quartile Deviation

4.2 MEASURES OF VARIABILITY

Measures of central tendency indicate one special aspect of a distribution. But a single value alone cannot adequately describe a set of observations. The measures of central tendency or dispersion gives no idea about the individual differences, as to how the scores of one individual differ from another in relation to the centre. If we are given the mean score of a distribution, we can not make out complete idea about the distribution as many distributions may have the same mean score e.g.

	Score		***Mean***
A	10, 10, 10, 10, 10, 10, 10	=	10
B	13, 12, 11, 10, 9, 8, 7	=	10
C	19, 16, 13, 10, 7, 4, 1	=	10

All the three series have same size and same mean. The spread of scores and deviation of scores in set B and set C is very high. Measures of variability help us in studying the dispersion or scatter of score around the mean.

Simpson and Kafka defined measure of variability as “the measurement of the scatterness of the mass of figures in a series about an average is called measure

of variation or dispersion". Simpson further said, "an average is hardly representative of the mass until we know the manner in which the individual scores scatter around it".

There are various measures of variability with the help of which scatter or dispersion of score around the mean can be studied. They are :

1. Range
2. Mean Deviation.
3. Standard Deviation.
4. Quartile Deviation.

CHECK YOUR PROGRESS EXERCISE 1

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. How do the measure of variability help in studying the distribution ?

   _____

   _____

   _____

2. Define measure of variability.

   _____

   _____

   _____

3. Different measures of variability are : _____,

   _____, _____,_____and_____

4.3 RANGE :

It is very simple and quick measure of variability. It is defined as the difference between the value of the smallest item and the value of the largest item included in the distribution. The range is calculated as follows :

Range = Highest score – Lowest score

Illustration :

Calculate range from the following data.

12, 6, 5, 4, 2, 8, 7, 9

Highest score = 12

Lowest score = 02

Thus Range = 12 – 02 = 10.

Limitations of Range :

(1) It does not indicate the variability of all set of scores.

(2) It has poor applicability.

(3) It is very crude measure of variability.

Merits of Range :

(1) Range is the simplest to understand and easiest to compute.

(2) It takes minimum time to compute Range.

(3) It gives a very quick picture of variability.

Demerits of Range :

1. Range is not based on each and every item of the distribution.
2. It is subject to fluctuation of considerable magnitude from sample to sample.
3. The range takes into account the extreme of the series of scores only and is, therefore, unreliable.

CHECK YOUR PROGRESS EXERCISE 2

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. Define Range.

_____

_____

_____

2. Calculate Range from the following distribution :

   20, 21, 08, 16, 22, 25

_____

_____

_____

3. Give Merits and Demerits of range.

_____

_____

_____

4.4 MEAN DEVIATION :

Mean deviation is also known as average deviation. It is the average distance between the mean and the scores in the distribution. It is the arithmetic mean of all the deviations when plus or minus signs are disregarded.

The mean deviation is calculated by using the following formula :

$$\text{M.D/A.D.} = \frac{\Sigma \mid x \mid}{N}$$

M.D/A.D. = Mean deviation/Average deviation.

Σ = Summation

x = X – M (Scores – Mean)

| | = Mod or two vertical lines (scores if placed between Mod, magnitude of the value is taken irrespective of signs.

Calculation of Mean Deviation through Ungrouped data :

Steps :

(1) Compute the mean of the scores.

(2) Deviate the scores from the value of mean and denote it by x.

(3) Obtain the total of these deviations and find Σx.

(4) Divide the total obtained in step 3 by the number of observations.

Illustration

S. No.	Scores	Deviation with sign	Deviation without sign
1	13	+3	3
2	12	+2	2
3	11	+1	1
4	10	0	0
5	9	–1	1
6	5	–5	5
	Σ 60	0	12

$$\text{Mean} = \frac{60}{6} = 10$$

$$M = \Sigma X = 12 \quad N = 6$$

$$\text{Mean Deviation} = \frac{\Sigma \mid x \mid}{N}$$

$$= \frac{12}{6} = 2$$

Calculation of Mean Deviation from Grouped Data :

The mean deviation is computed by employing the same steps which are followed in ungrouped data and the formula is :

$$\text{Mean Deviation} = \frac{\Sigma \mid fx \mid}{N}$$

where $\Sigma \mid fx \mid$ = Summation of fx.

N = Number of observations.

Steps :

(1) Calculate the mean of the series.

(2) Take the deviation of the items from mean ignoring the signs and denote them by x.

(3) Multiply these deviations by the respective frequencies and obtain the $\Sigma \mid fx \mid$.

(4) Divide the total obtained in step 3 by the number of observations.

Illustration :

Calculate the Mean Deviation from the following score :

Class Interval	Frequency (f)	Mid point (x)	Deviation x	fx
29–31	2	30	(30–23.4) = 6.6.	13.2
26–28	3	27	(27–23.4) = 3.6.	10.8

23–25	4	24	(24–23.4) = 0.6.	2.4
20–22	3	21	(21–23.4) = –2.4	–7.2
17–19	2	18	(18–23.4) = –5.4	–10.8
14–16	1	15	(15–23.4) = 8.4.	–8.4
	N = 15	Mn - 23.4		Σ | fx | 52.8

$$MD = \frac{52.8}{15} = 3.52$$

Merits of Mean Deviation :

(1) It is simple to understand and easy to compute.

(2) It is based on each and every item of the data.

(3) Mean deviation is less affected by the value of extreme items than the standard deviation.

Demerits of Mean Deviation :

(1) In mean deviation the algebraic signs are ignored while taking the deviation which is mathematically wrong.

(2) This method may not give us accurate results.

(3) It is not capable of further algebraic treatment.

CHECK YOUR PROGRESS EXERCISE 3

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. Define Mean deviation

_____

_____

_____

2. Calculate Mean deviation from the following :

(i) 3, 5, 7, 4, 8, 9

(ii)

Class interval	f
90–94	2
85–89	2
80–84	4
75–79	8
70–74	6
65–69	11
60–64	09
55–59	07
50–54	05
45–49	00
40–44	02
	N = 56

3. Give Merits and Demerits of Mean deviation.

_____

_____

_____

4.5 STANDARD DEVIATION :

The standard deviation is by for the most important and most widely used index of variability. It makes complete use of information on variability contained in the data, and is much more meaningful. The concept of standard deviation was introduced by Karl Pearson in 1893 as a measure of variability.

Standard deviation is defined as the positive square root of the arithmetic mean of the squares of the deviation of the given scores from their arithmetic mean. In computing mean deviation, the signs are disregarded and all deviations are treated as positive, where as in computing standard deviation, the problem of signs is avoided by squaring the deviations. The squared deviation used in computing the standard deviation are always taken from mean, never from the median or mode. The symbol for standard deviation is Greek letter sigma (σ).

(a) Calculation of Standard Deviation from Ungrouped scores :

Standard Deviation can be calculated by using the formula as :

$$\text{S. D./ } \sigma = \sqrt{\frac{\Sigma d^2}{N}}$$

where σ = Standard Deviation

Σd^2 = Sum of the squares of the difference of each score from the mean.

N = Number of scores.

The following steps are used for computing S. D.

1. Mean is calculated of the set of data.

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

2. The deviations are calculated of the scores from the mean

$$d = (X–M) \text{ or (Score – Mean).}$$

3. The deviations are squared to make all deviation positive.

$$d^2 = (X–M)^2$$

4. The sum of the squares of deviations is obtained and divided by the number of individuals of the group.

$$\frac{\Sigma d^2}{N} \quad \text{or} \quad \frac{\Sigma(X - M)^2}{N}$$

5. The S. D. value is obtained by the square root of the variance (large sample).

$$SD \text{ or } \sigma = \sqrt{\Sigma d^2/N} = \sqrt{\Sigma(X - M)^2/N}$$

where :

d = (X–M) = deviation from mean

N = Size of the sample

X = Score

M = Mean of the scores.

Σ = Sum

Illustration :

Calculation of SD from Ungrouped Scores.

	Score	Deviation from the Mean X	Squared Deviation
	X	(X – M)	x^2
1	10	+2	4
2	7	–1	1
3	9	+1	1
4	6	–2	4
5	8	0	0
N=5	Σx = 40		$\Sigma x^2 = 10$

M = 40/5

= 8

$$\text{Var} = \frac{\Sigma x^2}{N} = \frac{10}{5} = 2$$

$$\text{SD or } \sigma = \sqrt{\frac{\Sigma x^2}{N}} = \sqrt{\frac{10}{5}} = \sqrt{2}$$

$$= 1.414$$

Calculation of S.D. from Grouped Data :

When the number of scores is large, the data is grouped in frequency distribution and value of S. D. is calculated. The formula for calculating standard deviation is :

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

where σ = Standard deviation.

Σfd^2 = Summation of frequency multiplied by square of d.

d = deviation.

N = Number of observations.

Steps :

(1) Find out the Mean from the series.

(2) Take the deviation of mid points from the mean and denote it by d.

(3) Multiply these deviation i.e. d by the respective frequencies and obtain fd.

(4) Multiply fd by d and obtain fd^2.

(5) Add the items at fd^2 and obtain Σfd^2.

(6) Divide fd^2 by N i.e. Number of observation.

(7) Find the square root of the value obtained.

Illustration :

Computation of S.D. from Grouped Data

Scores	*f*	*d*	*fd*		fd^2
40–44	1	+3	3		9
35–39	3	+2	6	13	12
30–34	4	+1	4		4
25–29	7	0	0		0
20–24	5	–1	–5		5
15–19	3	–2	–6	–14	12
10–14	1	–3	–3		9
	N=24		$\Sigma fd = -1$		$\Sigma fd^2 = 51$

The formula for the computation of standard deviation from the grouped data is :

$$\sigma = i\sqrt{\frac{\Sigma fd^2}{N} - \left(\frac{\Sigma fd}{N}\right)^2}$$

$$= 5\sqrt{\frac{51}{24} - \left[\frac{(-1)}{N}\right]^2}$$

$$= 5\sqrt{2.125 - 0.002}$$

$$= 5\sqrt{2.123}$$

$$= 5 \times 1.457$$

Hence $\sigma = 7.285 = 7.29$

Merits of Standard Deviation:

1. Standard deviation is the best measure of variability because of its mathematical characteristic.
2. It is less affected by fluctuation of sampling.

3. Standard deviation is used in further statistical work,
4. It is the most reliable measure of variability.
5. It is suitable for further algebraic treatment.

Demerits of Standard Deviation.

1. It is difficult to compute than other measures of variation.
2. It gives weight to extreme values.

CHECK YOU PROGRESS EXERCISE NO. 4

Note :- Use the space given below for your answer. Use separate sheet if required.

1. Write the symbol used for Standard Deviation.

   _____

   _____

2. Calculate Standard Deviation from the following scores.

a) 40, 39, 36, 35, 33, 28, 34

b)

Class interval	f
45-49	2
40-44	3
35-39	2
30-34	6
25-29	8
20-24	8
15-19	7
10-14	5
05-09	9

4.6 QUARTILE DEVIATION :

Quartile are points which divide a distribution into 4 quarters. A quartile is defined as one of the 3 points measured along the scale of the plotted variable which divide the frequency distribution into 4 parts each containing one fourth of the cases.

The quartile deviation in its procedure does not consider the highest 25 percent and lowest 25 percent scores. It considers the middle 50 percent scores. There are three quartiles i.e. Q3, Q2, and Q1

Q_3 = Contains 75% of the cases

Q_2 = Contains 50% of the cases.

Q_1 = Contains 25% of the cases.

The quartile deviation or Q.D. is one half the range of the middle 50% of the cases. It is distance between 75th and 25th percentile in a frequency distribution. The formula is

$$Q = \frac{Q_3 - Q_1}{2} = \frac{P_{75} - P_{25}}{2}$$

The one half of the range from Q_1 to Q_3 is sometimes used as an index of variability. This index is also known as the semi-interquartile range. The first quartile or Q_1 is the 25th percentile below which 25% of the cases lie. The 75th percentile or Q_3 is the third quartile the point below which 75% of the scores are located. Quartile Deviation (Q.D.) tells how for above the median and how for below the median we have to go to include half of the cases which lie between Q_1 and Q_3.

$$Q.\ D. = \frac{Q3\ -Q1}{2}$$

Where : Q_3 = P_{75} or 75th percentile or ¾ of N.

Q_1 = P_{25} or 25th percentile or ¼ of N.

N = Number of scores.

$$Q.\ D. = \frac{(Q_3 - Mdn) + (Mdn - Q_1)}{2}$$

The quartile deviation is useful only in the situations in which a crude measure is sufficient for the purpose of the particular analysis.

Method for calculating Q

A frequency distribution of 50 subject is given below. Calculate quartile deviation

of the distribution.

Class interval (x)	Frequencies (f)	Cumulative frequencies (cf)
40–42	5	50
37–39	8	45
34–36	9	37
31–33	10	28
28–30	7	18
25–27	5	11
22–24	4	6
19–21	2	2
	Total N = 50	Upward

Q_1 or P_{25} is calculated by using the formula :

$$Q_1 \text{ or } P_{25} = L_1 + \left(\frac{N/4 - fb}{fa} \right) \text{ C. I.}$$

Where :

Q_1 = First quartile or P_{25}.

L = Lower limit of class interval in which Q_1 or P_{25} falls.

N = Size of the group.

fa = Actual frequency of the C.I.

fb = Frequency below the C.I.

C.I. = Size of the class internal.

Putting the values in the formula :

$$Q_1 = 27.5 + \left(\frac{12.5 - 11}{7} \right) \times 3$$

$$= 27.5 + 0.64 = 28.14$$

Similarly Q_3 or P_{75} is calculated by employing the following formula.

$$Q_3 \text{ or } P_{75} = L_3 + \left(\frac{3N/4 - fb}{fa} \right) \text{ C. I.}$$

Where :

Q_3 = Third quartile or P_{75}.

L_3 = Lower limit of class interval in which Q_3 or P_{75} falls.

N = Size of sample.

fa = Actual frequency of the C.I.

fb = Frequency below the C.I.

C.I. = Size of the class internal.

Putting the values in the formula :

$$Q_3 = 36.50 + \left(\frac{37.5 - 37}{8} \right) \times 3$$

$$= 36.50 + 0.19 = 36.69$$

Now the value are put in formula for Q. D.

$$QD = \frac{Q_3 - Q_1}{2}$$

$$Q.D = \frac{(36.69 - 28.14)}{2} = \frac{8.55}{2} = 4.28$$

The quartile deviation is 4.28

Merits of Quartile Deviation :

1. It is easy to understand and calculate.
2. It is not affected by extreme observations.
3. It is a better measure than range as it makes use of 50% of data.

4. It can be computed with the open ended class intervals.
5. It can be used with frequency distributions which have unequal class intervals.
6. It is also useful in badly skewed distributions.

Demerits :

1. It is not based on all observations of the data.
2. It ignores top and bottom 25% of the data.
3. It is easily affected by sampling fluctuations.
4. It is not suitable for further calculations.

CHECK YOUR PROGRESS EXERCISE 5

Note : Use the space given below for your answer. Use separate sheet if required.

1. What is meant by Quartile and Quartile deviation ?

   _____

   _____

   _____

2. Calculate Quartile Deviation from the following :

Scores	f
58–65	5
50–57	7
42–49	9
34–41	15
26–33	10
18–25	8
10–17	6
02–09	2

3. Give Merits and Demerits of Quartile Deviation.

_____

_____

_____

4.7 LET US SUM UP :

Measures of central tendency are not sufficient to describe the data unless a measure of variability is also given. Variability means variation or dispersion among the scores in a sample. The measures include Range, Mean deviation/Average deviation, Standard deviation and Quartile deviation.

The range is the simplest measure of variability, calculated by substracting the lowest score from the highest.

The mean deviation also known as average deviation is the average distance between the mean and the scores in the distribution.

The standard deviation is the most stable measure of variability. Variance is the square of standard deviation (S^2). Standard deviation reflects how much the scores tend to vary or depart from the mean score or reflects the average distance of all the scores around the mean.

The quartile deviation or Q.D. is one half the range of the middle 50% of the cases. It is distance between 75th and 25th percentile in a frequency distribution. It is also known as the semi-interquartile range.

4.8 LESSON END EXERCISE

Long Answer

Q1. Calculate standard Deviation from the following data.

C. I.	f
40 - 42	5
37 - 39	8

34 - 36	9
31 - 33	10
28 - 30	7
25 - 27	5
22 - 24	4
19 - 21	2

N = 50

Q2. Calculate Mean Deviation from the following Data

C.I.	f
29 - 31	2
26 - 28	3
23 - 25	4
20 - 22	3
17 - 19	2
14 - 16	1

N = 15

Short Answer

Q1. Discuss the Merits and Demerits of Standard Deviation.

Q2. What do you mean by Range and Mean Deviation.

4.9 SUGGESTED READINGS

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4. Guilford, J.P., & Fruchter, B. (1978). Fundamental Statistics in Psychology and Education (6th ed.) New York: McGraw. Hill.

5. Kothari, C.R. (2004). Research Methodology : *Methods and Techniques New Delhi : New Age International (P) Ltd., Publishers.*

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LESSON NO. 5 **UNIT–III**

PERCENTILES AND PERCENTILE RANK

Structure

5.0 INTRODUCTION

In this Chapter the Meaning and Definition of Percentiles, Percentile Rank will be discussed. How to Calcuate percentile and pecentile rank will also be discussed.

5.1 OBJECTIVES :

After going through this lesson the student shall be able to :

— Understand the meaning of Percentile.

— Compute the value of Percentile.

— Understand the meaning of Percentile rank.

— Compute the Percentile rank.

5.2 PERCENTILES :

Meaning and definition

The percentiles are relative value in a group of an individual interm of percent. It locates the position of an individual in his group, interns of percent of the individuals below him or above him. Thus the raw scores are transformed into percentiles.

Definition :

J. P. Guilford has defined the term percentile :

"A score or percentile is a value on the scoring scale below which are any percentage of the cases".

The percentiles of a given score distribution is the point on the score scale below which x percent of the scores fall.

The total area of frequency is divided into 100 equal points. Percentiles are linked with percentage which is equal to 100 points. The percentile points may be represented by the symbols P_0, P_{10}, P_{20},.....P_{90}, P_{100}. The percentiles P_0 to P_{100} are the limits which include all members of the same distribution. P_{10} means that a point in the distribution which has 10 percent of the cases lying below it. Several percentiles have special names such as median for P_{50}, first quartile (Q_1) for P_{25} and third quartile (Q_3) for P_{75}.

Percentite can be computed from ungrouped and grouped data.

Calculation of Percentiles from Ungrouped data :

The formula for computing percentiles is :

Value of	P_1 = 1% of N	$^1/_{100}$ of N
	P_{10} = 10% of N	$^{10}/_{100}$ of N
	P_{30} = 30% of N	$^{30}/_{100}$ of N
	P_{80} = 80% of N	$^{80}/_{100}$ of N

Steps :

(1) Obtain the value of the percentile point.

(2) Looking at the table find the score given against the value obtained in Step 1.

(3) Find the mean of score of step 2 and the next score.

(4) The value obtained in step 3 is the value of percentile.

Illustration :

Find the value of P_{10}, P_{30}, P_{50}, and P_{70} from the scores given below :

Students	Scores	Students	Score
1	12	11	34
2	17	12	35
3	20	13	35
4	27	14	36
5	28	15	37
6	29	16	38
7	30	17	39
8	31	18	40
9	32	19	40
10	33	20	41

N = 20.

P_{10} = 10% of N

P_{10} = $^{10}/_{100}$ of 20 = 2

$$P_{10} = \frac{\text{Score of 2 + Score of 3}}{2} = \frac{17+20}{2} = \frac{37}{2} = 18.5$$

$\therefore$ Value of P_{10} = 18.5

P_{30} = 30% of N.

= $^{30}/_{100}$ of 20 = 6.

$$P_{30} = \frac{\text{Score of 6 + score of 7}}{2} = \frac{29+30}{2} = \frac{59}{2} = 29.5$$

∴ Value of P_{30} = 29.5

P_{50} = 50% of N.

= $^{50}/_{100}$ of 20 = 10.

$$P_{50} = \frac{\text{Score of 10 + score of 11}}{2} = \frac{33+34}{2} = \frac{67}{2} = 33.5$$

∴ Value of P_{50} = 33.5

P_{70} = 70% of N.

= $^{70}/_{100}$ of 20 = 14.

$$P_{70} = \frac{\text{Score of 14 + score of 15}}{2} = \frac{36+37}{2} = \frac{73}{2} = 36.5$$

∴ Value of P_{70} = 36.5

Calculation of Percentiles (P_p) in a Frequency distribution :

The formula for percentiles are as follows :

$$P_p = L + \frac{pN - fb}{fa} \times C.\ I.$$

Where :

P_p = Percentage of the distribution as median is P_{50} or Q_2.

L = Lower limit of the class interval in which P_p falls.

pN = Part of N to be counted in order to reach Pp.

fb = Frequency below L of the class interval.

fa = Actual frequency in which class-interval Pp falls.

C.I. = Size or length of the class interval.

The following steps are used in calculating percentiles :

1. A cumulative frequency are prepared for the frequency distribution either upward or downward direction.
2. The obtained cumulative frequency are converted into percent, Ppercent of Cf= Cf×100/N.
3. The pN is calculated for which Pp is required.
4. The class-internal is located with the help of pN in which it lies. The lower limit of the class-interval (L) is calculated.
5. These values are placed in the formula :

$$P_p = L + \left(\frac{pN - fb}{fa} \right) \times C.I.$$

Illustration :

From the frequency distribution given below calculate the values of P_{25}, P_{40}, and P_{60}.

Class interval	f	cf	Percentiles
75–79	3	50	100
70–74	5	49	98
65–69	4	42	84
P_{75} 60–64	6	38	76
P_{60} 55–59	7	32	64
P_{40} 50–54	9	25	50
P_{25} 45–49	6 fa	16	32
40–44	5	10 fb	20
35–39	3	5	10
30–34	2	2	4
	Total Σf=N=50	Upward cf	Percentage of cf

$$P = L + \left(\frac{pN - fb}{fa} \right) \times C.I.$$

$$P_{25} = 44.5 + \left(\frac{12.5 - 10}{6} \right) \times 5$$

$$= 44.5 + \left(\frac{12.5}{6} \right) = 44.5 + 2.08 = 46.58$$

$$= 46.58 \text{ or } 47$$

$$P_{40} = 49.5 + \left(\frac{20 - 16}{9} \right) \times 5$$

$$= 49.5 + \frac{20}{9} = 49.5 + 2.22 = 51.72$$

$$= 51.72 \text{ or } 52$$

$$P_{60} = 54.5 + \left(\frac{30 - 25}{7} \right) \times 5$$

$$= 54.5 + \frac{25}{7} = 54.5 + 3.57 = 58.07$$

$$= 58.07 \text{ or } 58.$$

Merits of Percentiles :

(1) Percentiles are easy to compute and interpret.

(2) It helps in splitting the group into sub groups on the basis of percent of the cases.

(3) It helps in interpreting test scores.

(4) Percentiles are used in computing other statistics.

(5) It gives a meaningful insides of performance and a persons relative ranking in the group.

Demerits of Percentlies :

(1) Differences in percentiles do not represent true differences at the extreme than at the middle of the normal distribution.

(2) The size of percentile units is not constant in terms of the raw score units.

CHECK YOUR PROGRESS EXERCISE 1

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. What is meant by Percentiles ?

_____

_____

_____

2. Find the value of P_{35}, P_{55}, P_{74} from the scores given below :

   40, 41, 42, 43, 47, 52, 53, 54,. 55, 56, 58, 59, 60, 61, 62, 64, 65, 66, 67, 72, 73, 75, 76, 76, 76

_____

_____

_____

3. Pick up P_{25}, P_{50}, P_{75}, P_{10}, P_{15}, P_{85} and P_{94} from the data given below :

Scores	***f***
80–89	12
70–79	18
60–69	20
50–59	50
40–49	50
30–39	20

20–29	10
10–19	14
0–9	6
	N = 200

4. Give merits and demerits of Percentiles.

_____

_____

_____

5.3 PERCENTILE RANK :

Percentile rank is the position or rank of an individual obtained on the basis of percent cases falling below the score attained by any individual in the distribution. Percentile rank is reverse of percentiles. The percentile rank (PR) of a given score in the distribution represents the percent of the total number of cases lying below a given score. It indicates percent of all the scores in a frequency distribution that fall below a given raw score. It is the position on a scale of 100 to which the subject score entitles him. Percentiles are an ordinal scale indicating a rank order. The procedure followed in computing percentile rank is the reverse to the process of computing percentiles.

Computation of Percentile Rank :

The PR of any score can be calculated with the help of following formula

$$PR = \frac{100}{N}\left[Cfb + \frac{X\text{- lower limit}}{i} X\ fp \right]$$

Where :

PR = Percentile Rank

N = Number of Observations

X = Score of which PR is calculated.

Cfb = Cumulative frequency below the class interval in which PR falls.

f = Frequency of the class interval in which PR falls

L = Lower limit of the class interval in which PR falls

i = Size of the class interval.

Steps :

1. Locate the value of asked PR in the column of class interval.
2. Add the number of frequencies to obtains total value of N.
3. Find out the value of Cfb i.e. cumulative frequencies.
4. Find out the exact lower limit of the class interval in which PR falls.
5. Find out the value of fb i.e., actual frequency against the class interval in which PR falls.
6. Find out the value of the size of class interval i.e., number of scores in the class interval in which PR falls.

Illustration :

Find out the PR of 27 in the data given below :

Frequency Distribution for the computation of PR

Class interval (C.I.)	Frequency (f)	Cumulative frequency
40-44	1	30
35-39	3	29
30-34	6	26
25-29	10	20
20-24	5	10 cfb
15-19	3	5
10-14	2	2
	N = 30	

Substituting the values in the formula :

$$PR = \frac{100}{N}\left[Cfb + \frac{X\text{- lower limit}}{i} X\ fp \right]$$

$$PR = \frac{100}{30}\left[10 + \frac{27 - 24.5}{5} X\ 10 \right]$$

$$= 3.33 \left[10 + \frac{2.5}{5} X\ 10 \right]$$

$$= 3.33 \left[10 + \frac{25}{5} \right]$$

$$= 3.33 \left[10 + 5 \right]$$

$$= 3.33 \times 15$$

$$= 49.95 \text{ or } 50$$

Hence, the PR of 27 is 50. It means there are 50% of the cases which falls below score of 27.

Merits of Percentile Rank :

1. It is widely used and easily understood.
2. It is used for preparing norms of a group.
3. It indicates person's relative position in a group in terms of percentage of persons scoring below him.

Limitations of Percentile Rank :

1. Percentile ranks is on an ordinal scale, so the scores can not be added, substracted, multiplied or divided.
2. Percentile ranks have unequal units.
3. It is difficult to combine or average percentile ranks.
4. The PR of one group can not be compared with that of another.

Check your progress Exercise No. 2 :

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. Define Percentile Rank

_____

_____

_____

2. Compute PR of 20 and 34

Score	f
48-50	2
45-47	3
42-44	4
39-41	6
36-38	8
33-35	8
30-32	7
27-29	7
24-26	6
21-23	3
18-20	1
	N = 50

_____

_____

_____

3. Give merits and demerits of Percentile Rank

_____

_____

_____

5.4 LET US SUM UP

Percentile locates the position of an individual in his group, interms of percent of the individuals below him or above him.

Percentile points may be represented by the symbols P_0, P_{10}, P_{20} ..... P_{90}, P_{100}. Several percentiles have special names such as median for P_{50}, first quartile (Q_1) for P_{25} and third quartile (Q_3) for P_{75}. The percentile can be calculated for ungrouped and grouped data. They are helpful in interpreting test scores.

Percentiles Rank (PR) is the position or rank of an individual obtained on the basis of percent cases falling below the score attained by any individual in the distribution. PR is widely used for preparing norms of a group.

5.5 LESSON END EXERCISE

Long Answer

Q1.Find the values of P25, P40, and P60. from the data given below :

C. I.	f
75 - 79	3
70 - 74	5
65 - 69	4
60 - 64	6

55 - 59	7
50 - 54	9
45 - 49	6
40 - 44	5
35 - 39	3
30 - 34	2

N = 50

Q2. Find the percentile rank of the in dividents who have scared 42 and 73 in the above frequency distribution.

Short Answer :

Q1. Define percentile give its merits and demerits.

Q2. What do you mean by percentile rank. Discuss its merits and demerits.

5.6 SUGGESTED READINGS

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LESSON NO. 6 **UNIT–III**

CORRELATION : MEANING OF CORRELATION AND ITS USES. PRODUCT MOMENT METHOD. CALCULATION OF COEFFICIENT OF CORRELATION FROM UNGROUPED DATA (RAW SCORE AND DEVIATION SCORE) RANK DIFFERENCE METHOD.

Structure

6.0 INTRODUCTION :

This lesson familiaries the students with the concept and uses of correlation Calculation of Correlation by using product moment method and Rank difference method will be discussed. In the end of the Lesson, Interpretation of Correlation is discussed.

6.1 OBJECTIVES :

After going through this lesson, the student shall be able to :

— Know the uses of correlation

— Compute correlation by using Product Moment Method.

— Compute correlation by using Rank Difference Method.

— Interpret the value of correlation.

6.2 CONCEPT OF CORRELATION :

The correlation is the extent of relationship between any two variables. It is a measure of relationship between two variables. The pairs of measurement of two variables of the same group is called bivariate data or bivariate distribution. The data for example may be I.Q. and marks obtained in a test. It is very important to evaluate the relationship between two variables as they may be closely related or may be relatively independent i.e, not related. For this we need an index of association or relationship between the two variables. This is known as Coefficient of Correlation.

A Coefficient of Correlation is a single number that tells us to what extent two variables or things are related and to what extent variations in one variable go with variations with the other. When ever two measurements, for the same individual can be paired for all the individuals in a group, the degree of relationship between the paired score is called "Correlation".

Definition of Correlation : "Whenever two variables of the same group are so related that the increase or decrease to one corresponds to the increase or decrease to the other or conversely increase or decrease corresponds to the decrease or increase to another, they are said to be correlated".

Simpson defined correlation as the magnitude of association between two variables.

L. R Conner defined correlation as "If two or more quantities vary in sympathy so that movement in one tend to be accompanied by corresponding movement in the

others then they are said to be correlated. Tuttle defines correlation as "Correlation is an analysis of covariance between two or more variables". The relationship is described through a quotient, ratio or coefficient and hence, called coefficient of correlation.

A Correlation coefficient is a pure number, limited by the values ranging from - 1.00 through 0.00 to +1.00 that reflects the extent of linear relationship and expresses the degree of relationship between two sets of scores. The letter 'r' is usually used to represent the coefficient of correlation.

The various values of correlation existing between the scores of two variables are described as ;

1. Positive Correlation (+)
2. Negative Correlation (-)
3. Near Zero Correlation

1. Positive Correlation means that the increase of one variable corresponds to the increase of another variable or decrease of one variable corresponds to the decrease of another variable. The value of perfect positive correlation is +1.00. The positive correlation ranges between 0.00 to 1.00.

2. Negative Correlation means that the increase of one variable corresponds to the decrease of another or the decrease of one variable corresponds to the increase of another. Negative coefficient ranges from -1.00 to 0.00. The perfect negative correlation is -1.00

3. Near Zero correlation means there is no systematic trend and both the variables are acting at random. The correlation is near zero or no relationship exists in the two variables. The index is represented by 0.00

CHECK YOUR PROGRESS EXERCISE - I

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. What is meant by correlation ?

_____

_____

_____

2. Define Correlation ?

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_____

3. What are the various values of Correlation ?

_____

_____

_____

6.3 USES OF CORRELATION :

The study of correlation is of immense use in practical life because most of the variables show some kind of relationship and once we know that the two variables are closely related we can estimate the value of one variable given the value of another. The uses include :

1. Correlation is used in making predictions.
2. It is used in estimating reliability and validity of tests.
3. It is used in certain statistical techniques.
4. It is used as a criterion for selecting sub-tests in a battery of tests.

6.4 PRODUCT MOMENT METHOD :

This method was developed by Karl Pearson and is widely used in research and measurement. The coefficient of correlation is denoted by symbol r. The Pearson

Product Moment method is based on following assumptions :

1. Paired scores must be linear i.e. the ratio of change in one should be accompanied by the ratio of change in the other variable.
2. The variance in scores of two variables should be equal. It means the variability in X and Y should be equal and *vice versa.*
3. The distribution of two variables should be symmetrical and should not be skewed.
4. Both variables should be continuous.
5. Both variables should be measured on an interval or ratio scale.
6. The sample should be large to obtain a reliable r.

Calculation of coefficient of correlation from ungrouped data using raw scores :

The formula for computation of correlation through Pearson's Product Method is :

$$r = \frac{N\Sigma XY - \Sigma X \Sigma Y}{\sqrt{[N\Sigma X^2 - (\Sigma X)^2]\,[N\Sigma Y^2 - (\Sigma Y)^2]}}$$

where :

r = Coefficient of Correlation.

N = Number of individual scores

ΣX = Sum of Scores of X variable.

$(\Sigma X)^2$ = Sum of X score squared.

ΣY = Sum of Scores of Y variable.

$(\Sigma Y)^2$ = Sum of Y score squared.

ΣX^2 = Sum of squares of X.

ΣY^2 = Sum of squares of Y.

ΣXY^2 = Sum of Products of X and Y for each score.

Example : Calculate the coefficient of correlation from given data using raw scores.

Subject	Scores	
	X	**Y**
1.	1	4
2.	4	3
3.	6	2
4.	5	7
5.	2	1
6.	1	5
7.	6	10
8.	2	5
9.	8	11
10.	5	12

Steps :

1. The score of X and Y are given.
2. Find out the square of each score given in X variable and put them inder X^2.
3. Find out the square of each score given in Y variable and put them under Y^2.
4. Find out the products of X and Y and put them under XY.
5. Find out the sum of X, Y, X^2 and Y^2 and XY to get the values of ΣX, ΣY, ΣX^2, ΣY^2 and ΣXY.
6. Find the number of scores i.e. N.
7. The calculated values are put in the formula.

Subject	Scores				
	X	**Y**	**X^2**	**Y^2**	**XY**
1.	1	4	1	16	4
2.	4	3	16	9	12
3.	6	2	36	4	12
4.	5	7	25	49	35
5.	2	1	4	1	2
6.	1	5	1	25	5
7.	6	10	36	100	60
8.	2	5	4	25	10
9.	8	11	64	121	88
10.	5	12	25	144	60
N=10	40	60	212	494	288
	ΣX	ΣY	ΣX^2	ΣY^2	ΣXY

formula $r = \frac{N\Sigma XY - \Sigma X.\Sigma Y}{\sqrt{[N\Sigma X^2 - (\Sigma X)^2][N\Sigma Y^2 - (\Sigma Y)^2]}}$

$= \frac{10\times288 - 40\times60}{\sqrt{[10\times212 - (40)^2][10\times494 - (60)^2]}}$

$= \frac{480}{\sqrt{[1340\times520}}$

$= +0.58$

The coefficient of correlation between X and Y is 0.58 positive and both are moderately related to each other.

Method for calculating coefficient of correlation using Deviation Score :

It is also known as short method and by using deviation from assumed mean technique the long calculations are avoided. The formula used is :

$$r = \frac{N\Sigma xy - \Sigma x \cdot \Sigma y}{\sqrt{[N\Sigma x^2 - (\Sigma x)^2][N\Sigma y^2 - (\Sigma y)^2]}}$$

where

r = Pearson's coefficient of correlation.

x = deviation of X from assumed mean.

y = deviation of Y from assumed mean.

Σ = sum

N = size of sample.

Example : On a sample of 14 subjects, Math (Y) and Hindi (X) achievement test were administered and the obtained scores are given below. Apply Pearsons method of assumed mean for calculating coefficient of correlation.

Subjects	Hindi X	Math Y
1	10	20
2	12	20
3	8	15
4	21	18
5	25	21
6	10	17
7	11	19
8	20	10
9	15	16
10	18	22
11	7	13
12	20	19
13	18	22
14	11	12

Subject	Hindi	Math	(X–M)	(Y–M)

	X	Y	x	y	x^2	y^2	xy
1.	10	20	–5	+3	25	9	–15
2.	12	20	–3	+3	9	9	–9
3.	8	15	–7	–2	49	4	14
4.	21	18	+6	+1	36	1	6
5.	25	21	+10	+4	100	16	40
6.	10	17	–5	0	25	0	0
7.	11	19	–4	+2	16	4	–8
8.	20	10	+5	7	25	49	–35
9.	15	16	0	–1	0	1	0
10.	18	22	+3	+5	6	25	15
11.	7	13	–8	–4	64	16	32
12.	20	19	+5	+2	25	4	10
13.	18	22	+3	+5	9	25	15
14.	11	12	–4	–5	16	25	20
N=14			Σx=–4	Σy=6	Σx^2=408	Σy^2=188	Σxy=85

Steps :

1. (a) For data X, assumed mean is taken (nearest to the middle score) i.e. 15 and deviations x = (X –Mx) is obtained for each score.

   (b) For data Y, assumed mean is taken (nearest to the middle score) i.e. 17. Deviation Y = (Y – My) are calculated.

   (c) Take sum of deviations Σx and Σy.

2. The square of the deviation (x and y) are obtained. Take the sum of the square Σx^2 and Σy^2.

3. The corresponding pairs of deviation x and y are multiplied. Take the sum of products of deviation Σxy and total observation as N.

4. The calculated values are put in the formula.

$$r = \frac{N\Sigma xy - \Sigma x.\Sigma y}{\sqrt{[N\Sigma x^2 - (\Sigma x)^2]\,[N\Sigma y^2 - (\Sigma y)^2]}}$$

$$= \frac{14\times 85 - (-4)\times 6}{\sqrt{[14\times 408 - (-4)^2]\,[14\times 188 - (6)^2]}}$$

$$= \frac{1214}{\sqrt{5696\times 2596}}$$

$$= \frac{1214}{3834}$$

$$= 0.317 \text{ or } 0.32$$

The correlation is (+0.32) positive in sign, but low correlation between maths and hindi achievements.

CHECK YOUR PROGRESS EXERCISE - 2

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. What is Product Moment Method ?

_____

_____

_____

2. What assumptions should the data fulfil in Product moment method ?

_____

_____

_____

3. Who developed Product Moment Method ?

_____

_____

_____

4. Compute Coefficients of Correlation from the following data :

Subject	Scores	
	X	**Y**
1.	41	21
2.	42	16
3.	40	15
4.	42	18
5.	50	22
6.	46	20
7.	43	19
8.	45	17

5. Compute 'r' from ungrouped data by using deviations score.

Subject	Scores	
	X	**Y**
1.	74	40
2.	71	36
3.	67	28
4.	71	34
5.	50	22
6.	54	25
7.	56	34
8.	59	28
9.	60	26
10.	62	30
11	61	32
12	65	30

6.5 RANK DIFFERENCE METHOD :

In case when distribution of scores are not normal or when the distribution of scores are markedly skewed, measurements of correlation is done by ranking the scores according to size and making further computations on ranks rather than on original scores. Sometimes when the number of observations is small and parametric assumptions are not met, the data is reduced to ranks (ordinal) to get a coefficient of rank correlation as denoted by p (read as Rho) instead of r.

This method was developed by Charles Edward Spearman in 1904. This method is especially useful when quantitative values for certain factors such as judgement of beauty, honesty, sincerity etc. can not be fixed but the individuals in group can be ranked. It takes into account position of scores in series.

Computation of correlation by Spearman's Rank Difference Method :

Spearman's Coefficient of Correlation (p) is determined with the help of formula given below :

$$p = 1 - \frac{6\Sigma d^2}{N(N^2 - 1)}$$

Where :

p = Coefficient of rank correlation.

Σd^2 = Sum of squared differences in ranks.

N = Number of individuals.

Illustration :

Calculation of coefficient of rank correlation between marks obtained by 10 students in two subjects.

Individual	Marks	
	X	Y
1.	50	56
2.	53	52
3.	46	44
4.	48	43
5.	43	41
6.	44	48
7.	47	54
8.	54	55
9.	55	47
10	49	46

Steps :

1. Scores are written in first two colums. Choose the highest score in first column and assign a rank of 1.
2. Similarly, choose the highest score in second column and assign it rank of 1.

   If there is some score occurring regularly, average of score should be found out and similar score will get the averaged ranks and the ranks are put under R_1/R_2 respectivley as the case may be.

   The number of ranks should not exceed the number of scores.
3. Find out different between two sets of Ranks i.e. $R_1–R_2$.
4. Square each difference of ranks to get the value of d^2 and then sum the column of square for Σd^2.
5. Substitute the values of Σd^2 and N in the formula of Rank Difference method.

Individual	Scores					
	X	**Y**	$\mathbf{R_1}$	$\mathbf{R_2}$	**d**	$\mathbf{d^2}$
1.	50	56	4	1	3	9
2.	53	52	3	4	–1	1
3.	46	44	8	8	0	0
4.	48	43	6	9	–3	9
5.	43	41	10	10	0	0
6.	44	48	9	5	4	16
7.	47	54	7	3	4	16
8.	54	55	2	2	0	0
9.	55	47	1	6	–5	25
10.	49	46	5	7	–2	4
N = 10						$\Sigma d^2 = 80$

$$p = 1 - \frac{6\Sigma d^2}{N(N^2 - 1)}$$

$$= 1 - \frac{6 \times 80}{10(100 - 1)}$$

$$= 1 - \frac{480}{990}$$

$$= 1 - 0.48$$

$$= 0.52$$

Hence, the coefficient of rank correlation between scores obtained is + 0.52.

CHECK YOUR PROGRESS EXERCISE - 3

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. When the Rank Difference Method is used ?

_____

_____

2. Rank difference method was developed by

3. Compute the coefficient of Correlation by rank difference method of the data given below :

X	Y
17	22
11	19
9	18
16	13
15	17
13	12
12	16
10	15

6.6 INTERPRETATION OF CORRELATION :

The interpretation of Correlation is essential in order to estimate about the magnitude of its relationship. The correlation is an index which gives an idea about the association of traits or characterstics between the two variables or independence between the two variables.

Sign : The sign indicates the direction of relationship. Positive value indicates direct relationship and negative value indicates inverse relationship.

Magnitude : The minimum coefficient is 0.00 which indicates no correlation. The maximum value ranges between ±1.00. Both minus and plus 1.0 values indicate perfect relationship as per Garret (1973) the correlation values may be interpreted as detailed below :

(i)	r from 0.00 to ± 0.20	denotes indifferent or negligible relationship.
(ii)	r from ± 0.20 to ± 0.40	low correlation/relationship.
(iii)	r from ± 0.40 to ± 0.70	substantial or marked relationship.
(iv)	r from ± 0.70 to ± 0.80	High correlation/relationship.
(v)	r from ± 0.80 to ±1.00	Very high correlation.

CHECK YOUR PROGRESS EXERCISE - 4

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. What is the relationship between X and Y when the value of r is (i) + 0.25 (ii) –0.83 (iii) –0.75 (iv) +0.92

_____

_____

_____

6.7 LET US SUM UP

Correlation is a measure of degree and direction of relationship between two variables. A correlation coefficient is a pure number, limited by the values ranging from –1.00 to +1.00, that reflects the extent of linear relationship and expresses the degree of relationship between two sets of scores. It range from perfect positive through 0.00 to perfect negative. A zero correlation reflects absence of any relationship between two variables. It is calculated by Pearsons Product Moment Method using raw scores or deviation scores (short method). Coefficient of correlation is denoted by sign 'r'. When the number of observations is small, distribution of scores are

markedly skewed, the correlation is calculated by Rank Difference Method. The Coefficient of correlation is denoted by sign '*p*' (Rho).

The correlation is used in making predictions, estimating reliability and validity of tests and in certain other statistical techniques.

6.8 LESSON END EXERCISE

Long Answer

Q1. Calculate Coefficient of Correlation by using product Moment method of the following data.

N	X	Y
Subjects	Hindi	Science
1	10	20
2	12	20
3	8	15
4	21	18
5	25	21
6	10	17
7	11	19
8	20	10
9	15	16
10	18	22
11	7	13
12	20	19
13	18	22
14	11	12

Q2. Calculate Coefficient of Correlation by Using Rank Difference Method of the given data.

SUBJECT	X	Y
1	32	27
2	28	25
3	35	26
4	26	22
5	22	15
6	20	18
7	30	24

Short Answer

Q1. What do you mean by Correlation Discussion the uses of Correlation.

Q2. Discuss the Assumption of Product Moment method and Rank Difference Method.

6.9 SUGGESTED READINGS

1. Sharma, R. A. (2008). Advanied Statistics in Education and Psychology. U.P. : R. Lall Book Depot.
2. Garrett, H.E. & Woodworth, R.S. (1981). Statistics in psychology and education. David Mckay & Longman Group Ltd. New York.
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LESSON No. 7 **UNIT–IV**

PSYCHOLOGICAL TESTING

7.0. INTRODUCTION

Definition and Uses of a Psychological test will be discussed in this chapter. Criteria of a good test shall also be discussed.

7.1. OBJECTIVE

After going through this lesson the student will:

(1) be able to understand meaning of psychological test

(2) be able to understand uses of psychological test

(3) have an understanding of criteria of a good test

7.2. DEFINITION OF PSYCHOLOGICAL TEST

As data gathering devices, psychological tests are among the most useful tools of psychological research. They provide the data for most experimental and descriptive studies in psychology. A psychological test is essentially an objective and standardized measure of sample behaviour. Psychological tests are like the tests in any other science, in so far as observations are made on a small but carefully chosen sample of an individual's behaviour. If the psychologist wishes to test the extent of a child's vocabulary, a clerk's ability to perform arithmetic computations, or a pilot's eye hand coordination, he or she examines their performance with a set of words, arithmetic problems, or motor tests. Whether or not the test adequately covers the behaviour under consideration obviously depends on the number and the nature of items in the sample. The predictive value of a psychological test depends on the degree to which it serves as an indicator of a relatively broad and significant area of behavior.

Tests may be used to compare the behaviour of two or more persons at a particular time or of one or more persons at different times. Psychological tests yield objective and standardized descriptions of behaviour, quantified by numerical scores.

There are many ways of classifying psychological tests.

(1) performance test Vs paper-and pencil test

(2) power Vs speed test

(3) standardized Vs non standardized test

(4) individual Vs group test

Psychological tests may also be classified in terms of their purpose that is, what types of psychological traits they describe and measure. 1. Achievement tests 2. Aptitude tests, 3. Interest inventories 4. Personality inventories 5. Projective devices.

Check your progress exercise-1

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

(1) Define psychological test?

_____

_____

_____

(2) Why psychological test is called objective & standardized measure of sample behaviour?

_____

_____

_____

(3) What are the different types of psychological tests?

_____

_____

_____

7.3 USES OF PSYCHOLOGICAL TESTS

Traditionally, the function of psychological tests has been to measure differences between individuals or between the reactions of the same individual under different circumstances. One of the earliest problems that stimulated the development of psychological tests was the identification of mentally retarded persons. To this day, important applications of certain types of psychological tests are:

(1) The detection of intellectual deficiencies.

(2) Another clinical uses of tests are examination of persons with severe-emotional

disorders and other types of behavioural problems.

(3) In school psychological tests are used to identify outstandingly slow or fast learners.

(4) Psychological tests are used for educational counseling.

(5) In industry these are used for selection and classification of industrial personnel such as hiring job assignment, transfer, promotion or termination.

(6) In industry for high level jobs, test are used as an adjunct to skillful interviewing, nevertheless, testing continues an important part of the personnel progress.

(7) Psychological tests are used in the selection & classification of military personnel. These were used extensively in World War I & II in all branches of the armed forces.

(8) The tests are used in individual guidance and counseling for educational, vocational plan, emotional well being and effective interpersonal relations.

(9) The uses of tests to enhance self-understanding and personal development.

(10) Psychological test gives objective impartial information about an individual. Which aids his or her decision-making processes.

Thus psychological test helps in studying the nature & extent of individual differences, the organization of psychological traits, the measurement of group differences, and the identification of biological and cultural factors associated with behavioural differences.

Check your progress exercise-3

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

(1) What are the clinical uses of psychological tests?

_____

_____

(2) What are the industrial uses of psychological tests?

(3) What are the educational uses of psychological tests?

(4) What are the uses of psychological test in armed services?

(5) How psychological test helps in identification of biological & cultural factors associated with behavioural differences. Give an example?

7.4 CRITERIA OF A GOOD TEST

A good test has following features:

1. a statement of what the scale measures;
2. justification for the scale-its uses, and advantages over existing measures;
3. a description of how the preliminary pools of items was drawn up;
4. a description of the sample used for testing;

5. an indication of the populations (kinds of people) for whom the measure would be appropriate;
6. descriptive statistics (norms): means, standard deviations, ranges, different subscales;
7. reliability statistics;
8. validity statistics;
9. the scale itself (instructions, items, or example of items).

A statement of what the scale measures

This would not normally be very long. However it is often difficult to produce. The reason for the difficulty is that one is required to formulate and define the obvious! Try to formulate this statement very early in the development of any scale. Preferably it should be the first thing you do, if you are producing a scale.

Justification for the scale

The scale's background and history, including underlying theory, its uses, and advantages over existing measures should be explained.

You may need to include a rationale for having a scale at all, rather than a single item measure. For example, explaining why you need 20 or 30 questions looking at different facets of belief about prayer, or different symptoms of depressive illness, rather than just one question asking for an indication of favourability to prayer, or extent of depression typically, a multi-item measure is needed where there is an underlying central conceptual entity, with a number of facets, which may not be tapped by a single question. In the case of depression, for example, depressed mood, suicide plans, sleep disturbance, and so forth do not always go along with each other, and could not be tapped with single question.

How the preliminary pool of items was drawn up

Give details of the sources used, how if at all they were sampled, and any special steps taken to check the wording of the items. For example you might describe how you asked say, three people to read the items to check for meaning, clarity, ambiguity,

and double-barrelled-ness, and then report that you made amendments in the light of their comments.

Description of the sample used for testing

Any psychological test or measure should be presented with a description of the group or groups of people who did the test and contributed to the mean score(s). if the test is given to different types of people, we would not necessarily expect their performances to be similar. Thus anyone using your test needs to know whether their testee came from the same population as your norming sample, in order to interpret their score(s) in the light of your norms. Any special local or historical circumstances should be noted. For example:

126 female New Zealand psychology undergraduates,

42 male first admission schizophrenics,

31 children aged 6-9 years described by their teachers as having reading difficulties (20 boys and 11 girls),

535 male British army recruits, tested in the 2 weeks following the outbreak of the Falklands war.

Mean age and age range should be given where possible, and any details of cultural background that cannot be inferred from knowing the country in which the test was carried out. Ideally, performance of males and females (and any other subgroups) should be examined separately, and if performances differ, means should be presented separately. The overall scale mean should of course be given, and, if wished, overall item means (see the discussion that follows).

Means standard deviations, and ranges (norms)

These should always be presented. Believe it or not, there are published tests that do not give these details, and it is very annoying to test users to discover that they are not available, because one would generally wish to compare performances of one's testees with norms.

Means and ranges (highest and lower scores) are easy to work out. Standard deviations take a while if you are without computer software, but hopefully you will

have the use of statistical package.

The mean (average) is the most commonly used measure of central tendency. It is the total of everyone's total scores on the test, divided by the number of people who did the test. Some would prefer to quote an item mean, which is the mean score for one item (the scale mean is divided by the number of items). This has the advantage that if the number of items in the scale is varied, comparisons can still be made between people doing different versions of the scale, the different numbers of items in each version. The standard deviation is a measure of how much spread there is in the scores. The range is simply the highest and the lowest score. It is a good idea to show the range actually obtained, and the theoretically possible range if this is different from the range actually obtained. For example:

Mean: 13.45

Standard deviation: 6.74

Range (obtained): 2-24; Full range: 0-25.

Reliability

Definition

Reliability is consistency. Do different bits of your measure give similar results?. If you gave your measure again to the same people would they score similarly? If you gave your measure to similar people, would they score similarly? If you gave your measure to similar people, would they score similarly? The British Psychological Society Steering Committee on Test Standards (1992) defines reliability as “the extent to which the outcome of a test remains unaffected by irrelevant variations in the conditions and procedures of testing”, and as “consistency of measurement”. The British Psychological Society Steering Committee on Test Standards (1999) says that reliability is a reflection of “how accurate or precise a test score is”. A very friendly introduction to reliability and related issues appears in Gravetter and Wallnau (1999), “when you think about reliability, think CONSISTENCY”.

There are different measures of reliability. An unreliable measure is of limited value. If different questions or items on your test give inconsistent results, then you are not assessing anything. This may seen trivial, but a crucial hallmark of a good test is that you do the work necessary to establish its reliability.

Validity Statistics

Definition of validity and its relation to reliability

A valid test is one that measures what it is supposed to measure. The British Psychological Society (BPS) Steering Committee on Test Standards, Psychological Testing: A Guide (1992) defines validity as "the relevance of the scores" and the "extent to which it is possible to make appropriate inferences from the test scores". The 1999 Guide says, "validity is concerned with that the tea score actually measures". Unless a test is reliable it is unlikely to be valid. There are several different types of validity, and you do not have to use them all. You should select one or more methods, depending on your resources and needs.

The scale

Spell out the scale itself, or sample items, plus instructions to participants. Before you start work, find out if anyone else has already developed a scale measuring what you want to measure. If they have, ensure that you have justified your new measure.

Three more features of most psychological measures

Any measure of the type you might want to construct using this book will involve two important assumptions, namely additivity and interval measurement.

Additivity

The construct measured (for example, depression, or liking for psychologist) will be assessed by asking people to carry out your instructions with regard to a number of test items. You might ask people, for example, whether certain mood-adjectives were generally applicable to them, or whether they agreed with certain statements about psychologists. You then add up the answers, to give an overall measure of depression, or liking for psychologists. It is up to you to decide

whether additivity seems to be justified. It would not make sense to add the answers to depression items to the answer to items about liking for psychologists, for example.

Interval measurement

Once a total score has been obtained by addition, you have to think about whether the "intervals" in your scale are roughly equal. For instance, consider three people scoring say 0,5 and 10 on a depression measure. To qualify as an interval scale, you have to be fairly confident that the person who scored 10 is more depressed than the person who scored 5, to the same extent that the 5 scorer is more depressed than the 0-scorer. If this is difficult to decide, you could comfort yourself with the thought that you may be using Likert's solution, described very shortly. Likert (1932) developed a method for scaling using what he called "equal-appearing intervals". This involved asking people to say how much they agreed or disagreed with test items, or how much the items were applicable to them. For example, how much do you agree with the following? (Underline one of the five alternative answers).

Answers to items like this are converted to numbers (+2, +1, 0, -1, -2 for example), and the numbers are added up to give an overall score. The Likert approach is often followed. Interval measurement is not absolutely essential. For example, yes/no answers are a popular option, and can be used additively, but some answer formats give answers that cannot legitimately be added (for example, ranking in order of preference) - so interval measurement is a good thing to aim for.

Discriminative power

The third important feature of a psychological test is that it should have discriminative power. This means that if every person taking the test gets a very similar score-whether all very high, or all very low, or all medium-then the test is useless since it cannot discriminate between people. Such a test will also perform poorly in a statistical evaluation of reliability and validity.

Check your progress exercise-3

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

(1) What are the features of a good test?

_____

_____

_____

(2) What are the descriptive statistics used for finding norms?

_____

_____

_____

(3) How the preliminary pools of items are drawn?

_____

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_____

(4) How reliability and validity are related?

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_____

7.5 LET US SUM UP

The criteria of "good" psychometric measures are reliability, validity, norms and usability. Other important properties include additivity, interval measurement and discriminatory power.

7.6 LESSON END EXERCISE

Long Answer

Q1. Define Psychological Tests. Discuss the various uses of Psychological Tests with suitable examples.

Q2. Describe in detail the criteria of a good test.

Short Answer

Q1. Discuss breifly the discriminative power of psychological test.

Q2. Discuss briefly the reliability and validity of a good psychological test.

7.7 SUGGESTED READINGS

1. Garrett, H.E. and Woodworth, R.S. (1981). Statistics in psychology and education. David Mckay & Longman Group Ltd. New York.
2. Guilford, J.P., & Fruchter, B. (1978). Fundamental Statistics in Psychology and Education (6th ed.) New York: McGraw. Hill.
3. Anastasi, A. (1954). Psychological testing. New York: Mc Millan.
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LESSON No. 8 **UNIT-IV**

RELIABILITY AND VALIDITY

8.0 INTRODUCTION

This Chapter will focus on the reliability and its various types, validity and its types.

8.1 OBJECTIVES

After going through this lesson the student will:

(1) be able to know meaning & concept of reliability

(2) be able to know different types of reliability

(3) be able to know concept of validity

(4) be able to know different types of validity

8.2 THE CONCEPT OF RELIABILITY

The concept of reliability in relation to a research instrument has a similar meaning: if a research tool is consistent and stable, and hence, predictable and accurate, it is said to be reliable. The greater the degree of consistency and stability in an instrument, the greater is its reliability. Therefore, 'a scale or test is reliable to the extent that repeat measurements made by it under constant conditions will give the same result'. (Moser and Kalton 1989: 353).

The concept of reliability can be looked at from two sides:

1. How reliable is an instrument?
2. How unreliable is it?

The first question focuses on the ability of an instrument to produce consistent measurements. When you collect the same set of information more than once, using the same instrument and get the same or similar results, under the same or similar conditions, an instrument is considered to be reliable. The second question focuses on the degree of inconsistency in the measurement made by an instrument, that is, the extent of difference in the measurements when a you collect the same set of information more than once, by using the same instrument under the same or similar conditions. Hence, the degree of inconsistency in the different measurements is an indication of the extent of its inaccuracy. This 'error' is a reflection of an instrument's reliability. Therefore, reliability is the degree of accuracy or precision in the measurements made by a research instrument. The lower the degree of 'error' is an instrument, the higher is the reliability.

Let us take an example. Suppose you develop a questionnaire to ascertain the prevalence of domestic violence in a community. You administer this questionnaire and find that domestic violence is prevalent in, say, five percent of households. If you follows this with another survey using the same questionnaire on the same population under the same conditions, and discover that the prevalence of domestic violence is, say, fifteen per cent, the questionnaire has not given a comparable result, which may

mean it is unreliable. The less the difference between the two sets of results, the higher the reliability of the instrument.

Methods of determining the reliability of an instrument

There is a number of ways of determining the reliability of an instrument. The various procedures can be classified into two groups:

1. external consistency procedures; and
2. internal consistency procedures.

External consistency procedures

External consistency procedures compare cumulative test results with each other as a means of verifying the reliability of the measure. The two methods are as follows.

- **Test/re-test**–this is a commonly used method for establishing the reliability of a research tool. In the test/re-test (repeatibility test) an instrument is administered once, and then again, under the same or similar conditions. The ratio between the test and re-test scores (or any other findings, e.g., prevalance of domestic violence, a disease or incidence of an illness) is an indication of the reliability of the instrument. The greater the value of the ratio, the higher the reliability of the instrument. As an equation:

$$\textbf{(Test score)/(Re-test) = 1}$$

or

$$\textbf{(Test score)-(Re-test) = 0}$$

A ratio of 1 shows 100 per cent reliability (no difference between test and re-test) and any deviation from it indicates less reliability. The less the value of this ratio, the less the reliability of the instrument. Expressed in another way, zero difference between the test and re-test scores is an indication of 100 per cent reliability. The greater the difference between the test scores/ findings, the greater the unreliability of the instrument. The main advantage of

the test/re-test procedure is that it permits the instrument to be compared with itself, thus avoiding the sort of problems that could arise with the use of another instrument.

The main disadvantage is that a respondent may recall the responses that he or she gave in the first round, which in turn may affect the reliability of the instrument. Where an instrument is reactive in nature (when an instrument educates the respondent with respect to what the researcher is trying to find out) this method will not provide an accurate assessment of its reliability. One of the ways of overcoming this problem is to increase the time-span between the two tests, but this may affect reliability for other reasons, such as the maturation of respondents and the impossibility of achieving conditions similar to those under which the questionnaire was first administered.

- **Parallel forms of the same test–**In this procedure, the researcher constructs two instruments that are intended to measure the same phenomenon. The two instruments are then administered to two similar populations. The result obtained from one test are compared with those obtained from the other. If they are similar, it is assumed that the instruments are reliable.

The main advantage of this procedure is that it does not suffer from the problem of recall found in the test/re-test procedure. Also, a time lapse between the tests is not required. A disadvantage is that a researcher needs to construct two instruments, instead of one. Moreover, it is extremely difficult to achieve comparability in the two population groups and in the two conditions under which the tests are administered.

Internal consistency procedures

The idea behind internal consistency procedures is that items measuring the same phenomenon should produce similar results. The following method is commonly used for measuring the reliability of an instrument.

- **The split-half-technique–** this technique is designed to correlate half of the items with the other half and is appropriate for instruments that are designed

to measure attitudes towards an issue or phenomenon. The questions or statements are divided in half in such a way that any two questions or statements intended to measure the same aspect fall into different halves. The scores obtained by administering the two halves are correlated. Reliability is calculated by using the product moment correlation between scores obtained from the two halves. Because the product moment correlation is calculated on the basis of only half the instrument, to assess reliability for the whole it needs to be corrected. Thus is known as stepped-up reliability. The stepped-up reliability for the whole instrument is calculated by a formula called the spearman-Brown formula.

Check your progress exercise-3

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

(1) Define reliability. Give a comprehensive definition of reliability?

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_____

_____

(2) What are the methods used for finding external consistency of the test?

_____

_____

_____

(3) What are the methods used for finding internal consistency of the test?

_____

_____

_____

8.3 VALIDITY

Validity is the ability of an instrument to measure what it is designed to measure. 'Validity is defined as the degree to which the researcher has measured what he has set out of measure' (Smith 1991:106). According to Kerlinger, "the commonest definition of validity is epitomized by the question: Are we measuring what we think we are measuring? (1973:457). Babbie writes," …validity refers to the extent to which an empirical measure adequately reflects the real manning of the concept under consideration' (1990:133). These definitions raise some questions:

- Who decides that an instrument is measuring what it is supposed to measure?
- How can it be established that an instrument is measuring what it is suppose to measure?

Obviously the answer to the first questions the person who has designed the study and experts in the field. The second question is extremely important. On what basis does a researcher or an expert make this judgement? In the Social Sciences there appear to be two approaches to establishing the validity of a research instrument: logic and statistical evidence. Establishing validity through logic implies justification of each question in relation to the objectives of the study, whereas the statistical procedures provide hard evidence by way of calculating the coefficient of correlation's between the questions and the outcome variables.

It is important to remember that the concept of validity is only pertinent to a particular instrument and it is an ideal state that researchers aim to achieve.

Types of validity

There are three types of validity:

1. Face and content validity.
2. Concerned and predictive validity; and

3. Construct validity.

Face and content validity

The judgement that an instrument is measuring what it is supposed to is primarily based upon the logical link between the questions and the objectives of the study. Hence, one of the main advantages of this type of validity is that it is easy to apply. Each question or item on the scale must have a logical link with an objective. Establishment of this link is called face validity. It is equally important that the items and the questions cover the full range of the issue or attitude being measured. Assessment of the items of an instrument in this respect is called content validity. In addition, the coverage of the issue or attitude should be balanced, that is, each aspect should have similar and adequate representation in the question or items. Content validity is also judged on the basis of the extent to which statements or questions represents the issue they are supposed to measure, as judged by the researcher and experts in the field. Although it is easy to present logical arguments to establish validity, there are certain problems:

1. The judgement is based upon subjective logic, hence no definite conclusions can be drawn. Different people may have different opinions about the face and content validity of an instrument.

2. The extent to which questions reflect the objectives of a study may differ. If the researcher substitutes one question for another, the magnitude of the link questions selected for an instrument.

Concurrent and predictive validity (Criterion based validity)

'In situations where a scale is developed as an indicator of some observable criterion, the scales validity can be investigated by seeing how good an indicator it is'. (Moser and Kalton 1971:356). Suppose you develop an instrument to determine the suitability of applicants for a profession. The instrument's validity might be determined by comparing it with another assessment, for example, by a psychologist, or with a future observation of how well these applicants have done in the job. If both assessments are similar, the instrument used to make the assessment is assumed to have higher validity.

These types of comparisons establish two types of validity: predictive and concurrent. Predictive validity is judged by the degree to which an instrument can forecast an outcome. Concurrent validity is judged by how well an instrument compares with a second assessment concurrently done. 'It is usually possible to express predictive validity in terms of the correlation coefficient between the predicted status and the criterion. Such a coefficient is called a validity coefficient'. (Burns 1994:220)

Construct validity

Construct validity is a more sophisticated technique for establishing the validity of an instrument. It is based upon statistical procedures. It is determined by ascertaining the contribution of each construct to the total variance observed in a phenomenon.

Suppose you are interested in carrying out a study to find out the degree of job satisfaction among employees of an organisation. You consider status, the nature of the job and remuneration as the three most important factors indicate the job satisfaction, and construct questions to ascertain the degree to which people consider each important for job satisfaction. After the pre-test or data analysis you use statistical procedures to establish the contribution of each construct (status, the nature of the job, and remuneration) to the total variance (job satisfaction). The contribution of these factors to the total variance is an indication of the degree of validity of the instrument. The greater the variance attributable to the constructs, the higher the validity of the instrument.

One of the main disadvantages of construct validity is that a researcher needs to know the required statistical procedures.

Check your progress exercise-3

Note: use the space given below for your answer. Use separate sheet if required.

(1) Define Validity? Give definition of Kerlinger?

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_____

(2) What are criterions based on validity? Explain?

(3) Differentiate between content validity and construct validity?

8.4 LET US SUM UP

The concept of validity refers to quality and can be applied to any aspect of the research process. With respect to measurement procedures it relates to whether a research instrument is measuring what it set out to measure. There are three types of validity: face and content, concurrent and predictive, and construct validity. The reliability of an instrument refers to its ability to produce consistent measurements each time. When we administer an instrument under the same or similar conditions to the same population and obtain similar results, we say that the instrument is 'reliable'. The more similar the results, the greater and reliability. There are external and internal consistency procedures for determining reliability. Test/re-test and parallel forms of the same test are the two procedures that determine the external reliability of a research instrument, whereas the split-half technique is classified under internal consistency procedures.

8.5 LESSON END EXERCISE

Long Answer

Q1. What do you mean by Reliability. Discuss its types with suitable examples.

Q2. Define validity. Describe the various types of validity.

Short Answer

Q1. Differentiate between face and content validity.

Q2. Discuss the various External Consistency Procedures.

8.6 SUGGESTED READINGS

1. Garrett, H.E. and Woodworth, R.S. (1981). Statistics in psychology and education. David Mckay & Longman Group Ltd. New York.
2. Guilford, J.P., & Fruchter, B. (1978). Fundamental Statistics in Psychology and Education (6th ed.) New York: McGraw. Hill.
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4. Anastasi, A., & Urbina, S. (1997). Psychological Testing. (7th ed.) Prentice Hall New Jersy.

LESSON NO. 9 **UNIT–IV**

POPULATION, SAMPLING AND TYPES

Structure

9.0 OBJECTIVES :

This Lesson starts with the concept of population. The concept of sample will be discussed Different types of sampling will also be discussed in this Lesson.

9.1 OBJECTIVES :

After going through this lesson, the student :

(1) has the concept of population and the sample drawn from that population.

(2) learns how to take a sample.

(3) knows about different kinds of sampling.

9.2 POPULATION :

All items in any field of inquiry constitute a 'Universe' or 'Population'. A complete enumeration of all the items in the population is known as census inquiry. It can be presumed that in such an inquiry when all the items are covered no element of chance is left and highest accuracy is obtained. But in practice this may not be true. The researcher must decide the way of selecting a sample or what is popularly known as the sample design in order to remove the bias.

From a statistical point of view the term universe refers to the total items or units in any field of inquiry, whereas the term "population" refers to the total items about which information is desired. The attributes that are the object of study as referred to as characteristics and the units possessing them are called as elementary units. Thus all units in any field of inquiry constitute universe and all elementary units constitute population.

The population can be finite or infinite.

(a) *Finite population :* The population is said to be finite if it consists of a fixed number of elements so that it is possible to enumerate it in its totality. For example, the population of a town, the number of teachers in a School etc. The symbol 'N' is generally used to indicate how many elements or items are there in case of a finite population.

(b) *Infinite Population :* An infinite population is that population in which it is theoretical by impossible to observe all the elements. Thus, in an infinite population, the number of items is infinite i.e. we cannot have any idea about the total number of items. The total No. of stars in the sky is typical example of infinite population. From a practical consideration, we use the term infinite population for a population that cannot be enumerated in a reasonable period of time. This way we use the theoretical concept of infinite population as an approximate of a very large finite population.

CHECK YOUR PROGRESS EXERCISE 1

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

(1) What do you mean by "Population"?

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(2) What is finite population ?

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9.3. SAMPLE :

Sample may be defined as the selection of some part of an aggregate or totality on the basis of which a judgement or inference about the aggregate or totality is made. It is the process of obtaining information about an entire population by examining only a part of it. It is not possible to examine every item in the population and it becomes necessary to obtain sufficiently accurate results by studying only a part of total population.

It needs to be emphasized that when universe is a small one, it is no use to examine a part of it. When field studies with large population are undertaken in practical life, consideration of time and cost invariably lead to a selection of respondents i.e. selection of only a few items. The respondents selected should be as representative of the total population as possible in order to produce a small cross-section. The selected respondents constitute what is technically called a "Sample" and selection process is called sampling technique and the survey conducted on the basis of the sample is described as sample survey.

Sample should be truly representative of population characteristics without any bias so that it may result in valid and reliable conclusions.

Sampling is important because :

(a) it can save time and money. Sample study is usually less expensive and produces data at a relatively faster speed.

(b) Sampling may enable more accurate measurements as it is conducted by trained and experienced researchers.

(c) Sampling is the only choice when a test involves the destruction of an item under study.

(d) It remains the only way when population contains infinitely many members.

(e) Sampling usually enables to estimate the sampling errors and thus, assists in obtaining information concerning some characteristics of the population.

Algebraically, let the population size be 'N' and if a part of size 'n' (which is always < N) of this population is selected according to some rule for studying some characteristic of the population, the group consisting of these 'n' units is known as 'sample'. In sampling analysis the question is what should be the size of the sample or how large or small should 'n' be. As a general rule, one can say that the sample must be of an optimum size i.e. it should neither by excessively large nor too small. Technically, the sample size should be large enough to give a confidence interval of desired width and as such the size of sample must be chosen by some logical process. Size of sample should be determined by keeping the points like nature of Universe, number of groups and sub groups proposed, nature of study, type of sampling, availability of finance, size of population, size of questionnaire etc. in mind.

CHECK YOUR PROGRESS EXERCISE 2

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

(1) What is a sample ?

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_____

(2) What points are kept in mind while choosing a sample ?

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_____

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(3) What is the use of sampling ?

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_____

9.4. TYPES OF SAMPLING

Following are the important types of sampling :

1. *Deliberate Sampling :* Deliberate sampling is also known as purposive or non-probability sampling. This sampling method involves purposive or deliberate selection of particular units of the universe for constituting a sample which represents the universe. When population elements are selected for inclusion in the sample based on ease of access, it can be called convenience sampling. e.g.. If a researcher wishes to get data about ice-cream eaters, he will go to ice-cream shop and interview people. At times such results give biased results. On the other hand judgement sampling is where researcher's judgement is used for selecting items which he considers as

representative of the population. e.g. Students might be taken as a sample to find out about teaching methods.

2. *Simple Random Sampling :* This type of sampling is also known as chance sampling or probability sampling where each and every item in the population has equal chance of inclusion in the sample and each one of the possible samples, in case of finite universe, has the same probability of being selected. It is that method of sample selection which gives each possible sample combination an equal probability of being picked up and each item in the entire population to have an equal chance of being included in the sample. This applies to sampling without replacement i.e. once an item is selected for the sample, it cannot appear in the same again. In short, the implication of simple random sampling are ; (a) it gives each element in the population an equal probability of getting into the sample, and all choices are independent of one another. (b) It gives each possible sample combination an equal probability of being chosen. Under this sampling design, a lottery method in which individual units are picked up from whole group not deliberately but by some mechanical process is used. Here it is blind chance alone that determine whether one item or the other is selected. Random sampling ensures the law of statistical regularity which states that on an average the sample chosen is a random one, the sample will have the same composition and characteristics as the universe. That is why random sampling considered to be the best representative sample.

3. *Systematic Sampling :* In some instances the most practical way of sampling is to select every 15th name on a list, every 10 house on one side of a street and so on. This type of sampling is systematic in nature. An element of randomness is usually introduced into this kind of sampling by using random numbers to pick up the unit with which to start. This procedure is useful when sampling frame is available in the form of a list. In such a design the selection process starts by picking some random point in the list and then every nth element is selected until the desired number is secured.

Systematic sampling has certain plus points. It can be taken as improvement over a simple random sample in as much as systematic sample is spread over the entire population. It is easier and less costlier and can be used in large population. If there is a hidden periodicity in the population, systematic sampling would prove to be inefficient method of sampling.

4. *Stratified Sampling :* If a population from which a sample is to be drawn does not constitute a homogenous group, stratified sampling technique is generally applied in order to obtain a representative sample. Under this sampling, the population is divided into several sub populations that are individually more homogeneous than the total population (the different sub-population are called strata) then we select items from each stratum to constitute a sample. Since each stratum is more homogenous than the total population, we are able to get more precise estimates for each stratum and by estimating more accurately each of the components parts, we get a better estimate of the whole. In short, stratified sampling results in more reliable and detailed information. Various strata should be formed in such a way as to ensure elements being most homogeneous within each stratum and most homogenous between the different strata. Thus strata are purposively formed and are usually based on past experience and personal judgement of the researcher.

5. *Quota Sampling :* In stratified sampling the cost of taking random samples from individual strata is often so expensive that interviewers are simply given quota to be filled from different strata, the actual selection of items for sample being, left to the interviewers's judgement. This is called quota sampling. The size of quota for each stratum is generally proportionate to the size of the stratum in the population. Quota sampling is thus an important form of non-probability sampling.

6. *Cluster Sampling :* Cluster sampling involves grouping the population and then selecting the groups or the clusters rather individual elements for inclusion in the sample. If the total area of interest happens to be a

big one, a convenient way in which a sample can be taken is to divide the area into a number of smaller non-overlapping areas and then to randomly select a number of these smaller areas (called clusters) with the ultimate sample consisting of all units in these small areas or clusters. Thus in cluster sampling the total population is divided into a number of relatively small subdivisions which are themselves clusters of still smaller units and then some of these clusters are randomly selected for inclusion in the overall sampling.

7. *Area Sampling :* If clusters happens to be some geographic subdivisions, in that case cluster sampling is better known as area sampling. Thus cluster designs where the primary sampling unit represents a cluster of units based on geographic area are distinguished as area sampling.

8. *Multistage Sampling :* Multi-stage sampling is a further development of the idea of cluster sampling. This technique is meant for big inquiries extending to a considerably large geographical area like entire country. Under this sampling the first stage may be to select large primary units such as states, then districts, then town and finally certain families within the towns. If the technique of random-sampling is applied at all stages, the sampling procedure is called multi-stage random sampling.

9. *Sequential Sampling :* This design is a complex sampling design. The ultimate size of the sample under this technique is not fixed in advance, but is determined according to mathematical decision rules on the basis of information yielded as survey progresses. This is usually adopted in case of acceptance sampling plan in context of statistical quality control. When a particular lot is to be accepted or rejected on the basis of a single sample, it is called as single sampling. When the decision is to be taken on two samples, it is known as double sampling and in case decision lies on more than two samples but the number of samples is certain and decided in advance, the sampling is known as multiple sampling. But when the number of samples is more than two but is

neither certain nor decided in advance, this type of system is known as sequential sampling.

CHECK YOUR PROGRESS EXERCISE 3

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

Q. 1. Name various types of sampling design.

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_____

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Q. 2. Distinguish between systematic and stratified sampling.

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Q. 3. What is area sampling ?

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9.5. LET US SUM UP

A sample design is a definite plan for obtaining a sample from a given population. Sample design is determined before data are collected. There are many sample designs from which a researcher can choose. Researcher selects sample according to the work under taken. He must select a sample design which should be reliable and appropriate for his research work. There are different types of sampling designs such as random sampling, quota sampling, stratified sampling, area sampling, cluster sampling, sequential sampling, systematic sampling etc.

9.6. LESSON END EXERCISE

Long Answer

Q1. Define Sample. Describe the various types of sampling.

Short Answer

Q1. Define Population. Differentiate between Finite and Infinite Population.

9.7. SUGGESTED READINGS

Singh, A. K. (2006) Tets, Measurements. and Rescerch Methods in Behavioursal Sciences. New Delhi : Bharati Bhawan (Publishers & Distributors)

Kothari, C. K. (2004). Research Methodology Methods and Techniques. New Delhi New Age International (P) Limited Publishers)

LESSON NO. 10 **UNIT–IV**

DESIGN AND CONTROL OF EXPERIMENTS

Structure

10.0 INTRODUCTION :

This lesson starts with the meaning of Experimental Design. Different types of exerpiemtnal Designs will be discussed. How to Locate a problem will also be discussed in this Lesson.

10.1 OBJECTIVES :

After going through this lesson, the student :

(1) is able to know meaning of experimental design.

(2) comes to know about various experimental designs.

(3) understands the importance of problem in an experiment.

10.2 MEANING :

Experiment is the proof of a hypothesis which seeks to take up two factors into a casual relationship through the study of contrasting situation which have been controlled on all factors except the area of interest, the later being either the hypothetical cause or the hypothetical effect. (Greenword).

The formidable problem that follows the task of defining the research problem is the preparation of the design of the research project and experiment.

An experimental design, then is one in which the investigator has direct control over at least one independent variable and manipulates at least one independent variable (Kerlinger).

According to Matheson "An experimental design is a plan or program for research, including the assignment of subjects and manipulation of the independent variable". By using the design, experimenter is successful in achieving the control for potential secondary variables.

Experimental design is needed because it facilitates the smooth sailing of the various research operations, thereby making research as efficient as possible, yielding maximal information with minimal expenditure of effort, time and money. Experimental design stands for advance planning of the methods to be adopted for collecting the relevant data and the techniques to be used in their analysis, keeping in view the objective of the research and the availability of staff, time and money.

A good experimental design has certain characteristic such as flexibility, appropriatness, efficiency and economy. Thus good experimental design minimises bias and maximises the reliability of the data collected.

There are different concepts relating to experimental design such as :

Dependent and Independent variables : A concept which can take on different quantitative values is called a variable. Qualitative phenomena are also

quantified on the basis of the presence or absence of the concerning attributes. Phenomena which can take on quantitatively different values even in decimal points are called "continuous variables." But all variables are not continuous. A variable for which the individual values fall on the scale only with distinct gaps is called a "discrete variable". If one variable depends upon or is a consequence of the other variable, it is dependent variable and the variable that is antecedent to the dependent variable is termed as independent variable.

Extraneous variable : Independent variables that are not related to the purpose of the study, but may affect the dependent variable are termed as extraneous variables. An experiment is always designed so that the effect upon the dependent variable is attributed entirely to the independent variables and not to some extraneous variables.

Control : To minimise the effect of extraneous variable in an experiment it is important to minimize the effect.

Confounded relationship : When the dependent variable is not free from the influence of extraneous variables, the relationship between the dependent and independent variables is said to confounded by an extraneous variable.

Hypothesis : Hypothesis is a predictive statement that relates an independent variable to a dependent variable. Research in which the independent variable is manipulated is called experimental hypothesis-testing research.

Experimental and control group : In an experimental hypothesis testing research when a group is exposed to usual conditions, it is termed as control group. When the group is exposed to some special condition it is termed as experimental group.

Treatments : The different conditions under which experimental and control group are put are referred to as treatments.

CHECK YOUR PROGRESS EXERCISE 1

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

Q. 1. What is the need for experimental design ?

_____

_____

_____

Q. 2. Name different characteristics of a design.

_____

_____

_____

Q. 3. What is a discrete variable ?

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_____

Q. 4. Which group is exposed to variable or special conditions ?

_____

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_____

10.3 EXPERIMENTAL DESIGNS :

Experimental design refers to the framework or structure of an experiment and as such there are different experimental designs. They can be classified into two broad categories (1) Informal Experimental Designs (2) Formal Experimental Designs.

Informal Experimental Designs : Informal experimental designs are those designs that normally use a less sophisticated form of analysis based on differences in magnitudes. Following are the designs in Informal Experimental Designs :—

(1) Before-and-after without control design : In such a design a single test

group or area is selected and the dependent variable is measured before the introduction of treatment. The treatment is then introduced and the dependent variable is measured again after the treatment has been introduced. The effect of treatment would be equal to the level of the phenomenon after the treatment minus the level of the phenomenon before the treatment.

(2) After-only with control design : In this design two groups are selected (Test and control group) and treatment is introduced into the test group only. The dependent variable is then measured in both the groups at the same time. Treatment impact is assessed by subtracting the value of the dependent variable in the control area from its value in the test group.

(3) Before-and-after with control design : In this design two areas are selected and the dependent variable is measured in both the areas for an identical time period before the treatment. The treatment is then introduced into the test area only, and the dependent variable is measured in both for an identical time period after the introduction of the treatment. The treatment effect is determined by subtracting the change in the dependent variable in the control area from the change in the dependent variable in test area.

Formal Experimental Designs : Formal experimental designs are those designs that offer relatively more control and use precise statistical procedures for analysis. Important formal experimental designs are :

(1) Completely randomized design (C.R. design) : This design involves only two principles i.e. the principle of replications and principle of randomization of experimental designs. The essential characteristic of this design is that subjects are randomnly assigned to experimental treatment or *vice-versa.*

(2) Randomized block design (R. B. Design) : has the principle of local control which is applied along with the other two principles of experimental designs. In this design subjects are first divided into groups, known as blocks. The main feature of R. B. design in that is this each treatment appears the same number of times in each block.

(3) Latin Square Design (L. S. Design) : This is an experimental design very frequently used in agricultural research. Latin Square design is used when there are two major extraneous factors.

(4) Factorial designs : Factorials designs are used in experiments where the effects of varying more than one factor are to be determined.

CHECK YOUR PROGRESS EXERCISE 2

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

Q. 1. Name some of the important experimental designs.

_____

_____

_____

Q. 2. Write short note on before-and-after with control design.

_____

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Q. 3. Name few informal experimental designs.

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_____

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10.4 LOCATING PROBLEM :

According to Kerlinger "A problem is an interrogative sentence or statement that asks what relations exist between two or more variables". It is said that 'a problem well put is half solved" : Because the clearest under standing of problem provides fruitful information of both practical and theoretical aspects of the

problem. Problem arises with the needs. If the problem is clear then it is possible to study scientifically. It is important for the researcher to study relevant literature, have minute observation of the scope and subject matter. The problem which is not solvable cannot take a form of scientific problem.

Before locating a problem the researcher should know the sources of the problem. The locating of problem is very difficult and it requires scientific approach. According to different researchers following points should be kept in mind (a) Determine the Broader area of field of research (b) Study of Related material (c) Self experience of experimenter (d) Replication of previous work.

Locating one problem out of several existing problems is also essential but difficult. The experimenter is unable to understand which is the most suitable problem. Before finalising he should get answer to questions like : (a) Is the problem interesting ? (b) Is it new ? (c) It is feasible etc. After getting answer to above question location or selection of a problem becomes easier. After selecting a problem, it should be written in an objective manner. The problem should express relations between two or more variables. The problem should be shared clearly and unambiguously in questions form. The problems should also be such as to imply possibilities of empirical testing.

The following points should always be in the mind of the researcher :

(i) Subject which is over done should not be chosen.

(ii) Controversial subject should not be taken.

(iii) The subject for research should be familiar.

(iv) The training of the researcher, the costs involved, the time factor should be kept for simplifying the problem.

CHECK YOUR PROGRESS EXERCISE 3

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section..

Q. 1. What is a problem ?

_____

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_____

Q. 2. What should be kept in mind while selecting a problem ?

_____

_____

_____

10.5 LET US SUM UP :

Experimental design is needed because it facilitates the smooth sailing of the various research operations, thereby making research operations, as efficient as possible yielding maximum information with minimum expenditure of efforts, time and money. The types of experimental design are formal and informal design—where variables are controlled and experiments designed according to group and variables.

10.6 LESSON END EXERCISE

Long Answer

Q1. What do you mean by experiental Designs. Discuss the various experimental Designs with suitable examples.

Short Answer

Q1. How one can locate and select a problem.

10.7 SUGGESTED READINGS :

Singh, A. K. (2006) Tets, Measurements. and Rescerch Methods in Behavioursal Sciences. New Delhi : Bharati Bhawan (Publishers & Distributors)

Kothari, C. K. (2004). Research Methodology Methods and Techniques. New Delhi New Age International (P) Limited Publishers)

LESSON NO. 11 **UNIT–IV**

HYPOTHESES, VARIABLES, GROUPS

Structure

11.0 INTRODUCTION :

This Lesson gives the students an overview of Hypothesis and how to formulate it. Different types of variables and different types of groups in an experiment will be discussed in this lesson.

11.1 OBJECTIVES :

After going through this lesson the learner will come to know :

(1) What hypotheses is ?

(2) How it is formed ?

(3) What are different variables effecting an experiment ?

(4) What is a control group and an experimental group ?

11.2 HYPOTHESIS :

It is clear that every scientific study starts with a problem. Problem can take a form of scientific problem only when it is testable. Before testing or experimentation, scientists formulate a tentative answer of the problem which may either be true or wrong. The trueness or wrongness depends on the results of the problem. So it can be said that hypothesis is a tentative solution to the problem. It is considered to be an useful instrument in research.

According to Kerlinger "A Hypothesis is a conjectural statement of the relation between two or more variables." According to Lundberg. "A hypothesis is a tentative generation, the validity of which remains to be tested. In its most elementary stages, the hypothesis may be any hunch, guess, imaginative idea or intuition what so ever which becomes the basis of action or investigation."

Hypothesis ordinarily means a mere assumption or some supposition to be proved or disapproved. But for an experimenter a hypothesis is a formal question that he intends to resolve. Thus hypothesis can be said to be a proposition or a set of propositions set forth as an explanation for the occurrence of some specified group of phenomena either asserted merely as a provisional conjecture to guide some investigation or accepted as highly probable in the light of established facts. So, hypothesis is a predictive statement, capable of being tested by scientific methods, that relates to an independent variable to some dependent variable.

Certain characteristics which a hypothesis must possess are :

1. Hypothesis should be capable of being tested.
2. It should be clear and precise.
3. It should be limited in scope and must be specific.
4. Hypothesis statement should be easily understandable.

5. It should be consistent with most known facts.

6. It should state relationship between variables.

Formulation of hypothesis : Research can reach to proper direction when the hypothesis given has all the characteristics that are required for a good hypothesis. It is only possible when experimenter proposes scientific hypothesis. For the formation of hypothesis, experimenter must know the sources of hypothesis. The sources of hypothesis can be categorized as :

1. Researcher's Capacity of Research

2. External Sources

1. *Researcher's capacity of Research :* This is related to internal sources of hypothesis which include researcher's insights, ideas, experience etc. Personal experience is helpful for the formation of hypotheses. If a researcher has a good knowledge of one area, then his knowledge will certainly help him to formulate hypothesis.

2. *External Sources :* Many primary sources help the researcher to formulate a hypothesis, such as :

(a) General Culture.—If a researcher can conduct systematic and deep study of general culture then he can get several hypotheses which can be verified through experimentation. So, it is clear that general culture becomes a source of hypothesis.

(b) Scientific theories.—Scientific theory is in itself a source of hypothesis. In every science different theories are available related to different subject and the theory gives direction to research by showing what is known.

(c) Analogy.—On the basis of cause and effect of similar events, one can formulate hypothesis. The researcher having knowledge of different disciplines, they can very easily form the hypotheses.

In addition to all the sources mentioned above Good and Scates and others have described many other basis for the formulation of hypotheses. They are—

(i) A deeper study of related areas.

(ii) Generalization of previous research findings.

(iii) Training and planning.

(iv) Creative thinking and experimenter's insight.

(v) Imagination power.

(vi) Intellectual level.

(vii) Analysis of factual conditions.

(viii) Proper contact with proper facts.

(ix) Knowledge of different instruments and apparatus.

(x) Availibity of data for the verification of proposed hypotheses.

CHECK YOUR PROGRESS EXERCISE 1

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

Q. 1 What is a hypothesis ?

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_____

Q. 2 Define Hypothesis.

_____

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_____

Q.3 On what basis can a hypothesis be formed ?

_____

_____

_____

11.3. VARIABLES :

A variable is any condition in a scientific investigation that may change in quantity or quality. According to Kerlinger "A variable is a symbol to which numeral or values are assigned. For instance, X is a variable : it is a symbol to which we assign numerical values. The variable X may take on any justifiable set of values, e.g. on an intelligence test or an attitude scale". According to D' Amato "what is meant by the term variable is related to those objects, events or traits which have characteristic of quantitative measurement.?"

Every experimenter requires atleast an organism. There is stimulus, organism and Response in order to study the behaviour. Whenever we study behaviour in experiment then we see role and mixture of certain variables. Certain variables are to be exposed and certain controlled. Following are the main variables in an experiment :

1. Independent variables.
2. Dependent variables.
3. Quantitative variables.
4. Qualitative variables.
5. Stimulus variables.
6. Behavioural variables.
7. Organismic, Intervening or Antecedent variables.

Independent Variable : According to D' Amato–independent variable is any variable manipulated by experimenter, either directly or through selection, in order to determine its effects on behavioural measure".

According to Edward—"The variable over which the investigator has control are called the independent variables. They are those which the investigator himself manipulates or varies". According to Townsend "An independent variable is that factor manipulated by the experimenter in his attempt to ascertain its relationship to an observed phenomenon."

On the basis of these definition independent variables are controlled and manipulated by an experimenter. For example, if the experimenter has to see the effect of smoking on the lungs of an individual. Smoking is the stimulus/variable in this experiment. It is an independent variable and depends on the experimenter as to how he will introduce it, how much will he introduce and how much will he control. Introduction of the smoking will be controlled and manipulated by the experimenter.

Independent variable falls in two categories.

1. *Environmental Variable :* An environmental variable is any characteristic of an organism's environment that may influence its variable". Room temperature, ventilation, location and surrounding of the place where an experiment is being conducted are few examples of environment variables.

2. *Organismic Variable :* An organismic variable is any physiological characteristic of an organism. Examples of organismic variables are sex, blood type, degree of fatigue and monotony, intelligence, mental set, interest, health conditions etc.

Dependent Variable : According to Townsend "A dependent variable is that factor which appears, disappears, or varies as the experimenter introduces, removes or varies the independent variable.

According to Kerlinger dependent variable depends upon independent variable, so it can be called as consequent. For example, the experimenter has alcohol as an independent variable and its effect on the brain cells is dependent variable. Content of alcohol is manipulated and varied to see the effect. The dependent variable can be measured by the following four methods :

(i) *Latency of Responses :* In the latency of response the time between the starting and respond is measured.

(ii) *Accuracy of the Responses :* If subject does not make an error or makes less errors, then on this accuracy of responses, the dependent variable can be measured.

(iii) *Speed of Responses :* The dependent variable can also be measured through the measurement of speed of responses or response speed.

(iv) *Frequency of Responses :* In this type number of responses are counted.

Control of Variables : According to Matheson, 'In an ideal experiment, all of the observed measures of the dependent variable are attributed to the manipulation of the independent variable". There are several factors which effect the behaviour of an individual at a given time. All these factors, in addition to independent variable may change the results of an experiment. This is the main duty of experimenter to eliminate these variation otherwise he will not get accurate results. So control is the attempt to produce a phenomenon in a pure condition by regulating its environment which is called controlling the situation or controlling experiment. The word control also implies that the experimenter has a certain power over the conditions of his experiment, he is able to manipulate variable in an effort to arrive at a sound conclusion.

Control of the variables is necessary for an experiment because it is possible to study the functional relationship of independent variable and dependent variable only by controlling and manipulating one variable. It is more adequate to predict the behaviour, on the basis of studied behaviour under controlled conditions. Under the control conditions, it is more easy to study scientifically the effect of Independent variable. It is possible and also very easy to verify the results of those experiments which were conducted under controlled conditions. By controlling the conditions, experimenter knows when, what and how he must take measurement. This knowledge of experimenter leads to more effective ways of making observations.

By Controlling we reduce the error.

While doing an experiment, several error enter. There should be reduction of errors by manipulating and controlling of variables. Errors can be reduced by experimental control of extraneous variable.

There are different techniques of control which helps the experimenter to control the variables which may effect Independent or dependent variable. The techniques are :

1. **Method of Removal :** In this method, experimenter eliminates those variables which effect dependent variable.

2. **Method of Consistency of Condition :** In this method we control the

variable through constant method. When we are unable to eliminate the external variable from experimental condition than we can provide uniformity of external variable qualitatively or quantitatively and this type of control is called the method of consistency conditions.

3. **Method of Screening or Balancing :** In this method for the removal of the affect of related variable we increase the intensity of the variable.

4. **Counter Balancing Method :** In an experiment fatigue effects the final results of the experiments. This is called an apparent progressive change in the subject's response. These effects should be controlled. These effects are labelled as constant errors. These constant errors can be controlled through counter balancing method.

11.4 GROUPS

In an experimental research the experimenter has to introduce independent variable in order to get the required results. For this purpose the experimenter has to make two groups of the population under research on investigation. Before starting the proper experiment the experimenter does the preliminary work by taking the two groups and test them on different variables and ultimately make groups which are well matched. The groups should be well matched at all the variables. Otherwise an error will occur in the end and the results will not be accurate.

There are two main groups formed in an experimental hypothesis research.

(1) Control Group : In this group the experimenter keeps the independent variable under control. The group is exposed to usual conditions and is not exposed to independent variable. The results of the control group are without the effect of independent variable.

(2) Experimental Group : When the group is exposed to some novel or special conditions, it is called experimental group. Experimental Group is where an independent variable is introduced. The manipulation of control of the variable is done by the experimenter in experimental group only. The results or dependent variable here will be different from control group as no independent variable was

introduced there. On this basis the experimenter sees the effect of the independent variable.

Examples

(a) In an experiment on transfer of training the experimenter takes two groups. Experimental group is exposed to treatment i.e. independent variable in this form is given to this group. No training is given to control group and the results on both groups are studied.

	Training	**Test**
Experimental Group	A	B
Control Group	-	B

(b) In an experiment on retroactive inhibition the experimental group learn one list of items (List A) and then learn second list of items (List B). After and interval they recall List A. Whereas the control group learn only one list of item (List A) and then take rest. After taking rest they recall list A. If a control group that has not learnt List B recall List A better than the group that has learnt the new list, we infer that new learning interferes with the recall of List A

	Step I	**Step II**	**Step III**
Experimental Group →	Learn List A	Learn List B	Recall List A
Control Group →	Learn List A	Rest on engage in related activity	Recall List A

CHECK YOUR PROGRESS EXERCISE 3

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

Q1. What is an independent variable ?

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_____

_____

Q2. Define Dependent Variable.

_____

_____

_____

Q3. Which group is exposed to independent variable ?

_____

_____

_____

Q4. What is a Control Group ?

_____

_____

_____

11.5 LET US SUM UP

For any good experimental design it is very important to have a proper hypothesis, knowledge of variables, control of variables and clear position of the groups where these variables have to be manipulated. Hypothesis is a tentative solution to the problem. The experimenter comes to a conclusion before starting the real experiment A concept which can take on different quantitative values is called a variable. If one variable depends upon or is a consequence of the other variable, it is termed as a dependent variable, and the variables that is antecedent to the dependent variable is independent variable. Group exposed to independent variable is called experimental group and where this variables is kept under control it is called control group.

11.6 LESSON END EXERCISE

Long Answer

Q1. Define Hypothesis. How it can be formulated.

Q2. What do you mean by variable Discuss the various types of variable with suitable examples.

Short Answer

Q1. Discuss different sources of Hypothesis.

Q2. Differentiate between experimental and control group.

11.7 SUGGESTED READINGS

Singh, A. K. (2006) Tets, Measurements. and Rescerch Methods in Behavioursal Sciences. New Delhi : Bharati Bhawan (Publishers & Distributors)

Kothari, C. K. (2004). Research Methodology Methods and Techniques. New Delhi New Age International (P) Limited Publishers)

LESSON NO. 12 **UNIT–V**

MEASUREMENT SCALES

Structure

12.0 INTRODUCTION :

This Lesson starts with the introduction of Measurement. Different types of Measurement scales will be discussed. Sources of error in measurement will also be discussed in this Lesson.

12.1 OBJECTIVES :

After going through this lesson the student is able to :

(1) understand the meaning of measurement.

(2) learn about different measurement scales.

(3) measure different properties

12.2 MEASUREMENT

Measurement is the process of assinging numbers to objects or observations, the level of measurement being a function of the rules under which the numbers are assigned. Measurement is a process of mapping aspects of a domain into other aspects of a range according to some rule of correspondence. In measuring we devise some form of scale in the range and the transform or map the properties of objects from domain on to this scale.

Scales of measurement can be considered in terms of their mathematical properties. The most widely used classification are as following :

1. Nominal Scale
2. Ordinal Scale
3. Interval Scale.
4. Ratio Scale

Nominal Scale

Nominal scale is a system of assigning number symbols to events in order to label them. The usual example of this is the assigning number to players in order to identify them. Such numbers cannot be considered to be associated with an ordered scale for their order is of no consequence; the numbers are just convenient lables for the particular class of events and as such have no quantitative value. Nominal scales are convenient ways of keeping track of people, objects and events. Nothing much can be done with the numbers involved. One can not compare the numbers assigned to one group with the numbers assigned to another. The counting of numbers is the only possible arithmetic operation when a nominal scale is employed. Thus, there is restriction to use mode as the measure of central tendency.

This scale is the least powerful level of measurement. A nominal scale simply describes differences between thing by assigning them to categories. Thus nominal data is counted data. Inspite of all this the scale is widely used in surveys.

Ordinal Scale

Commonly used having lowest level of ordered scale is the ordinal scale. The ordinal scale places events in order, but there is no attempt to make the intervals of the scale equal in terms of some rule. Rank orders represent ordinal scales and are frequently used in research relating to qualitative phenomena. A students position in an examination involves use of ordinal scale. Ordinal Scale only permit the ranking of items from highest to lowest. Ordinal measures have no absolute values and the real difference adjacent ranks may not be equal. One can only say that one person is higher or lower on the scale than another. In ordinal scale an equality statement is not acceptable. It only shows greater than or less than. Precise comparisons can not be made with the help of this scale. Since the numbers of this scale have only a rank meaning, the appropriate measure of central tendency is the median.

Interval Scale

An interval scale has all characteristics of both nominal and ordinal scales plus one more characteristics that the magnitude may be specified in terms other than greater or less. In the case of this scale, the intervals are adjusted in terms of some rule that has been established as a basis for making the units equal. The units are equal only in so far as one accepts the assumption on which the rule is based. Interval scales have an arbitrary zero, but it is not possible to determine for them what may be called an absolute zero. The primary limitation of the interval scale is the lack of a true zero which may not enable the scale to measure the complete absence of a trait or characteristics.

Interval scales provide more powerful measurement than ordinal scales for internal scale also incorporates the concept of equality of interval. As such more powerful statistical measure can be used with interval scales. Mean, Standard Deviation, Order correlation can be used.

Ratio Scale

The highest form of scale is the ratio scale. It has all the qualities of the nominal, ordinal and interval scales as well as an additional characteristics that with the ratio

scale one can perform operations on the data in such a way that the quality of ratio's is maintained. Ratio scales have an absolute or true zero of measurement. The term absolute zero is not as precise as it was once believed to be. We can conceive of an absolute zero of length or time. But an absolute zero of temperature is theoretically unobtainable and it remains a concept existing only in the scientists mind. Ratio scale represents the actual amount of variables. Measures of physical dimensions such as weight, height, distance etc. are examples. All statistical techniques are usable with ratio scales and all manipulations that one can carry out with real numbers can also be carried out by ratio scale values. Multiplication and division can be used with this scale. Geometric mean, Harmonic Mean and percent variation is permissible.

CHECK YOUR PROGRESS EXERCISE 1

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. Name three scales used for measurement ?

   _____

   _____

   _____

2. How useful is ordinal scale ?

   _____

   _____

   _____

3. What is an interval scale ?

   _____

_____

_____

4. What statistical tools are permissible in Ratio Scale ?

_____

_____

_____

12.3 SOURCES OF ERROR IN MEASUREMENT :

Measurement should be accurate, precise and unambiguous in an ideal research study or survey. There should be clarity of the concepts used in measurement. However, this accuracy cannot be met fully. As such the researcher must be aware about the errors in the measurement and the sources of errors in measurement. The following are the few sources of error in measurement :

(a) Respondent : In many cases the respondent is not willing to express strong negative feelings or it is just possible that he may have very little knowledge that may not show his ignorance. Many factors like interest, fatigue, boredom etc. may limit the ability of the respondent to respond accurately and fully.

(b) Situation : Situational factors may come in the way of correct measurement. Any condition which places a strain on interview can have adverse effect on the interviewer - respondent rapport. If the interviewer gives a feelings of not keeping the anonymity, the respondent will not open up and will not express his views and feeling sincerely.

(c) Measurer : The behaviour of the interviewer, way of asking and reaching to the answers may encourage or discourage certain answers. Distortion of words or non-clarity of words can lead to misinterpretation. Errors can creep in because of incorrect coding, faulty tabulation or statistical calculations, particulary in the data analysis stage.

(d) Instrument : Error may arise due to the defective measuring instrument. The use of complex words, poor printing, inadequate space for replies may lead to error in measurement. Poor sampling of the population or the universe or items of concern is another instrument deficiency which can become an error.

Correct measurement depends on successfully meeting all of the problems. Final result will depend on the control of the sources of errors in measurement.

CHECK YOUR PROGRESS EXERCISE 2

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. On what basis can final results of survey be inaccurate ?

   _____

   _____

   _____

2. How can accuracy be brought in a research project ?

   _____

   _____

   _____

12.4 LET US SUM UP

In our daily life also we need scales to determine weight, height, time, temperature etc. So, scales are required. Nominal scale has determination of equality, ordinal scales operates determination of greater or less. Internal scale has determination of equality of intervals or of difference whereas Ratio scale has determination of equality of Ratios. Researchers should be fully conscious of the fact that there can be any type of error in measurement. He should check the source of error in order to get reliable results.

12.5 LESSON END EXERCISE

Long Answer

Q1. Describe in detail the different types of Measurement Scales with suitable examples.

Short Answer

Q1. Discuss the various sources of Error in Measurement.

12.6 SUGGESTED READINGS

1. Singh, A. K. (2006) Tets, Measurements. and Rescerch Methods in Behavioursal Sciences. New Delhi : Bharati Bhawan (Publishers & Distributors)

2. Kothari, C. K. (2004). Research Methodology Methods and Techniques. New Delhi New Age International (P) Limited Publishers

3. Verma, L. K. & Sharma, N. K. (2000). Advanced Statistics in Education and Psychology. Jalandhar : Narendra Publishing House.

LESSON NO. 13 **UNIT–V**

SCALING TECHNIQUES

Structure

13.0 INTRODUCTION :

This Lesson will discuss the scaling. Different types of Scaling Techniques like Rating Scales and Summated Scales will be discussed.

13.1 OBJECTIVES :

After going through this lesson the learner is :

(1) able to know what scaling is.

(2) able to measure abstract concepts more accurately.

(3) able to know different scaling techniques.

13.2 SCALING :

Scaling describes the procedure of assigning numbers to various degrees of opinion, attitude and other concepts. This can be done in two ways.

(i) making a judgement about some characteristic of an individual and then placing him directly on a scale that has been defined in terms of that characteristic and

(ii) Constructing questionnaires in such a way that the score of individual's responses assigns him a place on a scale. A scale is a continuum, consisting of the highest point and the lowest point along with several intermediate points between these two extreme points. Scaling has been defined as a "Procedure for the assignment of numbers to a property of objects in order to import some of the characteristics of numbers to the properties in question."

CHECK YOUR PROGRESS EXERCISE 1

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. Define scaling.

_____

_____

_____

2. Describe scaling in one line.

_____

_____

_____

13.3 SCALING TECHNIQUES :

The important scaling techniques often used in the research or survey are as following :

(1) Rating Scales

(2) Ranking Scales

(3) Differential Scales

(4) Summated Scales.

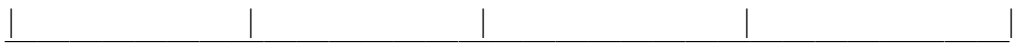
Rating Scale

The rating scale involves qualitative description of a limited number of aspects of a thing or of traits of a person. When we use rating scales, we judge an object in absolute terms against some specified criteria i.e. we judge properties of objects without reference to other similar objects. These ratings may be in such forms such as "like – dislike", "above average, average, below average" or "excellent–good–average–below average–poor" and so on. There is no specific rule whether to use a two-point scale, three point scale or seven point scale or still more points. Generally, three to seven points scales are generally used for the simple reason that more points on a scale provide an opportunity for greater sensitivity of measurement. There are two types of rating scales.

(1) The graphic rating scale.

(2) Itemized rating scale.

1. The graphic rating scale : It is a simple scale and is commonly used. Under this scale various points are usually put along the line to form a continuum and the rater indicates his rating by simply making a mark or tick at the appropriate point on a lien that runs from one extreme to the other. Scale points with brief descriptions may be indicated along the line, their function is to help the rater in performing his job. Following is an example of a rating scale where you have to give your opinion about the cleanliness of the city.



Excellent good average below average Poor

This fine point scale will help the rater to give his opinion and the researcher can find out the result from the rating.

This method has certain limitation. The meanings of the terms like good or below average may depend on respondent frame of reference so much so that the statement may not have the equal meaning for all.

2. The Itemized Rating Scale : This scale is also called numerical scale. It presents a series of statements from which a respondent selects one as best reflecting his evaluation. These statements are ordered progressively in terms of more or less of some property. Following is the example of itemized scaling.

(a) He is almost always seen in a temple.

(b) He is often seen in a temple.

(c) He some times prays in a temple.

(d) He infrequently visits a temple.

(e) He almost never goes to a temple.

By ticking one statement the researcher can find out the opinion of the rater regarding visiting temple.

Rating scales require less time and have a wide range of application. But it has its own limitations. The respondents are not very careful while rating. The respondent in many instances is not sure of the opinion thus can not make a good judgement.

Ranking Scale

Ranking scales are also known as comparative scales. Under these scales we make relative judgements against other similar objects. The respondent under this method directly compare two or more objects and make choices among them.

Following are the scales used under ranking scales :

1. Method of Paired comparisons.
2. Method of Rank order.

1. *Method of Paired Comparisons :* Under this method the respondent can express his attitude by making a choice between two objects e.g. between a colour of cloth and texture of cloth. When there are more than two stimuli to judge, the number of judgements required in a paired comparison is given by the formula—

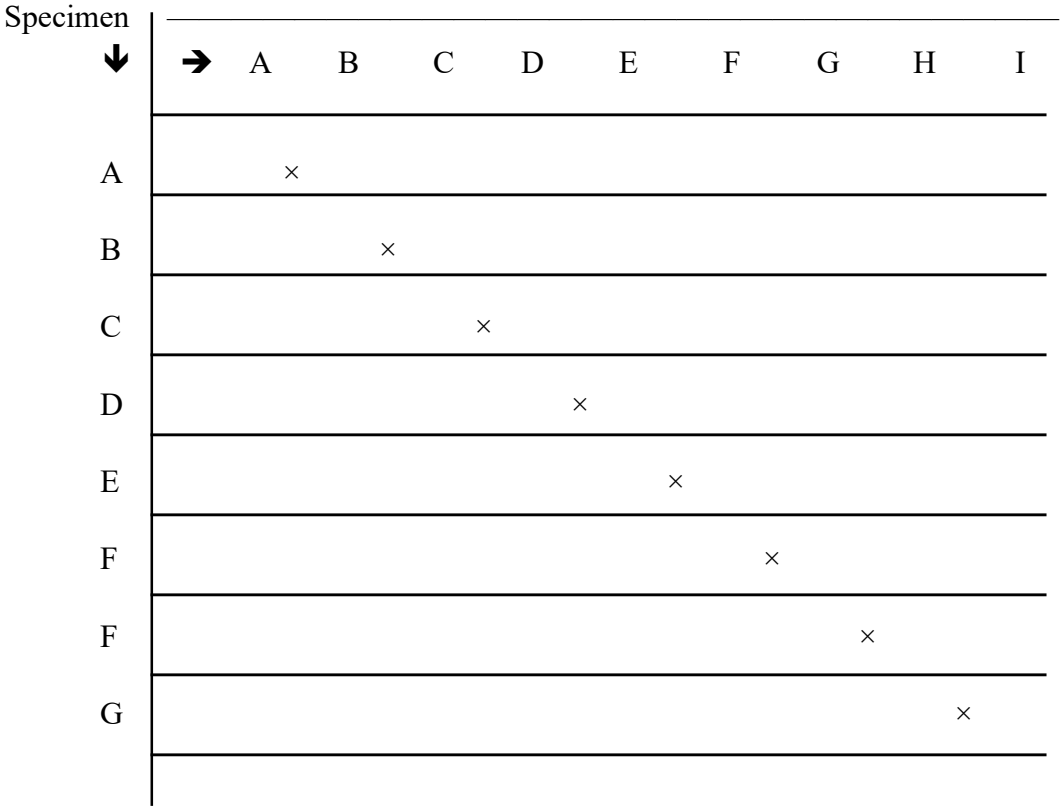
$$N = \frac{n\,(n-1)}{2}$$

where N = no. of judgements.

n = no. of stimuli or objects to be judged.

When N happens to be a big figure there is risk of respondents giving irregular answers. Researcher should reduce to number of comparisons per respondent either by presenting to each one of them only a sample of stimuli or by choosing a few objects which cover the range of attractiveness at about equal intervals and then comparing all other stimuli to do these few standard objects.

The job can be shortened by breaking up a long series of specimens into two or three or even more overlapping series. The researcher must take care of guarding against time and space errors by placing each specimen first in some pairs and second in others. One individual's record form in a tabulor form is prepared and is filled out. Each specimen is given a place in a row and a column. For example.



If, for example, the observer prefers G to B, the letter G is written at the point of intersection of G column and B row. In this way all the choices are made. Since the number of specimen are 8 (A to G) only 28 comparisons may be made. The mark (×) indicates that no comparison can be made in case the specimens on two sides are identical or same. When all the entries in the record form are made, the researcher counts them for each specimens and records them at the foot of the columns prescribed for each of the specimen. These are called choice scores showed by the letter C-scores. The next thing is to calculate is percent score or p-score which is obtained by dividing the c-score by N or in general by (n–1). The p value can be convered into z - values from a table.

This method of paired comparison was introduced by Cohn (1894) in his study of colour preferences.

Differential Scale

This is also known as Thurstone-type scales. The name of L. L. Thurstone is associated with differential scales and use consensus scale approach. Under such an approach the selection of items is made by a panel of judges who evaluate the items in terms of whether they are relevant to the topic area and unambiguous in implication. The steps involved are :

(i) The researcher gathers a large number of statements, usually twenty or more, that express various points of view toward a group, person, idea, feeling etc.

(ii) These statements are then submitted to a panel of judges, each of whom arranges them in eleven groups or piles ranging from one extreme to another in position. Each of the judges is required to place the most unfavourable in first pile, next most unfavourable in next pile. He goes on doing it till in the eleventh pile he puts the statements which he considers to be the most favourable.

(iii) This sorting by each judge yields a composite position for each of the items. In case of marked disagreement between the judges in assigning a position to an item, that item is discarded.

(iv) Items those are retained, each is given its median scale value between one and eleven as established by the panel. Thus, the scale value of any one statement is computed as the median position to which it is assigned by the group of judges.

(v) A final selection of statements is then made. For this purpose a sample of statements, whose median scores are spread evenly from one extreme to the other is taken. The statements selected constitute the final scale to be administered to respondents. The position of each statement on the scale is same as determined by the judges.

Once the scale is developed the respondent are asked during the administration of the scale to check the statements with which they agree. The median value of the statements that they check is worked out and this establishes their score or quantifies their opinion. It may be noted that in the actual instrument the statements are arranged in random order of scale value.

Thurstone type scales are considered appropriate and reliable when used for measuring a single attitude. But much cost and effort is required to develop them. Subjectivity of judges may reflect in the selection of items.

Summated Scale

Summated Scales also known as Likert-type scales are developed by using the item analysis approach whe in a particulars item is evaluated on the basis of how well it discriminates between those persons whose total score is high and those whose score is low. Those items or statements that best meet this sort of discrimination test are included in the final instrument.

Following are the step used in the summated scales.

(i) The researcher collects a large number of statements which are relevant to the attitude being studied and each of the statement expresses definite favourableness or unfavourablness to a particular point of view or the attitude and that the number of favourable and unfavourable statements is approximately equal.

(ii) After the statements have been gathered, a trial test should be administered to a number of subjects. Small group of people are asked to indicate their response to each statement on a five point scale.

(iii) The response to various statements are scored in such a way that a response indicative of the most favourable attitude is given the highest score of 5 and that with the most unfavourable attitude is given the lowest score of 1.

(iv) Total score of each respondent is obtained by adding his score that he received for separate statement.

(v) The next step is to array these total scores and find out those statements which have a high discriminatory power. For this some part of the highest and the lowest total scores e.g. top 25 and low 25 are selected. These two extreme groups are interpreted to represent the most favourable and least favourable attitudes and are used as criterion groups by which to evaluate individual statements. This way we determine which statements consistently correlate with low favourability and which with high favourability.

(vi) Only those statements that correlate with the total test should be retained in the final instrument and all others must be discarded from it.

Likert type scale is more reliable and provides more information and data. It takes less time but it has its limitation. The more and less favourableness can be statement but how much more or less can not be studied with the help of Litkrt Type scale. Inspite of its limitation, this method is regarded as the most useful when we are concerned with a programme of change or improvement in which case we use the scales to measure attitudes before and after the programme to assess whether our efforts have had desired effects.

CHECK YOUR PROGRESS EXERCISE 2

(a) Use the space below for your answer. Use separate sheet if required.

(b) Compare your answer with the above sub-section.

1. What are different scaling techniques ?

_____

_____

_____

2. How may points should be in a scale ?

_____

_____

_____

3. Make a five point scale

_____

_____

_____

4. What is Likert type scale known as ?

_____

_____

_____

13.4 LET US SUM UP :

In research we often face measurement problem specially when the concepts to be measured are complex and abstract and we do not possess the standardized measurement tools. It is here that scaling techniques are required. Rating scales, Ranking scale, Thurstone scales and Likert-type scales are often used in the context of research.

13.5 LESSON END EXERCISE :

Long Answer

Q1. Describe in detail the various scaling techniques.

Short Answer

Q1. Discuss the Graphic and Itemized Rating Scale.

Q2. Discuss the Method of Paired Comparsions and Method of Rank order.

13.6 SUGGESTED READINGS

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