ASSESSMENT FOR LEARNING

Unit 10: Technological based Quantitative and Qualitative analysis of learning outcomes

Quantitative and Qualitative- Meaning and difference- Data-Tabulation – measures of central tendency – measures of dispersion – normal distribution – correlation and their interpretation- Graphical representation of data-Exploration of software for assessment of CCE– Managing students Data in computer – inferences, Diagnosis, feedback and remedial learning alternatives – e-portfolio assessment – evaluation Rubrics

10.1 MEANING OF DATA

You might be reading a newspaper regularly. Almost every newspaper gives the minimum and the maximum temperatures recorded in the city on the previous day. It also indicates the rainfall recorded, and the time of sunrise and sunset. In your school, you regularly take attendance of children and record it in a register. For a patient, the doctor advises recording of the body temperature of the patient at regular intervals.

If you record the minimum and maximum temperature, or rainfall, or the time of sunrise and sunset, or attendance of children, or the body temperature of the patient, over a period of time, what you are recording is known as data. Here, you are recording the data of minimum and maximum temperature of the city, data of rainfall, data for the time of sunrise and sunset, and the data pertaining to the attendance of children.

As an example, the class –wise attendance of students, in a school, is as recorded in table.

Table Class-wise Attendance of Students

Class	**No. of Students Present**
VI	42
VII	40
VIII	41
IX	35
X	36
XI	32
XII	30
Total	256

Table, gives the data for class-wise attendance of students. Here the data comprise 7 observations in all. These observations are, attendance for class VI, VII, and so on. So, **data** refers to the set of observations, values, elements or objects under consideration.

The complete set of all possible elements or objects is called a **population.** Each of the elements is called a **piece of data.**

Data also refers to the known facts or things used as basis for inference or reckoning facts, information, material to be processed or stored.

10.2 NATURE OF DATA

For understanding the nature of data, it becomes necessary to study about the various forms of data, as shown below:

- ***Qualitative and Quantitative Data***
- Continuous and Discrete Data
- Primary and Secondary Data

10.3 QUALITATIVE AND QUANTITATIVE DATA

Let us consider a set of data given in Table

Management-wise Number of Schools

Management	**No. of Schools**
Government	4
Local Body	8
Private Aided	10
Private Unaided	2
TOTAL	**24**

In Table numbers of schools have been shown according to the management of schools. So the schools have been classified into 4 categories, namely, Government Schools, Local Body Schools, Private Aided Schools and Private Unaided Schools. A given school belongs to any one of the four categories. Such data is shown as **Categorical or Qualitative Data.** Here the category or the quality referred to is management. Thus categorical or qualitative data result from information which has been classified into categories. Such categories are listed alphabetically or in order of decreasing frequencies or in some other conventional way. Each piece of data clearly belongs to one classification or category.

We frequently come across categorical or qualitative data in the form of schools categorized according to Boys, Girls and Co-educational; Students' Enrolment categorized according to SC, ST, OBC and 'Others'; number of persons employed in various categories of occupations, and so on.

Let us consider another set of data given in Table

Number of Schools according to Enrolment

Enrolment	**No. of Schools**
Upto 50	6
51 - 100	15
101- 200	12
201-300	8
Above 300	4
Total	**45**

In Table, numbers of schools have been shown according to the enrolment of students in I the school. Schools with enrolment varying in a specified range are grouped together, e.g. there are 15 schools where the students enrolled are any number between 51 and 100. As the grouping is based on numbers, such data are called **Numerical or Quantitative Data.** Thus, numerical or quantitative data result from counting or measuring. We frequently come across numerical data in newspapers, advertisements etc. related to the temperature of the cities, cricket averages, incomes, expenditures and so on.

10.4 DIFFERENCE BETWEEN QUANTITATIVE AND QUALITATIVE DATA

QUANTITATIVE DATA	**QUALITATIVE DATA**
Explains ‘who’, ‘what’, ‘when’ ‘how much’, and ‘how many’	Explains ‘how’ and ‘why’
Deals with numbers	Deals with descriptions

Data can be observed and measured Exactly	Data can be observed and assessed approximately/indirectly
Usually gathered by surveys from large number of respondents	Data can be collected individually or from the group of respondents
It is useful when pieces of information required can be counted mathematically and analyzed using statistical methods	It is useful when a broader understanding and explanation is required on a particular topic for which quantitative data alone is not sufficient
It is used when 'accurate' and 'precise' data are required	When information is needed on 'what students think about a particular situation, and what are their priorities'; it is useful. It is also useful while seeking to understand 'why students behave in a certain way'.
Ensures objectivity, reliability and the ability to generalize; but hardly provides any in-depth description	It can't be generalized
Data can be generated through the same tool irrespective of context	Context is important in qualitative data

10.5 GROUPING AND TABULATION OF DATA

It is cumbersome to study or interpret large data without grouping it, even if it is arranged sequentially. For this, the data are usually organized into groups called classes and presented in a table which gives the frequency in each group. Such a frequency table gives a better overall view of the distribution of data and enables a person to rapidly comprehend important characteristics of the data.

For example, a test of 50 marks is administered on a class of 40 students and the marks obtained by these students are as listed below in Table 12.5.

Table

35,40,22,32,41,18,20,40,36,29,24,28,28,31,39,37,27,29,40,35,

38,30,45,26,20,25,32,31,42,28,33,32,29,26,48,32,16,46,18,44.

By going through the marks of 40 students listed in Table 12.5, you may be able to see that the marks vary from 16 to 48, but if you try to comprehend the overall performance it is a difficult proposition.

Now consider the same set of marks, arranged in a tabular form, as shown in Table.

Table

Mark	No. of Students
45-49	**3**
40-44	**6**
35-39	**6**
30-34	**8**
25-29	**10**
20-24	**4**
15-19	**3**
Total	**40**

From Table, one can easily comprehend the distribution of marks e.g. 10 students have scores from 25 to 29, while only 7 students have a score lower than 50% etc.

Various terms related to the tabulation of data are being discussed below:

Table 'shows the marks arranged in descending order of magnitude and their corresponding frequencies. Such a table is known as **frequency distribution.** A grouped frequency distribution has a minimum of two columns - the first has the classes arranged in some meaningful order, and a second has the corresponding frequencies. The classes are also referred to as class intervals. The range of scores or values in each class interval is the same. In the given example the first class interval is from 45 to 49 having a range of 5 marks i.e. 45, 46, 47, 48, and 49. Here 45 is the lower class limit and 49 is the upper class limit. As discussed earlier the score of 45 may be anywhere from 44.5 to 45.5, so the exact lower class limit is 44.5 Instead of 45. Similarly, the exact upper class limit is 49.5 instead of 49. The range of the class interval is 49.5 - 44.5 = 5 i.e. the difference between the upper limit of class interval and the lower limit of class interval.

For the presentation of data in the form of a frequency distribution for grouped data, a number of steps are required. These steps are:

1. Selection of non-overlapping classes.

2. Enumeration of data values that fall in each class.

3. Construction of the table.

Let us consider the score of 120 students of class X of a school in Mathematics, shown in Table.

Table, Mathematics score of 120 class X Students

71 85 41 88 98 45 75 66 8138 52 67 92 62 83 49 64 52 90 61 58 63 91 57 48
75 89 73 64 80 67 76 65 76 65 61 68 84 72 57 77 63 52 56 41 60 55 75 53 45
37 91 57 40 73 66 76 52 88 62 78 68 55 67 39 65 44 47 58 68 42 90 89 39 69
48 82 91 39 85 44 71 68 56 48 90 44 62 47 83 80 96 69 88 24 44 38 74 93 39
72 56 46 71 80 46 54 77 58 81 70 58 51 78 64 84 50 95 87 59

First we have to decide about the number of classes. We usually-have 6 to 20 classes of equal length. If the number of scores/events is quite large, we usually have 10 to 20 classes. The number of classes when less than 10 is considered only when the number of scores /values is not too large. For deciding the exact number of classes to be taken, we have to find out the range of scores. In Table, scores vary from 37 to 98 so the range of the score is 62 (98.5 - 36.5 = 62).

The length of class interval preferred is 2, 3, 5, 10 and 20. Here if we take class length of 10 then the number of class intervals will be 62/10 = 6.2 or 7 which is less than the desired number of classes. If we take class length of 5 then the number of class intervals will be (1215 = 12.4 or 13 which is desirable.

Now, where to start the first class interval? The highest score of 98is included in each of the three class intervals of length 5 i.e. 94 - 98, 95 - 99 and 96 - 100. We choose the interval 95- 99 as the score 95 is multiple of 5. So the 13 classes will be 95 - 99,90 - 94, 85 - 89, 80 -84, ... , 35 - 39. Here, we have two advantages. One, the mid points of the classes are whole numbers, which sometimes you will have to use. Second, when we start with the multiple of the length of class interval, it is easier to mark tallies. When the size of class interval is 5, we start with 0, 5, 10, 15, 20 etc.

To know about these advantages, you may try the other combinations also e.g. 94 -98, 89 - 93, 84 - 88, 79 -83 etc. You will observe that marking tallies in such classes is a bit more difficult. You may also take the size of the class interval as 4. There you will observe that the mid points are not whole numbers. So, while selecting the size of the class interval and the limits of the classes, one has to be careful.

After writing the 13 class intervals in descending order and putting tallies against the concerned class interval for each of the scores, we present the frequency distribution as shown in Table 12.8.

Table 12.8 Frequency Distribution of Mathematics Scores of 120 Class X Students

Scores	Tally	No. of Students
95 – 99	III	3
90 – 94	~~IIII~~ III	8
85 – 89	~~IIII~~ III	8
80 – 84	~~IIII~~ ~~IIII~~	10
75 – 79	~~IIII~~ ~~IIII~~	10
70 – 74	~~IIII~~ ~~IIII~~	10
65 – 69	~~IIII~~ ~~IIII~~ IIII	14
60 – 64	~~IIII~~ ~~IIII~~ I	11
55 – 59	~~IIII~~ ~~IIII~~ III	13
50 – 54	~~IIII~~ III	8
45 – 49	~~IIII~~ ~~IIII~~	10
40 – 44	~~IIII~~ III	8
35 – 39	~~IIII~~ II	7
	Total	120

Procedure for writing the class intervals

At the top we write the first class interval which is 95 - 99. Then we find the second class interval by subtracting 5 points from the corresponding figures i.e. 90 - 94, and write it under 95-991**.** On subtracting 5 from 90- 94, the third class interval will be 85 - 89. The procedure is to be followed till we reach the class interval having the lowest score.

Procedure for marking the tallies

Let us take the first score in the first row i.e. 71. The score of 7 1 is in the class interval 70 - 74(70, 71, 72, 73, 74) so a tally *(I)* is marked against 70 - 74. The second score in the first row is 85, which lies in the class interval 85 - 89 (85, 86, 87, 48, 89), so a tally *(1)* is marked against 86 - 89. Similarly, by taking, all the 120 scores, tallies are put one by one. While ranking the tallies, put your finger on the scores, as a mistake can reduce the whole process to naught. The total tallies should be 120 i.e. total numbers of scores. When against a particular class interval there are four tallies *(I///)* and you have to mark the fifth tally, cross the four tallies *(MV)* to make it 5. So while marking the tallies we make the cluster of 5 tallies. By counting the number of tallies, the frequencies are recorded against each of the class intervals. It completes the construction of table.

In Table, the exact limits of class interval 95 - 99 are 94.5 and 99.5, as the score of 95 range from 94.5 to 99.5 and the score of 99 ranges from 98.5 to 99.5, making the exact range from (94.5 to 99.5. As discussed earlier the data are continuous based on the nature of the variable. The class interval, though customarily arranged in descending order, can also be arranged in ascending order.

10.6 MEASURES OF CENTRAL TENDENCY (Mean, Median, Mode)

Concept

You as a teacher might be coming across a variety of data pertaining to students' achievement or other characteristics, both of individuals or groups of individuals. We may often be interested in having a concise description of the performance of the group as a whole. In case there are more than one group one may like to compare the groups in terms of their typical performance. Such descriptions of group performances are known as measures of central tendency. Let us assume that we have got the scores of students of three sections of class IX with 40 students each in these sections. We may compute an index of the sets of scores of 40 students in each section which would represent the average performance of the three sections in a given subject. Such an index would be a measure of central tendency. It can very well be used to understand the nature of scores in each section and for making inter-group comparisons. The most commonly used measures of central tendency are

- Mode
- Median

- Mean.

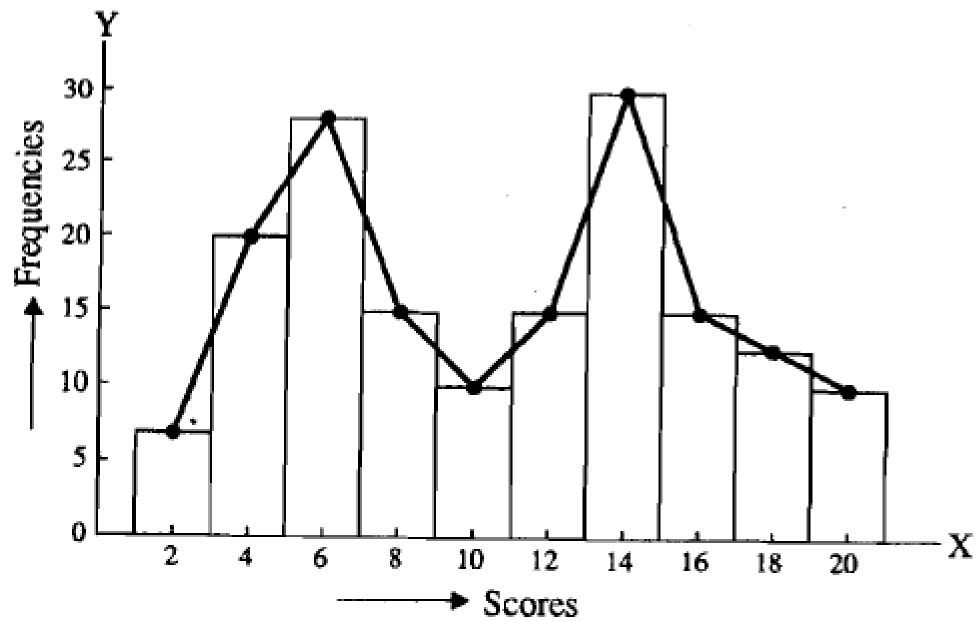
<u>Data on nominal scale and measure of central tendency</u>

<u>THE MODE</u>

Data obtained on the nominal scale is of classificatory type and mostly qualitative. We can count the number of cases in each category and obtain the frequencies. We may then be interested in noting down the class which is most populous or popular. We frequently deal with 'scores' in measurement in education. The score obtained by the largest number of individuals is the mode of that group of scores. For example, if in a section of 40 students of class IX the number of students obtaining the score of 55 is the highest, 55 would be called the mode of the scores for that section. Generally such values are seen to be centrally located, with other values in either direction having relatively lower frequencies. Thus the mode presents a rough estimate of the most typical or the average score in a group of values. It is not essential to have precise scores of all the individuals of the group for finding out mode.

For continuous variables mode provides a quick measure which is less precise and less dependable as compared to other measures of central tendency. If you draw a frequency polygon or a histogram, you will notice the maximum height of this point or the bar.

Sometimes the scores of a group tend to concentrate on two distinctly separate places on the scale. In such a situation the distribution is said to be bimodal and the value or score with highest frequency cannot be said to be the mode. You may examine the following histogram and frequency polygon.



In the above histogram and frequency polygon you may notice that the distribution has two peaks, one at score 6 and the other at score 14. Obviously 14 cannot be the only mode here. Hence it represents a bimodal distribution having two modes at 6 and 14. Some distributions can even be multimodal i.e. having more than two modes. We may define Mode as the point on the scale of measurement with largest frequency in relation to other frequency values in the neighborhood.

Mode in ungrouped data

In a simple ungrouped set of measures, the mode is the single measure or score which occurs most frequently. For example, if the scores of tea students are 13,12, 14, 15, 12, 14, 18, 12, 14, 14, the most frequent score is 14 as it has been obtained by 4 students. It is, thus, the made for the given ungrouped data.

Calculating the mode for the grouped data

When the data have been grouped in terms of class intervals and frequencies, the point of greatest concentration of frequencies or the peak in the frequency distribution happens to be the mode. In such a situation the mode can be identified by inspection alone. The Mode is the midpoint of the class interval having the greatest frequency. Became of this estimation, it is sometime referred to as Crude Mode.

Example 1: Find the mode for the frequency distribution given below:

Class Interval	Frequency

100 - 104	3
95 - 99	4
90 - 94	8
85 - 89	5
80 - 84	2

In the given distribution there are maximum (8) frequencies in the class interval 90 - 94. So the midpoint, i.e. *92,* is the mode.

Educational situations and use of mode

Mode may be used in the following type of educational situations:

- When the most typical value is wanted as a measure of central tendency. For instance, the most liked boy in the class, the most popular belief of students about vocational courses etc., etc.
- When a quick and approximate measure of central tendency is require.
- When data is incomplete or the distribution is skewed, where most of the values are towards the extremes.

Limitations of mode

Mode has the limitations associated with the scale of measurement for which it stands. Mode can obviously not be subjected to further statistical analysis. It remains as only a rough estimate. Sometimes we may come across bimodal distributions (having two modes) and we do not easily find one composite measure. You may examine the following two situations and appreciate the limitations of mode:

Situation I: The scores of students in History for Class VII A are as follows:

22, 37, 45, 66, 32, 64, 65, 67, 66, 67, 65, 67, 38, 66, 66, 65, 32, 66, 67, 65, 64, 64, 67, 52, 47, 67, 68, 67, 70

Situation II: The scores of students in Maths for Class IX A are as follows:

18, 20, 23, 24, 24, 25, 24, 24, 24, 30, 35, 40, 46, 48, 50, 56, 62, 62, 62, 62, 60, 47, 38, 62, 62, 24, 28, 62, 80

An inspection of situation I gives the mode of 67 while the adjacent scorer of 64, 65 and 66 seem to be equally potent to become mode. In situation II you notice a bimodal distribution having two modes at 24 and 62 as both seem to be equally frequent in their own places. We may thus conclude that mode is only a crude measure which can be of value when a quick and rough estimate of central tendency is required.

THE MEDIAN

When data have been arranged in rank order the measure of central tendency may be found by locating a point that divides the whole distribution into two equal halves. Thus median may be defined as the point on the scale of measurement below and above which lie exactly 50 percent of the cases. Median can therefore be found for truncated (incomplete) data provided we know the total number of cases and their possible placements on the scale. It may be noted that median is defined as a point and not as a score or any particular measurement.

Median in ungrouped data

For finding out median in ungrouped data let us study the following examples: -

Example : Find the Median for the scores:

2, 5, 9, 8, 17, 12, 14

Here we have seven scores. On arranging them in ascending (or descending) order we may have the sequence of scores as under:

2, 5, 8, 9, 12, 14, 17

We find that there are 3 cases above and below 9 and *9* itself is the mid-point of unit interval 8.5 to 9.5. Thus 9 divides the whole distribution into two equal halves. Therefore 9 would be the Median in this case.

Calculation of median in grouped data

As stated earlier, median is a point on the scale of measurement below which lie exactly fifty percent cases. Obviously fifty percent cases will be above it. For calculating the median, the assumption made in case of grouped data is that frequencies are evenly distributed within the class interval.

Let us take an example to illustrate the point.

Example : Find the Median for the distribution given below:

Class Interval	Frequency	
45 - 49	3	13 = number of cases above the
40 - 44	4	interval containing Median
35 - 39	6	8 = cases in the Median class (fm)
30 - 34	8 (fm)	19 = number of cases (fb) below the
25 - 29	7	interval containing Median
20 – 24	4	
15 – 19	5	
10 – 14	3	
	(N=40)	

In the above example there are a total of 40 cases. We have to find a point below and above which lie 20 cases. There are 13 cases in top 3 class intervals and 19 cases in the bottom four class intervals. The point segregating the values into two halves may be found in class interval 30 - 34 which has 8 cases in it. It is thus called the Median class. Assuming that these 8 frequencies are evenly distributed within the class interval 30 - 34 (exact limits 29.5 to 34.3, we may find the median point which has to be 1 case above 29.5 (or 7 cases below 34.5).

There are 8 cases covering a space of 5 units so one case would take 518 spaces. Hence the

Median would be $29.5 + \frac{1 \times 5}{8} = 29.5 + 0.625$

$= 30.13$ (taking approximation upto two decimal points)

This type of calculation gives rise to the formula:

$$\text{Median} = L + \frac{N/2 - fb}{f} \times i$$

Where L = Lower limit of Median class

N = Total number of cases

fb = Cumulative Frequency below the Median class

f = Frequency in Median class

i = Size of the class interval

Using this formula for the previous example you can see that

$$\text{Median} = 29.5 + \frac{(20 - 19) \times 5}{8}$$

Now we will calculate Median using this formula: = 29.5 + 5/8

= 29.5 + 0.625

= 30.13

Educational situations and use of median

Median is used in the following situations:

- When incomplete distribution is given.
- When the point dividing the distribution into two equal parts is needed,
- When a distribution is markedly skewed. That is, one or more very extreme cases are there to one side of the distribution. Say, in a group of 20 students **18** of them are scoring very low marks say **15** to 40 out of **100** and two students score 95 and **100.** Such distributions are known as skewed.
- When interest is limited to finding the placement of cases in the lower half or upper half of the distribution and not in finding how far they are from the central point.

Limitations of median

Median is not dependent on all the observations and ignores their numerical values. It cannot be used as the centre of gravity of the distribution. Also, it cannot be used for inferential statistical analyses.

THE MEAN

Mean is calculated when the data are complete and presented on equal interval scale. It is most popularly known as the 'Arithmetic Mean'. Mean provides an accurate description of the sample and indirectly, that of the population. It is the sum of measurements* divided by their number.

$$\text{Mean} = \frac{\sum X}{N}$$

Where $\sum X$ = Sum of all values

N = Number of cases

- Mean of a distribution of scores may be defined as the point on the scale of measurement obtained by dividing the sum of all the scores by the number of scores.

Calculating mean for ungrouped data

When raw data are given the Mean is computed by adding all these values and dividing by the total number.

Example : Compute Mean for the scores given below

25,36,18,29,30,41,49,26,16,27

$$\text{Mean} = \frac{\sum X}{N} = \frac{25+36+18+29+30+41+49+26+16+27}{10}$$

$$= \frac{297}{10} = \mathbf{29.7\ (Answer)}$$

Calculating mean for grouped data

There can be two situations of grouped data:

- When scores and frequencies are given; and
- When data have been grouped i.e. frequency is given for each class interval. In the second case we may compute either by long method or by the short method, using the Assumed Mean. These are explained below:

(A) Calculating Mean when Scores and Frequencies are given

Example : Compute Mean for the following data:

Score	18	20	24	35	42	48	50
Frequency	2	4	3	8	6	4	3

Solution: We use the following formula:

$$\text{Mean} = \frac{\sum \boldsymbol{f\, x}}{N}$$

Where X = Score

f = frequency

N = ∑f = total number of cases (frequencies)

SCORE X	f	fX	
18	2	36	
20	4	80	$\text{Mean} = \frac{\sum fx}{N}$
24	3	72	
35	8	280	$= \frac{1062}{30}$

42	6	252	
48	4	192	=35.4 (answer)
50	3	150	
	N= 30	∑fX = 1062	

(B) Calculating Mean from Grouped Frequency Distribution

When grouped frequency distribution is given, the Mean is calculated using the above formula i.e.

$$\text{Mean} = \frac{\sum fx}{N}$$

Where X = Midpoint of the class interval

f = Frequency

N = Cf Total number of cases

Here an assumption is made that all frequencies are concentrated at the midpoint of the class interval. So mid points of class intervals are used for scores.

<u>Educational situations and use of mean</u>

Mean is used when:

- Scores are nearly symmetrically distributed around a central point i.e. distributions are not markedly skewed.
- We wish to know the centre of gravity of a sample.
- Central tendency with greatest stability is wanted.
- When other statistics (standard deviation, coefficient of correlation etc.) for inferential purposes are to be calculated.
- Group performances are to be compared with accuracy and precision.

<u>Limitations of mean</u>

Sometimes mean of a distribution is highly misleading especially when some of the observations are too large or too small as compared to the others. If you want to study the average class size and there are 5 classes with 100 - 150 students, 10 classes having 50 to 100 students and 35 classes having 30 to 50 students each. Then the Mean of 55.5 would not represent the typical case. Even within a class if 5 students' scores are 12, 15,20,25 and 100, the Mean of 34.4 can be misleading. There are situations where mean may not provide meaningful information.

Relationship between mean, median and mode

In your dealings with a variety of data you may come across situations where these three measures of central tendency are very close to each other or at divergence. This largely depends upon the nature of the distribution. In a perfectly symmetrical unimodal distribution these three measures come very close to each other or even become identical. As the symmetry of 35 the distribution varies the three measures (Mean, Median and Mode) register divergence. A very crude sort of relationship among them is shown by the equation:

Mode = 3 Median - 2Mean

Comparison of mean, median and mode

The Characteristics of Mean, Median and Mode have been discussed in the preceding sections besides mentioning some situations where they can be appropriately used. Mean, Median and Made differ from each other on various counts. These should be used as per the nature of the data indicated, by the scale of measurement used and the purpose in hand. However, the mean is a more precise, reliable and stable measure. Its use should be avoided when data are skewed or truncated. If some decision is to be taken on the face value of data, mode is the best measure. But to have a suitable measure when data are incomplete or skewed, Median may be preferred. If further statistical analysis is to be carried out we should go for Mean. It will not be desirable to consider any one of them to be superior or inferior in all situations as it is rather contextual. We should consult an expert if required.

10.7 MEASURES OF DISPERSION (Range, Q.D, S.D, M.D Percentile)

Concept

The averages are representatives of a frequency distribution. But they fail to give a complete picture of the distribution. They do not tell anything about the scatterness of observations within the distribution.

Suppose that we have the distribution of the yields (kg per plot) of two paddy varieties from 5 plots each. The distribution may be as follows

Variety I	45	42	42	41	40
Variety II	54	48	42	33	30

It can be seen that the mean yield for both varieties is 42 kg but cannot say that the performances of the two varieties are same. There is greater uniformity of yields in the first variety whereas there is more variability in the yields of the second variety. The first variety may be preferred since it is more consistent in yield performance. Form the above example it is obvious that a measure of central tendency alone is not sufficient to describe a frequency distribution. In addition to it we should have a measure of scatterness of observations. The scatterness or variation of observations from their average are called the dispersion. There are different measures of dispersion like the range, the quartile deviation, the mean deviation and the standard deviation.

Characteristics of a good measure of dispersion

An ideal measure of dispersion is expected to possess the following properties

1. It should be rigidly defined
2. It should be based on all the items.
3. It should not be unduly affected by extreme items.
4. It should lend itself for algebraic manipulation.
5. It should be simple to understand and easy to calculate

RANGE

This is the simplest possible measure of dispersion and is defined as the difference between the largest and smallest values of the variable.

• In symbols, Range = L – S

Where L = Largest value.

S = Smallest value.

In individual observations and discrete series, L and S are easily identified.

In continuous series, the following two methods are followed.

Method 1

L = Upper boundary of the highest class

S = Lower boundary of the lowest class.

Method 2

L = Mid-value of the highest class.

S = Mid-value of the lowest class.

Example1

The yields (kg per plot) of a cotton variety from five plots are 8, 9, 8, 10 and 11. Find the range.

Solution

L=11, S = 8.

Range = L – S = 11- 8 = 3

Example 2

Calculate range from the following distribution.

Size:	60-63	63-66	66-69	69-72	72-75
Number:	5	18	42	27	8

Solution

L = Upper boundary of the highest class = 75

S = Lower boundary of the lowest class = 60

Range = L – S = 75 – 60 = 15

Merits of range

1. It is simple to understand.

2. It is easy to calculate.

3. In certain types of problems like quality control, weather forecasts, share price analysis, etc., range is most widely used.

Demerits of range

1. It is very much affected by the extreme items.

2. It is based on only two extreme observations.

3. It cannot be calculated from open-end class intervals.

4. It is not suitable for mathematical treatment.

5. It is a very rarely used measure.

STANDARD DEVIATION

It is defined as the positive square-root of the arithmetic mean of the Square of the deviations of the given observation from their arithmetic mean.

The standard deviation is denoted by s in case of sample and Greek letter σ (sigma) in case of population.

The formula for calculating standard deviation is as follows

$$s = \sqrt{\frac{\sum x^2 - \frac{\left(\sum x\right)^2}{n}}{n-1}} \quad \text{for raw data}$$

And for grouped data the formulas are

$$s = \sqrt{\frac{\sum fx^2}{N} - \left(\frac{\sum fx}{N}\right)^2} \quad \text{for discrete data}$$

$$s = C \times \sqrt{\frac{\sum fd^2}{N} - \left(\frac{\sum fd}{N}\right)^2} \quad \text{for continuous data}$$

Where $d = \frac{x - A}{C}$

Example

Raw Data

The weights of 5 ear-heads of sorghum are 100, 102,118,124,126 gms. Find the standard deviation.

Solution

x	x^2
100	10000
102	10404
118	13924
124	15376
126	15876
570	**65580**

Standard deviation $s = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}}$

$$= \sqrt{\frac{65580 - \frac{(570)^2}{5}}{5-1}} = \sqrt{150} = 12.25 \ gms$$

Example

Continuous distribution

The Frequency distributions of seed yield of 50 seasamum plants are given below. Find the standard deviation

Seed yield in gms (x)	2.5-35	3.5-4.5	4.5-5.5	5.5-6.5	6.5-7.5
No. of plants (f)	4	6	15	15	10

Solution

Seed yield in gms (x)	No. of Plants f	Mid x	d= $\frac{x-A}{C}$	df	d^2 f
2.5-3.5	4	3	-2	-8	16
3.5-4.5	6	4	-1	-6	6
4.5-5.5	15	5	0	0	0
5.5-6.5	15	6	1	15	15
6.5-7.5	10	7	2	20	40
Total	**50**	**25**	**0**	**21**	**77**

A=Assumed mean = 5

n=50, C=1

$$s = C \times \sqrt{\frac{\sum fd^2}{n} - \left(\frac{\sum fd}{n}\right)^2}$$

$$= 1 \times \sqrt{\frac{77}{50} - \left(\frac{21}{50}\right)^2}$$

$$= \sqrt{1.54 - 0.1764}$$

$$= \sqrt{1.3636} = 1.1677$$

Merits of standard deviation

1. It is rigidly defined and its value is always definite and based on all the observations and the actual signs of deviations are used.
2. As it is based on arithmetic mean, it has all the merits of arithmetic mean.
3. It is the most important and widely used measure of dispersion.
4. It is possible for further algebraic treatment.
5. It is less affected by the fluctuations of sampling and hence stable.
6. It is the basis for measuring the coefficient of correlation and sampling.

Demerits of standard deviation

1. It is not easy to understand and it is difficult to calculate.
2. It gives more weight to extreme values because the values are squared up.
3. As it is an absolute measure of variability, it cannot be used for the purpose of comparison.

VARIANCE

The square of the standard deviation is called variance.
(i.e.) variance = (SD) 2.

COEFFICIENT OF VARIATION

The Standard deviation is an absolute measure of dispersion. It is expressed in terms of units in which the original figures are collected and stated. The standard deviation of heights of plants cannot be compared with the standard deviation of weights of the grains, as both are expressed in different units, i.e heights in centimeter and weights in kilograms. Therefore the standard deviation must be converted into a relative measure of dispersion for the purpose of comparison. The relative measure is known as the coefficient of variation. The coefficient of variation is obtained by dividing the standard deviation by the mean and expressed in percentage. Symbolically,

Coefficient of variation (C.V) = (SD/Mean) * 100

If we want to compare the variability of two or more series, we can use C.V. The series or groups of data for which the C.V. is greater indicate that the group is more variable, less stable, less uniform, less consistent or less homogeneous. If the C.V. is less, it indicates that the group is less variable or more stable or more uniform or more consistent or more homogeneous.

QUARTILE DEVIATION

Cocept

Quartiles: You know that median is that value of the variate which divides the total frequency of the distribution into two equal parts. Quartiles may be defined as those values of the variate which divide the total frequency into four equal parts. Quartiles are denoted by Q1, Q2 and Q3. Q2 is the same as median. The value of the variate which divides the lower half below the median, into two equal parts on the basis of frequency, is called Lower Quartile. It is denoted by Q1. Similarly, when the upper half which is above the median, is divided on the basis of frequency into two equal parts, the value of the variate is called Upper Quartile, denoted by Q3.

The difference between the two quartiles i.e. Q3-Q1, represents inter-quartile range. Half of this difference, which is semi-interquartile range is called quartile deviation. Thus quartile deviation, which is denoted by Q, is given by

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

<u>Calculation of quartile deviation</u>

The formula to be used for the computation of quartile deviation, Q is

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

Where Q1 and Q3 are the first and the third quartiles

For computing the value of Q, we have to first find the values of Q1 and Q3, we have to find the points on the scale of measurement upto which 25% and 75% of the cases lie respectively. The process of calculation of Q1 and Q3 is similar to the process of calculating the median, the only difference being that for the median we consider N/2 cases, while for the Q1 and Q3 we have to take N/4 and 3N/4 cases respectively.

<u>Interpretation of quartile deviation</u>

Let us first discuss the use and limitations of quartile deviation as a measure of dispersion. Quartile deviation is easy to calculate and interpret. It is independent of the extreme values, so it is more representative and reliable than range. Wherever median is preferred as a measure of central tendency, quartile deviation is preferred as measure of dispersion. However, like median, quartile deviation is not amenable to algebraic treatment, as it does not take into consideration all the values of the distribution.

While interpreting the value of quartile deviation it is better to have the values of Median. Q1 and Q3 along with Q. If the value of Q is more, then the dispersion will be more, but again the value depends on the scale of measurement. Two values of Q are to be compared only if the scale used is the same. Q measured for scores out of 20 cannot be compared directly with Q for scores out of 50. If median and Q are known, we can say that 50% of the cases lie between 'Median – Q' and 'Median + Q'. These are the middle 50% of the cases. Here, we come to know about the range of only the middle 50% of the cases. How the lower 25% of the cases and the upper 25% of the cases are distributed, is not known through this measure. Sometimes, the extreme cases or values are not known, in which case the only alternative available to us is to compute median and quartile deviation as the measures of central tendency and dispersion. Through median and quartiles we can infer about the symmetry or skewness of the distribution.

CONCEPT OF PERCENTILES

In case of median, total frequency is divided into two equal parts: in the case of quartiles, total frequency is divided into four equal parts: similarly in case of percentiles, total frequency is divided into 100 equal parts. Percentiles are denoted by P1, P2,P2,….. P100. Thus, percentiles may be defined as those values of the variate which divide the total frequency into 100 equal parts. So, there are 1 percent of the cases below the point P1, 2 percent of the cases below the point P2, and so on. As discussed earlier, Median is represented by P50 and the two quartiles Q1 and Q3 are represented by P25 and P75 respectively. Similarly, first, second, third,…..ninth deciles are represented by P10,P20,P30,…..P90 respectively.

Calculation of percentiles

For calculating the values of percentiles, we have to find the points on the scale of measurement upto which the specified percent of cases lie. The process of calculating the percentiles wherein we take into consideration the specified percent of cases is similar to that of calculating the quartiles. Thus,

```
R = P/100 x (N + 1)
```

Interpretation of percentiles

Percentiles are more frequently used in testing and interpreting test scores. For any standardized tests, percentile norms are reported with the test, so that the obtained test results may be interpreted properly. If the percentile rank of an individual is 60, we come to know that 60% of the students have scored less than that individual. If only the score of an individual is given, it is difficult to judge the performance. It can be judged only with reference to a particular group. However, with the help of the cumulative percentage curve, we can find the percentile rank of that individual and judge the performance on that basis.

Limitations of percentiles

The mastery of an individual is not judged by the use of percentiles, as the same person in a poor group will show better rank and in an excellent group will show comparatively poorer rank. Also, as in case of simple ranks the difference in percentile ranks at different intervals are not equal. As an example, P100 – P90 is not comparable to P50 – P40. The position of a student on total achievement cannot be calculated from percentiles given in several tests.

CONCEPT OF MEAN DEVIATION

The distance of a score from a central point is called a deviation. The simplest way to take into consideration the variation of all the values in a distribution is to find the mean of all the deviations of these values from a selected point of central tendency. Usually, the deviation is taken from the mean of the distribution. The average of the deviations of all values from the arithmetic mean is known as mean deviation or average deviation.

The measure of central tendency is such a point on the scale of measurement on both sides of which there are a number of values. So, the deviations from this point will be in opposite directions, both positive and negative. If the score is denoted by X. and the mean by M, then X – M denotes the deviation of scores from the mean. The deviation, where mean is greater than the score, will be negative. By definition of the mean, as measure of central tendency, the algebraic sum of all these deviations will come out to be zero, as the deviations on both the sides are equal. To avoid this problem, the absolute values of these deviations, i.e. /X –M / irrespective of their sign is taken into consideration. Thus,

$$\text{Mean Deviation} = \frac{\sum / X - M /}{N}$$

Where X is the score, M is the mean and N is the total frequency.

Interpretation of mean deviation

First of all, we should know when and where to use Mean Deviation as a measure of dispersion. Mean Deviation is the simplest measure of dispersion that takes into account all the values in a given distribution. It is easily comprehensible even by a person not well versed in statistics, but it has some limitations also. First, as it takes into account the absolute values of deviations, without considering the sign of the deviation, it is unwieldy in mathematical operations. So, it is used only as a descriptive measure of variability. Second, it is influenced by extreme values. But this influence is less than the influence on some other measures of dispersion which also take into consideration all the values.

For interpreting the mean deviation, it is always better to look into it along with the mean and the number of cases. Mean is required because the mean and the mean deviation are respectively the point and the distance on the same scale of measurement. Without mean, the mean deviation cannot be interpreted, as there is no clue for the scale of measurement or the unit of measurement. The number of cases is important because the measure of dispersion depends on it. For less number of cases, the measure is likely to be more.

10.8 NORMAL DISTRIBUTION *1* NORMAL PROBABILITY CURVE

The Concept of Normal Distribution

Carefully look at the following hypothetical frequency distribution, which a teacher has obtained after examining 150 students of class IX on a mathematics achievement test (see Table).

Table : Frequency distribution of the Mathematics achievement test scores.

Class Intervals	Tallies	Frequency
85-89	I	1
80-84	II	2
75-79	IIII	4
70-74	𝍸 II	7
65-69	𝍸 𝍸	10
60-64	𝍸 𝍸 𝍸 I	16
55-59	𝍸 𝍸 𝍸 𝍸	20
50-54	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	30
45-49	𝍸 𝍸 𝍸 𝍸	20
40-44	𝍸 𝍸 𝍸 I	16
35-39	𝍸 𝍸	10
30-34	𝍸 II	7
25-29	IIII	4
20-24	II	2
15-19	I	1
	Total	150

Are you able to find some special trend in the frequencies shown in the column 3 of the above table? Probably Yes! The concentration of maximum frequency (f=30) is at the central value 5 8 of distribution and frequencies gradually taper off symmetrically on both the sides of this value.

If we draw a frequency polygon with the help of the above distribution, we will have a curve as shown in the Fig.

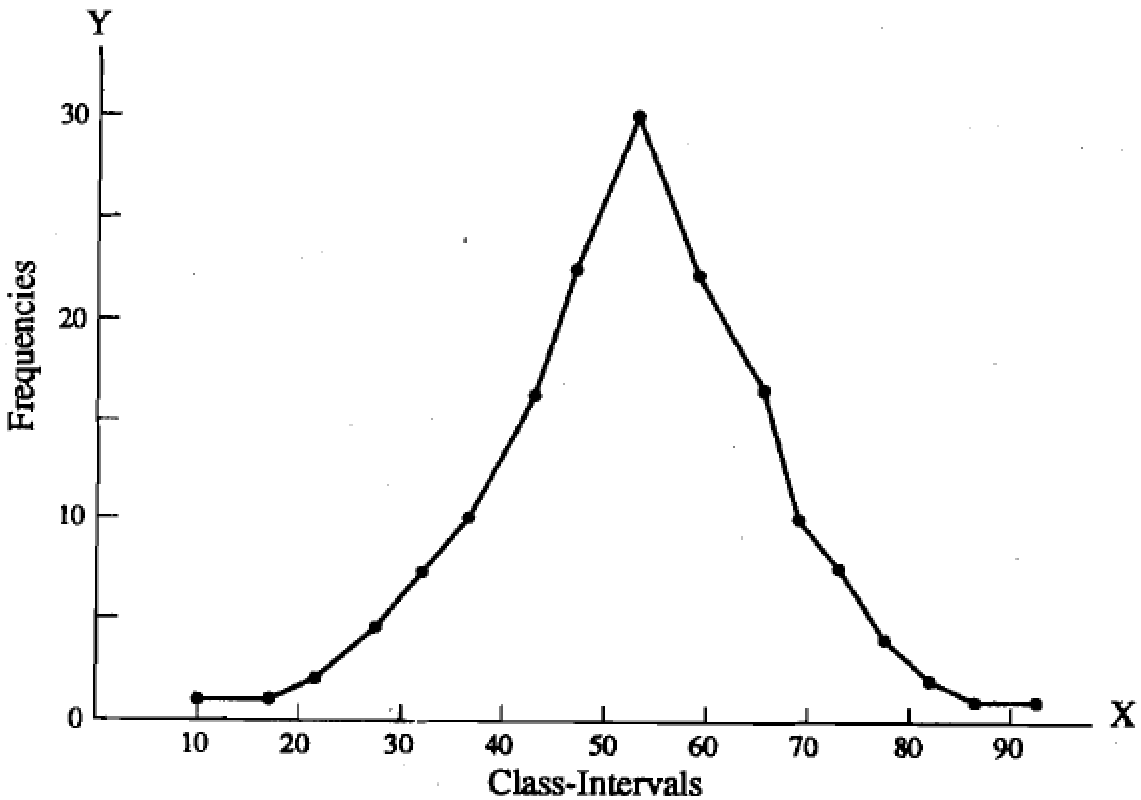


Fig. : Frequency Polygon 7f the data given in Table

The shape of the curve in Fig. is just like a 'Bell' and is symmetrical on both the sides.

If you compute the values of Mean, Medium and Mode, you will find that these three are approximately the same (M = Md = MO = 52).

This 'Bell' shaped curve technically known as Normal Probability Curve or Simply Normal Curve and the corresponding frequency distribution of scores, having equal values of all three measures of central tendency, is known as Normal Distribution.

This normal curve has great significance in mental and. educational measurement. In measurement of behavioral aspects, the normal probability curve has been often used as reference curve.

<u>The Normal Probability Curve: Its Theoretical Base</u>

The normal probability curve is based upon the law of probability (the games of chance) discovered by French Mathematician Abraham Demoivre (1667-1754) in the eighteenth century. He developed its mathematical equation and graphical representation also.

Properties of Normal Probability Curve

The properties of normal probability curve are:

- The Normal Curve is Symmetrical
- The Normal Curve is Unimodal
- The Maximum ordinate occurs at the Centre
- The Normal Curve is Asymptotic to the X-axis
- The Height of the Curve declines symmetrically
- The Points of Influx occur at Point +- 1 Standard Deviation (-+)
- The Total Percentage of area of the Normal Curve within Two Points of
- Influxation is fixed
- The Total Area under Normal Curve may be also considered 100 percent
- Probability
- The Normal Curve is Bilateral
- The Normal Curve is a Mathematical Model in Behavioral Sciences

Factors Causing Divergence in the Normal Curve/Normal Distribution

The reasons why distributions exhibit skewness and kurtosis are numerous and often complex, but a careful analysis of the data can often throw some light on the asymmetry. Some of the common causes are:

1. Selection of the Sample

Selection of the subjects (individuals) can produce skewness and kurtosis in the distribution. If the sample size is small or sample is biased one, skewness is possible in the distribution of scores obtained on the basis of selected sample or group of individuals.

The scores made by small and homogeneous group are likely to yield narrow and leptokurtic distribution. Scores from small and highly heterogeneous group yield platy kurtic distribution.

2. Unsuitable or Poorly Made Tests

If the Measuring tool of test is inappropriate for the group on which it has been administered, or poortly made, the asymmetry is likely to occur in the distribution of scores. If a test is too easy, scores will pile up at the high end of the scale, whereas when the test is too difficult, scores will pile up at the low end of the scale.

3. The Trait being Measured is Non-Normal

Skewness or Kurtosis will appear when there is a real lack of normality in the trait being measured. E.g. interests or attitudes.

4. Errors in the Construction and Administration of Tests

A poorly constructed test may cause asymmetry in the distribution of the scores. Similarly, while administrating the test, unclear instructions, error in timings, errors in the scoring practice and lack of motivation to complete the test may cause skewness in the distribution.

Interpretation of Normal Curve/Normal Distribution

Normal Curve has great significance in the mental measurement and educational evaluation. It gives important information about the trait being measured.

If the frequency polygon of observations or measurements of a certain trait is a normal curve, it indicates that:

- the measured trait is normally distributed in the Universe
- most of the cases are average in the measured trait and their percentage in the
- total population is about 68.26%
- approximately 15.87% of (50-34.13%) cases are high In the trait measured
- similarly 15.87% cases approximately are low in the trait measured
- the test which is used to measure the trait is good

- the test has good discrimination power as it differentiates between poor, average
- and high ability group individuals, and
- the items of the test used are fairly distributed in term of difficulty level.

Importance of Normal Distribution

The Normal Distribution is by far the most used distribution for drawing inferences from statistical data because of the following reasons:

- Number of evidences are accumulated to show that normal distribution provides a good fit or describe the frequencies of occurrence of many variable 'and facts in (i) biological statistics e.g. sex ratio in births in a country over a number of years, (ii) the anthropometrical data e.g. height, weight, (iii) wages and output of large numbers of workers in the same occupation under comparable conditions, (iv) psychological measurements e.g. intelligence, reaction time, adjustment, anxiety and (v) errors of observations in Physics, Chemistry and other Physical Sciences.
- The Normal Distribution is of great value in educational evaluation and educational research, when we make use of mental measurement. It may be noted that normal distribution is not an actual distribution of scores on any test of ability or academic achievement, but is instead, a mathematical model. The distribution of test scores approach the theoretical normal distribution as a limit, but the fit is rarely ideal and perfect.

Applications/Uses of Normal Curve/Normal Distribution

There are number of applications of normal curve in the field of educational measurement and evaluation. These are:

- to determine the percentage of cases (in a normal distribution) within given limits or scores
- to determine the percentage of cases that are above or below a given score or reference point
- to determine the limits of scores which include a given percentage of cases
- to determine the percentile rank of a student in his own group
- to find out the percentile value of a student's percentile rank
- to compare the two distributions in terms of overlapping

- to determine the relative difficulty of test items, and
- dividing a group into sub-groups according to certain ability and assigning the grades.

10.9 THE CONCEPT OF CORRELATION

To illustrate what we mean by a relationship between two variables, let us use the example cited in 16.1 i.e. the scores of 5 students in mathematics and physics. What pattern do you find in the data? You may notice that in general those students who score well in mathematics also get high scores in physics. Those who are average in mathematics get just average scores in physics and those who are poor in mathematics get low scores in physics. In short, in this case there is a tendency for students to score at par on both variables. Performance on the two variables is related; in other words the two variables are related, hence co-vary.

If the change in one variable appears to be accompanied by a change in the other variable, the two variables are said to be co-related and this inter-dependence is called correlation.

CO-EFFICIENT OF CORRELATION

To measure the degree of association or relationship between two variables quantitatively, an index of relationship is used and is termed as co-efficient of correlation.

Co-efficient of correlation is a single number that tells us to what extent the two variables are related and to what extent the variations in one variable changes with the variations in the other.

Symbol of co-efficient of correlation

The co-efficient of correlation is always symbolized either by r or p (Rho). The notion 'r' is known as product moment correlation co-efficient or Karl Pearson's Coefficient of Correlation. The symbol 'P' (Rho) is known as Rank Difference Correlation Coefficient or Spearman's Rank Correlation Coefficient.

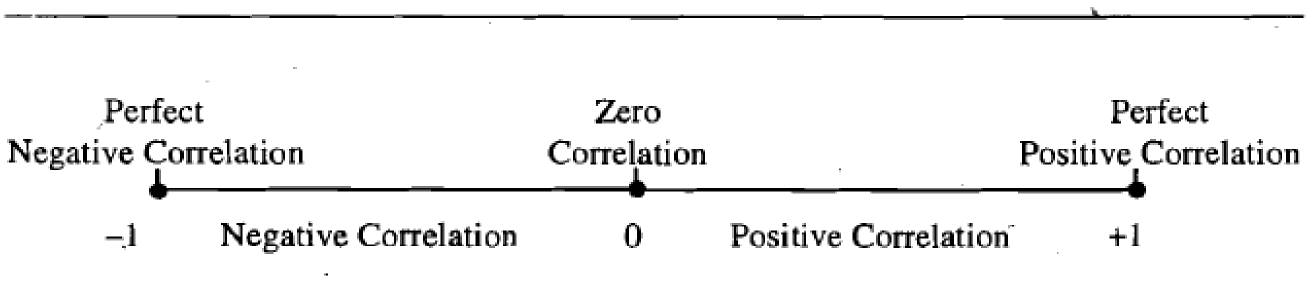
Maximum range of values of co-efficient of correlation

The measurement of correlation between two variables results in a maximum value that ranges from -1 to +I, through zero. The+1 or - 1 values denote **perfect coefficient of correlation.**

Types of correlation

In a bivariate distribution, the correlation may be:

1. Positive, Negative or Zero; and
2. Linear or Curvilinear (Non-Linear)



Methods of computing co-efficient of correlation (ungrouped data)

In case of ungrouped data of bivariate distribution, the following three methods are used to compute the value of co-efficient of correlation.

- Rank Difference Co-efficient of Correlation or Spearman's Rank Order Co-efficient of Correlation.
- Pearson's Product Moment Co-efficient of Correlation.
- Pearson's Product Moment Co-efficient of correlation from Scatter Diagram.

***Rank Difference Co-efficient of Correlation** (p)*

When the observations or measurements of the bivariate variable is based on the ordinal scale in the form of ranks, the rank difference co-efficient of correlation is computed by using the following formula.

$$\rho = 1 - \frac{6\sum D^2}{N(N^2 - 1)}$$

Where: p = The Spearman's Rank Co-efficient of Correlation

D = Difference between paired Ranks

N = Number of subjects or items ranked

Example

In a speech contest Prof. Mehrotra and Prof. Shukla, judged ten pupils. Their judgments were in ranks, which are presented below. Determine the extent to which their judgments were in agreement.

Table

Pupil	Prof. Mehrotra's Ranks (Rl)	Prof. Shukla's Ranks (R2)	Difference D = (R2-R 1)	D^2
A	1	1	0	0
B	3	2	-1	1
C	4	5	+1	1
D	7	9	+2	4
E	6	6	0	0
F	9	8	-1	1
G	8	10	+2	4
H	10	7	-3	9
I	2	4	+2	4
J	5	3	-2	4
N=10			$\sum D=0$	$\sum D^2=28$

$$\rho = 1- \frac{6x\sum D^2}{N(N^2 -1)}$$

$$= 1- \frac{6x28}{10 (10^2 - 1)}$$

$$= 1 - \frac{168}{990}$$

$$= 1 - .17$$

$$\boldsymbol{\rho = +.83}$$

The value of co-efficient of correlation is +.83, This shows a high degree of agreement between the two judges.

<u>Pearson's product - moment coefficient of correlation</u>

The most often used and most precise coefficient of correlation is known as the Pearson's Product - Moment Coefficient. It is computed when data are expressed in interval or ratio form and distribution of X and Y have a linear relationship. Here linear relationship means, if we draw a line graph by taking X variable on X-axis and Y variable on Y axis the obtained graph should be straight line.

The formula used for computing the Pearson's coefficient of correlation 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 = Pearson's Coefficient of Correlation

$\sum \boldsymbol{X}$ = Sum of the Scores of X Variable

$\sum Y$ = Sum of the Scores of Y Variable

$\sum \mathbf{X2}$ = Sum of the Squared X Scores

$\sum Y2$ = Sum of the Squared Y Scores

$\sum XY$ = Sum of the Product of Paired X and Y Scores

N = Number of Paired Scores

Example

The scores given below were obtained on an Intelligence Test and Algebra Test by 10 students of class VIII. Compute Pearson's Coefficient of Correlation.

Table

Students	Scores on Intelligence Test X	Scores on Algebra Test Y	X^2	Y^2	XY
1	24	13	576	169	312
2	20	9	400	81	180
3	18	12	324	144	216
4	17	20	289	400	340
5	15	11	225	121	165
6	12	16	144	256	192
7	10	5	100	25	50
8	8	2	64	4	16
9	6	7	36	49	42
10	4	1	16	1	4
N = 10	$\Sigma X = 134$	$\Sigma Y = 96$	$\Sigma X^2 = 2174$	$\Sigma Y^2 = 1250$	$\Sigma XY = 1517$

$$r = \frac{10(1517)-(134)\times(96)}{\sqrt{\{10(2174)-(134)^2\}\{10(1250)-(96)^2\}}}$$

$$= \frac{2306}{\sqrt{(3784)(3284)}}$$

$$= \frac{2306}{3525.5}$$

$$= +0.65$$

The steps in computing 'r' from ungiouped scores may be outlined thus:

Step 1 : Find the sum of the scores of X and Y variable.

Step 2 : Square each score of X variable and find their sum i.e. **Cx2** (Col. 4)

Step 3 : Square each score of Y variable and find their sum i.e. **Cy2** (Col. 5)

Step 4 : Multiply the X scores and Y scores in the same rows, and enter these products in the column XY, i.e. Col. 6; and get the sum of XY i.e. **(ZXY)**

Step 5 : Put all the values of N, **CX, CY, Cx2, Cy2** and **ZXY** in the formula, and simplify.

Interpretation of the co-efficient of correlation

Merely computation of correlation does not have any significance until and unless we determine how large must the coefficient be in order to be significant, and what does correlation tell us about the data? What do we mean by the obtained value of coefficient of correlation?

To have an answer, generally, the coefficient of correlation is interpreted in verbal description. The rule of thumb for interpreting the size of a correlation coefficient is presented below:-

Size of Correlation	**Interpretation**
±1	Perfect Positive/negative Correlation
±90 to ±99	Very High Positive/Negative Correlation
±70 to ±90	High Positive/Negative Correlation
±50 to ±70	Moderate Positive/Negative Correlation
±30 to ±50	Low Positive/Negative Correlation
±10 to ±30	Very low Positive/Negative Correlation
±00 to ±10	Markedly Low and Negligible Positive/Negative Correlation

Factors influencing the size of the correlation coefficient

Learners should so be aware of the following factors which influence the size of the coefficient of correlation and can lead to misinterpretation:

- ❖ The size of "r" is very much dependent upon the variability of measured values in the correlated sample. The greater the variability, the higher will be the correlation, everything else being equal.

- The size of "r" is altered, when an investigator selects an extreme group of subjects in order to compare these groups with respect to certain behavior. "r" obtained from the combined data of extreme groups would be larger than the "r" obtained from a random sample of the same group.
- Addition or dropping the extreme cases from the group can lead to change on the size of "r". Addition of the extreme case may increase the size of correlation, while dropping the extreme cases will lower the value of "r".

Importance and use of correlation in educational measurement and evaluation

Correlation is one of the most widely used analytic procedures in the field of Educational Measurement and Evaluation. It not only describes the relationship of paired variables, but it is also useful in:

- Prediction of one variable - the dependent variable on the basis of the other variable the independent variable.
- Determining the reliability and validity of the test or the question paper.
- determining the role of various correlates to a certain ability.
- factor analysis technique for determining the factor loadings of the underlying variables in human abilities.

10.10 GRAPHICAL REPRESENTATION OF DATA

The data which has been shown in the tabular form may be displayed in pictorial form by using a graph. A well-constructed graphical presentation is the easiest way to depict a given set of data.

Types of graphical representation of data

Here only a few of the standard graphic forms of representing the data are being discussed as listed below:

- Histogram
- Bar Diagram or Bar Graph
- Frequency Polygon

- Cumulative Frequency Curve or Ogive

Histogram

The most common form of graphical presentation of data is histogram. For plotting a histogram, one has to take a graph paper. The values of the variable are taken on the horizontal axis/scale known as X-axis and the frequencies are taken on the vertical axis/scale known as Y-axis. For each class interval a rectangle is drawn with the base equal to the length of the class interval and height according to the frequency of the C.I. When C.I. are of equal length, which would generally be the case in the type of data you are likely to handle in school situations, the heights of rectangles must be proportional to the frequencies of the Class Intervals. When the C.I. are not of equal length, the areas of rectangles must be proportional to the frequencies indicated (most likely you will not face this type of situation). As the C.1.s for any variable are in continuity, the base of the rectangles also extends from one boundary to the other in continuity. These boundaries of the C.1.s are indicated on the horizontal scale. The frequencies for determining the heights of the rectangles are indicated on the vertical scale of the graph.

Let us prepare a histogram for the frequency distribution of mathematics score of 120 Class X students (Table).

For this, on the horizontal axis of the graph one has to mark the boundaries of the class intervals, starting from the lowest, which is 34.5 to 39.5. So the points on X-axis will be 34.5, 39.5, 44.5, 49.5, and 99.5. Now on the vertical axis of the graph, the frequencies from 1 to 14 are to be marked. The height of the graphical presentation is usually taken as 60 to 75% of the width. Here, we take 1 cm on X-axis representing 5 scores and 1 cm on Y-axis representing a frequency of 2. For plotting the first rectangle, the base to be taken is 34.5 -39.5 and the height is 7, for the second the base is 39.5 - 44.5 and the height is 8, and so on.

The histogram will be as shown in Figure.

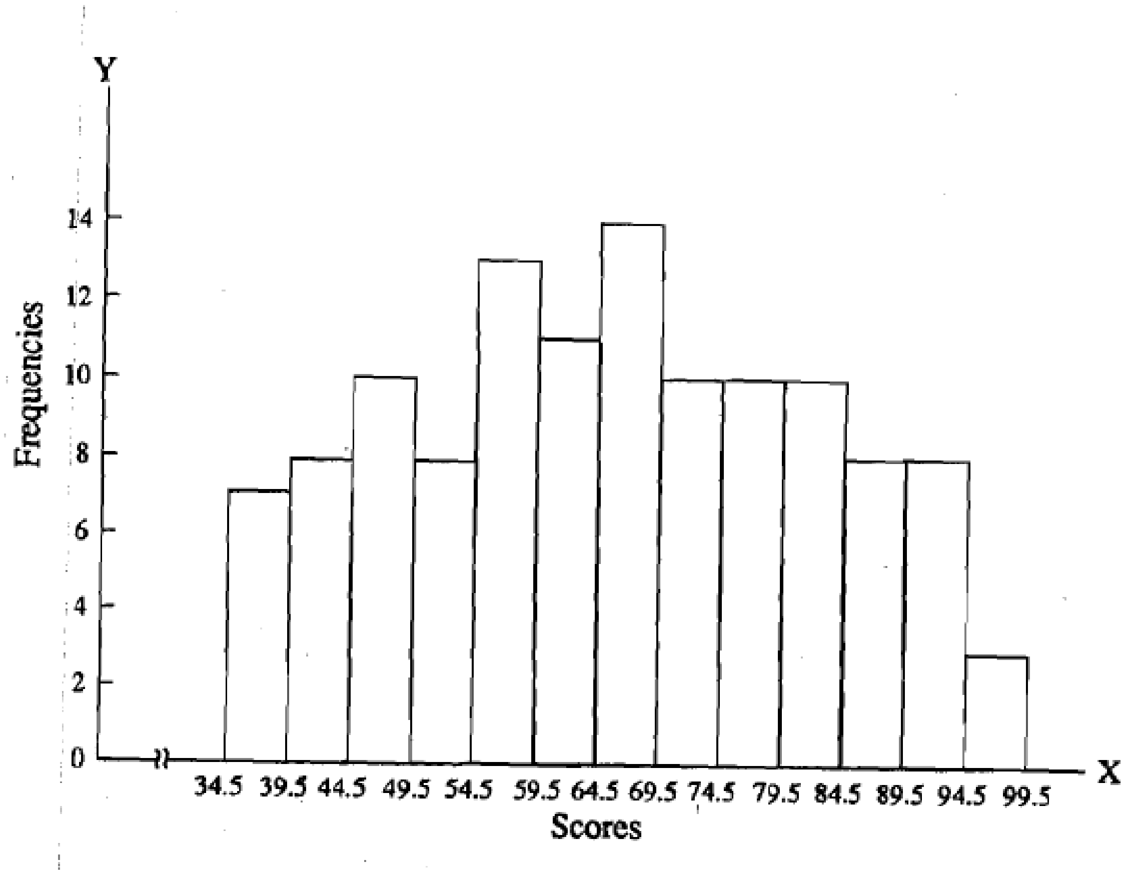


Fig.: Distribution of Mathematics Scores

Let us re-group the data of Table 12.8 by having the length of class intervals as 10, as shown in Table.

Table :Frequency Distribution of Mathematics Scores

Scores	**Frequency**
90 - 99	11
80 - 89	18
70 - 79	20
60 – 69	25
50 – 59	21
40 - 49	18
30 - 39	7
Total	**120**

To plot the histogram, we-mark the boundaries of the class intervals on X-axis. Here the points will be 29.5,39.5,49.5,. . .-. . . . , 99.5. On they-axis, the frequencies to be marked are from 1 to 25. On X-axis, a distance of 1 cm represents a scare of 10, while on Y-axis; 1 cm represents a frequency of 5. The histogram will be as shown in Figure

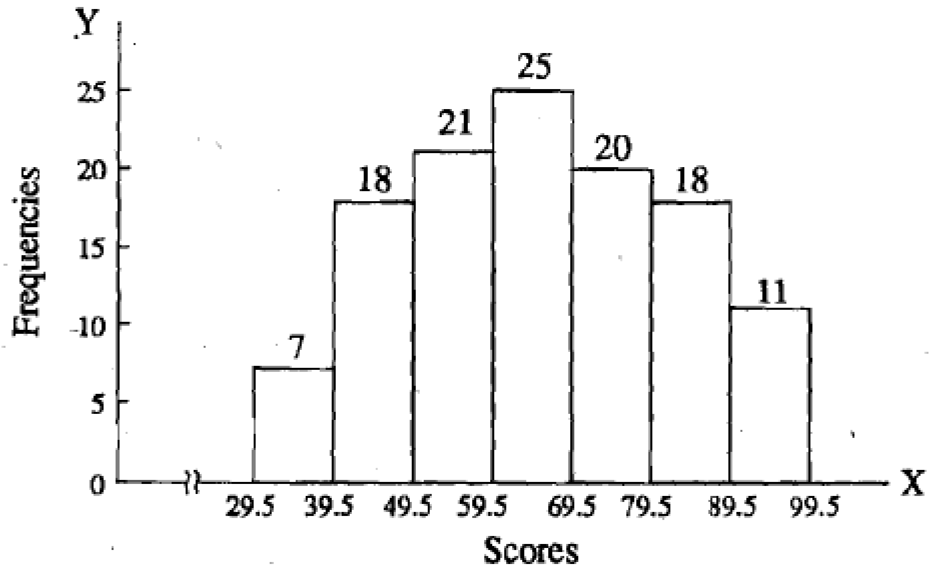


Fig. Distribution of Mathematics Scores

If we observe Figures, we find that second figure is simpler than Figure one. Figure one is complex because the number of class intervals is more. If we further increase the number of class intervals, the figure obtained will be still more complex. So for plotting the histogram for a given data, usually we prefer to have less number of class intervals.

Bar Diagram or Bar Graph

If the variable is discrete, then a histogram cannot be constructed as the classes are not comparable in terms of magnitude. However, a simple graphical presentation, quite similar to histogram, known as bar graph, may be constructed. In a particular town, total number of schools is 24 and the management-wise distribution of schools is as shown earlier in Table

Management	No. of Schools
Government	4
Local Body	8
Private Aided	10

Private Unaided	2
Total	24

The bar graph will be as shown below in Figure.

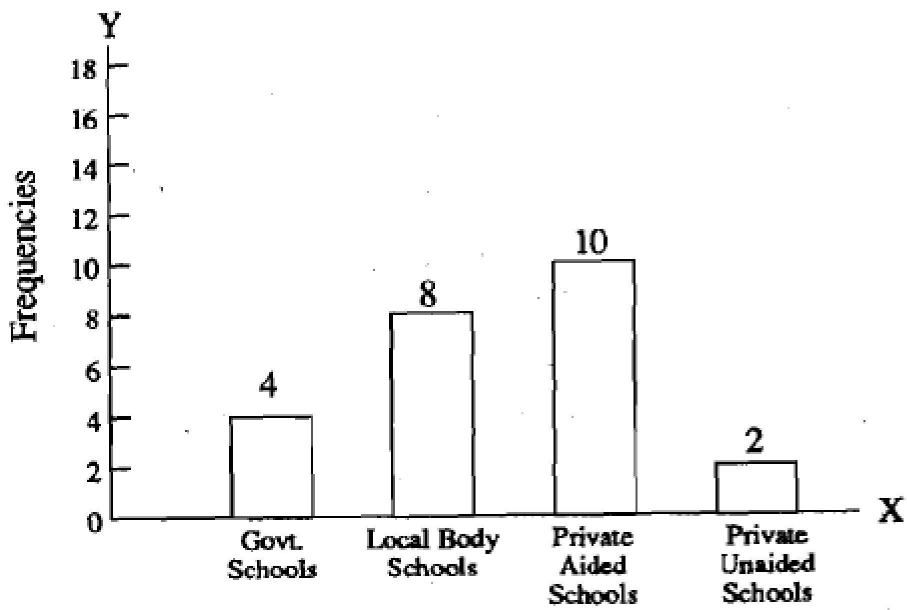


Fig. 12.3: Management-wise distribution of Schools in a Town

For a discrete variable the unit of measure on the horizontal axis is not important. Neither are 1 the classes related to each other. So the bars arc equally spaced and are of equal width on the horizontal axis. However, the height of the bars are proportionate to the respective frequencies. Bar graphs are frequently used for pictorial presentation of discrete data. If two variables are used simultaneously, even then bar graphs may be quite effective. For example, if along with the total number of schools (management-wise) the number of boys' schools, girls' schools and co-ed schools are also to be indicated then this can be done on the same graph paper by using different colours, each indicating the sex-wise category. For each management there will be 4 bars having different colours indicating different categories.

Frequency polygon

For plotting a frequency polygon, as in case of histogram, the values of the variable are taken on the horizontal axis of the graph and the frequencies are taken on the vertical axis of the graph. In the case of a frequency polygon, one has to indicate the mid points of the C.I. on the horizontal axis, instead of indicating the boundaries of the interval, Here the midpoint of the intervals just before the lowest interval and just after the highest interval are also to be indicated. Now by taking the mid points one by one, the points above them are to be plotted corresponding to the frequencies of the intervals. In case of the two additional mid points, the frequency being zero, the points to be plotted are on the X-axis itself. The adjoining points so plotted are to be joined by straight line segments.

Let us again consider the frequency distribution of mathematics scores shown in Table 12.9 and prepare the frequency polygon for the same. The mid points of the C.1.s are respectively 34.5,44.5,54.5, ... 94.5. Two additional mid points required are 24.5 and 104.5. Now on the horizontal axis of the graph locate the points 24.5,34.5,44.5, ...94.5, 104.5 as shown in Figure

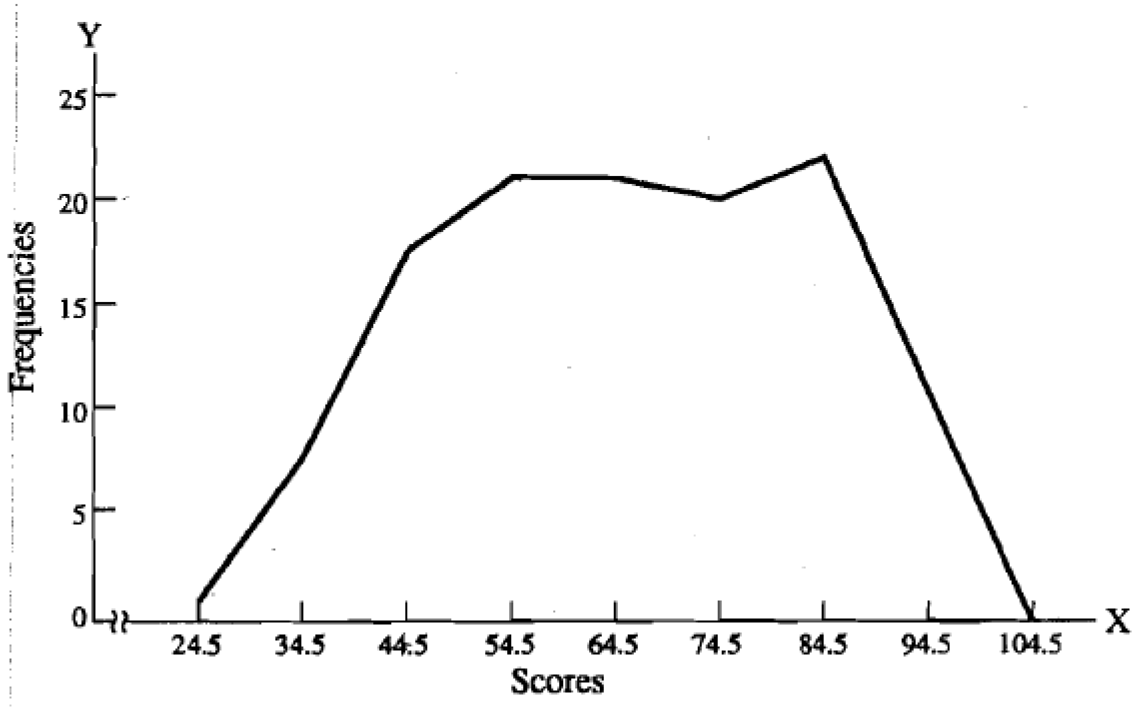


Fig. Frequency Polygon of Mathematics Scores

Take the points above the plotted points by taking the heights as 0,7, 18,21,25,20, 18, 11 and *0* respectively. Join these points in a sequence. The frequency polygon obtained will be as shown in Figure .

The mid points of the tops of the rectangle and extend them to one interval on either end of the figure with zero frequency, the figure so obtained will be the frequency polygon.

The primary purpose of frequency polygon is to show the shape of the distribution. When two or more frequency distributions are to be compared, the relative frequency polygons are constructed against the same set of axes. Any difference in the shape of these distributions becomes visible. Frequency polygon has an advantage over the histogram.

Cumulative frequency curve or ogive

For plotting a cumulative frequency curve or Ogive, first of all cumulative frequencies against each of the intervals are to be written. If we take the frequency distribution of Table

Table : Cumulative Frequency Distribution of Scores

Scores	Frequency	Cumulative Frequency
30-39	**7**	**7**
40-49	**18**	**25**
50-59	**21**	**46**
60-69	**25**	**71**
70-79	**20**	**91**
80-89	**18**	**109**
90-99	**11**	**120**

For getting the cumulative frequencies of a C.I. we take the cumulative frequencies upto the previous interval and add the frequency of that interval into it. Here C.F. indicates that upto **39.5** there are 7 cases, upto **49.5** there are **25** cases, upto **59.5** there are **46** cases, and so on. The difference between the construction of the frequency polygon and ogive is that for frequency polygon, one takes the mid points of the C.I. on horizontal axis, while for ogive one takes the upper boundary of the C.I. on horizontal axis. Again on the vertical axis, in case of Ogive one takes cumulative frequency/cumulative percentage instead of frequency only. The cumulative frequency curve or Ogive for the given data in Table 12.10, will be as shown in Fig.

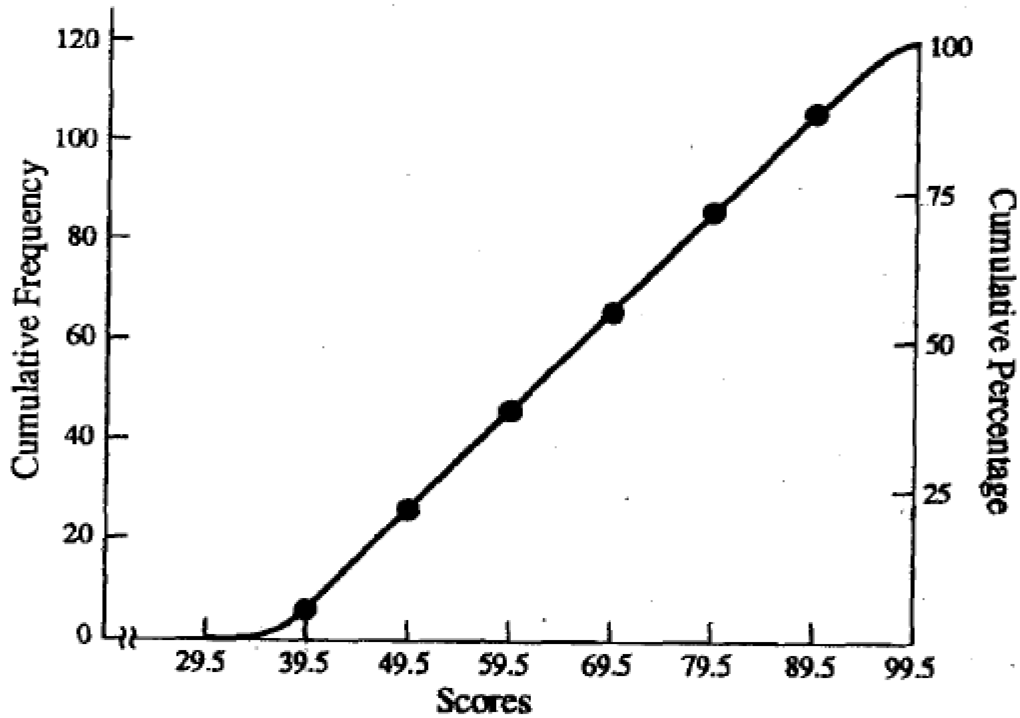


Fig. : Cumulative Frequency Curve or Ogive

In **Fig.,** the curve starts from 29.5 (0 Cumulative Frequency) and moves upto 99.5 **(**120 C.F.). In this case the points have been joined in a sequence with a smoothened curve, instead of straight line segments. From ogive we can easily find out a point on horizontal axis upto which the specified number of cases or the specified percentage of cases will be available. The only difference between the cumulative frequency curve and ogive is that for cumulative frequency curve, on vertical axis, we take cumulative frequencies, while in case of ogive we also have to take cumulative percentages

10.11 EXPLORATION OF SOFTWARE FOR ASSESSMENT OF CCE

CCE - The scientific method tries to determine the strengths and weaknesses of students, improves students acquisition levels, strengthens school teamwork and societal co-operation. Student's interaction and behaviour are well taken care of along with academics. At the core of the new educational vision, the objective of making the learning process joyful for the child is envisaged. When the child takes greater responsibility for his /her own learning and by giving freedom to the learner to experiment and explore, the learning process can be made exciting and meaningful to each learner. Thus learning can be de-stressed by introducing alternatives to homework in smaller classes and by gradual elimination of pass/fail criterion along with the introduction of grades.

10.12 MANAGING STUDENTS DATA IN COMPUTER

Inferences

Generally inference means a conclusion made on the basis of evidence or reasoning where a sin assessment, inference occur when we can see something happening. In contrast, inferences are what we figure out based on an experience. Helping students understand when information is implied, or not directly stated, will improve their skill in drawing conclusions and making inference. These skills will be needed for all sorts of school assignments, including reading, science and social studies. Inferential thinking is a complex skill that will develop over time with experience.

Diagnosis

No one source of data can be sufficient to assess what a pupil knows about school-related content. What is called for is a triangulation of several kinds of data drawn from various types of tests: standardized tests of achievement and aptitude, teacher-made quizzes, observations of behavior, and the like. Diagnosis does not necessarily mean prescription unless the data collected have demonstrated high reliability and validity.

Feedback

Good feedback generally focuses on behavior or the outcomes of behavior rather than on the inherent characteristics of the person concerned. It leaves that person feeling positive and able to move forward. The timing of the feedback is important. It needs to be given as soon as possible after the event. The greater the delay, the less likely it is that the student will find it useful or be able or inclined to act on it.

Feedback also needs to be clear. Handwritten feedback should be legible. The language should be comprehensive to students. You need to take care with style and tone as misunderstanding can easily arise. This partially applies when feedback is written.

Remedial learning alternatives

The test scores will help the students can know their strengths and weakness in respective subjects. It provides feedback to the students. It also provides a basis for checking the adequacy of their own progress in a particular subject, as well as their study habits, interest, home influence etc. Which influence their performance?

Based on the test scores, teachers may infer about the success of instruction process adopted by them. Also they may provide more appropriate instructional guidance for individual students or the class as a whole.

10.13 E-PORTFOLIO ASSESSMENT

Portfolio

It is a form of alternative assessment intended to accumulate evidence to measure growth over time of a student's or teacher's performance. It is a purposeful collection of student work that exhibits student's efforts, progress and achievements in one or more areas. Each portfolio might contain a selection of exemplars of the student's work.

E- Portfolio Assessment

It is the systematic, longitudinal collection of student work created in response to specific, known instructional objectives and evaluated in relation to the same criteria.

Portfolio creation is the responsibility of the learner, with teacher guidance and support and often with the involvement of peers and parents.

Characteristics of E - Portfolio Assessment

- A portfolio is a form of assessment that students do together with their teachers.
- A portfolio is not just a collection of student work but a selection.
- A portfolio provides samples of the student's work which show growth over time.
- The criteria for selecting and assessing the portfolio contents must be clear to the teacher and the students at the beginning of the process.
- The entries in the portfolio can demonstrate learning and growth in all learning competencies.

Strengths of E- Portfolio Assessment

- Measures student's ability over time
- Done by teacher and student: student aware of criteria
- Embedded in instruction
- Involves students in own assessment
- Student learns how to take responsibility

Why Use Portfolio Assessment?

Portfolios provide teachers with a tool for showing what, how, and how well students learn both intended and incidental outcomes. They provide students and teachers with creative, systematic, and visionary ways to learn, assess, and report skills, processes, and knowledge.

Reasons in Using E-Portfolio Assessment

- Portfolio assessment matches assessment to teaching.
- Portfolio assessment has very clear goals.
- Portfolio assessment gives a profile of the learner's abilities.
- Portfolio assessment is a tool for assessing a variety of skills.
- Portfolio assessment develops among students awareness of their own learning.
- Portfolio assessment caters to individuals in the heterogeneous class.
- Portfolio assessment develops social skills.
- Portfolio assessment develops independent and active learners.
- Portfolio assessment can improve motivation for learning and achievement.
- Portfolio assessment is an efficient tool for demonstrating learning.
- Portfolio assessment provides opportunity for teacher-student dialogue.

Advantages of Using E- Portfolio Assessment

- Serves as a cross-section lens, providing a basis for future analysis and planning.
- Serves as a concrete vehicle for communication, providing on-going communication or exchanges of information among those involved in assessment.
- Promotes a shift in ownership; students take an active role in examining what they have done and what they want to accomplish.
- Offers the possibility of assessing the more complex and important aspect of a learning area or subject matter; and
- Covers a broad scope of knowledge and information from many different people involved in the assessment of students' learning and achievement.

Disadvantages of Using E- Portfolio Assessment

- It may be seen as less reliable or fair than more quantitative evaluations.
- Having to develop one's individualized criteria can be difficult or unfamiliar at first.
- It can be very time consuming for teachers to organize and evaluate the content of portfolios.
- Portfolio can be just a miscellaneous collection of artifacts that do not show patterns of growth and achievement.
- Data from portfolio assessments can be difficult to analyze or aggregate to show change.

Essential Elements of a Portfolio

- Cover Letter
- Table of Contents
- Entries
- Dates
- Drafts
- Reflections

Three Basic Models (Grosvenor)

- ➨ Showcase Model
  - ➨ Consists of work samples chosen by the students
- ➨ Descriptive Model
  - ➨ Consists of representative work of the student, with no attempt at evaluation
- ➨ Evaluative Model
  - ➨ Consists of representative products that have been evaluated by criteria

10.14 EVALUATION RUBRIC

Meaning

- A Rubric is an authentic assessment tool used to measure students' work.
- A Rubric is "a scoring tool that lists the criteria for a piece of work". (Goodrich H.)
- A Rubric is a scoring guide used to evaluate a student's performance based on the sum of a full range of criteria rather than a single numerical score.
- A Rubric is a ***formative*** type of assessment because it becomes an ongoing part of the whole teaching and learning process.

Advantages of using rubrics

- Rubrics improve student performance by clearly showing the student how their work will be evaluated and what is expected.
- Rubrics help student become better judges of the quality of their own work.
- Rubrics promote student awareness about the criteria to use in assessing peer performance.
- Rubrics force the teacher to clarify his/her criteria in specific terms.
- Rubrics provide useful feedback to the teacher regarding the effectiveness of the instruction.
- Rubrics reduce the amount of time teachers spend evaluating student work.
- Rubrics allow assessment to be more objective and consistent.

Example: 1

The example in table lists the criteria and gradations of quality for verbal, written, or graphic reports on students inventions-for instance, inventions designed to ease the westward journey for 19^{th} century pioneers for instance, or to solve a local environmental problem, or to represent an imaginary culture and its inhabitants, or anything else students might invent.

This rubric lists the criteria in the column on the left,

The report must explain,

1. The purposes of the invention.
2. The features or parts of the invention and how they help it serve its purposes.
3. The pros and cons of the design.
4. How the design connects to other things past, present and future.

The rubric could easily include criteria related to presentation style and effectiveness, the mechanics of written pieces, and the quality of the invention itself.

The four columns to the right of the criteria describe varying degrees of quality, from excellent to poor. As concisely as possible, these columns explain what makes a good piece of work good and a bad one bad.

S.No	Criteria	Quality			
1.	Purposes	The report explains the key purposes of the invention and points out less obvious ones as well.	The report explains all of the key purposes of the invention.	The report explains some of the purposes of the invention but misses key purposes.	The report does not refer to the purposes of the invention.
2.	Features	The report details both	The report details the	The report neglects	The report does not

		key and hidden features of the invention and explains how they serve several purposes.	key features of the invention and explains the purposes they serve.	some features of the invention or the purposes they serve.	detail the features of the invention or the purposes they serve.
3.	Critique	The report discusses the strengths and weaknesses of the invention, and suggests way in which it can be improved.	The report discusses the strengths and weaknesses of the invention.	The report discusses either the strengths or weaknesses of the invention but not both.	The report does not mention the strengths or the weaknesses of the invention.
4.	Connections	The report makes appropriate connections between the purposes and features of the invention and many different kinds of phenomena.	The report makes appropriate connections between the purposes and features of the invention and one or two phenomena.	The report makes unclear or inappropriate connections between the invention and other phenomena.	The report makes no connections between the invention and other things.

Example 2: Book Talk Rubric

S.No.	Criterion	Quality		
1.	Did I get my audience's attention?	Creative beginning	Boring beginning	No beginning
2.	Did I tell what kind of book?	Tells exactly what type of book it is	Not sure, not clear	Didn't mention it
3.	Did I tell something about the main character?	Included facts about character	Slid over character	Did not tell anything about main character
4.	Did I mention the setting?	Tells when and where story takes place	Not sure, not clear	Didn't mention setting
5.	Did I tell one interesting part?	Made it sound interesting – I want to buy it!	Told part and skipped on to something else	Forgot to do it
6.	Did I tell who might like this book?	Did tell	Skipped over it	Forgot to tell
7.	How did I look?	Hair combed, neat, clean clothes , smiled, looked up, happy	Lazy look	Jest-got-out-of-bed look, head down
8.	How did I sound?	Clear, strong. Cheerful voice	No expression in voice	Difficult to understand-6-inch voice or screeching