# Department of Distance Education

# Punjabi University, Patiala

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***Lesson No.***



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**Lesson No. 2.1** **Author: Dr. Meena Thakur**

# STATISTICAL TOOLS AND TECHNIQUES, FREQUENCY DISTRIBUTION PERCENTAGE AND PERCENTILE RANK



## 2.1.1 Introduction

In the field of education and psychology it is very important that the students pursing these fields must know certain basic skills related to research. So for developing such skills regarding planning or conducting research, the knowledge about quantitative research analysis of data, interpretation of results etc. is very important. For this a basic Knowledge of statistics is very important. In this chapter we will discuss the counting and tabulation of data, how to find frequency, percentage and calculation of percentile rank.

## 2.1.2 OBJECTIVES

- Develop the skills to understand tabulated data.
- Explain the meaning of percentage and to use it in research work.
- Compute percentile rank.

## 2.1.3 PERCENTAGE

**Per cent** is derived from the **LATIN** word **per centum** meaning per hundred and it is denoted by the symbol % and means hundredths. So, 1% means one out of hundred or 1/100. It is a part of a whole. In mathematics and statistics, percentage is a number or ratio expressed as a fraction of hundred. Percentages are frequently used and applied in research works. It helps to compare different sample sizes, to find the amount of change over time and to express increase or decrease in any quantity with respect to initial size

Example 1: Express 1/4 as per cent
Solution: To convert 1/4 as per cent, multiply the fraction by 100%
That is, 1/4 = 1/4 x 100= 25%
In general, to convert fraction p/q to percentage, multiply p/q by 100 & write the answer using symbol %. In order to convert per cent to fraction, write p% as p/100 and reduce it to its simplest form.
Example 2: Ramesh got 20% of his answers correct in a test for 50 marks. What was his scores out of 50?
Solution: Ramesh scored 20% of 50. In order to find 20% of 50, you need to convert the per cent into a fraction and then multiply with the given number.
That is, 20/100 x 50= 10
Therefore, Ramesh scored 10 out of 50.
Hence, percentages are related to fractions and decimals and express values in common currency of parts per hundred. They are useful in statiscs and research works

**2.1.4 PERCENTILE RANK**

In a frequency distribution percentile rank is that score below which a certain percentage of scores fall. It is a rank or a graded position of a given score on a scale of 100 among all the score of a sample. The major disadvantage of PR is that it has universal meaning. A percentile rank of 90 is high in a distribution whereas 30 is low. The major difficulty with this scale is as with other ordinal statistics. Percentile ranks cannot be added, subtracted, multiplied or divided.
Computation of PR can be calculated from:

a) Frequency Distribution
b) Ranked Data

**a) Computation of Percentile Rank in a frequency distribution of score obtained 200 students is an arithmetic reasoning test**

The PR of a given score belonging to a grouped data or a frequency distribution is computed by applying the formula:

$$PR = \frac{100}{N}\left[F + \left(\frac{x\text{-}l}{i}\right)f\right]$$

Where
PR = Percentile rank for the given score x
F = Cumulative frequency just below the interval containing score x
X = Score for which PR is wanted
l = Exact lower limit of the interval containing X
i = Size of class interval
f = Frequency of the interval contain x
N = Total number of cases in frequency distribution.
Let us compute

PRs of 22, 38, 58 from the following data:

| Score | F | Cum. F |
|---|---|---|
| 55-59 | 2 | 200 |
| 50-59 | 25 | 198 |
| 45-49 | 48 | 173 |
| 35-39 | 19 | 78 |
| 30-34 | 26 | 59 |
| 25-29 | 15 | 33 |
| 20-24 | 9 | 18 |
| 15-19 | 7 | 9 |
| 10-14 | 2 | 2 |
| i=4 | N=200 | |

$$X = 22,\ PR = \frac{100}{200}\left[9 + \left(\frac{22\text{-}19.5}{5}\right)x9\right]$$

$$= 6.75$$

$$X = 38,\ PR = \frac{100}{200}\left[59 + \left(\frac{38\text{-}34.5}{5}\right)x19\right]$$

$$= 36.15$$

$$X = 58,\ PR = \frac{100}{200}\left[198 + \left(\frac{58\text{-}54.5}{5}\right)x2\right]$$

$$= 99.7$$

**b) Computing Percentile Ranks from ranked group.**

Suppose in given frequency distribution the percentile rank for a score of 60 is 70. This means 70 percent of scores in the distribution fall below 60. The median frequency distribution is the 50th percentile rank below which 50 percent of the scores fall. The formula for the percentile rank is

$$100 - \left(\frac{100RK - 50}{N}\right)$$

PR = Percentile Rank
RK = Rank of the score from the top
N = Total number of cases

Example: Find percentile rank of a student whose rank in 140 student is 40th from the top

Solution:

$$PR = 100 - \left(\frac{100(40) - 50}{140}\right)$$

$$= 71.79$$

This means in the distribution 71.79 percent of the students have scores below him.

### 2.1.4.1 Use of Percentile and Percentile Rank

**Percentile and Percentile ranks are important. The uses are as follows:**

1) Percentile and percentile ranks are used in behavioral and social sciences.
2) It is used to indicate the relative position of an individual with respect to some attributes in his/her own group.
3) It is used for comparing the performance of two or more individuals belonging to two or more sections.
4) It helps to prepare the percentile norms for various standardized tests, inventories scales.
5) It also helps in useful interpretations and classifications.
6) Important for making decision about child's
7) Understanding scores cam help to gain a clear picture of child's abilitiies and help in spotting areas where he may need extra assistance.

### 2.1.5. Frequency Distribution:

Frequency refers to the number of cases or scores that are there in certain size or category or class interval. Distribution means a set of scores or measures. The manner in which the class frequencies are distributed over the class interval is called Frequency Distribution. There is no definite rate for forming class-intervals. The length of the class-interval may be 2, 3, 4, 10 or 12.1. Whatever the length, all class-intervals in a certain distribution table should be of equal length, i.e. include the same range of possible scores.

For purposes of illustration, scores of an intelligence test are reproduced here.

78, 79, 87, 85, 89, 118, 114, 103, 108, 104,
106, 102, 99, 97, 114, 115, 78, 72, 88, 60,
90, 92, 104, 102, 96, 98, 105, 75, 76, 89
76, 92, 88, 87, 130, 121, 102, 98, 95, 89
01, 100, 67, 75, 84, 112, 81, 114, 109, 87,

### 2.1.5.1. Steps in the Grouping of Data:

**1. Finding the range**: The first thing to be done is to find out the range of distribution of scores. The lowest score and the highest score signify the range of the distribution. Here in the case of above mentioned

Intelligence Test the lowest score is 60 and the highest score is 130. So the range of distribution is 60-130 (70).

**2. Determining the length of class-interval**: After finding out the range the next step is to determine the length of the step-interval or class interval. That will depend on the number of groups into which we wish to divide the whole data. The length of class-interval may vary from situation to situation and its length is determined according to our convenience. But the guiding principle is that the class-interval should be so fixed that it yields not less than 10 groups and not more than 20 groups. Less than 10 groups will make the task difficult and calculations un-necessarily lengthy. In the case of above listed distribution 5 as well as 6 are suitable class-inteval. But class interval of 5 should be preferred because the mid points so yielded will be in whole numbers. An even class-interval yields mid points in decimal fractions.

**3. Writing the steps**: After deciding the class-interval all the steps of the distribution are written down.

**4. Tally Marks**: The scores given in the data are taken one by one and are allotted plaes in the respective group to which they belong. This is done by 'Tally' marks. The tally marks are then counted and converted into figures which are noted against each step interval. These counted numbers are called the frequencies of that class.

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

The scores of the Intelligence Test as listed above are given below:

| Class-Interval | Tallies | Frequencies (f) |
|---|---|---|
| 60-64 | I | 1 |
| 65-69 | I | 1 |
| 70-74 | I | 1 |
| 75-79 | IIII̸ II | 7 |
| 80-84 | II | 2 |
| 85-89 | IIII̸ I | 6 |
| 90-94 | III | 3 |
| 95-99 | IIII̸ IIII̸ | 10 |
| 100-104 | IIII̸ II | 7 |
| 105-109 | IIII | 4 |
| 110-114 | IIII | 4 |
| 115-119 | II | 2 |
| 120-124 | I | 1 |
| 125-129 | | 0 |

| | | |
|---|---|---|
| 130-134 | I | 1 |
| | | N=50 |

N stands for total number of scores in the data.

**3. Graphic representation of ungrouped data**: For the data which is not grouped into a frequency distribution we (i) Bar Graphs, (ii) Line Graphs, (iii) Picto-Graphs, (iv) Circle gram or Pie-Diagram.

**4. Graphic representation of grouped data (frequency distribution)**: Through graphic representation we are able to present briefly all the numerical data and are able to draw the conclusions. The following principles of graphical representation of data shoule be served:

**(i) Taking point of origin**: In drawing ordinary mathematical scores on a graph paper we take two lines on it, one horizontal and an other vertical, cutting each other at a point at right angles. The horizontal line is known as abscissa or x-axis and the vertical line as ordinate y-axis. The point at which they cut each other is known as origin. In other words, the intersecting point of x-axis and the y-axis (the vertical line and the horizontal line of the graph) is taken as the point of origin its value is zero for values plotted on either line.

**(ii) Marking of class-intervals and frequencies**: The scores or the points of class-intervals are marked off at regular intervals along the axis and the frequencies are marked off along the y-axis. The middle point of each class-interval represents the class-intervals.

**(iii) Joining the points**: After plotting all the points, they are joined together with a running line. In order to give the curve the shape of frequency distribution the lowest and the highest points on the x-axis are also joined.

**(iv) Selecting appropriate units**: Another important principle of graphical representation of data is that of selecting the appropriate units of representation along the x-axis and y-axis. If the x-axis is unduly long it will stretch the polygon and if the y-axis is unduly high it will result in an exaggerated view, Similarly unduly short x-axis crowds the x-axis and short y-axis will give a flattening tendency to the polygon. The general guiding principle in this direction should, therefore, be that the units of x-axis and y-axis be so selected that the height of the resulting polygon is 75% of its width.

### 2.1.6 Suggested Questions:

Q.1 What do you understand by the terms percentage and percentile rank. Discuss the difference between them with an example.

Q.2 Enumerate the utility of percentage and percentile rank in the behavioral sciences.

Q.3 Tabulate the Army Alpha scores made by 50 college students:

185 166 176 145 166 191 177 179 171 174
147 178 176 142 170 158 171 181 180 178
173 148 168 187 181 172 169 165 173 184
175 156 158 187 156 172 193 169 172 188
197 181 151 161 153 172 181 193 188 172

**2.1.7 Suggested Readings:**


1. Garrett H.E- Statistics in psychology and education.
2. Sharma, R.A. - Advanced Statistics in education and psychology.
3. Guilford, J.P- Fundamental Statistics in psychology and education
4. Singh, I. Bhatia, M.K., Kaur R and Kaur, P. (2009) Research methodology and statistics methods, Kalyani publishers Ludhiana.
5. Aggarwal. Y.P. (2012). Statistical methods concepts. Applications and computation. Studying Publishers Pvt. Ltd.
6. Nandra, ID (2016) Assessment for learning Twenty First century Publications, Patiala.

**Lesson No. 2.2** **Author: Dr. Meena Thakur**

## Statistical Tools and Techniques: Graphical percentage of performance.



### 2.2.1 Objectives

After going through this lesson students will be able to:

1. Understand the concept of graphical presentation of performance.
2. Know the significance of graphs in statistics
3. Explain general principles of graphical representation of data
4. Describe various methods used to depict frequency distribution in graphical form.
5. Understand the concepts of histogram, bar diagram, frequency polygon and pie graphs and also justify their, importance in representing distribution of data.
6. Differentiate between various methods used to depict graphical frequency distribution.

### 2.2.2 Introduction

In professional fields like education and psychology etc. for developing skills regarding research, analysis of data and interpretation of results statistics is applied. For a prospective teacher it is inevitable to know the basic statistics as he she has to deal with a large number of student. Statistics is considered as a subject of study that helps in the scientific collection, presentation, analysis and interpretation of numerical facts.

**2.2.3 Graphical Presentation of data:**

One of important and appealing way of presenting statistical result is through diagrams and graphs. It helps readers to understand complex figures by presenting numbers in concise and visual format .Classification and tabulation statistical data reduce the numerical facts to logical arrangement. The graphical method is mainly used to give a simpler, permanent idea and to emphasize the relative aspect of data. Graphical representation is very much desired when fact at one time or over a period of time has to be described. It must not be forgotten that tabulation of statistical data is necessary, graphical representation is not graphical representation of data can not replace tabular form of data but it can supplement the tabular form.

**Significance of Graphs:**

Graphical representation has a number of advantages, some of which are given below:

1. Graphs give a bird's eye view of the entire data, therefore the information presented is easily understood.
2. Graphs are more attractive to the eyes. Figures are dry but diagrams are more impressive and fascinating.
3. The impression created by graphs last must longer than those created by numerical presentation.
4. They facilitate quick and accurate comparison of data.
5. Graphical representation of data converts the complex and huge data into a readily, intelligible form and introduces an element of simplicity in it.

**2.2.3.1 General Principles of Graphical Presentation of Data:**

A graphs is sort of chart through which statistical data are represented in the form of lines or curves drawn across the coordinated points plotted on its surface. There are some algebraic principles which apply to all types of graphic representation of data.

1. In graphs there are two lines called co-ordinate axes.
   a) The vertical line is known as Y-axis or 'ordinate'.
   b) The horizontal line is known as X-axis or 'abscissa'.

These two simple lines are known as co-ordinate axes that are perpendicular to each other. The point of intersection of coordinate axes is called 'origin' or the 'zero point'.p

In the figure (X'OX is the X-axis, Y'OY is the Y-axis and '0' is the origin. Both the negative and positive values can be plotted on the graph. Positive values are shown to the right of '0' on the X-axis. The negative values are shown to left of

'0' on the X-axis and below the '0' on Y-axis. The whole area of the graph is divided into four quadrants: I$^{st}$, II$^{nd}$, III$^{rd}$ and IV$^{th}$.

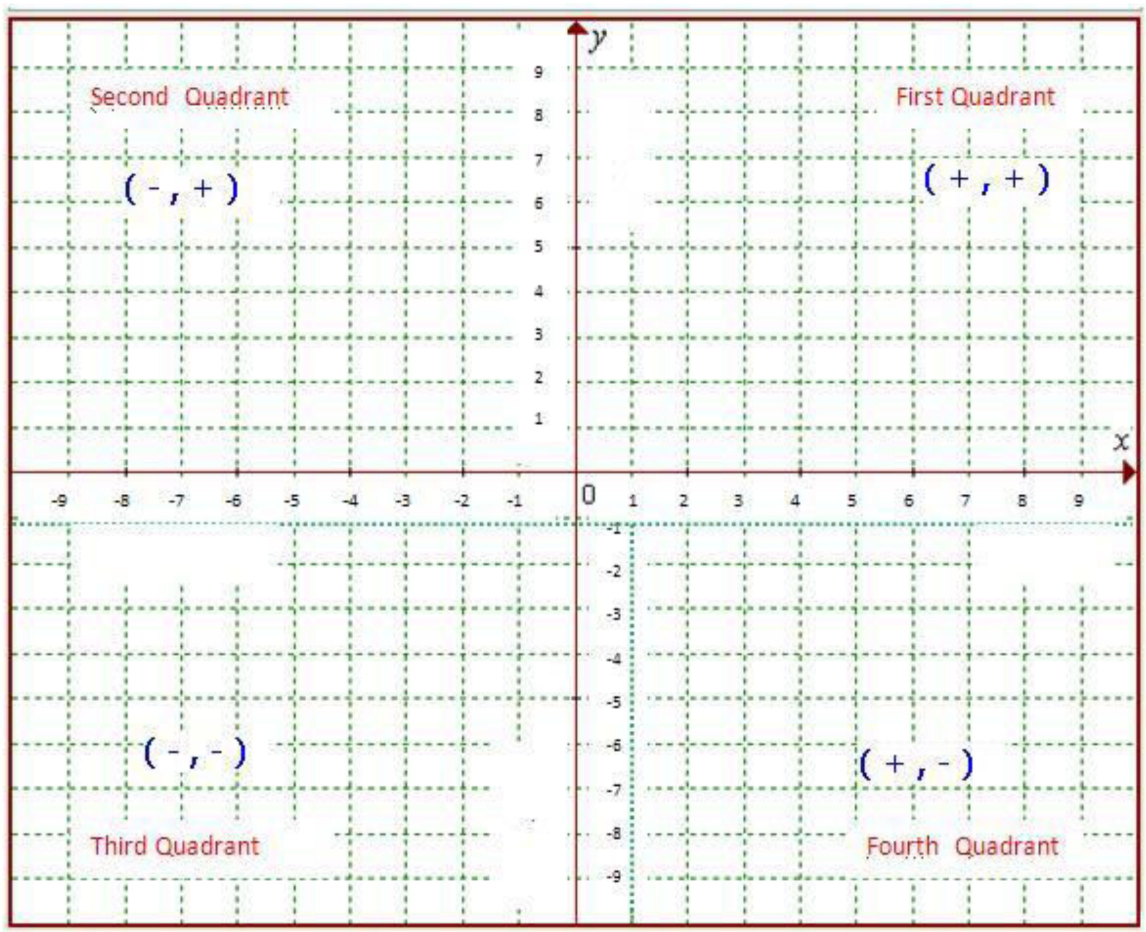



**Figure 2.2.1 Showing Four Quadrants In Graph Paper**

a) In the first quadrant all the values of X and Y are positive.
b) In the second quadrant the value of X is the and Y is negative.
c) In the third quadrant all the values X and Y are negative.
d) In the fourth quadrant the value of X is negative and of Y it is positive.

2. It must not be assumed that scales for both axes will be same. The determination of scale depends upon our own convenience and the type and nature of data.
3. The scale should be selected in such a way that accuracy of data is clearly visible. If scale is very small fluctuations may not be clearly visible. The selection of scales should be in such way that graph is neither too sharp nor too flat.

4. There are two types of variables used in social sciences – dependent variable and independent variable. It is a common practice to show dependent variable on the Y-axis and independent variable on X-axis.
5. The title of the graph should be given.

### 2.2.4 Methods Used to Depict Frequency Distribution in Graphic Form.

The following methods are commonly used to depict frequency distribution in graphic form.

A. Graphs of one variable.
B. Graphs of two or more variable.

#### 2.2.4.1 Graphs of one variable:

When only one variable is to be presented. On the X-axis time is plotted and on the Y-axis various values of variable are taken and points are plotted on the graph which are further joined by a straight line. The fluctuation of this line shows the variations in the variable, and the distance of the plotting from the base time of the graph indicates the magnitude.

**Example: Represent the following data by a suitable graph**

**Table 2.2.1: No. of teachers recruited in government school**

| Year | No. of teachers recruited in government school |
|---|---|
| 2000 | 175 |
| 2001 | 132 |
| 2002 | 165 |
| 2003 | 142 |
| 2004 | 150 |
| 2005 | 177 |

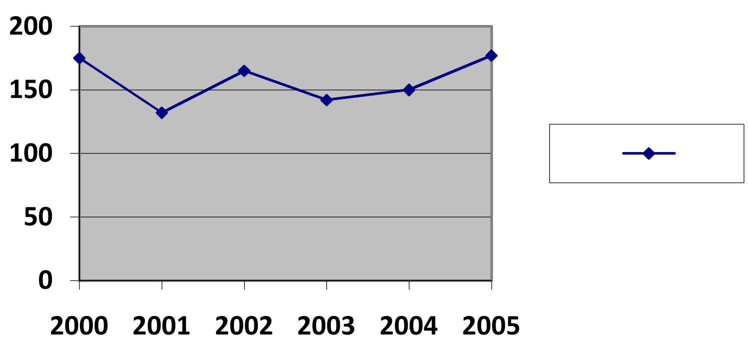



**Figure 2.2.2 Line graph showing number of teachers recruited in government school**

### 2.2.4.2. Graphs of two or more variables:

i). Representation of two or more variable on the same graph, if the unit of measurement is the same can be possible. The make the comparison easy. But if the number of variables is large, they cannot be represented on the same graph as it creates confusion. So graph of more than 5 or 6 variables should not be drawn on the same graph. Researcher can use thick, thin, broken, dotted lines, etc. different colored lines, to distinguish between the various variables.

ii). A frequency distribution can be presented graphically in any of the following way:

a) Histogram
b) Bar diagram/Bar graphs
c) Frequency polygon
d) Smoothed frequency polygon
e) Cumulative frequency graphs
f) Cumulative percentage curve or Ogive
g) Pie graph.

### 2.2.4.2.1 Histogram:

"A histogram is a bar chart or graph showing the frequency of occurrence of each value of the variable being analyzed."- *Opermann*

Histogram is used for graphical representation of frequency distribution. It is a set of vertical bars whose areas are proportional to frequencies represented. The area of the histogram represents the total frequency as distributed through out the class.

**Construction of Histogram**

i). For the case when distribution are with equal class intervals.

**Example: Represent the following data by histogram**

**Table 2.2.2 Marks obtained by students in mathematics achievement test**

| Marks | 0-10 | 10-20 | 20-30 | 30-40 | 40-50 | 50-60 | 60-70 | 70-80 | 80-90 | 90-100 |
|---|---|---|---|---|---|---|---|---|---|---|
| No. of students | 8 | 12 | 22 | 35 | 40 | 60 | 52 | 40 | 30 | 5 |

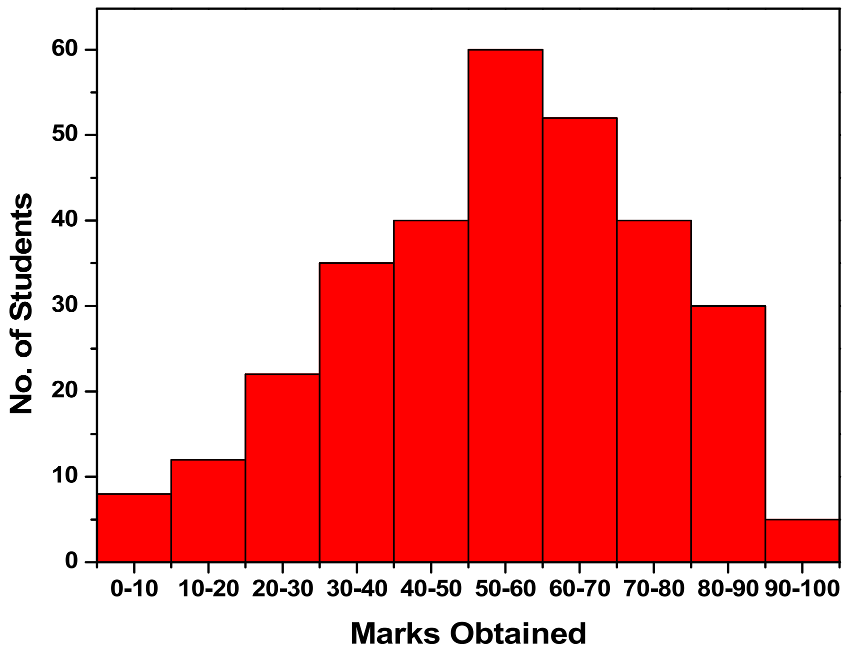



**Figure 2.2.3 Histogram showing marks obtained by students in mathematics achievement test**

ii). For the case when distribution are with unequal class interval.

**Example: Represent the following data by histogram**

**Table: 2.2.3 Scores of 50 Students in achievement test**

| Class Interval | True Class Interval | Interval | Class Frequency | Height of Rectangle |
|---|---|---|---|---|
| 200-204 | 199.5-204.5 | 5 | 0 | 0/1=0 |
| 195-199 | 194.5-199.5 | 5 | 1 | 1/1=1 |
| 185-194 | 184.5-194.5 | 10 | 6 | 6/2=3 |
| 180-184 | 179.5-184.5 | 5 | 5 | 5/1=5 |
| 175-179 | 174.5-179.5 | 5 | 8 | 8/1=8 |
| 170-174 | 169.5-174.5 | 5 | 10 | 10/1=10 |
| 165-169 | 164.5-169.5 | 5 | 6 | 6/1=6 |
| 160-164 | 159.5-164.5 | 5 | 4 | 4/1=6 |
| 150-159 | 149.5-159.5 | 10 | 6 | 6/2=3 |
| 145-149 | 144.5-149.5 | 5 | 3 | 3/1=3 |
| 140-144 | 139.5-144.5 | 5 | 1 | 1/1=1 |
| 135-139 | 134.5-139.5 | 5 | 0 | 0/1=0 |

**N=50**

The unequal class intervals are expresses as multiples of equal class interval size. Thus the size of rectangles of histogram of 4th and 10th class interval is double of the rest of the classes so height of rectangle in these column are divided by 2 and rest are divided by 1 . Histogram will drawn as mentioned in figure 2.1.3 but keeping in mind that the size of 4th and 10th bar to be double.

**2.2.4.2.2 Bar Graph:**

Bar graphs are one dimensional because in such type of presentation only one variable is presented.

The rectangles are group of equidistant rectangles. The discrete series data is presented in bar diagram/graphs.

The gap between one bar and another should be equal. The width of bars should be same. The presentation of bars can be vertical or horizontal.

**Example: Represent the following data by using Bar graph/diagram**

**Table 2.2.4: Birth rate per minute in six different countries.**

| Country | India | Germany | U.K. | Pakistan | Australia | Sri Lanka |
|---|---|---|---|---|---|---|
| Birth Rate | 33 | 16 | 20 | 40 | 30 | 15 |

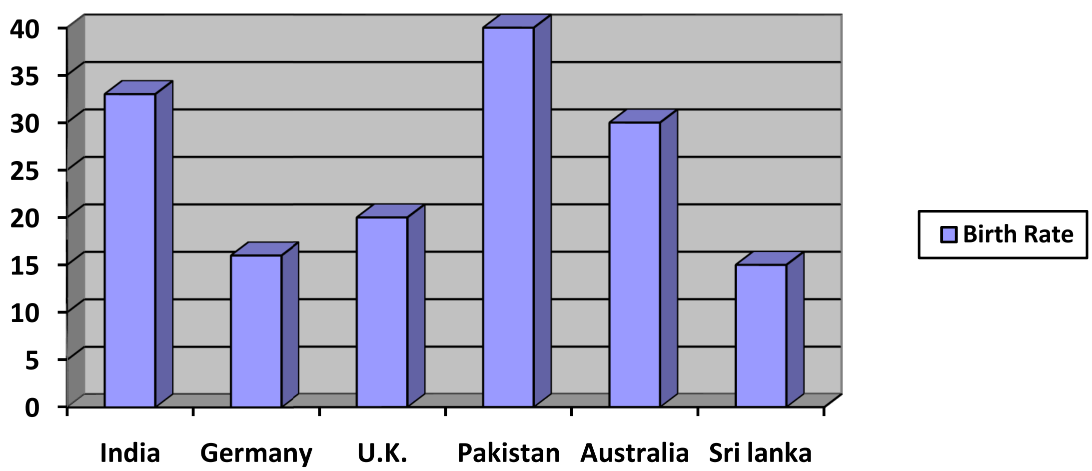



**Figure 2.2.4 Bar Graph Showing Birth Rate per minute in Six Different Countries.**

There are 5 types of bar diagrams/graphs

a) Simple bar diagrams/graphs.
b) Multiple bar diagrams/graphs.
c) Sub-divided bar diagrams/graphs.
d) Percentage bar diagrams/graphs.

e) Deviation bars.

### 2.2.4.2.3 Frequency Polygon:

A polygon is a many angled close figure. The frequency polygon is a graphical representatives of frequency distribution in which the mid points of the class interval are plotted against frequencies. In order to draw frequency polygon find the midpoints of the class interval and mark them on X-axis and mark frequencies of the class interval on Y-axis. Now plot all the point on the graph and join them by a straight line to form a frequency polygon.

**Example: Represent the following data by frequency polygon:**

**Table: 2.2.5 Scores of 50 Students in achievement test**

| Class Interval | Class Frequency | Mid Point |
|---|---|---|
| 200-204 | 0 | 202 |
| 195-199 | 1 | 197 |
| 190-194 | 2 | 192 |
| 185-189 | 4 | 187 |
| 180-184 | 5 | 182 |
| 175-179 | 8 | 177 |
| 170-174 | 10 | 172 |
| 165-169 | 6 | 167 |
| 160-164 | 4 | 162 |
| 155-159 | 4 | 157 |
| 150-154 | 2 | 152 |
| 145-149 | 3 | 147 |
| 140-144 | 1 | 142 |
| 135-139 | 0 | 137 |

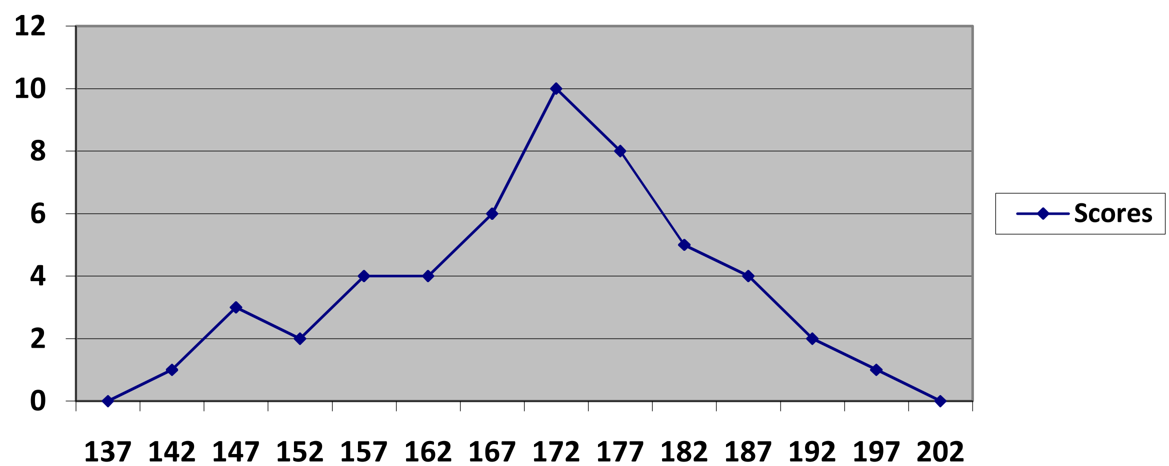



**Figure 2.2.5 Frequency Polygon Showing Scores of 50 Students in Achievement Test**

### 2.2.4.2.4 Smoothed Frequency Polygon:

When the sample is small the frequency distribution is sometimes irregular, in order to make the frequency polygon smoothed, a series of moving averages are taken from which adjusted frequencies are determined. In order to find the "smoothed" f, f of the given interval and f's of interval just below and above the selected interval and divided the result by 3.

**Table: 2.2.6 Scores of 50 Students in achievement test**

| Class Interval | Class Frequency | Smoothed Frequency | Mid Point |
|---|---|---|---|
| **200-204** | **0** | **0+0+1/3=0.33** | **202** |
| **195-199** | **1** | **0+1+2/3=1.00** | **197** |
| **190-194** | **2** | **1+2+4/3=2.33** | **187** |
| **185-189** | **4** | **2+4+5/3=3.67** | **182** |
| **180-184** | **5** | **4+5+8/3=2.1.67** | **177** |
| **175-179** | **8** | **5+8+10/3=7.67** | **172** |
| **170-174** | **10** | **8+10+6/3=8.00** | **167** |
| **165-169** | **6** | **10+6+4/3=6.67** | **162** |
| **160-164** | **4** | **6+4+4/3=4.67** | **152** |
| **155-159** | **4** | **4+4+2/3=3.33** | **147** |
| **150-154** | **2** | **4+2+3/3=3.00** | **142** |
| **145-149** | **3** | **2+3+1/3=2.00** | **137** |
| **140-144** | **1** | **3+1+0/3=1.33** | **142** |
| **135-139** | **0** | **1+0+0/3=0.33** | **137** |
| | N=50 | N=50.00 | |

For example the smoothed frequency for interval 135-139 is $\frac{1+0+0}{3}$ = 0.33; for interval 140-144 is $\frac{3+1+0}{3}$ = 1.33 and so on. Plot the graph like frequency polygon graph which is nearly a continuous flowing curve.

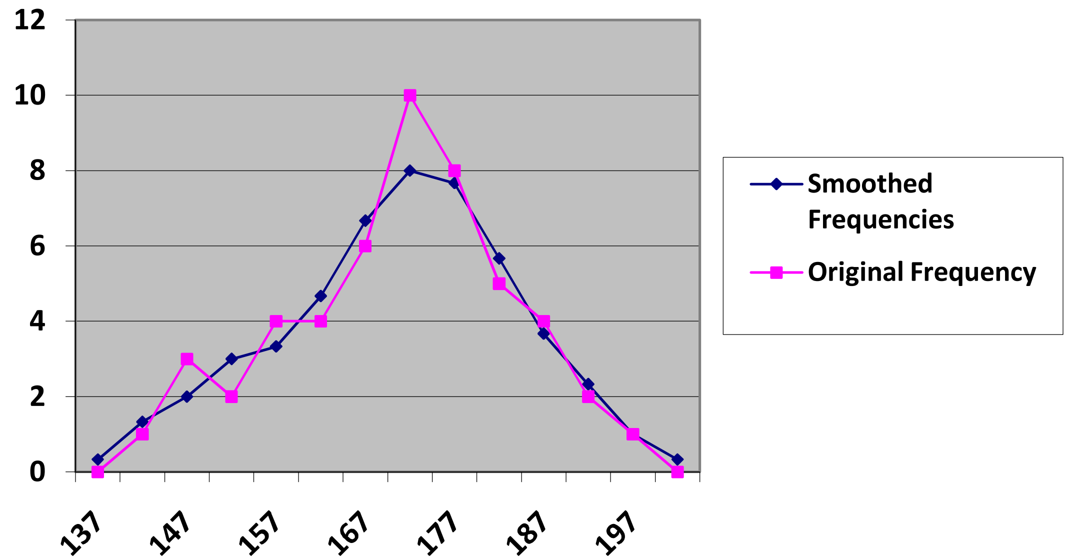



**Figure 2.2.6 Original and Smoothed Frequency Polygons**

### 2.2.4.2.5 Cumulative Frequency Graph:

For plotting the cumulative frequency polygon the frequency are added in progressive from bottom. It is plotted against the exact upper limit of the interval upon which it falls and cumulative frequency.

**Table: 2.2.7 Scores of 50 Students in achievement test**

| Class Interval | Upper Limit | Class Frequency | Cumulative Frequency | Cumulative% Frequency |
|---|---|---|---|---|
| 195-199 | 199.5 | 1 | 50 | 50/50x100=100 |
| 190-194 | 194.5 | 2 | 49 | 49/50x100=98 |
| 185-189 | 189.5 | 4 | 47 | 47/50x100=94 |
| 180-184 | 184.5 | 5 | 43 | 43/50x100=86 |
| 175-179 | 179.5 | 8 | 38 | 38/50x100=76 |
| 170-174 | 174.5 | 10 | 30 | 30/50x100=60 |
| 165-169 | 169.5 | 6 | 20 | 20/50x100=40 |
| 160-164 | 164.5 | 4 | 14 | 14/50x100=28 |
| 155-159 | 159.5 | 4 | 10 | 10/50x100=20 |
| 150-154 | 154.5 | 2 | 6 | 6/50x100=12 |
| 145-149 | 149.5 | 3 | 4 | 4/50x100=8 |
| 140-144 | 144.5 | 1 | 1 | 1/50x100=2 |
| 135-139 | 139.5 | 0 | 0 | 0/50x100=0 |

To calculate cumulative frequency cf1=0;
cf2=cf1+1=1;
cf3= cf2+3=4;
cf4=cf3+2=6;
cf5=cf4+4=10........ and so on cf13=cf12+1=50

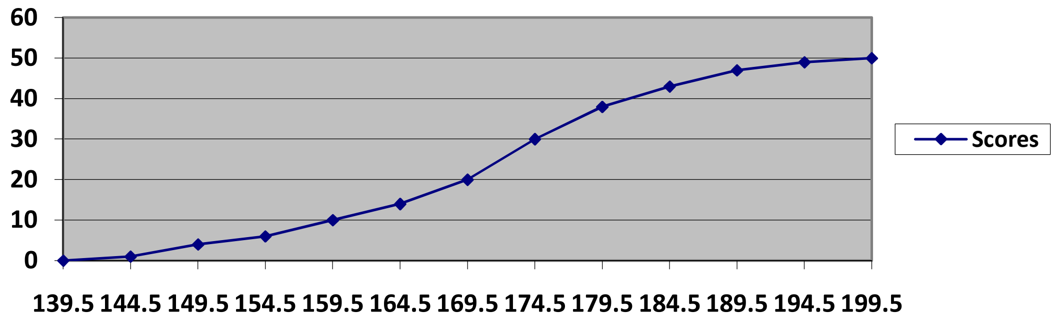



**Figure 2.2.7 Cumulative Frequency curve**

**2.2.4.2.6 Cumulative Percentage Curve or Ogive:** In cumulative percentage curve is plotted between cumulative percentage frequencies and upper limit of class interval from table. Ogive is plotted from above table no. 2.1.7

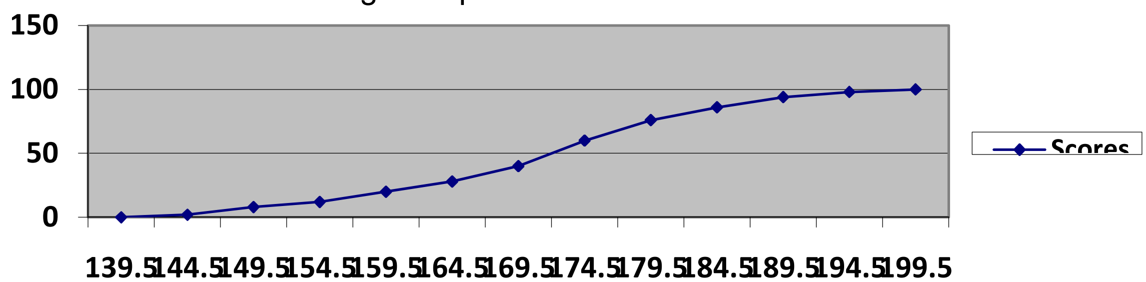



**Figure 2.2.8 Cumulative Percentage curve or Ogive**

**2.2.4.2.7 Pie Diagram**

Pie diagrams are used for presentation of the frequency distribution of attributes or data that is nominal scale. The diagram consists of a circle divided into segments. The entire area of the circle represents the total frequency (n) in the sample. Pie diagram can be used to show distribution of one type of sample.

**Example**

Draw a pie diagram of the following frequency distribution of blood groups in a sample.

| Blood Group | O | A | B | AB | Total |
|---|---|---|---|---|---|
| Frequencies | 258 | 172 | 387 | 43 | 860 |

**Solution**

Calculating $\theta°$

$$\theta° = 360 \ x \ \frac{f}{n}$$

For 'O' group $\theta = 360 \ x \ \frac{258}{860} = 108°$

For 'A' group $\theta = 360 \ x \ \frac{172}{860} = 72°$

For 'B' group $\theta = 360 \ x \ \frac{387}{860} = 162°$

For 'AB' group $\theta = 360 \ x \ \frac{43}{860} = 18°$

Using protractor(D) segments of 108°, 72°, 162° and 18° are drawn and the segments are shaded or colored differently from each other.

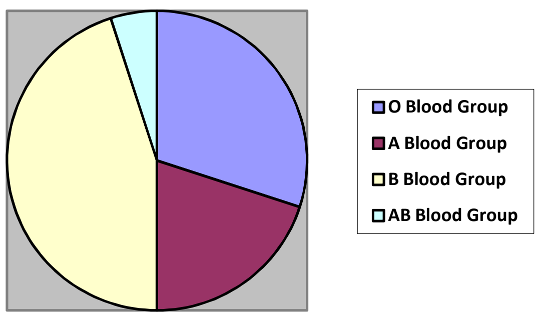



**Figure 2.2.9 Distribution of blood group in a sample of 860 persons**

**2.2.5 Suggested Questions:**

Q.1 How does a Histogram differ from a Frequency Polygon? What is their importance in educational measurement?

Q.2 Draw a Histogram of the following data. Draw its frequency polygon over the histogram.

| Class Interval | Frequency |
|---|---|
| 21-25 | 4 |
| 26-30 | 10 |
| 31-35 | 16 |
| 36-40 | 20 |
| 41-45 | 27 |
| 46-50 | 18 |
| 51-55 | 12 |
| 56-60 | 8 |
| 61-65 | 6 |
| 66-70 | 4 |

Q.3 What is smoothed frequency polygon? Draw a smoothed frequency polygon from the data given in the question number 4.

### 2.2.6 SUGGESTED READING:

Garrett, H.E. (2010): Statistics in Psychology and Education, Vishal Publisher, Chandigarh.

Srivastava, A.B.L. and Sharma, K.K. (1985): Elementary Statistics in Psychology and Education, Sterling Publisher Pvt. Ltd. New Delhi.

Mohanty,B., and Misra, S (2014): Statistics for Behavioural and Social Sciences, Sage Publications Pvt. Ltd, New Delhi.

Singh,I.,Bhatia,M.K.,Kaur,R. and Kaur, P.(2009): Research Methodology and Statistical Methods, Kalyani Publishers, Ludhiana.

**Lesson No. 2.3**

## Educational Statistics: Mean Median and Mode

2.3.1 Mean
    2.3.1.2 Calculations of mean for ungrouped data
2.3.2 Median
2.3.3 Mode
2.3.4 Comparison of Mean, Median and Mode
2.3.5 Summary
2.3.6 Evaluation
2.3.7 Suggested Readings

### 2.3.1 MEAN :

The mean is the average value of the total scores in a distribution. To simplify, the mean is a sum of the separate scores divided by their number. For example, five students of a class have secured 25,10,16,24 and 30 marks respectively in a test. The average score of the class in the test will be

$$\frac{25+10+16+24+30}{5} = 21.8$$

Therefore, we can say that mean is the sum of all scores in a distribution dividied by the number of scores in it.

### 2.3.1.2 Calculation of Mean from Ungrouped Data :

When the number of scores is not too large, we calculate the mean simply by adding the scores and dividing them by the number of scores.

**Example :** Calculate the mean of the following scores :

12, 14, 18, 24, 20, 15, 13, 22, 26, 30

X=12,+14+18+24+20+15+13+22+26+30 = 194

(Here Σ is a Geek letter called (Capital) sigma. It stands for sum (total) of scores and X stands for raw scores. N stands for number of scores in a distribution. Since there are 10 scores in number. The mean of a population is symbolized by μ, number of elements is N but the mean of a sample is denoted by x and number of elements by n.

So, N = 10

$$\text{Mean (M)} = \frac{x}{N} = \frac{194}{10} = 19.4$$

### 2.3.1.3 Calculation of Mean from Grouped Data :

When measures are too many, it is time consuming to add all the scores and then divide the total scores with N to find the mean. A short method is therefore used by grouping the data into a frequency table.

**Example :** Calculate the mean from the following grouped data :

| Class interval | frequency (f) | (x) | fx | |
|---|---|---|---|---|
| 35-39 | 5 | 3 | 15 | |
| 30-34 | 6 | 2 | 12 | |
| 25-29 | 9 | 1 | 9 | 36 |
| 20-24 | 11 | 0 | 0 | |
| 15-19 | 8 | -1 | -8 | |
| 10-14 | 7 | -2 | -14 | -42 |
| 5-9 | 4 | -3 | -12 | |
| 0-4 | 2 | -4 | -8 | |
| | N=52 | | Σfx = -6 | |

$$\bar{x} = A.M. + \frac{\Sigma fx}{n} \times i \qquad AM = \frac{20+24}{2} = 22$$

$$\bar{x} = 220 + \frac{-6}{52} \times 5 = 220 - .57$$

Mean = 21.43

Where AM stands for assumed mean which is the mid value of the class interval having the maximum frequency.

Σ = sum
f = frequency
x = deviation
N = number of frequencies
i = class interval

### 2.3.1.4 Steps to Calculate Mean :

1. Prepare a frequency table if data are not given in the tabular form and calculate the frequencies. Make sure that lower scores are at the bottom.
2. Calculate the assumed mean by taking the middle point of the class-interval having the highest frequency. In this example, A.M. of ci 20-24 is 22.0

3. In the third column, the deviations from the assumed mean are to be entered.

   Against ci 20-24 the deviation will be Zero because A.M. = 22.0 and 22.0 does not deviate from 22.0. Therefore, write 0 against the interval. As we move towards the class intervals of increasing scores the deviations from the true mean are 5.0, 10.0, 15.0 and 20.0 and as we move towards decreasing class-intervals, the deviations are – 5.0, -10.0, -15.0, -20.0 and –24.0 (all from am = 22.0). We see that as we go up, deviations from mean go up by 1,2,3 and so on and as we come down it goes down by –1, -2, -3, -4 and so on. Thus, write 1,2,3,4 and so on towards the class intervals of increasing scores and –1, -2, -3, -4 and so on towards the class intervals of decreasing scores.

4. The fourth column fx is the product of colum 2 and 3 and e.g.
   5 x 3 = 15, 6x2 = 12 and so on

5. Now add all the positive values and the negative values separately, which are + 36 and –42 in the above example and add these two values, this will give Σfx which comes out to be –6 in the example.

6. Put all the values in the formula to calculate mean by short cut method i.e.

   $$x = A.M. \pm \frac{\Sigma fx}{n} \times i$$, where AM = 22.0, Σfx = -6

   i = 5 and N = 52, the mean calculated is 21.43.

**2.3.1.5 PROPERTIES OF MEAN :**

The following are the main properties of mean :

1. The sum of the deviation from the mean of the scores is always zero. Mean is the central value of a distribution of scores.
2. The sum of the squares of deviations from the mean is always less than the sum of the squares of deviations from any other assumed mean.
3. The mean is central value of a set of data. Both sides from the mean, the deviations are equal.
4. The mean is sensitive measure of central tendency. If we add, substract, multiply or divide the set of scores by a constant, the mean value may change.
5. The mean value is a measure of sample or group. It is the most accurate measure of central value of the scores. The group performance is best indicated by this value when the distribution indicated by this value when the distribution is normal. It is used for interval and ratio variables.

**2.3.1.6 MERITS OF MEAN :**

1. It is clearly defined.
2. It is easy to calculate and understand.
3. It is based on all observations.
4. It is suitable for further mathematical treatment.
5. It is least affected by fluctuations in sampling.

**2.3.1.7 Demerits :**

1. Every single score affects the mean.
2. It cannot be located graphically or determined by casual inspection.
3. Qualitative characteristics cannot be dealt with mean.
4. Mean cannot be calculated if even single observation is missing.

**2.3.2 MEDIAN**

Median may be defined as the size of that item which falls just in the middle of a series or data arranged either in the ascending order or the descending order of their magnitude. Median is the size of that item which has as many items proceeding it as succeeding it. It lies in the center of a series or data and divides the series or data into two parts containing an equal number of items:

**2.3.2.1 Calculation of Median(Ungrouped data) :**

(i) **Individual Series :** The formula of calculating median is

is $= n + \frac{1}{2}$th item

e.g. Find out the median value of the following data :

3,9, 2, 8, 7, 4, 1, 3, 5, 4, 6, 2, 9, 7, 8, 4, 6

Arranging 1,2,2,3,3,4,4,4,5,6,6,7,7,8,8,9,9,

$M = \text{Size of } \frac{N+1}{2}\text{th item}$

$= \text{Size of } \frac{17+1}{2}\text{th item} = 9\text{th item i.e.} = 5$

Thus value of Median = 5

**2.3.2.2 Median in grouped Data :** When the data are available in grouped form i.e. in the form of frequency distribution, median can be calculated as follows :

| Class interval (ci) | Frequency (f) | Cumulative Frequency (cf) |
|---|---|---|
| 35-40 | 2 | 40 |
| 30-34 | 5 | 38 |
| 25-29 | 7 | 33 |
| 20-24 | 10 | 26 |
| 15-19 | 9 | 16 |
| 10-14 | 4 | 7 |
| 5-9 | 0 | 3 |
| 0-4 | 3 | 3 |
| | N = 40 | |

$$\text{Median} = l.l + \frac{N/2 - cf}{Fm} \; I$$

Where *l.l* is the lower limit of the class interval in which median lies.

N/2 = half the number of frequencies.

Fm = Frequency of the interval in which the median lies.

cf = cumulative frequency that lies below of class interval which contains the median. In above data, N/2 = 40 / 2=20.

Lower limit = 19.5

Fm = 10

cf = 16

i = 5

$$\text{Median} = 19.5 + \frac{40/2-16}{10} \times 5$$

$$= 19.5 + 2.0$$

$$\text{Median} = 21.5$$

**2.3.2.3 Steps to calculate median :**

1. calculate cumulative frequency in column 3 of the table by adding the frequencies from below and writing them against each class interval. For example, the frequency in the last interval is 3 Add three to the above frequency 4 and write 4+3 = 7 against third class interval from below. Similarly, add 9 to 7 and write 16 against fourth class interval from below till all the cumulative frequencies are calculated.
2. Divide N by 2. here, 40/2 = 20.
3. We have to reach a point where 20 fequencies are summed up we find against 15-19 ci, there are 16 frequencies summed up. To make 20, we need

4 more frequencies. We take them from this next ci which has 10 frequencies.

4. Class interval is 5 in the given example. Put all the values in the formula and calculate the median.

**2.3.2.4 MERITS AND DEMERITS**

**Merits :**

1. It is rigidly defined.
2. It is easy to understand and calculate
3. It is not affected by extreme observations.
4. It can be located by simple inspection and can be computed graphically.
5. It can be used for dealing with qualitative characteristics also. We can find average intelligence, average academic achievement etc., among a group of people.

**2.3.2.5 Demerits :**

1. It is not based on every item of the distribution
2. It is not suitable for further mathematical treatment
3. It is relatively less table than mean particularly for small sample because it is affected more by the fluctuations of sampling.

**2.3.3 MODE :** Mode is the value which occurs most frequently in a set of observations, for example, in the following set of scores : 13,15,15,18,14,12,12,12,16,19 only the score 12 occurs thrice. Therefore, we can say the mode in the above set of scores is 12. Important features of mode are it is the size of that item which has the maximum frequency. It is effected by frequencies of the neighbouring items.

**2.3.3.1 Calculation of Mode :** In an ungrouped data, mode can easily be located by counting the value which occurs most times in the distribution as in the above said case. But mode in grouped data can be calculated by using the following two formulas.

(1) Mode = 3 Median - 2 Mean.

(2) $$\text{Mode} = l.l. + \frac{f_0 - f_1}{2f_0 - f_1 - f_2} \times i$$

Where *1.1* = lower limit of the class interval in which mode lies.

$f_o$ = frequency against the modal c.i.

$f_1$ = frequency against the class interval preceding the model c.i.

$f_2$ = frequency against the class interval succeeding the model c.i.

i = class interval.

| Class Interval (ci) | frequency (f) |
|---|---|
| 70-79 | 1 |
| 60-69 | 8 |

| | |
|---|---|
| 50-59 | 10 |
| 40-49 | 5 |
| 30-39 | 6 |
| 20-29 | 4 |
| 10-19 | 3 |
| 0 - 9 | 3 |

Using the above formula

$$\text{Mode} = l.l. + \frac{f_0 - f_1}{2f_0 - f_1 - f_2} \times i$$

$$49.5 + \frac{10 - 5}{2 \times 10 - 5 - 8} \times 10$$

= 49.5 + 7.1

Mode = 56.6

2.3.3.2 **Step to Calculate Mode :**

1. Locate where maximum frequencies lie. This class interval will be called modal class. In the example, since maximum frequencies are 10. in class interval, 50-59, lower limit of which is 49.5.
2. The frequencies in modal (i) are denoted by to which is 10, the frequencies above the modal class interval are 8, which are denoted by $f_2$ and frequencies below the modal class interval are 5, denoted by $f_1$.
3. Put all the values in the above formula and calculate mode.
   There second method of finding the mode uses this following formula is Mode = 3 Mdn. - 2 mean.

This formula is the most correct result-giving formula. As such it is widely used. It makes use of mean and median.

**2.3.3.3 MERITS AND DEMERITS OF MODE :**

**Merits:**

1. It is easy to understand and calculate.
2. It can be located graphically or by mere inspection.
3. It is not affected by extreme observation.

**Demerits :**

1. It is not rigidly defined.
2. It is not based on all observation of the distribution.
3. It is not suitable for a further mathematical treatment.
4. Mode is affected to a greater extent by fluctuations of sampling.

### 2.3.4 COMPARISON OF MEAN, MEDIAN AND MODE

| Mean | Median | Mode |
|---|---|---|
| 1. Mean is interval variable. | 1. It is ordinal variable. | 1. It is normal variable. |
| 2. It is the central location of scores | 2. It is the central location of the frequency. | 2. The score occurs most frequently. |
| 3. It is a sensitive measure of central tendency. | 3. It is less sensitive measure of central tendency. | 3. It is crude measure of central tendency. |
| 4. It indicates the skewness of the distribution. | 4. It is used for the skewness of distribution. | 4. It indicates the modality of the distribution. |
| 5. It is used or normal distribution accurately. | 5. It is used for the skewed distribution. | 5. It is used for uni, bi and multi model nature. |
| 6. It has theoretical value rather than practical. | 6. It has theoretical value rather than practical. | 6. It has high practical value. |
| 7. It is used for comparing two or more groups for variance. | 7. It is used when extreme scores fluctuate. | 7. It is quick and approximate measure of central tendency. |

### 2.3.5 SUMMARY

Measure of central tendency are most common with the statisticians because these measures help them to reduce the complexity of data and make it comparable. We cannot remember the whole set of data and the analysis of such data is impossible. So in order to reduce the complexity and make the data comparable, we resort to averaging. Average must be representative the whole data, it should be based on all the observations, suitable for further mathematical treatment, calculated with reasonable ease and rapidity, rigidly defined and least affected by fluctuations of sampling. Mean, median and mode are measure of central tendency.

### 2.3.6 EVALUATION :

1. Define median and mode and its merits and demerits.
2. Calculate Mean, Median and Mode of the following grouped data:

(a)

| class interval | frequency |
|---|---|
| 90-99 | 1 |
| 80-89 | 3 |

| | | |
|---|---|---|
| | 70-79 | 5 |
| | 60-69 | 10 |
| | 50-59 | 25 |
| | 40-49 | 9 |
| | 30-39 | 7 |
| | 20-29 | 7 |
| | 10-19 | 03 |
| | | 70 |
| (b) | 40-44 | 1 |
| | 35-39 | 2 |
| | 30-34 | 8 |
| | 25-29 | 10 |
| | 20-24 | 19 |
| | 15-19 | 11 |
| | 10-14 | 6 |
| | 5 - 9 | 3 |
| | 0 - 4 | 01 |
| | | 61 |
| (c) | 90-99 | 5 |
| | 80-89 | 10 |
| | 70-80 | 15 |
| | 60-70 | 20 |
| | 50-60 | 45 |
| | 40-49 | 15 |
| | 30-40 | 8 |
| | 20-30 | 7 |
| | 10-20 | 04 |
| | | 124 |

**2.3.7 SUGGESTED READINGS:**

H.E. Garrett, *Statistics in Psychology and Education.*

J.P. Guilford, *Fundamental Statistics in Psychology and Education*

T.R. Sharma, *First Course in Statistics*

**LESSON NO. 2.4** **AUTHOR : DR. S.S. AGGARWAL**

## NORMAL PROBABILITY CURVE AND ITS IMPLICATIONS

**Structure of the Lesson**



### 2.4.1 Objectives :

After reading this chapter students will be able to learn the :

(i) Concept of Probability and meaning of normal distribution.
(ii) Properties of Normal Probability Curve.
(iii) Various applications of Normal Probability Curve.
(iv) Applications of knowledge of Normal Probability Curve in solving various practical problems.

### 2.4.2 Introduction :

We have already learnt, how calculated the measures of central tendency to describe the central value of the frequency distribution. We have also found the measures of variability to indicate its variations. All these descriptions have gone a long way in providing information about a set of scores. Sometime we need procedures for describing and individual's, position in a group or the cutting points to categories the group according to the level of ability or the nature of test paper which a teacher has used to assess the learning outcomes of the students.

In our daily life Probability or chance is very commonly used terms sometimes we use to say probably it may rain tommorrow. Probably may come for taking his class today. All these terms probability & possibility the conveys the same meaning. But in statistics probability has certain special connotation unlike in Layman's view. The theory of probability has been developed in 17th century. It has got its origin from games, tossing coins etc. In 1954 Antoine Gornbad had taken an initiation and an interest for this area. After him many authors in statistics had tried to remodel to idea given by the former. The probability has become one of the basic tools of statistics same time statistical analysis becomes paralysel without the theorem of probability.

**2.4.3 Normal Probability Curve :**

In statistics, normal distribution is considered as one of the most important distributions, particularly in the area of test construction. Let us consider the following smoothed polygon (fig. 1) and the histogram (fig. 2).

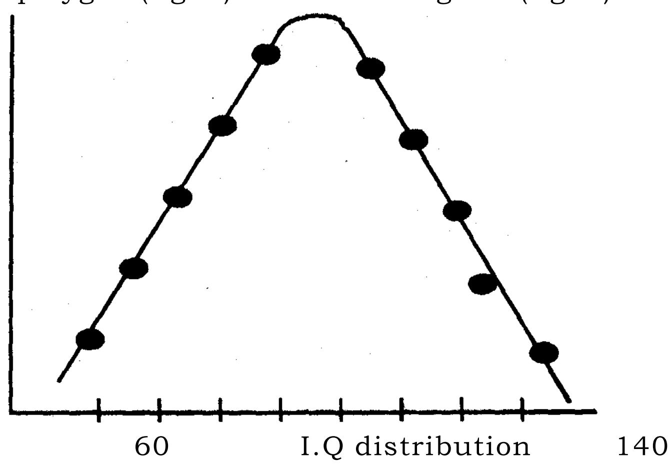



Fig. 1

The best fitting normal curve

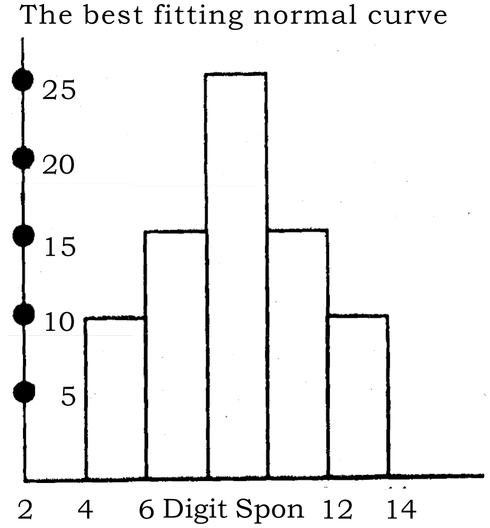
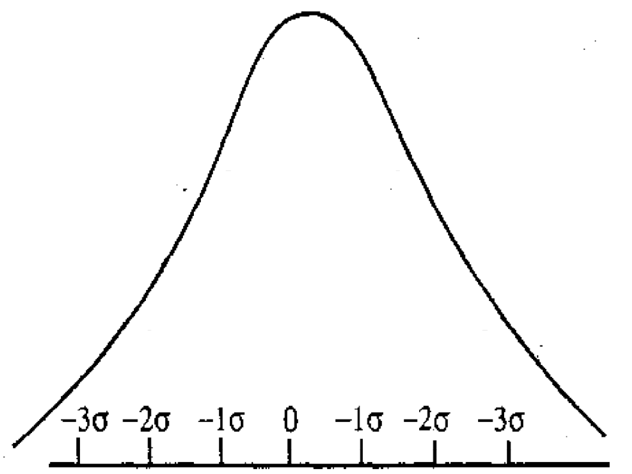



Fig. 2

Memory spanfor digits

These two graphs have the same general form; the measures are concentrated closely around the centre and taper off from the central high point to left and right. There are relatively few measures at the 'low score' end of the scale, and increasing number up to a maximum at the middle of position and a progressive falling-off towards the 'high score' of the scale. If we divide the area under each curve (the area between the curve and the X-axis) by a line drawn perpendicularly through the central high point to the baseline, the two parts thus formed will be similar in shape and very nearly equal in area. Each figure exhibits almost perfect bilateral symmetry. This perfectly symmetrical curve of frequency distribution to which the first two graphs (fig. 1 and fig. 2) approximate is shown in figure 3.



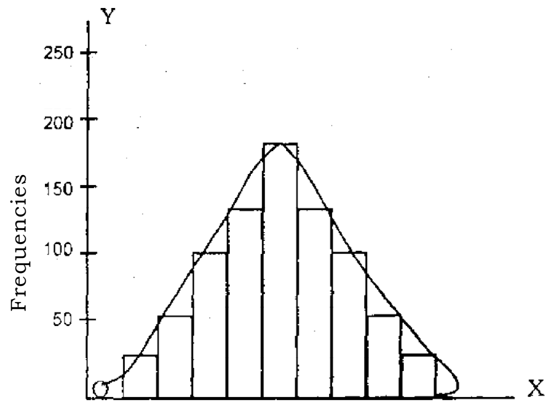

Normal Probability curve Figure . 3

This bell-shaped figure is called the normal probability curve (NPC) or simply normal curve, and is of great value in mental measurement. The curve is also called the Chance curve, Curve of Error, Probability curve or Gaussian Curve after the name of its discoverer Gauss. It has been seen that measurements of many natural phenomena and of many mental and social traits such as weight, height, wages and output of workers, intelligence, perception span, reaction time, educational test scores in spelling, reading, arithmetic etc. tend to be distributed symmetrically around their means in proportion which approximate those of the normal probability distribution. It has also been seen that many distributions are similar to those obtained by tossing coins or throwing dice because the former, like the later, are actual probability distributions.

If we toss ten coins simultaneously, the expression can be written $(H+T)^{10}$ where H stands for the probability of a head, T for the probability of a tail and 10 for the number of coins tossed $(H+T)^{10} = H^{10} + 1OH^{9}T + 45H^{8}T^{2} + 120H^{7}T^{3} +$

$210H^6T^4 + 252H^5T^5 + 210H^4T^6 + 120H^3T^7 + 45H^2T^8 + 10HT^9 + T^{10}$

If this expansion is graphically represented through a histogram and a polygon, we will have the following figure (Fig. 4).




Probabilities Curve obtained from expansion of $(H+T)^{10}$ (Fig.4)

The eleven terms of expansions have been laid off at equal distances along the X-axis and chance of occurrence of each combination of H's and T's are plotted as frequencies or the Y-axis. The result is a symmetrical frequency polygon with the greatest concentration in the centre and the score falling away by corresponding decrements above and below the central high point.

Now when n in the expression $(H+T)^n$ becomes infinite, the polygon would exhibit a perfect occurrence like that of this curve in figure 3. This ideal polygon represents the frequency of occurrence of various combinations of a very large number of equal, similar and independent factors (coins) when the probability of the appearance (H) or non-appearance (T) of each factor is the same. The normal distribution is not an actual distribution of test scores, but is instead a mathematical model.

**2.4.3.1 Assumptions of Normal Distribution :**

The basic assumption of normal distribution is that the variables of behavioural sciences, bio-sciences of a large sample or representative sample are commonly normally distributed.

1. The area covered by normal distribution is assumed an unit.
2. It assumes, mean is zero and standard deviation is one. The mean is three times of SD of normal curve.
3. The range of the curve is $6\sigma$ i.e. from $-3\sigma$ to $+3\sigma$.
4. It indicates standard scores are in the form of $\sigma$ scores on X-axis.

**2.4.3.2 Properties of Normal Distribution :**

1. The equation of the N. P. C. is

$$Y = \frac{N}{\sigma\sqrt{2\pi}} x \frac{-x^2}{2\sigma^2}$$

Where x = scores (expressed as deviations from the mean) laid along the X-axis.
y = the height of the curve above the X-axis.
N = number of cases.
σ = S.D. of the distribution.
x = 22/7 = 3.1416 (the ratio of the circumference of a circle to its diameter)
e = 2.7183 (base of Napierian system of logarithms)

2. The curve is symmetrical. The mean, median and mode coincide. The characteristic of symmetry about the ordinate at the central point of the curve implies that the size, shape and slope of the curve on one side of curve are identical to those on the other side. The value of mean, median and mode computed for a distribution following the curve are always equal.
3. The maximum ordinate of the curve occurs at the mean.
4. The curve is asymptotic. It approaches but does not meet the horizontal axis and extends from minus infinity (-) to plus infinity (-).
5. The points of infection of the curve occurs at point = 1 standard deviations unit above and below the mean. Thus, the curve changes from convex to concave in relation to the horizontal axis at these points.
6. 68.26% of the area of the curve falls within the limits ± 1 standard deviation units from the mean.

   If total area of the curve is 100, then 68.26 cases fall between the two ordinates at ± 1σ.
7. In the normal curve, the limits M ± 1.96σ include 95% and the limits M ±2.58 include 99% of the total area of the curve, 5% or 1% of the area respectively fall beyond these limits.

### 2.4.4 Applications of the Normal Probability Curve :

A number of problems can be solved if we assume that our obtained distributions can be treated as normal, or approximately normal. Table A at the end is made available for reference.

#### 2.4.4.1 Determination of percentages of cases between the given standard scores from the mean.

Percentage of cases can be known from Table A. The figures given in Table A against standard scores Z are the fractions of the total area under the curve. While converting the given value into percentage one will have to multiply it by 100.

**Example :** Given a distribution of scores with a mean of 16, and a SD σ of 4. Assuming normality find

(a) What percentage of the cases fall between scores 12 and 20 ?

(b) What percentage of the cases lie above score 22 ?

(c) Below score 10 ?

**Solution :**

(a) Given Mean = 16 and σ = 4

for score 12 the sigma distance $z_1 = \frac{X - M}{\sigma}$

$$= \frac{12-16}{4} = -1$$

$$= \frac{-4}{4} = -1$$

For score 20 $z_2 = \frac{(20-16)}{4} = +1$

$$= \frac{+4}{4} = +1$$

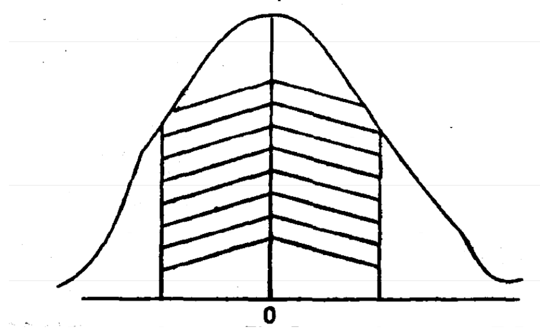


Fig.5

We have to find the area between $z_1$ and $z_2$. This is equal to area between z = 0 and z = 1, area between z = 0 and z = +1

=0.3413+0.3413

= 0.6826

Hence percentage of cases that fall between 12 and 20 = 68.26%

(See Table A)

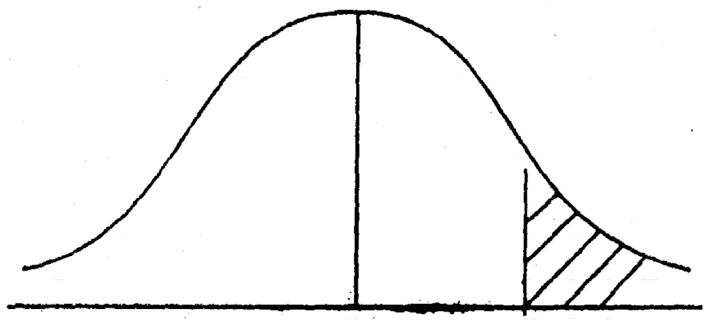
(b) In this question, the score 18 is not included. The upper limit of score of 18 is 18.5 which in standard units is :

$$z = \frac{22.5 - 16}{4} = \frac{6.5}{4} = 1.625$$

Now the required number of cases which lie above score 22 = area to the right of 1.625. From table A, we find that 44.79% of cases fall between mean and 1.625.

Therefore, .0521 lie above the upper limit of 22, (50 - 44.79)
or percentage of cases that fall above 22 = 5.21%

(c) The lower limit of score of 10 is 9.5 which in standard unit is



(Fig. 6)

$$z = \frac{9.5 - 16}{4} = -1.625$$

Now the required number of cases below score 10 = half this curve - area between mean area 1.625

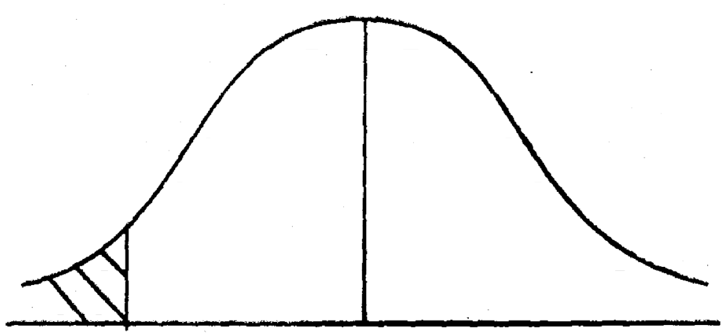
= .5 - .4479

= 0.0521

i.e. 5.21%

= Hence percentage of cases that fall below 10

= 5.21%



(Fig. 7)

**2.4.4.2 To find the limits in any normal distribution which include a given percentage of cases**

**Example :** Given a distribution of scores with a mean of 20 and $\sigma$ of 4. If we assume normality what limits will include the middle 75% of the cases.

**Solution :** Since a normal distribution is symmetrical about the ordinate at z = 0, the middle 75% of the cases are lying both sides of the mean, half and half i.e. 3750 on each side. Now from Table A (3749 quite close to 3750) has z = 1.15. Therefore 75% of the cases would fall between mean and ± 1.15σ.

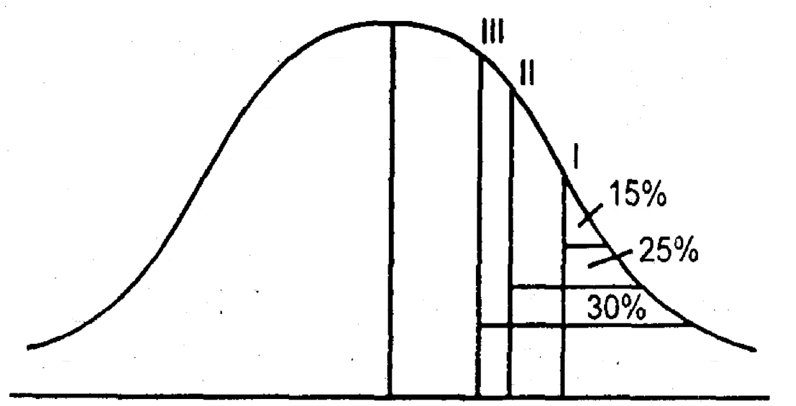
The limits would be 20 ± 4 x 1.15 = 20 ±4.6 = 24.6 and 15.4

**2.4.4.3 To determine the relative difficulty of test questions, problems and other test items :**

Problem A is solved by 15% of large unselected group, a second problem (B) is solved by 25 of the same and a third problem (C) solved 30%. If we assume the capacity measured by the test problem to be distributed normally, what is the relative difficulty of problem I, II and III.

**Solution :**

Our problem here is to find out the difficulty of each problem I, II and III. So that 15%, 25% and 30% of the entire group lies above and 85%, 75% and 70% below this cut point. For problem 15% lie above and 85% lie below the given point. The highest 15% in normally distributed group has (50-15) = 35% of cases between its lower limits and mean. From table A, we find that 35.00% (or .3508 out of 1) i.e. 35% of a normal distribution fall between the mean and 1.04σ. Hence problem I belongs to a point on the base line of the curve towards positive side, a distance of + 1.04σ from the mean and accordingly, +1.04 $\overline{0}$ may be as difficulty value of this problem.




3σ 2σ 1σ 1σ 2σ 3σ

(Fig. 8)

Calculate similarly, difficulty values of Second and Third problems and obtain the following :

| Problem | Passed by | % between mean & the cut point | σValue | Difference |
|---|---|---|---|---|
| 1 | 15% | 35% | +1.04 | 0.37 |
| 2 | 25% | 25% | +0.67 | |
| 3 | 30% | 20% | +0.52 | 0.15 |

The difference in difficulty between questions 2 and 3 is 0.15 which is less than 1/2 or the difference in difficulty between questions I and II.

**2.4.4.4 To compare two distributions in terms of overlapping :**

Example : Given the distribution of the scores made on a memory test by 300 boys and 250 girls.

The boy's means score is 20.49 with σ = 3.63

The girl's means score is 21.49 with σ = 5.12

The medians are : boys 20.41, girls 21.66

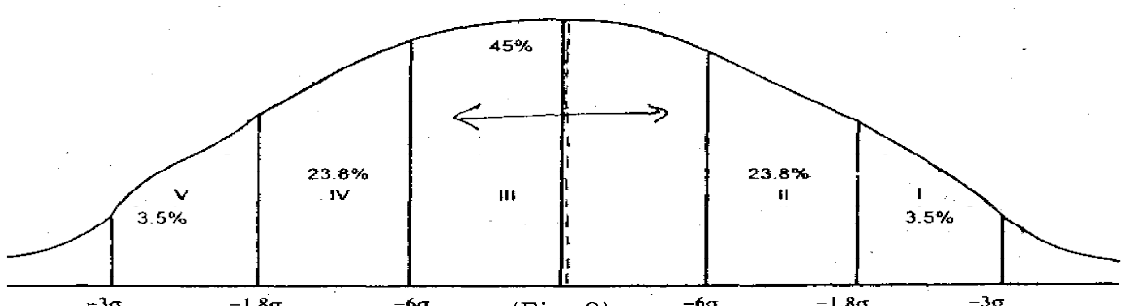
What percentage of girls exceed the median of the boys distribution?

**Solution :**

On the assumption that these distributions are normal, we may solve the problem with the help of Table A. The boys median is 20.41 - 21.49 = -1.08 score unit below the girls mean. Dividing 1.08 by 5.12 (The σ the girls distribution), we find that the boys median is. 21 σ below the mean of the girls distribution. Table A shows that 8.32% of the normal distribution lies between the mean and -.21σ hence 58% of the girls (50% + 8%) exceed the boys median.

**2.4.4.5 To classify a given group into sub-groups according to capacity when the trait is normally distributed.**

**Example :** Suppose, we have administered an entrance examination to 200 college students. We wish to classify our group into five sub-groups I, II, III, IV and V according to ability. The range of ability is to be equal in each subgroup. On assumption that the trait measured by our examination is normally distributed, how many students should be placed in group I, II, III, IV and V?




(Fig. 9)

**Solution :**

First, represent the position of the given sub-group diagrammatically on a normal curve as shown above. Consider the baseline or curve extending from $-3\sigma$ to $+3\sigma$ i.e. over a range of 6.

Dividing this range by 5 (the number of sub-groups, we get = $1.2\sigma$ as the base line extent be allotted to each group. These five intervals may be laid off on the base line as shown in figure perpendiculars erected to demarcate the various subgroups.

Group I covers the upper $1.2\sigma$

Group II the next $1.2\sigma$

Group III lies 0.6 to the right, and 0.6 to the left of this mean.

Group IV and V occupy the same relative position in the lower half of curve than II and occupy in the upper half.

To find what percentage of the whole group belongs in I, we must find what percentage of normal distribution lies between $3\sigma$ (upper limit of the I group) and $1.8\sigma$ (lower limit of group I). From Table A, 4986 i.e. 49.86% of a normal distribution is found to lie between the mean 3 and 46.41% between the mean and 1.8. Hence (49.86%-46.41% = 3.5%) of the total area under the normal curve lies between $3\sigma$ and $1.8\sigma$ and accordingly group I comprises 3.5% of the whole group.

The percentage of the other groups are calculated in the same way. Thus, 46.41% of the normal distribution falls between the mean and 1.8 (upper limit of group B), and 22.57% OR 23.84% or our distribution belongs to sub-group II.

Group III lies from 0.6 above -0.6 below the mean. Between the mean and .6 is 22.57% of the normal distribution and the same percent lies between the mean and -6, group III, therefore, includes 45.14% (22.57 x 2) of the distribution.

Finally, group IV, which lies between $-0.6\sigma$ and $-1.8\sigma$ contain exactly the same percentage of the distribution of sub-group II, and group V, which lies between $-1.8\sigma$ and $-3\sigma$ contains the same percent of the whole distribution as group I. The percentage and number of men in each group are given in this table below.

**Table**

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| Parentage of total individuals in each group | 3.5 | 23.8 | 45 | 23.8 | 3.5 |
| Number in each group 200 men in all) | 7 | 48 | 90 | 48 | 7 |

Uses of Normal Probability Curve

1. In research work.
2. For measurement and tet construction.
3. In statistical treatment.
4. In administration.
5. In developing norms.

6. To determine difficulty values of test items.
7. To compare two distributions.
8. To determine levels of significance.

**2.4.5 Statistics in Psychology and Education :**

Table A : Fractional parts of the total area (taken as 10.000) under the normal probability curve, corresponding to distance on the basseline between the mean and successive point laid off from the mean in units of standard deviation.

Example : between the mean and a point $1.38\,\overline{0}\left(\frac{x}{\overline{0}} = 1038\right)$ are found 41.02%

of the entire are under the curve.

| $\frac{x}{\sigma}$ | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 0000 | 0040 | 0080 | 01200160 | | 0100 | 0230 | 0270 | 0310 | 359 |
| 0.1 | 0398 | 0438 | 0478 | 0517 | 0557 | 0596 | 0638 | 0675 | 0714 | 453 |
| 0.2 | 0793 | 0832 | 0871 | 0910 | 0948 | 0987 | 1026 | 1084 | 1103 | 141 |
| 0.3 | 1179 | 1217 | 1255 | 1293 | 1331 | 1368 | 1408 | 1443 | 1480 | 517 |
| 0.4 | 1554 | 1501 | 1628 | 1664 | 1700 | 1736 | 1772 | 1808 | 1844 | 879 |
| 0.5 | 1915 | 1960 | 1985 | 2010 | 2054 | 2088 | 2123 | 2157 | 2190 | 224 |
| 0.6 | 2257 | 2291 | 2324 | 2357 | 2389 | 2422 | 2454 | 2488 | 2517 | 2549 |
| 0.7 | 2580 | 2611 | 2642 | 2678 | 2704 | 2734 | 2764 | 2794 | 2823 | 2852 |
| 0.8 | 2881 | 2910 | 2939 | 2987 | 2995 | 3023 | 3051 | 3078 | 3100 | 3172 |
| 0.9 | 3149 | 3180 | 3212 | 3238 | 3204 | 3290 | 3315 | 3340 | 3365 | 3389 |
| 1.0 | 3413 | 3438 | 3461 | 3485 | 3508 | 3531 | 3554 | 3577 | 3609 | 3621 |
| 1.1 | 3643 | 3665 | 3686 | 3708 | 3729 | 3749 | 3770 | 3790 | 3810 | 3830 |
| 1.2 | 3840 | 3859 | 3888 | 3907 | 3925 | 3944 | 3962 | 3980 | 3997 | 4015 |
| 1.3 | 4032 | 4049 | 4066 | 4082 | 4099 | 4115 | 4131 | 4147 | 4182 | 4177 |
| 1.4 | 4192 | 4207 | 4222 | 4236 | 4251 | 4262 | 4279 | 4292 | 4306 | 4319 |
| 1.5 | 4332 | 4345 | 4357 | 4372 | 4383 | 4394 | 4406 | 4418 | 4429 | 4441 |
| 1.6 | 4452 | 4403 | 4474 | 4484 | 4495 | 4505 | 4515 | 4525 | 4535 | 4545 |
| 1.7 | 4554 | 4564 | 4573 | 4582 | 4591 | 4599 | 4608 | 4616 | 4625 | 4663 |
| 1.8 | 4641 | 4649 | 4656 | 4604 | 4671 | 4678 | 4686 | 4693 | 4699 | 4706 |
| 1.9 | 4713 | 4719 | 4726 | 4732 | 4738 | 4744 | 4750 | 4758 | 4761 | 4767 |
| 2.0 | 4772 | 4778 | 4787 | 4788 | 4793 | 4798 | 4803 | 4808 | 4812 | 4817 |
| 2.1 | 4821 | 4826 | 4830 | 4834 | 4838 | 4842 | 4846 | 4850 | 4854 | 4857 |
| 2.2 | 4861 | 4864 | 4868 | 4871 | 4875 | 4878 | 4881 | 4864 | 4887 | 4890 |
| 2.3 | 4893 | 4896 | 4898 | 4871 | 4875 | 4878 | 4881 | 4884 | 4887 | 4890 |
| 2.4 | 4918 | 4920 | 4922 | 4925 | 4927 | 4923 | 4931 | 4932 | 4934 | 4936 |
| 2.5 | 4938 | 4940 | 4941 | 4943 | 4945 | 4996 | 4948 | 4949 | 4951 | 4952 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.6 | 4953 | 4955 | 4956 | 4957 | 4959 | 4960 | 4961 | 4962 | 4963 | 4964 |
| 2.7 | 4965 | 4966 | 4967 | 4968 | 4969 | 4970 | 4971 | 4972 | 4973 | 4974 |
| 2.8 | 4974 | 4975 | 4976 | 4977 | 4977 | 4978 | 4979 | 4979 | 4980 | 4981 |
| 2.9 | 4981 | 4982 | 4982 | 4983 | 4984 | 4984 | 4985 | 4985 | 4986 | 4986 |
| 3.0 | 4986.5 | 4986.9 | 4987.4 | 4988.2 | 4988.6 | 4988.3 | 4989.3 | 4989.7 | 4990.0 | |
| 3.1 | 4990.1 | 4999.3 | 4991.0 | 4991.3 | 4991.6 | 4991.8 | 4992.1 | 4992.4 | 4992.6 | 4992.9 |

4993.129
4995.160
4996.631
4997.674
4998.409
4999.519
4999.683
4999.966
4999.997132

**2.4.6 Summary :**

The normal frequency distribution curve is based upon the law of probability or the probable occurrence of certain events. The 'probability' of a given event is defined as the expected frequency of occurrence of this event among events of a like sort. It may be stated mathematically as a ratio. The probability of an unbiased coin falling heads is 1/2, and probability of dice showing a four-spot is 1/6. These ratios called 'probability ratios' are defined by that fraction, the numerator of which equals the derived outcomers and the denominator of which equals the total possible outcomes. A probability ratio always falls between the limits .00 and 1.00. All possible degrees of likelihood may be expressed by appropriate ratios between these limits. Application of the normal probability curve are : (i) Determination of percentages of cases between the given stand and scores from the mean (ii) To find the limits in any normal distribution which include a given percentage of cases (iii) To determine the relative difficulty of test questions-problems and other test items (iv) To compare the distribution in terms of overlapping and (v) To classify a given group into sub-groups according to capacity when the trait normally distributed.

**2.4.7 SUGGESTED QUESTIONS :**

1. (a) Define a NPC? Give its applications.
   (b) Discuss the properties of normal probability curve.
2. A test in Mathematics given to 1500 school leaving pupils, had a mean = 53.0 and a Standard Deviation of 8.0.
   Assuming normality, answer the following :
   (a) How many individuals score above 65?
   (b) How many individuals score between 45 and 75?
   (c) What are the scores between which the middle 60% cases lie?

(d) What would be the chances in 100 of selecting an individual at random who would score 60 or higher?

3. In a normal distribution, M = 200, and SD = 25.

(a) What percent of scores lie between 180 and 240?

(b) The middle 75% fall between which two scores?

(c) On what scores do $Q_1$ and $Q_3$ fall?

**2.4.8 SUGGESTED READINGS :**

Garret, H.E. : Statistics in Psychology and Education, Vakils, Feffer and Simons Ltd. Bombay 1985.

Guilford, J.P. and Fruether, B. : Fundamental Statistics in Psychology and Education, McGraw Hill, New Delhi, 1965.

**B.Ed. PART-II** | **Paper–XVIII**
**(Semester- IV)** | **Assessment for learning**

**LESSON NO. 2.5** **AUTHOR : DR. S.K. BAWA**

# SCORES AND THEIR KINDS

**Structure of the Lesson**



## 2.5.1 Objectives :

After reading this lesson students will be able to :

(i) Compute Z-score.
(ii) Interpret Standard Scores
(iii) Calculate T-Scores.
(iv) Compare the marks in different groups.

## 2.5.2 Introduction :

A measuring instrument involves four types of errors personal, variable, constant and interpretive errors using an objective test reduces the personal error, the variable error is reduced minimized by selecting a highly reliable test, selecting a valid test reduces the constant error and the interpretive error is minimized by developing test norms or standardization. The raw scores of highly reliable and valid test are meaningless. They are meaningful with the help of standard scores of norms. The term norms refers to a statistical procedure to minimize the interpretive error of a test scores. According to Freeman, "A norm is the average or standard score on a particular test made by a specified population : Norms of a test are essential because raw scores become interpretable.

### 2.5.3 Scores and their Kinds :

In Psychological and educational measurement raw scores have to be interpreted. These, scores obtained through highly reliable and valid test are meaningless unless transformed to make them' interpretable, because educational and psychological measurement is relative. If a child scores 80 marks in maths and 65 marks in science conveys no meaning until they are converted into percentage which will interpret the child's position in class or group in that subject and only then this score becomes interpretable. The percentage scores obtained by the child is relative as it refers to the child performance out of the total score of 100 and can be interpreted as above average performance. In order to determine more precisely the individual's performance with reference to the standardisation sample, the raw scores are converted into some relative measure. These derived scores are designed to serve a dual purpose.

1. They indicate the individual's relative standing in the normative sample and thus, permit an evaluation of his performance in reference to other persons.

2. They provide comparable measures that permit a direct comparison of the. individual's performance on different tests.

If a child scores 82 in a Maths test and 40 in English, it does not show anything about his relative performance, whether he is good in Maths or English or equally good in both. Since raw scores on different tests are usually expressed in different units. A direct comparison of both the raw scores is impossible because difficulty level of a particular test would affectsuch a comparison between raw scores. Whereasstandard scores make the comparison possible between the scores ofdifferent tests and different students. Thus, the individual's relative performance in many different functionscan be compared.

There are different methods of convert these raw scores into standard scores to serve the above said two purposes.

1. Z-scores
2. T-scores
3. Stanine Scores

### 2.5.4 Z-scores and Standard Scores :

Standard score is one derived from a raw score so that it can be expressed on a uniform standard scale without seriously altering its relationship to other scorer in the distribution. The mean and standard deviation describe the central tendency and variability of scores in a distribution. To compare an individual on different distributions, it is convenient to know how many standard deviations he is above or below the mean of each distribution. When scores arc expressed in standard deviation units, they are called standard scores. The most commonly used standard scores are Z-scores and T-scores.

Suppose a standard scores on different tests as given below :

| | Score | Mean | Standard Deviation | Sigma σ Score |
|---|---|---|---|---|
| Science | 70 | 65.0 | 2.0 | +2.5 σ |
| English | 70 | 65.0 | 10.0 | +0.5 σ |
| Social Studies | 45 | 50.0 | 3.0 | –1.67 σ |
| Hindi | 35 | 35.0 | 5.0 | 0.0 σ |

The above calculations show that lie is at mean in Hindi of his class, he is 5 points below in social studies, whereas he is 5 points above the mean in English and Science, Considering only student's scores and the means, it might appear that he equally well in English and Science because both are 5 points above the mean. However, according to standard deviation the scores of English are .5σ above mean and Science scores are 2.5σ above mean. If scores tend to cluster closely around the mean (if SD is small), a very high score represents a high standard of performance. However, if the scores tend to spread out, an identically high score does not represent an equally high standard of performance in relationship to the other scores on the test. Thus, consideration of SD is necessary when comparing scores on one distribution with scores on other. The number of points a person scores above or below the mean in relationship to the standard deviation of scores in the distribution is called a Z-score. In the above example the student was at mean score in Hindi but the standard deviation was five points. He is therefore at no standard deviation from mean and Z-score is 0. But in Social Studies, he is five points below mean and standard deviation is 3. His Z-score therefore is -5/3 or -1.67. On the basis of Z-scores, he did best in Science followed by English, Hindi and Social Studies.

Z-score can be calculated as —

$$Z = \frac{X - M}{SD}$$

X - M shows how many points the student scores above or below mean. When this difference is divided by the standard deviations, the number of standard deviations above or below the mean results. Z is a positive value for scores above the mean and is a negative value for scores below the mean. The principle to remember is that scores on different examinations should not be directly compared with each other unless both the means and standard deviations of the two distributions are the same. If either the means or the standard deviations differ scores must be converted to standard scores before comparing the standing the students.

Sigma scores (2 scores) are often decimal fractions like .63 and hence are some what awakward to deal with computations. Half of the σ scores which are below the mean have negative signs and half of then, above the mean have negative signs. To overcome the above drawbacks σ scores are converted into new distribution with M and σ so selected that we get all scores positive and they are easy to interpret. These scores are called standardscores. Raw test scores of Army General Classification Test are expressed as standard scores in a distribution with mean=100 and σ=20.

According to Garret H.E., "The shift from raw to standard score requires a linear transformation. This transformation does not change the shape of distribution in any way; if the original distribution was normal (or skewed) standard score distribution will be normal or skewed in exactly the same fashion."

The formula for converting a raw score to standard score is as follows :

Let X = a raw score in original distribution

$X^1$ = a standard score in new distribution.

M and M' = means of raw score and standard score distribution.

σ and σ' = standard deviation of raw and standard scores

The formula for converting raw score to standard Z-score is as under :

(a) Z for original distributioni s : $Z = \frac{X - M}{\sigma}$

(b) Z for distribution with predicided mean and standard deviation is $Z = \frac{X' - M'}{\sigma'}$

Therefore $\frac{(X' - M')}{\sigma'} = \frac{(X - M)}{\sigma}$

(c) Hence $X' = \frac{\sigma'}{\sigma}(X - M) + M'$

**Example :** If we have to convert the raw score of english and science to standardZ-scores with mean 100 and σ 10 thenthese will be :

**Standard Score For Science**

$$X' = \frac{\sigma'}{\sigma}(X - M) + M'$$

$$X' = \frac{10}{2}(70 - 65) + 100$$

$$= 125\ (125)$$

**Stan** = 5(5) + 100 **r English**

= 25 + 100

= 125

$$X' = \frac{\sigma'}{\sigma}(X - M) + M'$$

$$X' = \frac{10}{10}(70 - 65) + 100$$

$$= 105$$

**2.5.4.1 Advantages of Z-Scores :**

1. The performance of the same person on different tests is to be compared, whether they yield the same level of performance.
2. The standard scores have equal units of measurement and their size and range do not vary from distribution to distribution. The range of standard scores is always -3σ to 3σ or total 6σ . There is fixed percentage in units of Z-scores.
3. They are better than percentile scores and eliminate the limitation of inequality of percentile scores.
4. They are based on the nature of normal probability curve.
5. The linear transformation procedure of standard score is simple and easy.
6. They are easily understandable and interpretable.
7. They are widely used in intelligence and aptitude test.

**2.5.4.2 Limitations of Z-Scores :**

1. They are expressed in minus and plus, thus sometimes create confusion in educational measurement.
2. The interpretation of raw scores in reference position is not known. It only indicate the performance below or above man.
3. It is not used in achievement tests. The scores obtained in decimal points are difficult to handle.

**2.5.5 T-scores :**

T-score is a normalised standard score on a scale such that the distribution of T-score in the population from which they are derived has a mean of 50 and a standard deviation of 10. The original T-scores, designed by McCall and named in honour of Thorndike and Terman, were limited to scores which would be made on a standard test by an unselected group of twelve year old children.

T-scores are standard scores based on the number of standard deviations that a person falls above or below the mean but unlike Z-scores, they are neither fractional nor negative. T-scores are calculated by multiplying each Z-score by 10, the decimal is eliminated. By adding +50 points to that product, negatives are also eliminated. For example if a student's Z-score in English is 2.9. By multiplying it by 10, the value obtained 29 has no decimal in it. By adding 50 points to 29, the T-score comes out to be .79. Symbolically T-score = 10Z + 50.

**17.5.1 Advantages of T-scores :**

1. They are the improved scores over the sigma scores and are obtained in plus sign.
2. It is also the linear transformation of scores into standard scores or T-scores which can be used for comparing the same person's performance on different tests.
3. It is easy to develop T-score norms by using a simple formula.
4. They are easy to interpret. The level of performance can be located.
5. They are applicable in achievement and aptitude tests.

**17.5.2 Limitations of T-scores :**

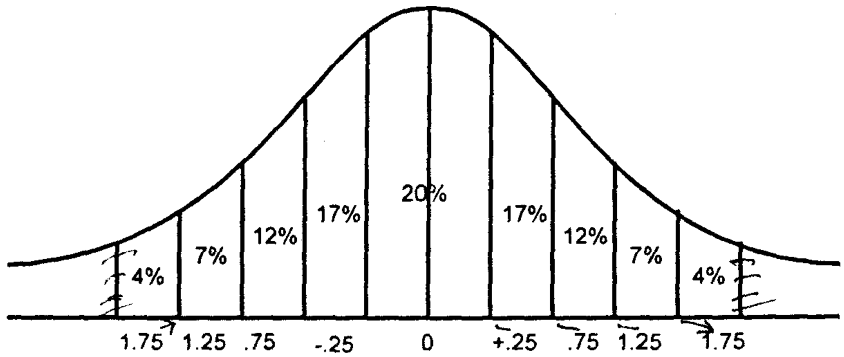
1. The value of T-score is computed from each raw score, thus tune consuming for developing norms.
2. It has the assumption of normal distribution of raw scores but usually the distribution of test scores are not normal. They are either positively skewed or negatively skewed.

**17.6 Stanine Scores :**

The stanine score is a single digit standard score on a nine-unit scale. The distribution of stanine scores in the population from which they were derived has a mean of 5 and standard deviation of 2. Stanines scores are normalised standard scores so that in the population from which they were derived, the proportion of each stanine score are approx. like this.

| Stanine Score: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| % of frequencies: | 4 | 7 | 12 | 17 | 20 | 17 | 12 | 7 | 4 |

Thus, it can be said that stanine scores are based upon the principle that there are fixed percentages between various standard^ deviations on the nornml curve. A slanine score is found by dividing the normal curve into nine equal segments, each having an interval representing half a standard deviation and assigning to each of these segments an ordered number from 1-9. The major advantage of using stanines are that they are easy to compute and all measurements are represented by a single digit whole number from 1-9. The following figure shows the approx. percentages of cases corresponding to each stanine.




Stanine 9 includes the highest 4% cases, stanine 8, the next lower 7% and so on.

**2.5.6.1 Advantages of Stanine Scores :**

1. These are developed through normalised standard scores.
2. The interpretation of stanine score is easier as the total scores are classified into nine standards. The position of the examinee can be located and interpreted easily. It indicates the distance from the reference point or average point of standardised sample.
3. They have high applicability in educational measurement.

**2.5.6.2 Limitations of Stanine Scores :**

1. They require long process for development. The range of each stanine is to be computed with the help of normal probability curve table.
2. The interpretation is done with reference to the average performance rather than the specific position in the group as indicated in percentiles.
3. There is variation in the ranges of stanine points.

**2.5.7 Summary :**

Standard scores is derived from raw score so that it can be expressed on a uniform standard scale without seriously attering its relationship to other scores in the distribution. The most commonly used standard scores are z-scores and t-scores. The standard scores have equal unit of measurement and their size and range donot vary from distribution to distribution. They are better than percentile scores and eliminate the limitations of inequality of percentile scores. They are based on nature of normal probability curve. The linear transformation procedure of standard score is simple and easy. They are easily understandable and interpretable. They are widely used in intelligence and aptitude test. T-scores are standard scores based on the number of standard deviations that a person falls above or below the mean but unlike z-scores. They are neither fractional nor negative. The stanine scores is a single digit standard scores on a nine-unit scale. The distribution of stanine scores in the population from which they were derived has a mean of 5 and standard deviation z. These are developed through normalized standard scores.

**2.5.8 Suggested Questions :**

1. Define Standard Scores and What are the different types of standard scores?
2. Short notes on :
   (i) T scores merits & demerits.
   (ii) Stanine scores merits & demerits.
   (iii) Standard scores merits & demerits.
3. Why are Z-scores and T-scores considered basically the same?
4. Find the Z-score and T-score in each of the cases : (a) Scores 48, M = 51, SD=8;
   (b) Score 12, M = 12, SD = 5.72.

**2.5.9 Suggested Readings :**

Sax, Gilbert : Principles of Educational Measurement and Evaluation.
Sharma, R.A.: Essential of Scientific Behavioural Research.
Ferguson, G.A. : Statistical Analysis in Psychology and Education.
Anastasi, A. : Psychological Testing.
Guilford, J.P. : Fundamental Statistics in Psychological and Education.
Garrett, H.E. : Statistics in Psychological and Education.
Sharma, R.A.: Advanced Statistics in Education and Psychology.

**Lesson No. 2.6** **Author: Dr. Manju Sood**

# FLEXIBILITY, QUALITY AND RANGE OF QUESTIONS, SCHOOL BASED CREDIT, ALTERNATIVE MODES OF EXAMINATION

## STRUCTURE OF THE LESSON



## 2.6.1 OBJECTIVES

The main objectives of this lesson are to :-

1. Write the various examination reforms which are required in the present system.
2. Explain the need of examination reforms.
3. Explain the quality and range of questions for evaluation.
4. Explain the need and types of flexibility in the examination system.
5. Write the methods to increase the effectiveness of School-based credit.
6. Write various alternative methods of examination.

## 2.6.2 INTRODUCTION

***"If examination reforms are necessary, a thorough reform of these is still more necessary."*** - Radhakrishnan commission (1948-49). It is through evaluation that end-products of all efforts for education are apprised. Therefore evaluation is a necessary evil which may be through examinations or any other means of evaluation. There have been dominance of written examination a means of evaluation since the pre-independence period and has continued till today in spite of its many demerits along with merits. Therefore reforms in examination have been suggested not only by Radhakrishnan commission but also by Kothari Commission, Committee on examinations (1970) and National Curriculum Framework-2005. The reforms in examination are needed to overcome their demerits and adopting other means of evaluation also and along with examinations. There is need for flexibility in the examination, need for quality improvement of questions and include variety of questions for evaluation. School-based credit should be there in evaluation and various alternative modes of examination should be adopted. This lesson deals with many such kind of examination reforms needed in the present system.

## 2.6.3 EXAMINATION REFORMS:

### 2.6.3.1 Why examination reforms are needed?

a) Because Indian school board exams are largely inappropriate for the 'knowledge society' of the 21st century and its need for innovative problem-solvers.

b) Because they do not serve the needs of social justice.

c) Because the quality of question papers is low. They usually call for rote memorization and fail to test higher-order skills like reasoning and analysis, lateral thinking, creativity, and judgment.

d) Because they are inflexible. Based on a 'one-size-fits-all' principle, they make no allowance for different types of learners and learning environments.

e) Because they induce an inordinate level of anxiety and stress. In addition to widespread trauma, mass media and psychological counselors report a growing number of exam-induced suicides and nervous breakdowns.

f) Because while a number of boards use good practices in pre-exam and exam management there remain several glaring shortfalls at several boards.

g) Because there is often a lack of full disclosure and transparency in grading and mark/grade reporting.

h) Because there is need for a functional and reliable system of school-based evaluation.

### 2.6.3.2. what reforms are needed?

The reforms needed in the examination are:-

- to include questions which need innovative problem solvers,
- bring social justice.
-test higher order skills like reasoning and analysis, lateral thinking, creativity, and judgement.
- flexiblilty so as to accommodate different types of learners and learning environment.
-not be stressful and anxiety-causing, have proper examination management in their conduction.
-have full disclosure and transparency in grading and grade reporting.
-and have functional and reliable school based credit.

**Short-in- text questions:-**

- Write any three reasons for introducing examination reforms.
- State any two reforms needed in the examination system.

### 2.6.4 FLEXIBILITY

We have different types of learners who are taught and learn in different environments.One Size Does Not Fit All. So is the case with the examination also. There is need for flexibility in exam systems. Examination system needs to be more flexible. We must ensure that education and assessment systems are fair to all social groups. We should ensure that they do not discriminate against particular kinds of learners. There is a lot of psychological data to suggest that different learners learn differently, and, hence, to test all learners through a written test of the same type in subject after subject is unfair to those whose verbal proficiency is superior to their writing skills, those who work more slowly but with deeper insight, or those who work better in groups than individually.

#### 2.6.4.1 Ways to introduce flexibility in examination

For introducing flexibility in the examination, the following solutions can be helpful:-

1. **Flexibility in assessment:-**

There should be more varied modes of assessment, including oral testing and group work evaluation. As sensitive teachers usually pick these unique strengths and weaknesses of students, one should utilize their insight in assessment and empower them and the system of internal assessment. At the same time, to prevent its abuse by schools (as is currently the case in practical exams), internal assessment must be graded on a relative, not an absolute, scale and must be moderated against the marks obtained in the external exam. External moderation of internal assessment through mandatory random sampling is strangely absent at present. Abuse of the system by schools is rampant, the end-users have little faith in it, and boards, aware of this, usually report internally assessed marks separately, thus allowing them to be ignored.

2. **Do not expect everything of everybody in every subject:-**

One can appreciate the rationale for not having different curricula for different types of schools and types of students. (As has been argued—most forcefully in Maharashtra—this would perhaps create a hierarchy within the same exam board and create two classes of learners.) But, just as we allow students and schools some element of choice in the choosing of their subjects, they should have the choice of picking one of two levels within the same subject. Of, say, six subjects, every student would choose to do 3 (or 4) exams at the higher level and 3 (or 2) exams at the standard level. Though set on the same curriculum, higher-level exams would have a large component of high-order-skill testing and demand greater speed, conceptual understanding, and depth of insight than the standard-level exams. Not only would the above reform cater for different kinds of learners and allow different levels of testing, it would also reduce overall student stress levels. Secondly, this reform, will also improve the overall pass rate.

3. **Flexibility in when exams are taken:**

If it is accepted that learners learn at different paces, there is no reason, other than administrative convenience, to test them after two years of higher secondary course in all subjects simultaneously. The students be allowed to clear some (up to two, perhaps) subjects at the end of the XIth (or the IXth grade for the secondary exam). This would not only reduce stress a year later but also make for better long-term learning—and cause very little inconvenience to exam boards. Allowing students to take another two exams in the middle of the XIIth (or the Xth for secondary exam) would require boards to depart from their once-a-year schedules (barring re-takes). It would lead to a more learner-friendly system. In general, every student should be given a three-year window within which all the subjects must be passed (or scores improved). In any one exam session students should have a choice of taking no exam, all exams, or a few exams. This reform besides allowing for learning and testing to take place when a student is ready for it (rather than when the board declares it on a one size-fits-all principle), also works towards social justice.

4. **Enhanced reporting of performance (or comparing apples with apples):**

Along with the absolute mark (or grade) in each subject, it is now very easy, given computer-based registration, to provide information of relative performance on the mark sheet. Percentile rank should be given with respect to (a) the entire universe of candidate (a) the entire universe of candidates in that subject, (b) all candidates in that school, and (c) all candidates in that block. A student from a disadvantaged area with low-quality educational infrastructure who scores, say, 70% (absolute marks)would attain a percentile rank on 95% within her block—a commendation that deserves mention. A South Mumbai student at an elite school who also attains 70% may, likewise, attain a percentile rank of only 50% within the school and 60% within the block.

**CONCLUSION:-**

Different learners learn differently and therefore there should be flexibility in modes of assessment also. There should be flexibility in choice of levels of the same subject. Different learners learn at different pace, therefore, there should be flexibility with respect to learners appearing for examinations.

**Short- in –text questions:-**

Complete the ways to introduce flexibility in examination:-

- Flexibility in ______________.
- Do not expect everything___________________.
- Flexibility in when ________________________.
- Enhanced reporting of _______________________.

### 2.6.5 QUALITY AND RANGE OF QUESTIONS

Paper setting is also one of the important aspects of examination which needs reforms. The questions that are set in the examination are just to test the cramming power of the students. These do not test higher order thinking skills of interpretation, analysis and creativity. Therefore question setting also needs improvement as discussed below:-

- Questions that require students to draw on two or more areas of the syllabus would also allow more comprehensive testing within lesser time, in addition to constituting good educational practice by calling on candidates to make relevant connections between material from different chapters. This is a much-needed skill but rarely tested in Indian board exams. If we accept that education is all about making lateral linkages, all about creating 'an ecology of knowledge in the brain', such questions are surely necessary.

-A shift in emphasis from 'short answers' which are often based on familiarity of two obscure lines on a particular page to MCQs designed to test real understanding of core concepts would help reduce student anxiety, in addition to allowing greater differentiation at the top end.

- A shift in emphasis to testing competencies and away from memory would certainly reduce stress, in addition to aiding the validity of exams. A long-term move toward open-book exams can be envisaged

-The focus of questions should, likewise, move to genuine applications from mere 'plug-in'-type problems. In history, questions which test whether students know where each of the Indian National Congresses met (pure rote) be replaced with questions on the significance of key Congress sessions.

**Quality and Range of questions:**

For evaluation purposes, question papers need to have questions of good quality. These shall be questions of wide range so as to enhance validity and reliability of evaluation. The characteristic of quality questions in general can be enlisted as follows:-

- **Clarity**: The question should have clarity so as to elicit correct response4s. The questions should not be ambiguous.
- **Grammatically correct**:- The stae4ment of the q1uestions should be grammatically correct so as to be understood by the students in correct sense.
- **No double questions**:- Questions asking for two things together should not be there such as "what and where" "Why and How" in a single statement.
- **Specific**:- The questions should pin-pointedly state the information to be sought.
- **Scorable** :- he question should be easily and fairly scorable.
- **In consonance with the aims of the subject**:-The question should be carefully prepared so as to take into consideration the aims of teaching the particular subject for which these are being prepared.
- **Covering the content**:-The questions should be spread over the whole syllabus.
- **Equal emphasis on all aspects**:- There should be equal emphasis on questions based on knowledge , understanding, skill and application type .

Along with quality of questions, examination should include wide range of questions also. These include; i) Essay type questions, ii) Objective type questions, iii) Short answer type questions and iv) Oral tests questions

- **Essay type questions**: Essay type questions call upon to answer to testing the student's abilities to organize and summarise ideas; describe events, persons and places; interpret date; apply principles; think creatively and critically. It evaluates the qualitative aspects of verbal expression of thought.

**Defects in the Essay type questions**:- Essay type questions have been criticized for being lengthy, not objective bases, not covering the whole syllabus , not having clear scope and definite and not being valid and reliable .

**How to increase validity and reliability of Essay type questions:-**

To increase validity of essay type questions, these should be objective based, complete coverage of syllabus, not requiring very lengthy discussions, clear and definite question, and thought provoking questions. For making essay type questions reliable, these should be with detailed instructions, good system of scoring, careful checking of answer sheets and avoidance of subjectivity and irregularity in scoring.

**Objective type questions**:

Objective type questions are constructed to avoid defects of essay type question. These help to avoid the variability of standard and of marking, the incidence of luck in answering, avoidance of subjective element in assessment and thorough and precise explanation of mind of each pupil.

**Defects of objective type questions**: Objective type question had certain defects like these do not have depth of knowledge, no focus on style and writing, inability to test controversial knowledge, encourage guessing, psychologically unsound, expensive and time consuming and need trained experts.

**Advantages of objective type questions:-** Objective type questions are highly reliable, highly objective, economical, comprehensive more scientific, need minimum cramming, eliminate bluffing, free of complications, test knowledge and not language and have no influence of style and handwriting in evaluation.

**Types of objective type questions:-**

i) True False, ii) Multiple Choice, iii) Matching type, iv) Completion test, v) Arrangement type, vi) Simple recall type, vii) Recognition type, viii) Distinction type, ix) Definition type, x) Classification type.

**iii)** **Short Answer type questions:-** Short questions require pin-pointed answers. Answers may vary from one word to fifty words. The main purpose here is to test a large amount of knowledge, ability and understanding within a short time.

**iv)** **Oral Tests:-**

Oral tests are useful in testing certain skills like pronunciations, comprehension, spontaneity of responses, promptness in arguing, verbal expression in language etc.

Oral tests have some draw backs like:-Oral testing for all pupils is difficult, no written proof for examiner, subjectivity on the part of examiner and not useful for recessive children.

In fact a judicious combination of essay type, objective type, short answer type and oral tests can be ideal for evaluative purpose.

**SHORT IN TEXT QUESTIONS**:-

Q1. Enlist any five characteristics of good quality questions?

Q2.Four main type of questions are :-

(i)____________,(ii)________________,(iii)________________,(iv)______________

_.
Q3.Name various types of objective type tests.
Q4. How can validity and reliability of essay type questions be increased ?

### 2.6.6 SCHOOL BASED CREDIT / SCHOOL-BASED ASSESSMENT

There is a need to increasingly shift towards school-based assessment, and devise ways in which to make such internal assessment more credible. Each school should evolve a flexible and implementable scheme of Continuous and Comprehensive Evaluation (CCE), primarily for diagnosis, remediation and enhancing of learning. The scheme should take, into account the social environment of and the facilities available in the school. Sensitive teachers usually pick up the unique strengths and weakness of students. There should be ways of utilising such insights. At the same time, to prevent abuse by schools (as is currently the case in practical examinations), the students could be graded on a relative, not an absolute, scale and must be moderated and scaled against the marks obtained in the external examination. More research is required on development, teacher training and relevant institutional arrangements. There is need to strengthen school based credit if examination reforms are to be done in reality.

1) **Continuous and comprehensive evaluation(CCE):** Evaluation is basically of two types- (1) Summative evaluation which is carried out at the end of the course to assess whole learning outcome. (2) Formative evaluation which is carried out to throughout the course regularly so as to assess learning time to time and bring improvements. The school-based continuous and comprehensive evaluation system should be established in order to (i) reduce stress on children, (ii) make evaluation comprehensive and regular, (iii) provide space for the teacher for creative teaching, (iv) provide a tool for diagnosis and for producing learners with greater skills. The CCE scheme should be simple, flexible, and implementable in any type of school from the elite one to a school located in rural or tribal areas. Keeping in view the broad principles of the scheme, each school should evolve a simple suitable scheme involving its teachers, and owned by the teachers.

2) **Issue of CCE certificate:** To make CCE effective, some weight to school-based assessment (SBA) should be given in the school-leaving certificate issued by State Education Boards. The certificate of the student's performance in the school, in all areas, should be issued along with the board certificate by the board. The performance should be shown in terms of grades in each area appropriate to the stage of schooling. The two types of assessments, i.e., internal and external, should, ideally, be shown separately in the certificate issued by the board.

**3) Keeping internal assessment honest:** A method of internal grading with external moderation(through random but mandatory sampling)by the board can help in keeping the internal assessment honest. In other words, designated samples of internally assessed work must be sent to the board in each subject. In cases where the board is satisfied with the quality, they should get its mark of approval. Otherwise, the remark accompanying the CCE mark on the mark sheet will read:‘ Declared by school with no board authentication.’ In cases where quality standards are met but the marks awarded are too high reference should be made to the school average for CCE—which would automatically deflate the attainment in the eyes of the end-user in cases of over generous marking.

**4) Practical Examinations:** The shabby assessment of science practicals by schools, in most boards, with a majority of candidates getting full or near-full marks(often without even the experiment having taken place) is a good illustration of what happens when boards abdicate their responsibility to monitor and moderate samples of school-based evaluation. Unless laboratory assessment is made less farcical, the quality of the country’s scientific manpower is under serious threat; the number of students interested in scientific pursuits is already stagnating in several states.

**Bases of internal assessment:**

Internal assessment should be based on the following:

1) Monthly tests and house examinations (Written); 2) Oral test; 3) Class-work and class discussion; 4) homework and assessments, 5) practical work in laboratory, 6) Articles prepared in the craft work, 7) self-study in library, 8) participation in debates, declamation contests, poetical recitations and dramatics etc, 9) participation in games, magazines and such like other activities.

**Merits of internal Assessment:**

1) More valid ,2) More reliable,3) Continuous evaluation, 4) Motivational value, 5) Diagnostic value , 6) Instructional value, 7) No undue strain, 8) Data for reports and records, 9) Basis for scholarships, 11) Positive result.

**Problems concerning school based credit**

- problem of competence of teachers, ii) Problem of coordination of standards, iii) Problem of lack of facilities, iv) Problem of workload of teachers, v) Problem of acceptance, vi) Problem of relating school based credit to external assessment, vii) Problem of scientific basis

**To overcome the shortcomings of school based credit, Indian education commission made the following recommendations**

- Comprehensive assessment, b) Descriptive and quantified, c) Use of standardized achievement test, d) Developing other tools of evaluation, e) Training to teachers, f) Separate results, g) Finding correlation.

**Safeguards for using school based credit as suggested by zonal workshops on examination reform 1974**

The introduction of school based credit has in the past led to some difficulty as it was adopted without adequate preparation. It is necessary to involve the students and teachers in the basic philosophy we should inspire and inform the scheme of school based credit. The following safeguards have been suggested so that the provision is not based for over-estimating or under estimating the performance of students by individual schools in order to compare with the other colleges or unscrupulous teachers to favour some students and victimize others.

- **Trying out** : School based credit may be tried out at least begin with first in the unitary universities , well established postgraduate departments and autonomous colleges.
- **Knowledge of result and revaluation:** it is necessary that marks or grades obtained by the students are made known to the immediately after evaluation is completed.
- **Records of school based credit** : the records of school based credit should be maintained so that a proper scrutiny or statistical analysis can be carried out. No private tuitions: teachers should not be allowed to take up private tuitions otherwise the scheme of school based credit will not work in view of vested interests.
- **Concrete performance as the base**: school based credit should be based on concrete performance as far as possible.

**Short-in- text questions:-**

- Write any three problems of school based assessment
- Complete the following sentences:-
- Two types of evaluation are:-(i) _____________and (ii) ________________.
- Continuous and comprehensive evaluation is to help in __________ and __________.
- To make CCE effective, some weightage must be given to ___________ in the school leaving certificate to be issued by the state board of examination.

### 2.6.7ALTERNATIVE MODES OF EXAMINATION

| | | |
|---|---|---|
| There are many approaches that are better than written tests for assessing learning–and, crucially, they do not penalise learners who struggle with academic exams. Here are some methods of assessment that can work.<br>1. **Adaptive testing:-**A computer-based testing model that automatically pinpoints areas where learners can improve. If the student gets a question wrong, an easier one is generated, or if they get one right, a harder one comes up. As the difficulty of each test is tailored to the student's ability, the candidate has a vastly enhanced learning experience. Moreover, all questions come from the same item bank, so the results can be graded and standardised nationally.<br>2. **On-screen testing:-**Computer-based testing allows an emphasis on non-written items, such as pictures, diagrams and drag-and-drop tasks, so language isn't a barrier. Learners can take tests whenever they are ready, not just at the end of term, as the randomised | | |

questions mean there's no danger of students copying each other. This method can be adopted specifically when assessing competency and capability skills, rather than knowledge. A great benefit of this approach is that teachers are saved a huge amount of admin and marking time.

3. **Simulations:-**Unlike written tests, technology can be used to immerse the learner in the simulation of a real-life scenario and assess how they respond to applying their knowledge in the appropriate context. This practical assessment of skills is delivered using web and tablet-based technologies. Sometimes, however, there is no substitute for testing skills in a real-life scenario and, as with adaptive testing.
4. **e-Portfolio:-**e-Portfolios are ideal for supporting coursework and end-of-course assessments. They allow a student's work to be assessed, verified, graded and given feedback remotely by the learning provider or a third party. They also mean students have an up-to-date, interactive representation of their achievements as they develop their skills. This approach is useful wherever a portfolio of evidence is needed to demonstrate practical skills. The only limitation is that some students may not have access to a device to create the portfolio.
5. **Pupil products:** The actual products made by the pupil provide useful way of getting evidence of behavior. For example, the creative work of art, painting, drawing etc. of the pupils provides direct evidence of their skills, interests, tastes and aptitudes.
6. **Questionnaire:** A questionnaire is presented to the child and he has to answer each question. Naturally, he shows his likes and dislikes, attitudes and interests through his responses.
7. **Check-list**: Check-list is just a form of questionnaire in which statements and questions are very specific and incorporate a checking feature.
8. **Observation:** pupil's emotional and intellectual maturity as well as his civic and social responsiveness is judged through observation.

Observation provides evidence on the habits and skills of the students and helps in formulating evidence on the habits and skills of the students and helps in formulating judgment about them. The teacher can observe the child in various situation note his comments, relationships with classmates and playmates, attitudes, feelings and new interests and changes in behavior pattern of the pupils. Observation can be of two types: **Current observation**: In current observation, we watch a person actually engaged in activity which may be natural or stages. **Retrospective observation**: Retrospective observation is used when one has to look back upon past experience is used when one has to look back upon past experience and pass a judgment on the child.

9. **Interviews:** by holding interviews the teacher can secure evidence on interests, change in attitudes, habits, and appreciations of interviews. He can elicit even those facts from the pupil which he would not tell otherwise.
10. **Group discussion**: Group discussion is an effective technique for appraising growth and development as all members of the group participate. Specific instances of behavior can be noted. Boldnessing of ideas, respect for the opinions for others, considerations of differing points of view and creativeness of contributions etc. can be observed. Thus an estimate of pupils' needs and potentialities can be performed.
11. **Daily diaries:** Daily diaries should be maintained by the pupils themselves wherein they should faithfully note down their daily activities and experiences, their social problems and personal tensions etc. If they are assured of the usefulness and confidentiality of this record, the pupils will not try to conceal any information from the teacher. These diaries will throw light on their appreciations, interests, and attitudes, personal and social problems.
12. **Anecdotal record**: An anecdotal record is an objective and significant account of pupils behavior

| | | |
|---|---|---|
| and personality in an incident or critical situation observed by the teacher. It throws light on pupil's reactions to various critical situations and his attitude to others.<br>13. **Cumulative record**: The cumulative record id an evaluation device which assists the teacher in knowing child's history in the school. It is a document which presents a complete, detailed and academic, vocational aspect of the personality of the pupil.<br>14. **Library record:** Library record indicates pupils reading interest and habits.<br>15. **Sociometry: this** device attempts to discover patterns of social acceptance and rejection, popularity and unpopularity, sociability and leadership traits in the students in relation to the wholeness.<br>16. **Case studies**: Case study means systematic, complete and intensive study of the pupil – his family background, his physical, social, emotional and intellectual environment.<br>17. **Rating scales:** by rating is meant the qualified judgment or opinion of one person by another. Opinions are usually expressed on judgments of the degree to which an individual possesses certain behavior.<br>**Conclusion:-** These alternatives to academic testing show that the key is finding the right balance. Some areas of education will always need a more academic, exam-based approach. But when assessing practical skills we need to be open-minded in the methods we use and take advantage of the opportunities that technology offers.<br>**Short in text Questions:**<br>Q.1. Name any four alternative modes of examination.<br>Q.2. Pupil's products, observation, Group discussion and interview can be used as ______modes of_________. | | |

## 2.6.8 SUMMARY

Evaluation is a necessary evil. Our examination system which is full of merits as well as demerits is being continued as such since olden times. With changes in the society and change in nature and type of learners, we need reforms in the examination system also.There need to be introduced flexibility . To increase reliability and validity of the examination, a good quality and wide range of question should be included so as to enhance responses of learners. Another reform to be included is school based assessment which should be utilized in its true sense. Alternative modes of evaluation should be there so as to give the chance to those learners even who are not able to perform well in written type examination.

## 2.6.9 KEY CONCEPTS

1. **Examination reform:** These are changes to be introduced in the examination system to do away with its faults.
2. **Evaluation:** Performance assessment of the learning of the learners which gives assessment of the teaching to the teachers also.
3. **Flexibility in examination:** To introduce different ways of examination allowing examination at learner's own pace etc. according to the learner's circumstances.
4. **School-**based credit/school based assessment:- Performance assessment or evaluation of the learners by their own teachers keeping in mind the type of learner along with strengths and weaknesses of the learner.
5. **Quality and range of questions:-** Evaluation of the performance of the learners can be considered best when questions of good quality and wide variety are included for testing.

## 2.6.10 SELF-CHECK EXERCISE

Q.1. Explain the need of examination reforms?

Q.2. Why examination system should not be rigid? What are various ways of introducing flexibility in the examination systems?

Q.3. Discuss various types of questions which can be put in the examination. Also write advantages and disadvantages of each type?

Q.4. Elaborate the concept of school based assessment.How its use can be made more effective?

Q.5. Write in detail various alternative methods of examinations?

## 2.6.11 SUGGESTED READING AND WEB RESOURCES

*Walia,J.S.(2005). Foundations of school administration and organization, Paul publishers, Jalandharcity(Punjab).*

*Aggarwal,J.C. (2001). School Organisation, administration and management, Doaba House, Delhi.*

*Safaya, R. &Shaida, B.D.(1972). A modern approach to school organization and administration and management. Dhanpat Rai & Sons. Delhi.*

*Sachdeva,M.S.(2008). A modern approach to school organization and administration. Vinod publications, Ludhian*

*Sodhi,T.S. & Suri, A. (2002).Management of School Education. Bawa Publications, Patiala.*

**Web Resources**

*epathshala.nic.in/wp-content/doc/NCF/Pdf/**exa***

*www.ncert.nic.in/rightside/links/pdf/.../Systemic%20Reforms.pdf*