UNIT 13 TABULATION AND GRAPHICAL REPRESENTATION OF DATA

Structure

13.1 INTRODUCTION

In schools we deal with different kinds of data, of which the one pertaining to students is of utmost importance as it is utilized to assess and grade children on the basis of their performance. Apart from assessing the children, data serve numerous purposes such as comparing the learning performance among students, modifying teaching-learning activities, evaluating the student achievement and so on. So as to carry out these activities, data pertaining to children's performance need to be collected. Generally data are collected in the form of numerical or alphabetical form. The process of collecting, organizing, interpreting and analyzing the data is termed as "statistics". In this unit, we shall discuss the uses of educational statistics in assessment, various kinds of data, method of organizing them and the different scales of measurement.

13.2 OBJECTIVES

After going through this Unit, you will be able to:

- describe the term statistics and its use in assessing and evaluating children's performance;
- state the meaning and nature of data;

- explain the importance of data organisation;
- present data in frequency tables;
- compare various methods of representing data;
- draw various types of graphs;
- explain the use of different graphical methods of representing data; and
- recognize scales of measurement.

13.3 USE OF EDUCATIONAL STATISTICS IN ASSESSMENT AND EVALUATION

Imagine an eighth standard classroom wherein 50 students got admitted in the year 2014, 48 in 2015 and 46 in the year 2016. The class teacher of that particular class organized the same data in a tabular form as shown in the Table 13.1.

Table 13.1: Year-wise admitted students

Admitted Year	No. of Students
2014	50
2015	48
2016	46

What can we understand from it? Generally the schools or any educational organization deal with different kinds of data related to students and administrative aspects, and such data need to be collected, organized and interpreted to make valuable decisions that have long term effect. Many a times, the schools find difficult to deal with large volume of data concerning their organizations and in such situations, the mathematical technique, 'statistics' help them deal with the data. **The mathematical process of collecting, organizing, interpreting and analyzing the data are termed as "statistics".** In statistics, data related to any individual/organization/behavior etc. are expressed in numerical form.

The word statistics is derived from the Latin word 'Status', Italian word 'Statista', German word 'Statistik', and French word 'Statiique' , which all means 'political state'. It provides data concerning the various attributes of state/country that help in successful administration.

Seligman defines "**Statistics is the science which deals with the methods of collecting, classifying, presenting, comparing and interpreting numerical data collected through some light on any sphere of enquiry**" (quoted from Pilai, 2008). In fact, educationists and psychologists use statistics widely to study human behavior. At the same time, statistics also help a teacher analyze and judge students' performance. In this Unit, we will study statistics in the context of assessment and evaluation. Before that, let us recapitulate some basic concepts of statistics. There are five types of statistics, which are described in Figure 13.1.

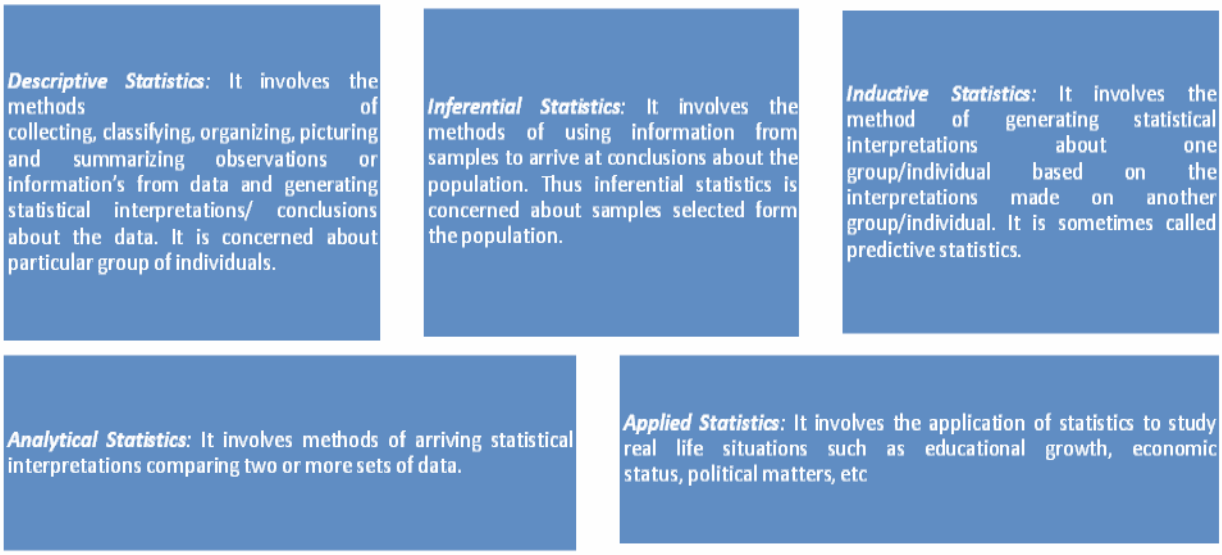

Figure 13.1: Types of Statistics

Statistics is used in many subjects like Mathematics, Science, Psychology, Commerce, Economics, Social Sciences, Geography, Agriculture, Business Management, etc. Being a teacher trainee, you are more concerned with its use in education. Can you identify few situations where statistics is made use of in education? Why don't you try the activity given below for better understanding?

Activity 1

Select a topic of your choice and teach it using two methods, say constructivist method and concept attainment model. Conduct an achievement test in both cases and analyse the results. Which method do you find effective? Prepare a report on the activity conducted.

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What do you observe as you complete the activity? How will you draw conclusion about the achievement of the students taught through two methods? Definitely, in order to draw conclusion, you might require the use of statistics. In education, you may find number of instances, where statistics is profusely used. This illustrates the significance of statistics in education. In the activity given above, you may use 'correlation', a statistical concept to make judgment

on the effectiveness of teaching methods. Similarly, statistical techniques like mean, median, mode, standard deviation, etc are widely used in analyzing and interpreting data. A few such applications are discussed below. These concepts/ techniques have been discussed in the further Units (Units 14, 15 & 16) of this Block.

- 'Raw scores' of children are converted to 'standard scores' to formulate inferences. At times even raw scores are also used to arrive at conclusion.
- 'Mean', 'median', 'mode' are used to find the average of observations.
- 'Range', 'Quartile deviation', 'Average deviation' and 'Standard deviation' are used to find the extent of variation from the mean scores of observations.
- 'Normal probability curve' helps us to understand the nature of particular group of students.
- 'Correlation' helps to find out the relationship between the groups with regard to certain variable.
- 'Analysis of variance' again helps teacher to compare performance of students and 'critical ratio' between means and test the significance of difference.

By this time, you understand that statistics plays a pivotal role in education. Without statistics, it is difficult for the teacher to interpret and judge the learning performance of children. Not only learning performance, performance of students in co-curricular/extracurricular activities analysed and interpreted using statistics. For example during sports meet, running time of students participating in 100m race marked in numerical terms. As we know, assessment and evaluation are two critical aspects of teaching –learning process. Assessment is the process of collecting scores and evaluation is the interpretation of that score. For example, a teacher conducts a unit test for a particular unit. The marks against each student depict the assessment while assigning them rank is evaluation. The whole process involved is statistics. The following are the utility of statistics in assessment and evaluation.

- It helps teacher analyse and interpret scores. Usually raw scores are collected from students performance in examinations, drawing test, sports activities, etc. Raw scores itself has no meaning and they are converted to standard scores/derived scores and interpreted to judge the students performance.
- It helps teachers compare the scores of different groups within the school or outside. A teacher can evaluate the achievement of students belonging to different classes using statistical procedures. Comparison can also be done among different organisations.
- It helps teacher construct standardized achievement test. The statistical procedures are followed at various stages of test construction, especially during item analysis.
- Statistics helps to determine the individual differences among children. As we are aware, no two individuals are alike and they differ in intelligence,

aptitude, attitude, personality, etc. Individual differences are measured with the help of various tests and the result is interpreted using statistical techniques.

- When the standardised tests are administered on children, the results obtained are analysed and used for providing counselling and guidance services.
- It helps a teacher predict the future performance of children. As discussed each individual is different from the other. A child who has scored high marks in an intelligence test may perform well in other fields. Accordingly the teacher would be able to predict his/her future career.
- It helps a teacher make selection, categorisation and promotion of students. The tests conducted at school level serve different purposes such as for promoting children to higher classes, for selecting to various arts/sports activities, and for categorising them based on their performance.
- It helps a teacher compare the functioning and working of his/her organisation with that of other. We have observed certain schools performing better compared to others which is revealed through statistical analysis.
- One of the most important applications of statistics is its use in educational research.

Let us attempt a question now.

Check Your Progress 1

Note: a) Write your answer in the space given below.

b) Compare your answer with those given at the end of the Unit.

1. What are the uses of educational statistics in assessment and evaluation?

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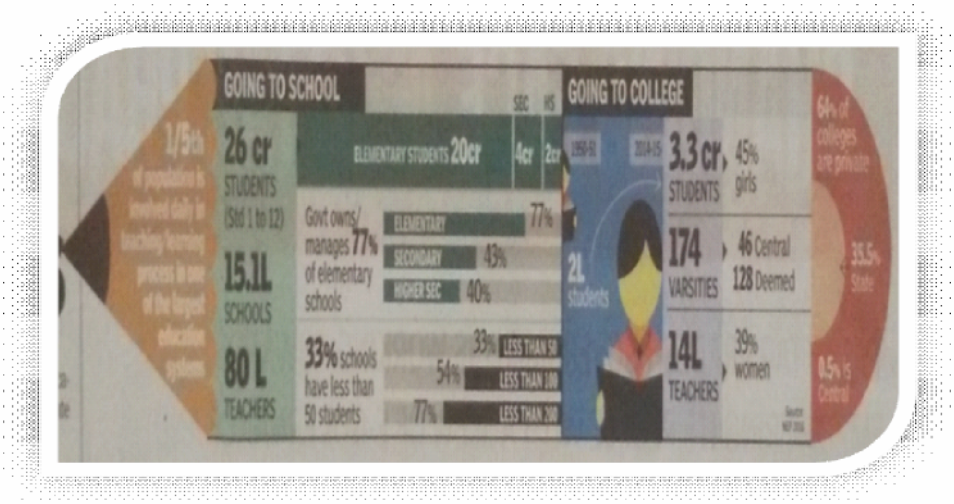
13.4 MEANING AND NATURE OF DATA

Joseph, a secondary school teacher was going through the newspaper 'Times of India' (June 18, 2016) and found interesting news about the 'draft education policy'. It says that, there are 26 crore students (1 to 12 standard), 15.1 lakh schools and 80 lakh teachers. The newspaper also had information related to other aspects of education, as shown in the figure 13.2. What does it imply? In daily life, people obtain different information either through newspapers, television, internet and other media. It is from such information meaningful interpretations are made.



Source: Times of India, (June 18, 2016)

Figure 13.2: Data in News Paper

Let us take another example. A teacher of eighth standard marks the attendance of children present on a particular day (the total number of students is 55). She asks children to raise their hands as she calls out their roll numbers. While she calls out roll numbers 3, 34 and 42 none of them raise their hands. In such a situation, the teacher would presume that, these children are absent on that particular day. So we have the information that the classroom mentioned is eighth standard, there are a total of 55 students and three students are absent. She can further enquire about the reasons of absenteeism. This is how interpretations are made from the available information. So whether it is newspaper, television or classroom, the information are collected and valid interpretations are generated. So in simple terms, the facts concerning situations/ individual/group from which conclusions are drawn are termed as data.

Data is the plural form of the word 'datum' which means 'fact'

Evidence or fact which describes group or a situation and from which conclusion is drawn is called data (Biswal & Dash, 2009). In statistics data represents any kind of information obtained from an experiment, observation, interview, or through any investigatory procedures. In the context of schools, the information about the total number of students, the number of teachers, the periods allotted for each subject, number of absentees each day, the marks scored by children in term end examinations and assignments, participation in co-curricular activities, mode of transportation in reaching schools, etc. represents data. These information (or data) would help a teacher in many ways such as, to judge her children's learning performance, recognize talents of children in extra curricular activities providing guidance and counselling services and so on. At this point, attempt the activity given below, and formulate a conclusion.

Activity 2

Distribute the following sheet to your peers and ask them to fill it. What conclusions would you about the socio-economic status of the peers arrive at?

S. No	Name of the Peer	Occupation		Annual Income		Education	
		Father	Mother	Father	Mother	Father	Mother

Let us explore a few more basic concepts of statistics and data in special. Data is any kind of information from which conclusions are made. Data are classified into two; primary data and secondary data. A brief description of them is given in figure 13.3:

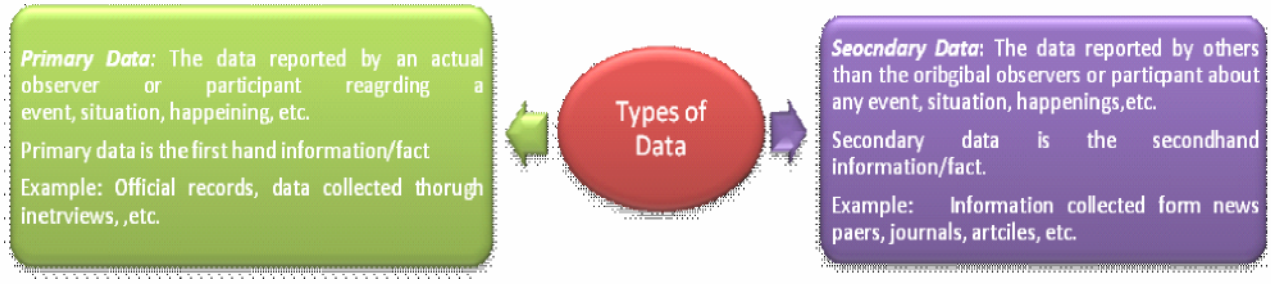


Figure 13.3 : Types of Data

Suppose you are planning to select 20 students from a total strength of 400, studying in seventh standard, to be trained for a drama competition for state level. In such a situation we have two sets of students i.e. the total 400 students and 20 students to be selected from the 400. You may come across similar situations action researches/educational researches. In educational research, two basic concepts; population and sample are very important. Let us briefly understand these two concepts from Figure 13.4.

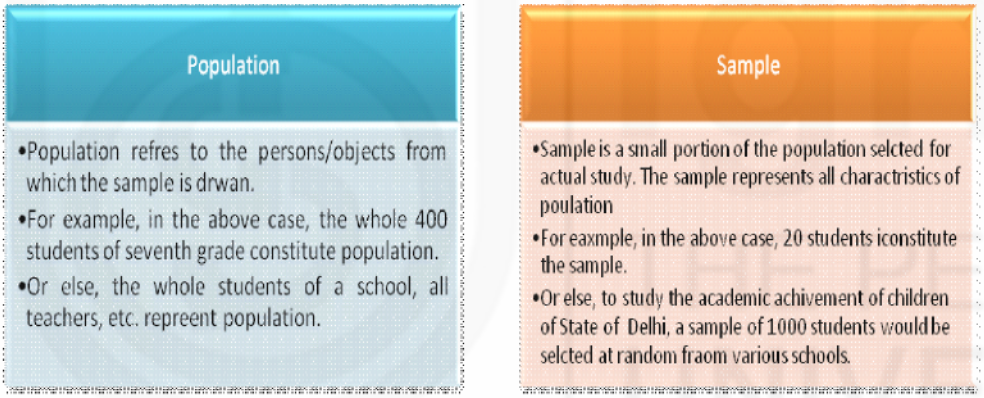


Figure 13.4 : Population and Sample

Having understood population and sample, let us explore the concept “score”, a common term, frequently used in educational research, statistics and school settings. Score refers to the numerical description of the performance of any test, for example, the score secured by a student in social science term-end examination. There are two types of scores. They are described in Figure 13.5.

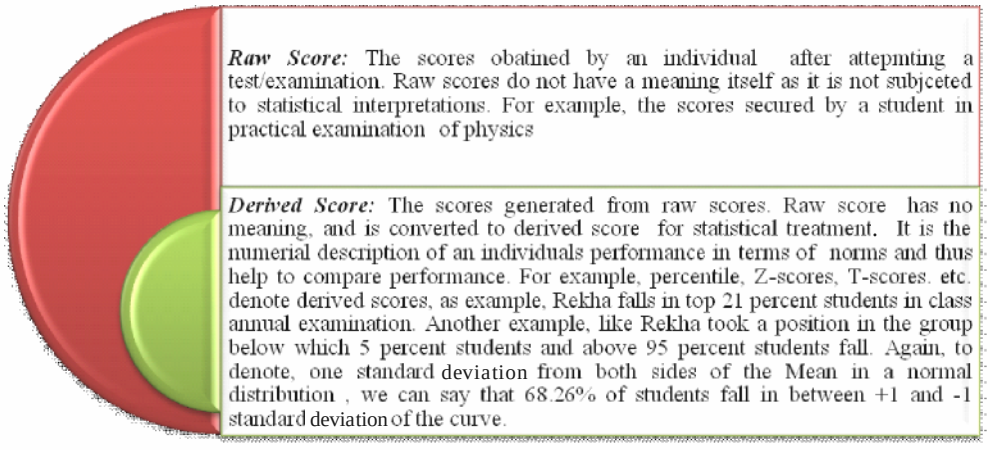


Figure 13.5: Raw and Derived Score

Check Your Progress 2

Note: a) Write your answer in the space given below.

b) Compare your answer with those given at the end of the Unit

2. Differentiate primary and secondary data.

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13.4.1 Discrete/Raw and Group Data

We have already discussed that data are the evidences or facts that describe a person/group from which conclusions are drawn. Generally the data are collected from the population. For example, number of students who failed in Class – X examination during the academic year 2015. Here the number of students failed (say for example 23 students) represents the data. Apart from primary and secondary data, data could be qualitative or quantitative; or continuous or discrete. Let understand each of these concepts.

Series: Series is the sequence of number that has some relationship with each other. For example, the weight of students may be 40kg, 41.5, kg and so on.

Qualitative Data/Series: The data (facts, Items. events, persons, phenomena, etc) expressed in qualitative terms are called qualitative data. Qualitative data are not measurable on a scale. For example, gender of students, type of school, mode of transportation of children, etc.

Quantitative Data/ Series: The data expressed in numerical format are called quantitative data. Such data are measurable and countable. For example, the data showing the children who passed tenth grade, children's attendance in a particular day, etc.

Continuous Series/Data: The data expressed in a sequence form are called continuous data. There will not be any gap in between the numbers. Continuous data are expressed as fractions. For example, the height of the children may be 5'7" or 5'4" and so on.

Discrete Series/Data: If the data expressed have gaps in between, such data are called discrete data. Discrete data are represented as whole numbers and not as fractions. For example, number of children in a particular class, number of periods in a day, etc.

13.5 ORGANIZATION/GROUPING OF DATA: IMPORTANCE OF DATA ORGANIZATION AND FREQUENCY DISTRIBUTION TABLE

You may recall the annual sports meet of your school. Suppose in the long jump event for junior girls, there were 15 students and each student got three chances. The competition was organized in such a manner that, each student attempted their first chance and the same was repeated till each participant completed their third chance. Rajendra Kumar, the mathematics teacher, was entrusted with the responsibility of entering the attempts made by each student. Let us see how he had done it.

1) Student 1 : 3.2m, 3.2m & 3.3m
2) Student 2 : 3.5m, 3.4m & 3.5m
3) Student 3 : 3.4m, 3.4m & 3.3m
4) Student 4 : 3.6m, 3.7m & 3.5m
5) ……
6) ……

Rajedra Kumar continued marking attempts made by 15 students. Now the question is, how will you determine the winner of the competition? The answer is very simple. Just look for the student, who had jumped maximum distance. But the question is, will you be able to identify the winner so quickly. The answer may probably be 'no'. Why is it so? In this case, Rajendra Kumar had marked student attempts in such a way that, it is difficult for someone to interpret so quickly. Here you may feel that, the winner can be easily identified as the number of students are comparatively less, but think of a situation, where there are large numbers of participants. So, there arises the need for organizing scores, measurements, attempts, etc, so that it will help one to interpret data easily.

Let us discuss another example. A teacher conducts a unit test in social science for 45 students. If the teacher arranges marks secured by each student in serial order, it may be difficult to identify the students who scored high mark, low mark, the students who failed and so on. In this case, the marks obtained will be converted to classes (for example, students who scored marks in between 10-20, 20-30 and so on), and then it is presented in a table so that one may be able to recognize the performance effortlessly. **The arrangement of data in a table in sequential manner is called frequency distribution.** The term 'frequency' refers to the number of cases or objects in a category or class. For example, suppose 8 students scored mark below 35 in the term examination, then the '8' represents frequency. The data may be arranged in a systematic way as follows (Biswal & Dash, 2009):

- In the form of statistical table
- In the form of rank order, and
- In the form of frequency distribution.

Let us elaborate our discussion on frequency distribution. Suppose, Ms Radhika, a physical education teacher is interested in measuring the weight of the children studying in seventh standard. To do the same, she arranges a weighing machine and calls students as per their roll numbers. She weighs each student's weight using the weighing machine and notes down them on a piece of paper. Her recordings students weights are shown in Table 13.2:

Table 13.2: Discrete Data

Roll No	Name of the Student	Weight
01	Student A	32
02	Student B	38
03	Student C	31
04	Student D	27
05	Student E	39
06	Student F	36
……..	……..	…….

The recording was done for 48 students of the class. Now the question is "can we locate the student who is underweight/overweight'? How many students have weight between 30kg-35kg? To answer such questions, we may convert the data into frequency distribution. So frequency distribution is the arrangement of scores and frequency of their occurrences or frequency distribution refers to the tabulation of quantitative data in class intervals which vary in size. From frequency distribution, it is easy to comprehend and understand the general trend of the group and accordingly interpretation can be made. Based on the interpretations appropriate corrective measures may be possible. Let us see the frequency distribution in the above case, where the weights of 48 children are recorded. The frequency distribution is presented in Table 13.3.

Table 13.3 : Grouped Data

Class Interval	Frequency
25-29	12
30-34	31
35-39	3
40-44	2

From the frequency distribution, it is evident that the students studying in seventh standard has a few student whose weight lies between 25-29 kg while majority of them has weight between 30-34kg. Many such interpretations can be made from the frequency distribution. Why don't you try it as an activity?

Activity 3

Analyse the frequency distribution given in Table-3 and note down the interpretations that can be made out of it.

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While discussing frequency distribution, you might notice that, so as to develop the frequency distribution, we need to follow certain procedures and steps. So now let us discuss the procedure followed in developing frequency distribution. For that, imagine a class test conducted by Mr. Ram Vallabh, English teacher of class sixth. The marks scored by 30 students are shown below:

2	22	31	24	15	48	43	28	6	9	38	29	26
37	33	32	26	34	34	40	17	42	40	29	18	35
39	27	25	32									

The above data represents the scores of students in class test and we are going to create the frequency distribution of this particular data. In order to make the frequency distribution the following procedure are carried:

1. Determining range
2. Determining size of class interval
3. Writing contents of frequency distribution

4. Writing class intervals
5. Putting tallies
6. Totalling the number of tallies
7. Checking the number of frequencies

Let us discuss each of these steps briefly.

1. ***Determining range:*** Range is the difference between highest and lowest score in the set of data. In the above case '48' is the highest score and '2'

   Therefore, Range = Highest Score-Lowest score

   Range = 48-2 = 46

2. ***Determining size of class interval:*** Generally the size of class interval is calculated using the formula;

   Size of the Class Interval = Range/No of classes desired

   In this case, Size of class interval = 46/10 = 4.6?5

> Each class has certain number size and is decided based on the following assumptions. But each individual has the freedom to follow these suggestions or not.
>
> - If the number of scores is more than 500, the number of class intervals should be within 25 to 50
> - If the number of scores is more than 200-500, the number of class intervals should be within 25 to 40
> - If the number of scores is more than 100-200, the number of class intervals should be within 15 to 25
> - If the number of scores less than 100, the number of class intervals should be within 5 to 15

3. ***Writing contents of frequency distribution:*** It is sure that, the frequency distribution is made out contents and the same being written in three columns as shown below:

1	2	3
Class Interval	Tallies	Frequency

4. ***Writing class intervals:*** In order to write the class interval, the lowest score and size of class interval is used. In the above case, the lowest score is '2' and size of class interval is '5' and hence the first class interval would be 2-6. The next class interval would be 7-11, 12-16 and so on.

5. ***Putting tallies:*** As the task of writing class interval is completed, you may start putting tallies against each class intervals. For this the number of cases occurring in each class interval is noted and is denoted using tallies. At this point, the style of putting tallies is to be paid attention. In order to put tallies, we may start from 1 and go up to 4, then after the fifth tally we mark it by drawing diagonal line as shown below. In the above example, the number of cases appearing in each class interval is represented using tallies as shown below:

Tally 1	Tally 2	Tally 3	Tally 4	Tally 5
I	II	III	IIII	~~IIII~~

6. ***Totalling the number of tallies:***

As you complete the task of tallying, the next task is to aggregate them. In this example, the total number of tallies against each class interval is given below:

Class Interval	Tallies	Frequency
1-4	I	1
5-9	II	2
10-14	0	0
15-19	III	3
20-24	II	2
25-29	~~IIII~~ II	7
30-34	~~IIII~~ I	6
35-39	IIII	4
40-44	IIII	4
45-49	I	1

7. ***Checking the number of frequencies:***

The final step is to check the total number of tallies to get the total number of cases, 'N'. This is found out by adding all the frequencies. In this case, the total frequency (Σf) is 30, wherein 'Σ' stands few sigma and 'f' for frequency.

Class Interval	Tallies	Frequency
1-4	I	1
5-9	II	2
10-14	0	0
15-19	III	3
20-24	II	2
25-29	~~IIII~~ II	7
30-34	~~IIII~~ I	6
35-39	IIII	4
40-44	IIII	4
45-49	I	1
	$\Sigma f=30=N$	

Check Your Progress 3

Note: a) Write your answer in the space given below.

b) Compare your answer with those given at the end of the Unit

3. Discuss the steps involved in development of frequency distribution.

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13.6 GRAPHICAL REPRESENTAION OF DATA: TYPES OF GRAPHS AND ITS USE

Many a times, numerical data is complex and difficult to interpret and understand. This is true for common people and investigators and in our context for teachers. For example, in the above case, the marks scored by students have been converted to frequency distribution. But at times frequency distribution may not serve the purpose as it is not appealing and complex. So a more interesting and attractive kind of representation came into practice and that is the graphical form of data representation. In graphical representation the data is represented as geometric figures which could be easily interpreted and understood by any one. But the geometric picture needs to be drawn keeping into account the proportion and measurements of data. Thus it is possible to visualize and transform numerical data to picture or graphic format drawn considering a reasonable proportion. Graph represents the numerical data in a geometric figure drawn on scale.

13.6.1 Importance of Graphical Representation

The graphical representation is important due to the following reasons:

- Graphical representations are attractive and beautiful.
- It helps easy visualisation and appealing to eyes.
- Graphical representation facilitates trouble-free interpretation and judgements.
- It gives a bird's eye view of the entire data.
- It is easy to construct.

You may notice that, although we said, graph is a form of pictorial/diagrammatic representation, both are different. Now let us look for the major difference between graph and diagram forms Figure 13.6.

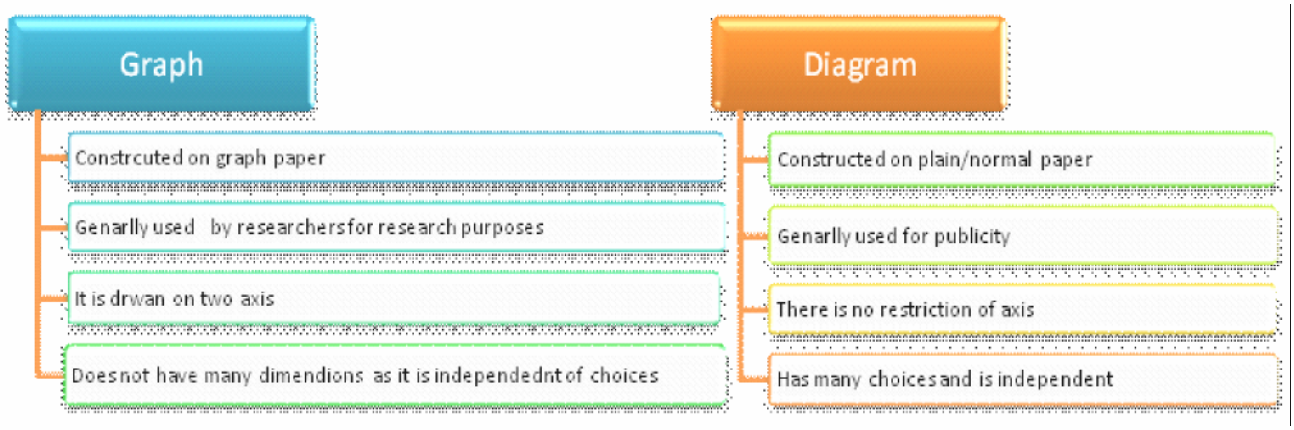

Figure 13.6: Graph and Diagram

13.6.2 General Principles of Drawing a Graph

When a teacher/investigator aspires to convert his/her data into graphical format, he/she needs to keep in mind the following procedures/principles.

1. Draw two perpendicular lines. The point where two lines intersect is called 'origin' and is represented using '0' (zero).
2. The horizontal line is called 'X' axis. The 'x-axis is called abscissa(base)
3. The vertical line is called 'Y' axis. The y-axis is called ordinate (height).
4. The ordinate/height of the graph must be 75% of the abscissa/base. This is called 75% rule. But there is the flexibility to dilate between 60% to 80%.
5. The graph generally has four quadrants as shown in Figure 13.7. But educationists/psychologists usually use the (++) quadrants to utilize maximum space of the graph paper.

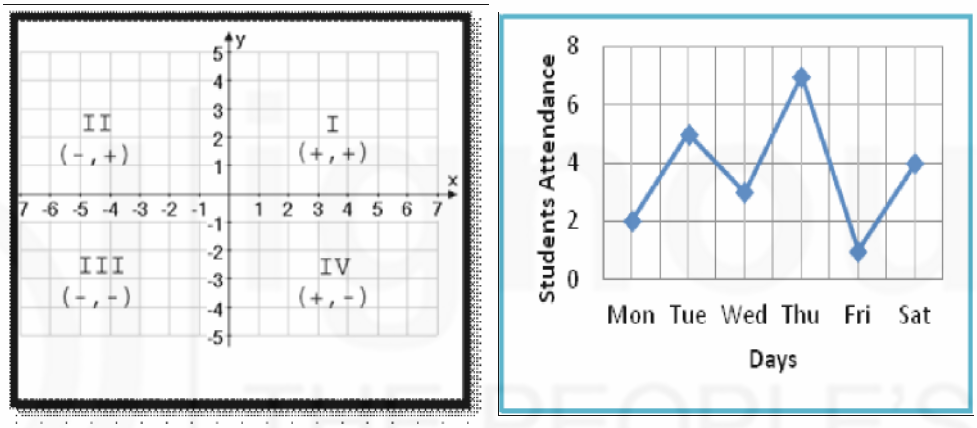

Figure 13.7: Drawing a Graph

13.6.3 Types of Graph/Graphical Representations

In the previous section, we have discussed what graphical representation, difference between graphs is and diagram, how bar graph is drawn, etc. In this section, we will discuss various types of graphical representation/graph and you will find them useful as you teach your students. There are various types of graphical representations for grouped and ungrouped data. Let us discuss those representations separately.

Graphical Representation of Grouped Data

The data in the form of raw scores is called ungrouped data while data organized in the frequency distribution is called grouped data. The following are the different types of graphs/diagrams which we use when the data is ungrouped.

i. Pictograph or pictogram
ii. Bar graph or bar diagram
iii. Circle or Pie graphs/diagram
iv. Line graphs

Now let us discuss each of these graphs in details.

Pictograph or Pictogram

A picture is said to be worth 100 times more meaningful than the words spoken or written. Pictures have the quality to convey ideas in a more meaningful way. Thus the statistical data can be translated into pictures. The pictorial representation of statistical data is known as pictograph or pictogram. Let us discuss an example for pictograph. Consider a school, having the following number of girls in various classes as shown below:

Table 13.4 : Data for Pictogram

S.No	Class	No. of Girls
1	8A	25
2	8B	20
3	8C	30
5	8D	15
6	8E	10

In order to construct the pictograph, we will assign a picture for girl. For example, the picture selected in this case is (a human face). After that, we will convert the above data into pictograph. The pictograph would be like the one given below. Remember that, to draw pictograph, we need to select a scale, for example the scale selected in this case is 5 girls for one picture.

Table 13.5 : Pictogram

S.No	Class	No. of Girls
1	8A	
2	8B	
3	8C	
5	8D	
6	8E	

Pictograph has both merits and limitations. The merit of pictograph is that, it is visually appealing and easy to comprehend. Anyone can easily make out number of girls present in each class without any difficulty. In the above example, the limitation of pictograph was not much visible as we have total number of girls, which is divisible by 5. If the number is not an exact multiple of five, we would have faced difficulty to represent them as pictures. For example, if the number of girls were 23, it would be difficult to represent them. Such complications are very minimal in the forthcoming representations.

Bar graph or bar diagram

In pictograph we have observed that, pictures were used to represent statistical data. Instead of pictures, bar (rectangles with similar width) are used in bar graphs. Thus the mode of representation of statistical data using bars is known as bar graph or bar diagram. The following are the steps used for constructing bar graph:

- Select x axis and y- axis on the graph paper. Generally the x axis is the horizontal line and y axis is the vertical line in the graph.
- The intersection of the x axis and y axis is the origin (marked as '0') of the graph.
- Choose a convenient scale for both the axis's
- Mark the corresponding values against each variable on x-axis and y axis and draw them as bars having equal widths.

Let us now apply these steps to draw the bar graph for the data given above. Here the number of girls studying in various eighth grades is given. In order to draw bar graph, number of girl's students is taken on the y axis and the corresponding grades are selected on the x axis. The resulting bar graph is given below:

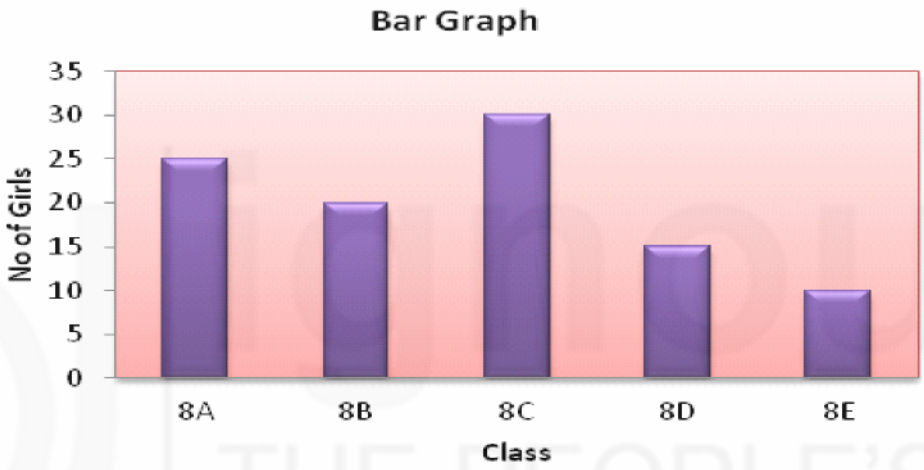

Figure 13.8 : Bar Graph

The next question is to how to interprete bar graph. In this case we can say that, the class 8C has more number of girls compared to rest of the classes and 8E has the least number of girls. What else can we infer? The difference in number of girls among classes 8E and 8C is 20. There are many more inferences that you can draw from the bar graph. Why don't you try it as an activity?

Activity 4

Draw other inferences from the bar-graph other than the ones already drawn above.

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Circle or Pie graphs/diagram

The pi-diagram/pie graph is known as circle graph as we represent the statistical data as circular figure considering weightage given to the proportion of data. Many a times, we are interested to discern percentage of statistical data and in such cases pie-diagram the most popular graphical representation is used.

Thus the percentage break-ups are represented in pi- diagrams. To construct a pie- diagram one should have the knowledge of angle measurements and percentages. Let us understand it with the help of an example.

Adya, the teacher in charge to organize arts festival of Bhawan public school has collected the details of children who wish to participate in picture drawing competition. As per the instruction many students have registered themselves for it. The details of their registrations are given in Table 13.6:

Table 13.6 : Data for Pie graph

S.No	Class	No of Students
1	10	16
2	9	29
3	8	36
4	7	13
5	6	41
	Total	**135**

Let us try to put these details into a pie-diagram. To do so, you should have the knowledge that, the value of a circle is π (2 pie). 2π is equal to $2\times180^0 = 360^0$. Thus the whole circle represents 360^0. Thus we will represent the the total sample i.e. 135 through a circle having 360^0. Let us see how it is done.

In the above example, there are 16 students from 10^{th} class registered for drawing competition. Thus, first we will find out the percentage of students out of 135.

i.e. proportion out of 135= $(16 \div 135) \times 100 = 11.85\% = 12\%$

Now we will find the proportion of 10^{th} class students in 360^0.

i.e. proportion out of 360^0 =$(16 \div 135) \times 360° = 42.66^0$.

Thus in the circle 42.66% represents 10^{th} class students registered for drawing competition. In a similar way we will calculate the student belonging to rest of the classes.

Class 9

Proportion out of 135= $(29 \div 135) \times 100 = 21.48\%$ = 21% (Approx.)

Proportion out of 360^0 =$(29 \div 135) \times 360° = 77.33^0$.

Class 8

Proportion out of 135= $(36 \div 135) \times 100 = 26.66\%$ = 27% (Approx.)

Proportion out of 360^0 =$(36 \div 135) \times 360° = 96.00^0$.

Class 7

Proportion out of 135= $(13 \div 135) \times 100 =$ **9.62%** = 10% (Approx.)

Proportion out of 360^0 =$(13 \div 135) \times 360° = 34.66^0$.

Class 6

Proportion out of 135= $(41 \div 135) \times 100 = 30.37$%s = 30% (Approx.)

Proportion out of 360^0 =$(41 \div 135) \times 360° = 109.33^0$.

Note that, if we add the proportions of different changes out of 360^0, we will get 42.66+77.33+96.00+34.66+109.33 = 359.98 = 360^0. Thus the number of students registered can be represented in percentages. The next step is transferring the percentage breakdowns into different sectors of a circle. For that, draw a circle with a compass. Then depict percentage corresponding to class 10 using the protractor. The same process is repeatedfor each class. The final pie-diagram is shown in Figure 13.9:

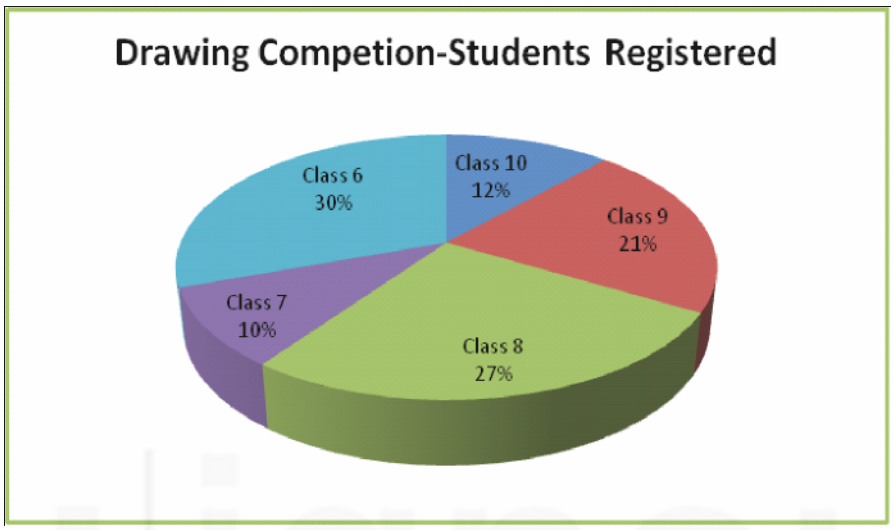


Figure 13.9 : Pie Graph

Check Your Progress 4

Note: a) Write your answer in the space given below.

b) Compare your answer with those given at the end of the Unit.

4. What is pie-graph? Develop pie-graph for the following data.

S.No	Class	No of Students from Urban Area
1	10A	35
2	10B	20
3	10C	42
4	10D	11
5	10E	34

Line graphs

Line graphs are one of the common modes of representations of statistical data. In a line graph the relationship between two variables are illustrated in a graph. The data pertaining to the variables will be marked on two axes namely the x axis and y axis by choosing appropriate scales. Let us illustrate line graph by choosing an example. Below, given are the details of absentees in a particular class.

Table 13.7 : Data for Line graph

Day	Mon	Tue	Wed	Thu	Fri	Sat
Absentees	2	5	3	7	1	4

To represent the data given in Table 13.7 in a line graph, we select two axes on the graph paper. Against the x axis 'day' and y axis, 'absentees' are marked. After that, appropriate scale is decided. In this case, as the number of absentees ranges from 1 to 7, we may choose I square of the graph as 1 along y-axis. Similarly against x axis, each square can be chosen as a day. Then after, the data of absentees pertaining to each day are marked. The resulting line graph is given below:

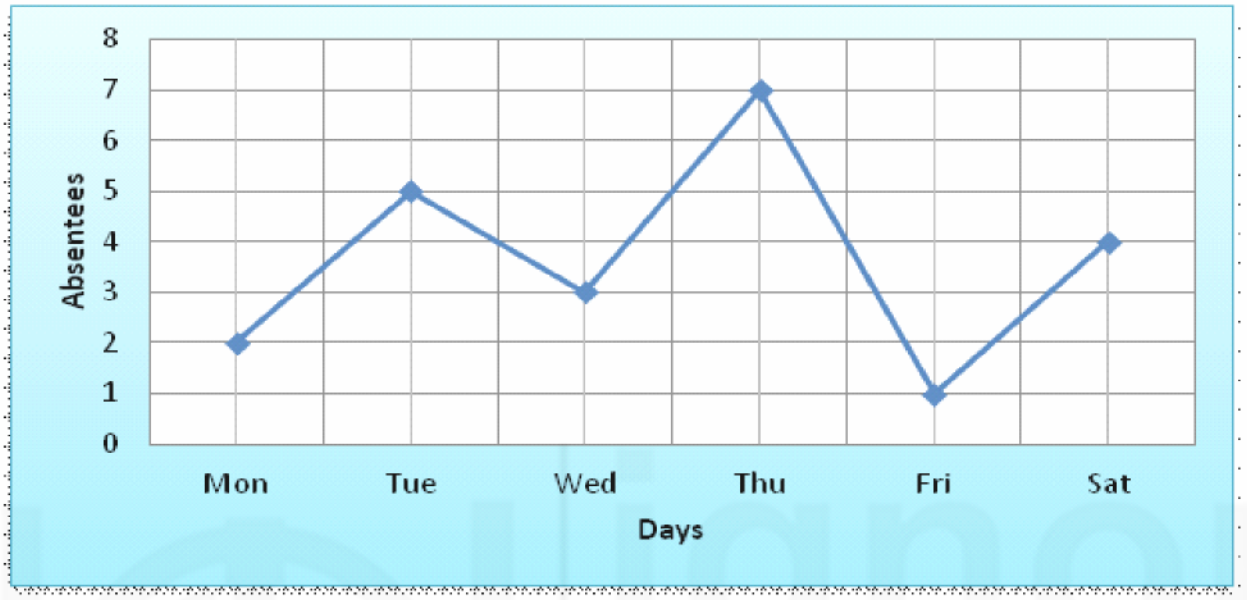


Figure 13.10: Line Graph

Graphical Representation of Grouped Data

When the raw scores are arranged in frequency distribution, the data obtained is called grouped data. The following are the graphical representations of grouped data.

1. Histogram or column diagram
2. Frequency polygon
3. Cumulative Frequency Graph
4. Cumulative Frequency Percentage Curve or Ogive.

Now let us discuss each of these representations with examples.

Histogram or column diagram

We have studied the bar graph and the process followed in constructing them. Histogram is essentially a bar graph of a frequency distribution. But histogram is used when the statistical data is arranged in class intervals. Here the frequency is represented using vertical adjacent rectangles. Generally the class interval is depicted in x axis and frequency on y axis. Thus the base of the rectangle represents the class interval and height its frequency. Thus histogram is the graphical representation of grouped data in the form of vertical bars (equal width) whose area is proportional to the frequency represented. It is to be noted that, histograms cannot be constructed with open end classes.

Now let us discuss the process followed in construction of histogram. For that, **Table 13.8 : Data for Histogram** the data given in Table 13.8 will be used.

Table 13.8 : Data for Histogram

Class Interval	Frequency(f)	Limits
30-34	8	29.5-34.5
25-29	5	24.5-29.5
20-24	3	19.5-24.5
15-19	6	14.5-19.5
10-14	2	9.5-14.5
5-9	3	4.5-9.5

To construct histogram using the frequency distribution given above the following process is followed.

- First the limits of the class intervals are calculated. To compute limits, both lower limit and upper limit of each class interval is found out. For example, the lower and upper the limits of class interval 5-9 is 4.5 and 9.5 respectively and the class interval is written as 4.5-9.5.
- The lower limit and upper limits are plotted in the x axis
- The frequencies are plotted on the y axis.
- Thereafter, each class interval is depicted using adjacent rectangular bars of equal width.
- Keep in mind to select appropriate scales for both x axis and y axis.
- While constructing histogram, 75% rule is followed i.e. the height of the figure should be approximately 75% of its width.

The histogram for the above frequency distribution is presented in Figure 13.11:

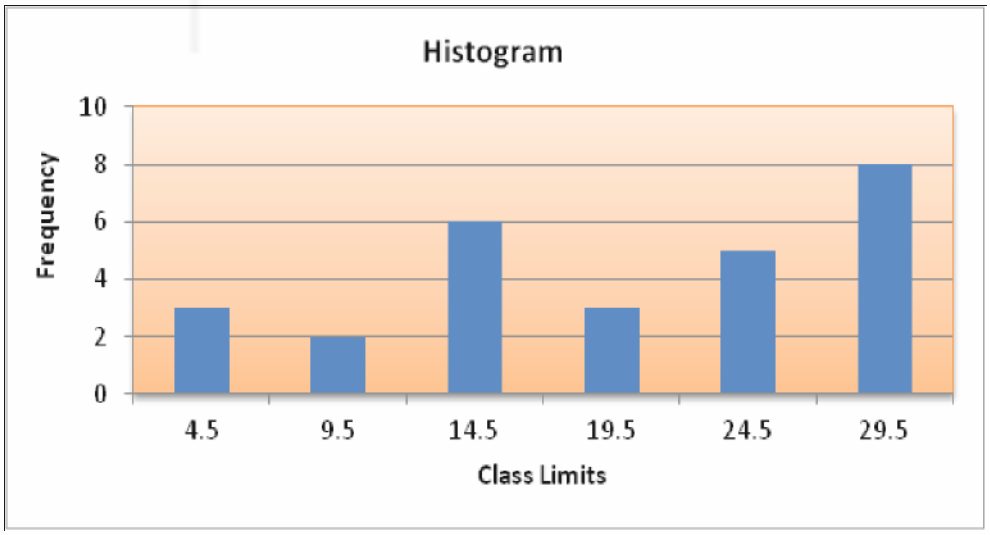


Figure 13.11 : Histogram

Frequency Polygon

What do you mean by polygon? Polygon is a closed figure with many sides. So, as you draw a frequency polygon get a many sided closed figure. Let us

explore a more specific definition of frequency polygon. Frequency polygon is a line graph representation of statistical data/frequency distribution. To construct frequency polygon, the mid points of histogram are joined together and the two end sides are connected to the base line(x axis). As the end points touch themselves form a closed a figure and hence the name frequency polygon. Now let us look at steps followed in construction of frequency polygon using the same data discussed in the previous section. The same data is reproduced in Table 13.9.

Table 13.9 : Data for Frequency Polygon

Class Interval	Frequency(f)	X
30-34	8	32
25-29	5	27
20-24	3	22
15-19	6	17
10-14	2	12
5-9	3	7

- To draw frequency polygon, first of all, the mid points of class interval are found out and are represented using the letter 'X'.
- The mid points of class intervals are represented on X-axis.
- The frequency of class intervals are indicated on Y-axis
- Then the corresponding frequency is plotted against each midpoint in the graph and is connected using straight lines.
- Finally, the start point and end points of the frequency polygon are connected to '0' on the x axis. This can be achieved by adding a lower limit and higher limit (add an extra class interval at the lower/higher limit). This helps to create a closed polygon.

The frequency polygon for the given frequency distribution is given in Figure 13.12:

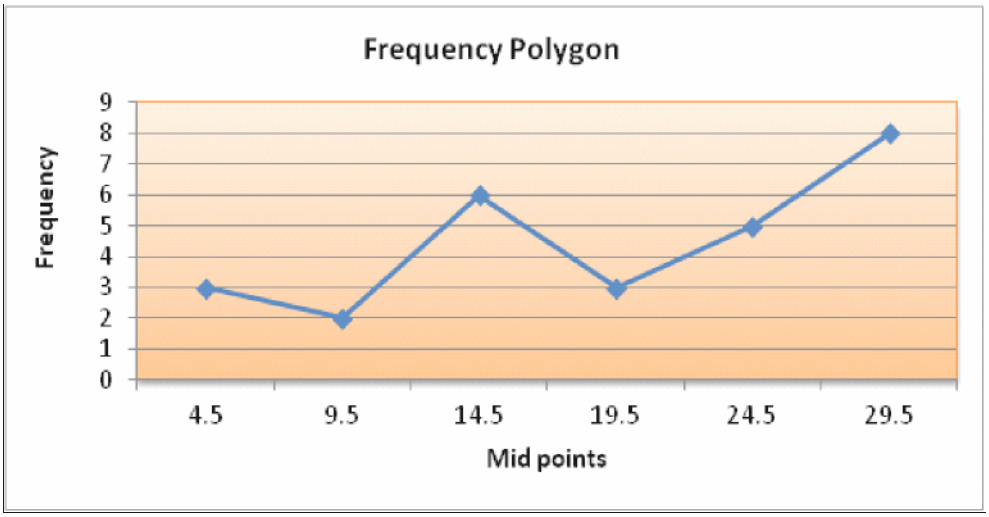


Figure 13.12 : Frequency Polygon

Cumulative Frequency Graph

The third method of representing grouped data is through cumulative frequencies. In cumulative frequency graph, the frequencies are added and the resulting cumulative frequencies are plotted in the graph. Let us represent the data given in Table 13.10 in a cumulative frequency graph.

Table 13.10 : Data for Cumulative Frequency Graph

Class Interval	Frequency(f)	Upper Limit Frequency	Cumulative
30-34	8	34.5	24
25-29	5	29.5	16
20-24	3	24.5	11
15-19	6	19.5	8
10-14	2	14.5	2
5-9 (Extra Class Interval)	0	9.5	0

To draw the cumulative frequency graph, an extra class interval is added at the lowest limit whose frequency is 0. Thereafter, the frequencies are added and thus the cumulative frequencies are found out. Then these frequencies are represented on the graph. The final frequency polygon is given in Figure 13.13.

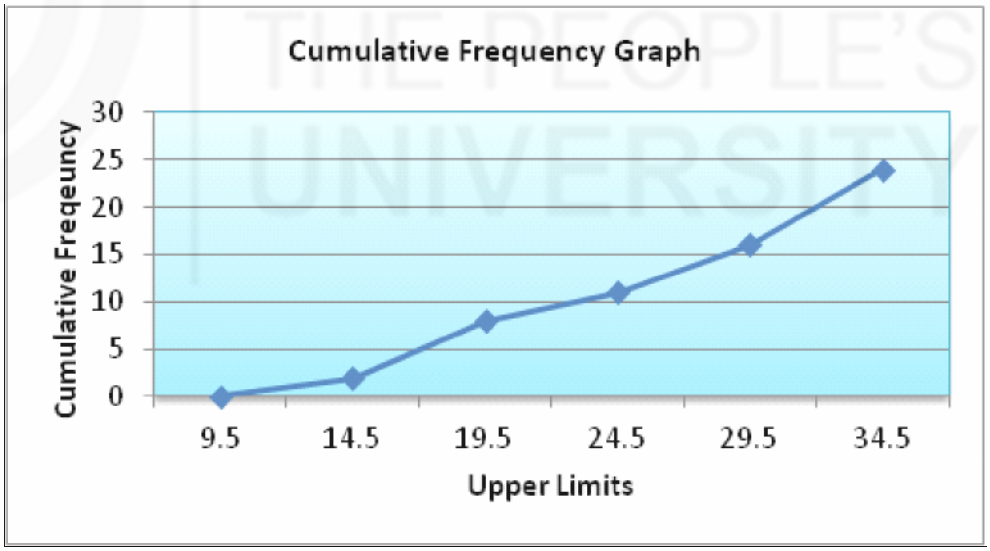


Figure 13.13 : Cumulative Frequency Graph

Cumulative Frequency Percentage Curve or Ogive.

Cumulative Frequency Percentage Curve or Ogive is drawn by following the similar procedure used for drawing cumulative frequency graph. But an extra step is followed. Here the cumulative frequencies are expressed in terms of cumulative percentages. Thus cumulative frequency percentage graph is a form of representation of statistical data in terms of cumulative percentages. Let us take the example given above and draw the corresponding cumulative frequency percentage graph.

Table 13.11 : Data for Ogive

Class Interval	Frequency(f) (N=24)	Upper Limit	Cumulative Frequency	% of Cumulative Frequency
30-34	8	34.5	24	100
25-29	5	29.5	16	66
20-24	3	24.5	11	45
15-19	6	19.5	8	33
10-14	2	14.5	2	8
5-9 (Extra Class Interval)	0	9.5	0	0

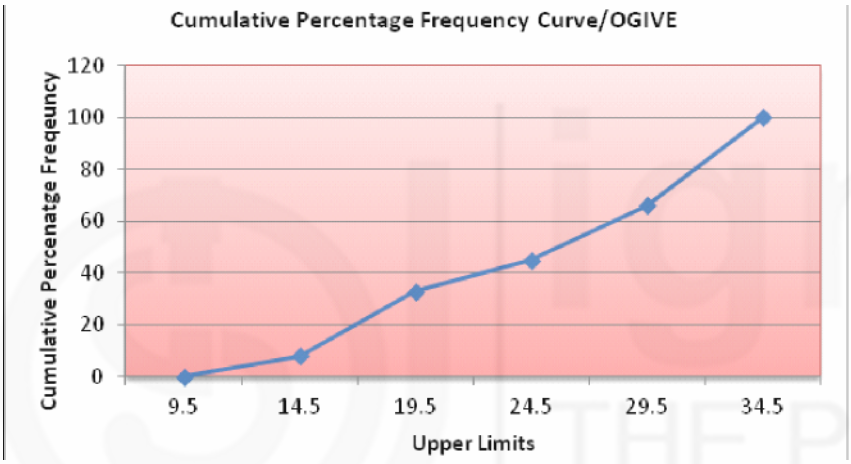
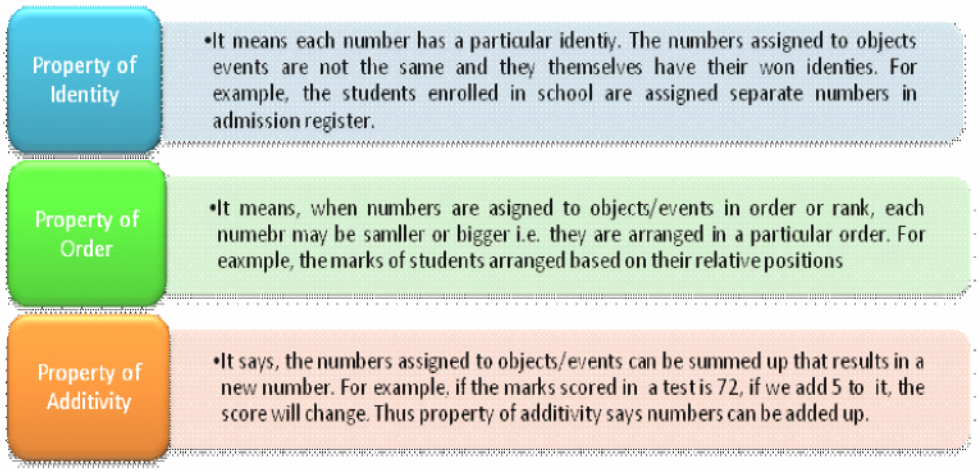


Figure 13.14 : Ogive

13.7 SCALES OF MEASUREMENT

Measurement is quantitative in nature. It is the process of assigning numbers to objects or events based on accepted norms and rules. For example, conducting a unit test and assigning scores/marks to children's performance is measurement. While assigning numbers to object/events, certain properties need to be considered. These properties are known as the different types of scales of measurement. The following are the properties:



Classification of Scales of Measurement

To measure variables one may use different instruments. If it is time, stop watch is used to measure academic achievement, achievement test is administered and so on. Thus the nature of measurements depends on the variables involved in the measurement process but all kinds of measurement can be classified into certain categories. These categories are called scales. There are four types of scales of measurement, based on the properties described above. They are:

1. Nominal Scale
2. Ordinal Scale
3. Interval Scale
4. Ratio Scale

A brief description of these scales of measurement is given below:

Nominal Scale: Measurement using nominal scale simply names or categorizes the responses. In nominal scale, numbers or symbols are assigned to represent individual/objects/events/categories, etc. Nominal scales employ the property of identity.

Example: Numbers assigned for jersey of players in a school football team, writing M/F to represent girls and boys, etc.

Ordinal Scale: In ordinal scale, the measurements are arranged on the basis of any particular order or rank ranging from lowest to highest or vice versa. Thus the objects/events are ranked. Ordinal in ordinal scale refers to 'order' and it provides direction in addition to nominal information. Ordinal scale employs the property of order. At the same time, ordinal scale applies the property of identity too.

Example: Ranking students on the basis of marks they scored, ordering children based on their difference in heights.

Interval Scale: Interval scales are numerical scales with equal intervals having the same interpretations. Interval scales do have order but with equal interval between them. For example, the interval between 40 and 50 degree and 80 and 90 in Fahrenheit has the same meaning. Interval scales are characterized by absence of 'zero' even if the measurement scales have it. For example, measurement of temperature in Fahrenheit scale has zero but '0' doesn't mean temperature is zero. Interval scales employ the property of identity, order and additivity.

Ratio Scale: This is the most informative scale of measurement. Ratio scales are the interval scales with presence of absolute zero. For example, in Kelvin scale, it has a zero point, which means temperature measurement '0' refers to zero itself.

Example: The measurement of money comes under ratio scale. There can have chances that a person may have Rs10 or Rs 1lakh or No money at all (The 'zero' case).

Check Your Progress 5

Note: a) Write your answer in the space given below.

b) Compare your answer with those given at the end of the Unit.

5. Discuss briefly the various scales of measurement with examples.

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13.8 LET US SUM UP

School is a rich source of information useful for educational research and results of such researches are used for improving educational practices and implementing innovative measures. In educational researches, statistics is used to collect, organise and interpret information. There are various methods to accomplish these tasks. In this Unit, we have touched upon various aspects of statistics such as use of statistics in educational assessment and evaluation, the meaning and nature of data and its types, various data organizing techniques, frequency distribution and the scales of measurement. All these would enable you to assess and improve your teaching –learning practices.

13.9 REFERENCES AND SUGGESTED READINGS

Garrett, H.E. (1956). *Elementary statistics*. Longmans, Green and Co: New York.

Guildford, J.P. (1965).*Fundamental statistics in psychology and education*. McGraw Hill Book Company: New York.

Rath, R.K. (1999). *Fundamentals of educational statistics and measurement*. Taratarini Pustakalaya: Orissa.

Asthana H.S. & Bhushan, B. (2007). *Statistics for social sciences*. Prentice Hall of India, Pvt. Ltd. :New Delhi.

Sahre, B.K. (2005). *Statistics in psychology and education*. Kalyani Publishers: Ludhiana.

Best J.W. (1977). *Research in education*. Englewood Cliffs, New Jersey: Prentice Hall Inc.

Bhatacharya S. (1968). *Foundation of education and educational research*. Acharya Book Depot: Baroda.

Koul L. (1984). *Methodology of educational research*. Vikas Publishing House Pvt. Ltd: New Delhi.

Pilai, RSN and Bhagavati (2008). Statistics – Theory and Practice (7th ed.), New Delhi : S. Chand and Company Ltd.

Wiersma, W. (1975).*Research methods in education: An introduction*. F. E: Peacock Publishers Inc: Illionois.

13.10 ANSWERS TO CHECK YOUR PROGRESS

1. To analyse students achievement scores, prepare progress report and report cards. This can also be used in conducting action research.
2. Primary data are collected by the teacher directly dealing with the students. Like achievement score of the students on the test which the teacher has taken. Secondary data are usually taken from various sources which has published in certain books, reports, encyclopaedias, etc.
3. Self exercise content section (refer 13.5).
4. Self exercise.
5. Nominal, ordinal, interval and ratio scales. For examples, refer section 13.7.