ANNAMALAI UNIVERSITY

DEPARTMENT OF EDUCATION

LECTURE NOTES

Programme Name & Year: B.Ed., II- Year **Course Instructor: Dr.T.Manickavasagan**

Course Name: Pedagogy of Physical Science (Part-2) **Designation: Associate Professor**

Course Code: BEDO234 **Credits: 4**

UNIT-6: EVALUATION IN PHYSICAL SCIENCE

TEST AND ITS TYPES

Definition of Evaluation

Kothari (1966) reports in the Indian Education Commission 1964-66 *"Evaluation is a continuous process it forms an integral part of the total system of education, and is intimately related to education objectives. It exercises a great influence on the pupils' study habits and teachers' methods of instruction and thus helps not only to measure educational achievement but also to improve it. The techniques of evaluation are means of collecting evidences about the students' development in desirable direction".*

Dressel (1954) states "Evaluation does not differ from instruction in purpose, in methods or in material and can be differentiated from instruction only when primary purpose is that of passing judgment of the achievement of a student at the close of a period of instruction".

Type of Evaluation

(i) Criterion-referenced Evaluation

- When students' performance are assessed and compared with standard or criterion without mentioning the performance levels of other students, evaluation is said as criterion-referenced evaluation.
- It is a development test. Here scores are compared to a set of performance standards.

(ii) Norms-referenced Evaluation

- Norms-referenced evaluation is the assessment of students' performance in relation to other to other students of the group.
- Here marks and ranks are awarded. Scores are determined by a comparison to the performances of other students who have taken the same test.

(iii) Formative Evaluation

- It is conducted to take decision to help the students and teaching-learning process. It provides feedback for making changes in the curriculum, textbook, teaching strategies and other learning environment. It is undertaken to improve the existing program.
- It is a continuous one. It is to keep the progress moving on the right direction.

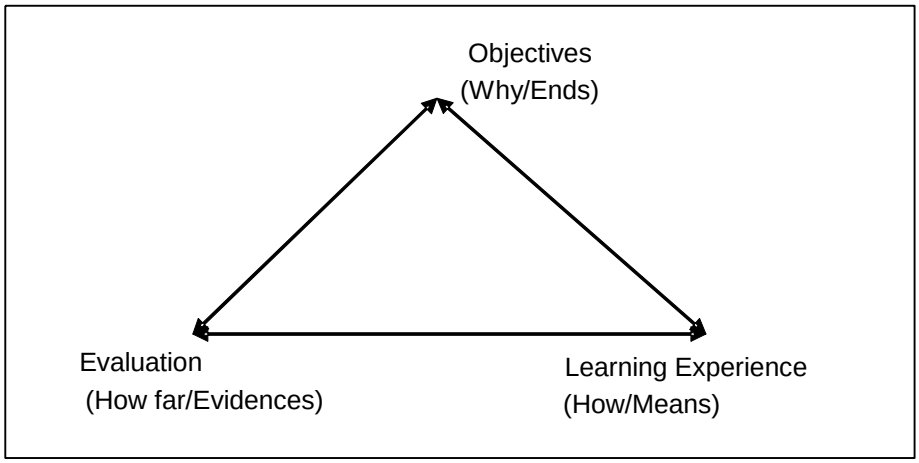
(iv) Diagnostic Evaluation

It collects information about the difficulties of the students in learning process for taking suitable remedial measures.

(v) Summative Evaluation

- It collects information to make final decisions other than helping. It is conducted on a finished product or a process. The terminal examinations both internal and external are the examples for summative evaluation.
- It is used for administration purpose. It aims at getting the total picture of the quality of the produced curriculum.

The Relationship between Objectives, Learning Experiences and Evaluation



- **Objectives** are the intended changes expected in the behavior of the students considering their cognitive, affective and psycho-motor aspects of behavior.
- The objectives provide the desired direction for teachers and learning for their activities.
- The answer to the question "Why should I Teach/learn?" is that to achieve the objectives. The objectives are the ends to be achieved.
- **Learning experiences** are selected and provided in the class, based on the specific objectives.
- The students get behavioral changes only through learning experiences.
- If we ask a question "How can the instructional objectives be achieved? The answer is that through learning experiences. Learning experiences are the means to achieve the ends known as instructional objectives.
- **Evaluation** shows the evidence for the achievement of objectives by the students.

- The answer for the question "How far the objectives are realized?" is given through the process of the instructional programs. Therefore, in the above Figure two-way arrows are shown to signify the interdependence, and interacting relationship among objectives, learning experiences and evaluation.

ACHIEVEMENT TEST

- **Ebel (1966) writes** "the test constructor faces two major problems. The first is to measure 'what to measure'. The second is to decide 'how to measure'."
- Achievement tests intend to measure students' educational development. Achievement test is a part of evaluation process, which aims at measuring the scholastic achievement of the students.
- Here the term achievement refers to achievement of instructional objectives namely, knowledge, understanding, application and skill.

CHARACTERISTICS OF A GOOD CHIEVEMENT TEST

- **Validity:** Any good test should measure what it claims to measure.
- **Reliability:** A good test is one that is reliable ie., it gives same rating to a candidate even if he is examined by different examiners and even at different times.
- **Objectivity:** A test can be considered objective if the scoring of the test is not affected in any way by the examiners personal Judgment. Thus the opinion, bias or judgment of the examiner can have no influence on the result of an objective test.
- **Practicability:** A test is called practicable if it can be easily administered. While preparing such a test, the time and cost of administration must be taken into consideration. The test should be usable and should serve a definite need in the situation in which it is used.

STEPS IN THE CONSTRUCTION OF AN ACHIEVEMENT TEST

Steps

1. Preparation of weightage tables on the basis of Objectives, Content covered and types of Questions to be included.
2. Preparation of Blue print on the basis of "weightage tables".
3. Setting the questions based on the "Blue print'.
4. Preparation of a Question wise analysis scheme based on questions constructed which enable the teacher to ensure the characteristics of a good test.
5. Preparation of Scoring key and marking scheme which enable the teacher to know and spell out the expected answers and marking procedures.
6. Printing of the question papers.
7. Conducting the test.

Table-1: Weightage in Terms of Content

Content	Marks	%
Three different states of matter	10	40
Compounds and Mixtures	10	40
Measurement of length	5	20
Total	**25**	**100**

Table – 2 : Weightage in Terms of Objectives

Objectives	Marks	%
Knowledge	8	32
Understanding	8	32
Application	4	16
Skill	5	20
Total	**25**	**100**

Table – 3 : Weightage in Terms of forms of Questions

Forms of questions	Marks	%
Objective type	10	40
Short answer type	10	40
Essay type	5	20
Total	**25**	**100**

Table – 4 : Content Vs Objectives

Content	K	U	A	S	Total
Three different states of matter	4	4	2	-	10
Compounds and Mixtures	4	4	2	-	10
Measurement of length	-	-	-	5	5
Total	**8**	**8**	**4**	**5**	**25**

Table - 4 Vs Table – 3

Content	Objectives	Form of questions			Total
Three different states of matter		O	SA	E	
	K	2	2	-	**4**
	U	2	2	-	**4**
	A	2	-	-	**2**
	S	-	-	-	-
Compounds and Mixtures	K	-	-	-	**4**
	V	2	2	-	**4**
	A	2	2	-	**2**
	S	-	2	-	-
Measurement of length	K	-	-	-	-
	U	-	-	-	-
	A	-	-	-	-
	S	-	-	5	**5**
	Total	**10**	**10**	**5**	**25**

BLUE PRINT:

ACHIEVEMENT TEST
SUBJECT - SCIENCE

Standard : IX **Maximum Marks : 25**

Maximum Time : 45 minutes

Units: Three different states of matter, Compounds & Mixtures and Measurement of length.

Objectives	Knowledge			Understanding			Application			Skill			Total
Form of questions	**O**	**SA**	**E**	**O**	**SA**	**E**	**O**	**SA**	**E**	**O**	**S A**	**E**	
Three different states of matter	2(2)	2(1)	-	2(2)	2(1)	-	2(2)	-	-	-	-	-	**10(8)**
Compounds and Mixtures	2(2)	2(1)	-	2(2)	2(1)	-	-	2(1)	-	-	-	-	**10(7)**
Measurement of length	-	-	-	-	-	-	-	-	-	-	-	5(1)	**5(1)**
Sub Total	4(4)	4(2)	-	4(4)	4(2)	-	2(2)	2(1)	-	-	-	5(1)	**25(16)**
Grand Total	**8(6)**			**8(6)**			**4(3)**			**5(1)**			**25(16)**

- **The figure inside the brackets indicates number of questions.**
- **The figure outside the brackets denotes marks.**
- **O-Objective type; SA – Short answer type; E – Essay type.**

QUESTION PAPER

1. Collection of particles that constitute a body is called as
   a) matter
   b) atom
   c) ion
   d) electron
2. Liquids and gases are also called as
   a) fluids
   b) pure substances
   c) fuels
   d) impurities

3. In solids the molecules are

a) closely compacted
b) far away from one another
c) moving in nature
d) none of the above

4. Low density matter is
a) solid
b) liquid
c) gas
d) none of the above

5. Identify the symbol for silicon
a) C
b) S
c) Sc
d) Si

6. Find out the polyatomic element in the following elements
a) Hydrogen
b) Bromine
c) Fluorine
d) Phosphorous

7. Substance made up of two or more elements chemically combined in a fixed ratio by weight is called
a) Compounds
b) molecules
c) isotopes
d) none of the above

8. A compound is always
a) homogeneous
b) heterogeneous
c) partially homogeneous
d) partially heterogeneous

9. Two or more elements or compounds when mixed in any ratio is known as
a) mixture
b) liquids
c) solids
d) colloids

10. Calcium carbonate is
a) insoluble in water
b) soluble in water
c) partially soluble in water
d) none of the above

11.What is crystal?

12.Differentiate between solids and liquids.

13.Write a short note on compounds.

14.Explain the characteristics of carbon-di-oxide.

15.Identify the correct molecular formula of Calcium carbonate and Sodium hydroxide in the following group of formulas (i) NaCl (ii) NaOH (iii) $CaCO_3$ (iv) CO_2

16.Draw the diagram of vernier callipers.

SCORING KEY AND MARKING SCHEME

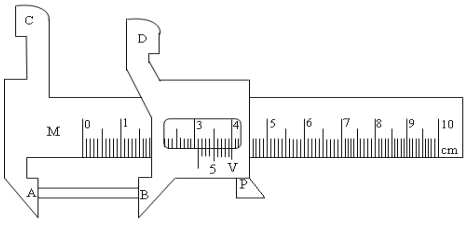
ACHIEVEMENT TEST – SCIENCE

Units: Three different states of matter, Compounds & Mixtures and Measurement of length.

Marks: 25

Q.NO.	1	2	3	4	5	6	7	8	9	10
Key	(a)	(a)	(a)	(c)	(d)	(d)	(a)	(a)	(a)	(a)

For question number 1 – 10 award one mark

Q. No.	Expected outline answer	Value of points	Marks
11.	**(i)** Atoms and molecules that are arranged in regular three-dimensional lattices-like the egg in a stack of egg-cartons. **(ii)** The structure is determined by the by the chemical bonds between the adjacent atoms and molecules.	2	Each point 1 mark
12.	1. Solid has a fixed volume, high density, definite shape and does not flow. 2. Liquid has a fixed volume, moderate to high density, it has no definite shape, takes the shape of the container and generally flows easily.	2	Each point 1 mark
13.	A compound is a substance made up two or more elements. 2. They are Chemically combined in a fixed ratio by weight.	2	Each point 1 mark
14.	1. All green plants need carbon-di-oxide to live and grow. 2. Carbon-di-oxide in the atmosphere helps to regulate the earth's temperature.	2	Each point 1 mark
15.	1. Calcium carbonate – $CaCO_3$ 2.Sodium hydroxide- NaOH	2	Each point 1 mark
16.	Vernier callipers  M = Main scale V = Vernier scale P = Ratchet		Drawing 3 marks Parts 2 marks

QUESTION –WISE ANALYSIS

ACHIEVEMENT TEST
SUBJECT: SCIENCE

Standard: IX **Maximum Marks: 25**

Maximum Time: 45 minutes.

Units: Three different states of matter, Compounds & Mixtures and Measurement of length.

S. No.	Objective	Specification	Topic/ content unit	Type of questions	Marks	Estimated time	Test difficulty level
1.	Knowledge	Recognises	States of matter	O	1	2	**C**
2.	Knowledge	Recognises	States of matter	O	1	2	**B**
3.	Understanding	Defines	Solids	O	1	2	**A**
4.	Understanding	Classifies	States of matter	O	1	2	**B**
5.	Application	Identifies	Symbols of elements	O	1	2	**C**
6.	Application	Finds out	Polyatomic elements	O	1	2	**A**
7.	Knowledge	Recognises	Compounds	O	1	2	**B**
8.	Knowledge	Recalls	Compounds	O	1	2	**C**
9.	Understanding	Explains	Mixtures	O	1	2	**A**
10.	Understanding	Defines	Calcium carbonate	O	1	2	**A**
11.	Knowledge	Recognises	Crystal	SA	2	4	**C**
12.	Understanding	Differentiates	Solids and liquids	SA	2	4	**B**
13.	Knowledge	Defines	Compounds	SA	2	4	**A**
14.	Understanding	Explains	Carbon-di-oxide	SA	2	4	**B**
15.	Applications	Identifies	Compounds	SA	2	4	**B**
16.	Skill	Draws	Vernier calipers	E	5	5	**A**

1. **A** - Difficulty level (More than 50% of the students gave wrong answer or omission)
2. **B** - Average level (50% of the students gave right answer 50% of students gave wrong answer)
3. **C** - Easy level (More than 50% of the students gave right answer)
4. **O**-Objective type
5. **SA** – Short Answer type
6. **E**- Essay type

ELEMENTARY STATISTICS: MEASURES OF CENTRAL TENDENCY

- The value of measures of central tendency is two-folded. First it is an average which represents all of the scores made by the group and as such gives a correct description of the performance of group as a whole, and also it enables us to compare two or more groups in terms of their performance.
- There are three averages or measures of central tendency in common use. They are **arithmetic mean, median and mode**.

Calculation of Arithmetic Mean when scores are ungrouped

- The arithmetic mean is the sum of the separate scores or measures divided by their number.
- If in a group five pupils score the following marks 40, 45, 50, 60, and 65, then the mean is 52.
- The formula for the mean of a series of ungrouped data is $M = \frac{\Sigma x}{N}$ in which N is the number of scores in the series and Σx-represents the sum of all the scores in the series.

Calculation of Mean when scores are grouped

- When scores are grouped into a frequency distribution, the mean is calculated by using a different method. It is rather easy because when the number of scores involved is very big we cannot find the total and divide by the number of score. It will be very tedious.

C.I.	F	X(mid-point)	fx
35-39	3	37	111
40-44	7	42	294
45-49	8	47	376
50-54	9	52	468
55-59	5	57	285
60-64	5	62	610
65-69	1	67	67
70-74	1	72	72
74-79	1	77	77
			Σfx=2060

$$\text{Mean} = \frac{\sum fx}{N} = \frac{2060}{40} = 51.5$$

In this method the mean is calculated using the formula

$\frac{\sum fx}{N}$ - where x-is the midpoint of the class interval.

Calculation of Median for ungrouped scores

The median is defined as the score or the point in a given distribution below which 50% of the scores and above which naturally, the other 50% of the scores lie.

The median is given by the formula

Median $= \left(\frac{N+1}{2}\right)$ the measure in order of size

Where, N is the number of scores given.

For example in the series, 7, 10, 8, 12, 9, 11 and 7

The median is $\frac{N+1}{2}$ the score in order.

Arranging the scores in descending order we get, 7, 7, 8, 9, 10, 11, 12 $\left(\frac{N+1}{2}\right) = \frac{7+1}{2} = 4.$

Median is the 4^{th} score. i.e., = 9.

Let us take another series, 7, 8, 9, 10, 11, 12

Here $\frac{N+1}{2} = \frac{6+1}{2} 3.5.$

3.5 Score in the series is between 9 and 10. Therefore median is 9.5.

Calculation of Median for grouped scores

- When scores in a continuous series are grouped into a frequency distribution, the median by definition is the 50% point in the distribution.
- Median may be calculated using the formula.

$$\textbf{Median} = l + \left(\frac{N/2 - F}{fq}\right) xi$$

Where,

L	-	is the lower real limit of the class interval where the median falls.
N	-	is the total number of scores.
F	-	is the sum of the scores on all intervals below ℓ.
fq	-	is the frequency (number of scores), within the interval upon

which the median falls.

i - is the size of the class interval.

Example:

C.I.	F	Cum f
35-39	3	3
40-44	7	10
45-49	8	18
50-54	9	29
55-59	5	32
60-64	5	37
65-69	1	38
70-74	1	39
75-79	1	40

Steps in calculating median

- Find N/2 that is one half of the cases in the distribution.
- Begin at the small score at end of the distribution and count of the scores in order, up to the exact lower (ℓ) of the interval which contains the median. It is otherwise known as cumulative frequencies. The sum of these scores is denoted as cum f.
- In the above cumulative frequencies, find out the cumulative frequency that contains N/2 and fix that range.
- Find out the F value, which is the cumulative frequency just above the marked area in the table, which is 18 for our example.
- Then calculate the value of fq, which is frequency that lies in the marked area, where the median falls, and is 9.
- Then, find out, ℓ which is the lower real limit of the class interval where the median lies.
- The i value is 5, which is the size of the class interval.

By applying these values in the formula we get

$$\text{Median} = 49.5 + \frac{20-18}{9} \times 5$$

$= 49.5+2/9\times5$

$= 49.5+10/9$

$= 49.5+11$

$= 50.6$

Calculation of Mode

- It is another measure of central tendency. It is calculated using the formula.

Mode = 3 median – 2 mean

$= 3 \times 50.6 - 2 \times 51.75$

= 151.78 – 103.50

= 48.3

- Measures of central tendency make us aware of only one aspect of distribution. Scores are spread or dispersed widely. It deviates from the central measures.
- Even if the mean scores in a subject for two classes remain to be same, we cannot say that their standard is the same. It is because though the two means are the same, the spread of the scores may be different. In one class most of the pupils would have scored around the mean whereas in the other class a few would have scored very high marks and a few would have scored very low marks. Thus there are wide individual differences among the pupils in the second class.

MEASURES OF VARIABILITY

There are four statistical measures namely range, average deviation, standard deviation and quartile deviation used to measure the spread of the scores in any distribution.

Range

Range is the interval between the highest and the lowest scores. It is the simplest measure of variability. This is the most general measure of spread of scatter, and is computed when we wish to make a rough comparison of two or more groups of variability.

Average Deviation

Average deviation is the mean of the deviations of all the separate scores in a series taken from their mean. As far as these deviations are concerned, signs are not taken into account and all deviations whether plus of minus are treated as positive. The mean of the 5 scores 6, 8, 10, 12 and 14 is 10. The deviations of the separate scores from this mean are (6 – 10 = – 4, 8 – 10 = – 2) – 4, – 2, 0, 2 and 4. The sum of these 5 deviations disregarding signs is 12 and dividing 12 by 5 (N) we get 2.4. This is the average deviation or the mean of the deviations. The formula for Average Deviation is

$$AD = \frac{\sum fd}{N}$$

Where $d = X - M$

This indicates that signs are disregarded in arriving at the sum.

Standard Deviation

- The Standard Deviation or SD is the most stable index of variability and is of much importance in research studies.
- In computing AD we disregard the signs, simply add the deviations (d) taken them all to be positive and take their mean in the calculation of average deviation.
- But, in the case of standard deviation, we square the deviations of the scores from their mean (X – M) and thus get rid of the signs. The symbol used to denote standard deviation is σ (Sigma).

Calculation of Standard Deviation from ungrouped scores

- For the scores 6, 8, 10, 12 and 14 the mean is 10 and the deviations of the individual scores from the mean are – 4, – 2, 0, 2 and 4 respectively.
- When each of this deviation is squared we get 16, 4, 0, 4 and 16. The sum is 40 and N is 5. Then SD can be calculated using the formula.

$$\sigma = \sqrt{\frac{\sum d^2}{N}}$$

$$= \sqrt{\frac{40}{5} 2.83}$$

Calculation of SD from grouped data

The process used is identical with the one used for ungrouped data. But here the squares of the deviations are multiplied by the frequency. This gives the fx'^2 ($fx' \times x'$) column in table. The sum of the fx'^2 column is taken. Then applying the formula

$$SD = \frac{i}{N} \sqrt{N \sum fx'^2 - \sum (fx')^2}$$

We can calculate the standard deviation as

Class Interval	f	X'	fx'	fx'^2
35-39	3	-3	-9	27
40-44	7	-2	-14	28
45-49	8	-1	-8	8
50-54	9	0	0	0
55-59	5	+1	5	5
60-64	5	+2	10	20
65-69	1	+3	3	9
70-74	1	+4	4	16
75-79	1	+5	5	25
			-4	138

$$SD = \frac{i}{N} \sqrt{N \sum fx'^2 - \sum (fx')^2}$$

$$= \frac{5}{40} \sqrt{40 \times 138 - (-4)^2}$$

$$= \frac{1}{8} \sqrt{5520 - 16}$$

$$= \frac{1}{8}\sqrt{5504}$$

$$= \frac{1}{8} X 74.2$$

$$= 9.27.$$

If we know the S.D, of any distribution, we can have some idea of the scatter of scores about their mean. If the S.D is large, we can say that the scores are scattered or widely distributed. But if it is small; the scores are close to their mean.

Quartile Deviation (Q)

The quartile deviation or Q is one half the scale distance between the 75th and 25th percentiles in a frequency distribution. The 25th percentile or Q_1, is the first quartile on the score scale, the point below which lie 25% of the scores. The 75th percentile or Q_3 is the third quartile on the score scale, the point below which lie 75% of the scores. When we have these two points the quartile deviation or Q is found from the formula.

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

From the formula, it is clear that we have to first compute Q_3 and Q_1 i.e., the 75th & 25th percentiles. The 75th and the 25th percentiles are calculated. Just like the 50th percentile, the median ¼ of N is counted off to find Q_1 and ¾ N is counted off to find Q_3.

Q_1 and Q_3 could be calculated using the following formula,

$$Q_1 l + \left\{ \frac{\frac{N}{4} - F}{fq} \right\} \times i \qquad Q_3 = l + \left\{ \frac{\frac{3N}{4} - F}{fq} \right\} \times i$$

The above formula can be applied to the following example

Class interval	F	Cum. f
35-39	3	3
40-44	7	10
45-49	8	18
50-54	9	27
55-59	5	32
60-64	5	37
65-69	1	38
70-74	1	39
75-79	1	40

Calculation of Q_1

To calculate Q_1, the following steps can be followed:

- In the above cumulative frequencies, find out the cumulative frequency that contains N/4 (N/4=10) and fix that range.
- Find out the F value, which is the cumulative frequency just above the marked area in the table, which is 3 for our example.
- Then calculate the value of fq, which is frequency that lies in the marked area, where the N/4 value lies and is 7.
- Then, find out, ℓ which is the lower real limit of the class interval where the N/4 value lies.
- The i value is 5, which is the size of the class interval.

Therefore, N/4 = 10; F = 3 fq = 7; ℓ = 39.5 and i = 5

By applying these values in the formula we get

$$Q_1 = 39.5 + \frac{10-3}{7} \times 5$$

$$= 39.5+5$$

$$= 44.5$$

Calculation of Q_3

Class interval	F	Cum. f
35-39	3	3
40-44	7	10
45-49	8	18
50-54	9	27
55-59	5	32
60-64	5	37
65-69	1	38
70-74	1	39
74-79	1	40

The Q_3 value can be calculated from the following steps:

- In the above cumulative frequencies, find out the cumulative frequency that contains 3N/4 (3N/4=30) and fix that range.
- Find out the F value, which is the cumulative frequency that just above the marked area in the table, which is 27 for our example.
- Then calculate the value of fq, which is frequency that lies in the marked area, where the 3N/4 value lies and is 5.
- Then, find out, ℓ which is the lower real limit of the class interval where the 3N/4 value lies.
- The i value is 5, which is the size of the class interval.

Therefore, N/4 = 30; F = 27 fq = 5; ℓ = 54.5 and i = 5

By applying these values in the formula we get

$$Q_3 = 54.5 + \frac{(30-25)}{5} \times 5$$

=57.5

Then the value of Q can be calculated as

$$Q = \frac{57.5 - 44.5}{2} = \frac{13}{2}$$

Q = 6.5

CORRELATIONAL TECHNIQUES

- The aforesaid methods of computing some of the statistical measures will represent the performance of an individual or a group in a reliable way. At the same time, it is also equally important to examine the relationship of one variable to another. It is also of interest to examine how variations in one variable are associated with or related with the variations in another variable. Correlation represents the commonness between the variables.
- The index of relationship between the two variables is known as co-efficient of correlation. A coefficient of correlation is a single number that tells us to what extent two variables are related and to what extent variations in one variable go with variations with the other. Whenever two measurements for the same individual can be paired for all the individuals in a group, the degree or relationship between the paired scores is called 'Correlation'.

Calculation of Correlation Coefficient by Rank Difference Method

Differences among individuals in many traits can be expressed by ranking the subjects in 1-2-3 order when such differences cannot be measured directly. We can rank the pupils in the order of their scores in the two subjects and correlation coefficient could be calculated using the formula.

$$\text{Correlations coefficient } \rho = 1 - \frac{6\Sigma\Sigma^2}{N(N^2-1)}$$

Where; ΣD^2 is the sum of squares of differences in rank

N-number of scores

ρ- the correlation coefficient

Example:

Scores of 10 students in English and Science are given.

Students	Scores in	Rank in English	Scores in Science	Rank in Science	Difference in rank	D^2

	English					
1	85	2	85	3	1	1
2	65	7.5	70	6.5	- 1	1
3	78	4	90	2	- 2	4
4	59	9	68	8.5	- 0.5	0.25
5	88	1	80	4	3	9
6	74	5	68	8.5	3.5	12.25
7	65	7.5	78	5	- 2.5	6.25
8	53	10	70	6.5	- 3.5	12.25
9	82	3	95	1	- 2	4
10	72	6	62	10	4	4

$\Sigma D^2 = 66.00$

Note: When ranks are assigned, for the same scores as in this case of English two pupils have scored 65 each, their ranks should be in the order 7 & 8. Hence they are placed at 7.5; $\left(\frac{(7+8)}{2}\right)$. Similarly in the case of Science also we find that the same scores are obtained by pupils. Hence they are placed at 6.5 and 8.5

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

$$= 1 - \frac{6 \times 66}{10(10^2-1)}$$

$$= 1 - \frac{396}{990}$$

$$= 1 - 0.4$$

$$= 0.6$$

- From the obtained value of ρ, we come to know that there is some disparity in the marks of English and Science. But the disparity is not very much.
- Thus the aforesaid calculations of statistical measures are helpful in analyzing the scores or the marks secured by the students in the achievement test and thereby we can interpret the students' achievement and derive conclusions.

Graphical Representation of Data

- Statistics is a special subject that deals with large (usually) numerical data. The statistical data can be represented graphically. In fact, the graphical representation of statistical data is an essential step during statistical analysis.

- A graph is the representation of data by using graphical symbols such as lines, bars, pie slices, dots etc. A graph does represent a numerical data in the form of a qualitative structure and provides important information.
- Let us go ahead and study about various types of graphical representations of the data.

Graphical Representation of Ungrouped Data

For the ungrouped data (data not grouped into a frequency distribution) we usually use of the following graphical representation.

1. Bar Graphcx

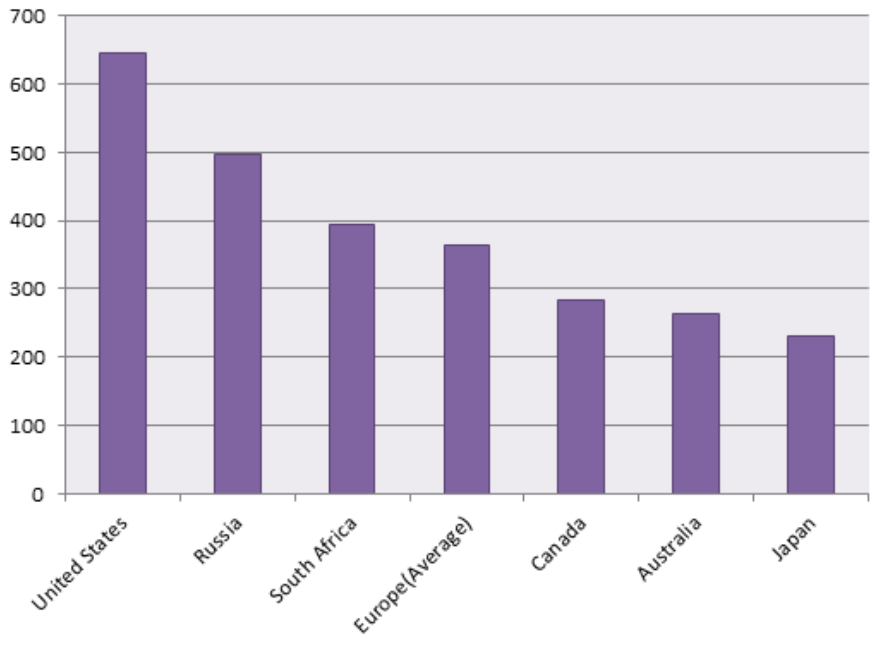
2. Circle/Pie Diagram

Bar Graph

- A bar graph is a very frequently used graph in statistics as well as in media. A bar graph is a type of graph which contains rectangles or rectangular bars. The lengths of these bars should be proportional to the numerical values represented by them.
- In bar graph, the bars may be plotted either horizontally or vertically. But a vertical bar graph (also known as column bar graph) is used more than a horizontal one.

A vertical bar graph is shown below:

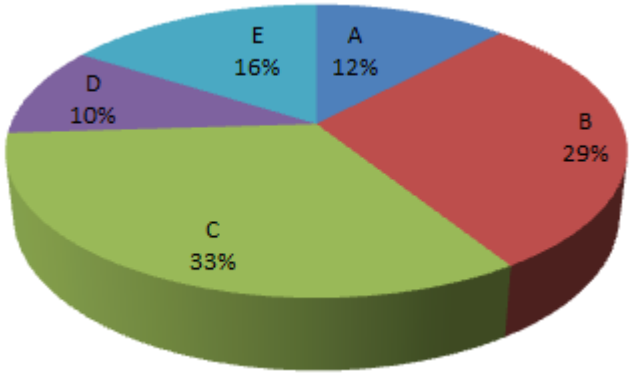
Number of students went to different states for study:



- The rectangular bars are separated by some distance in order to distinguish them from one another. The bar graph shows comparison among the given categories.
- Mostly, horizontal axis of the graph represents specific categories and vertical axis shows the discrete numerical values

Circle Graph/Pie Graph

A circle graph is also known as a pie graph or pie chart. It is called so since it is similar to slice of a "pie". A pie graph is defined as a graph which contains a circle which is divided into sectors. These sectors illustrate the numerical proportion of the data. **A pie chart is shown in the following diagram:**



The arc lengths of the sectors, in pie chart, are proportional to the numerical value they represent. Circle graphs are quite commonly seen in mass media as well as in business world.

Graphical Representation of Grouped Data (Frequency Distribution)

1. The histogram

2. The frequency polygon

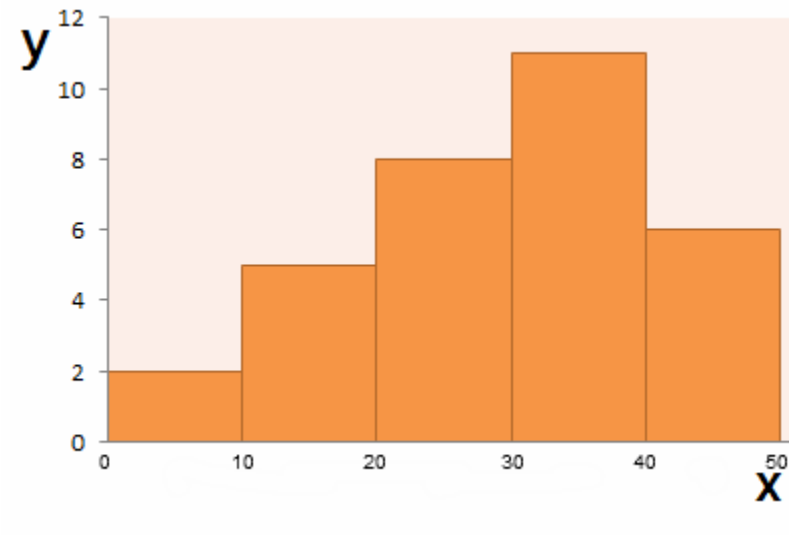
3. The cumulative frequency graph

4. The cumulative frequency percentage curve or ogive.

Histogram and Frequency Polygon

A histogram is defined as a graphical representation of the mutually exclusive events. A histogram is quite similar to the bar graph. Both are made up of rectangular bars. The difference is that there is no gap between any two bars in the histogram. The histogram is used to represent the continuous data.

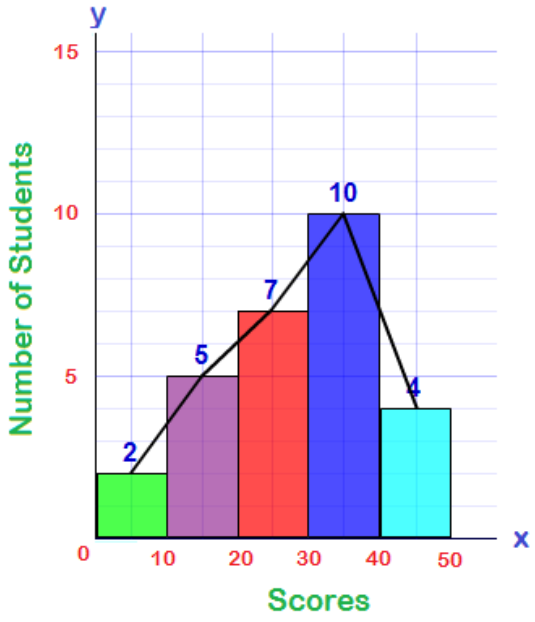
A histogram may look like the following graph:



Frequency Polygon

The frequency polygon is a type of graphical representation which gives us better understanding of the shape of given distribution. Frequency polygons serve almost the similar purpose as histograms do.

But the frequency polygon is quite helpful for the purpose of comparing two or more sets of data. The frequency polygons are said to be the extension of the histogram. When the midpoints of tops of the rectangular bars are joined together, the frequency polygon is made.



Cumulative Frequency

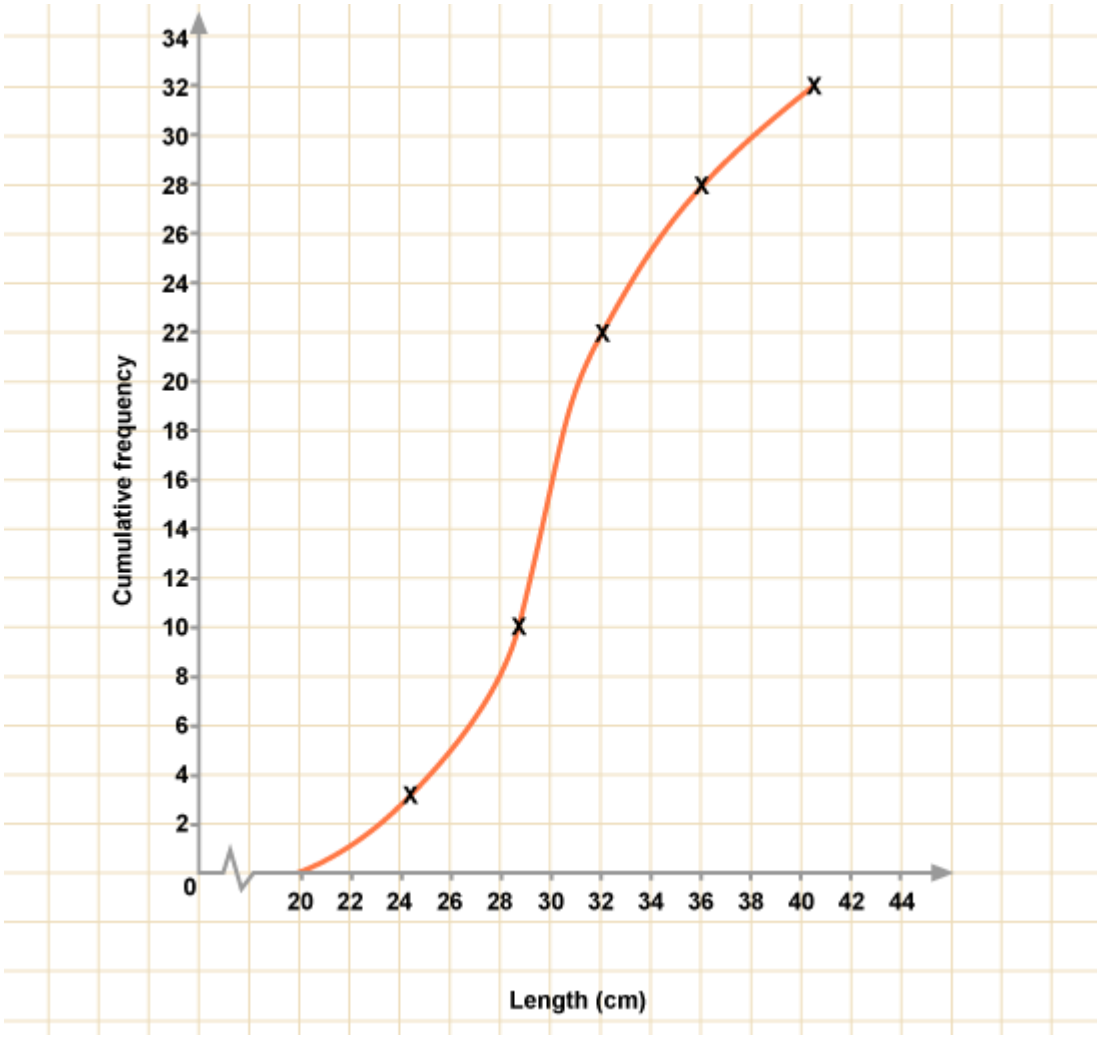
The cumulative frequency is obtained by adding up the frequencies as you go along, to give a 'running total'.

Drawing a cumulative frequency diagram

Length	Frequency	Cumulative Frequency
21-24	3	3
25-28	7	10 (= 3 + 7)
29-32	12	22 (= 3 + 7 + 12)
33-36	6	28 (= 3 + 7 + 12 + 6)
37-40	4	32 (= 3 + 7 + 12 + 6 + 4)

The table shows the lengths (in cm) of 32 cucumbers. Before drawing the cumulative frequency diagram, we need to work out the cumulative frequencies. This is done by adding the frequencies in turn.

- The points are plotted at the upper class boundary. In this example, the upper class boundaries are 24.5, 28.5, 32.5, 36.5 and 40.5. Cumulative frequency is plotted on the vertical axis.
- For plotting the actual upper limits of the class intervals on the x-axis and respective cumulative frequencies on the y-axis of the graph paper, we must select a suitable scale with reference to the range of data to be plotted and the size of graph paper to be used.
- All the plotted points representing upper limits of the class interval with their respective cumulative frequencies will then be joined through a successive chain of strait lines resulting in a line graph.

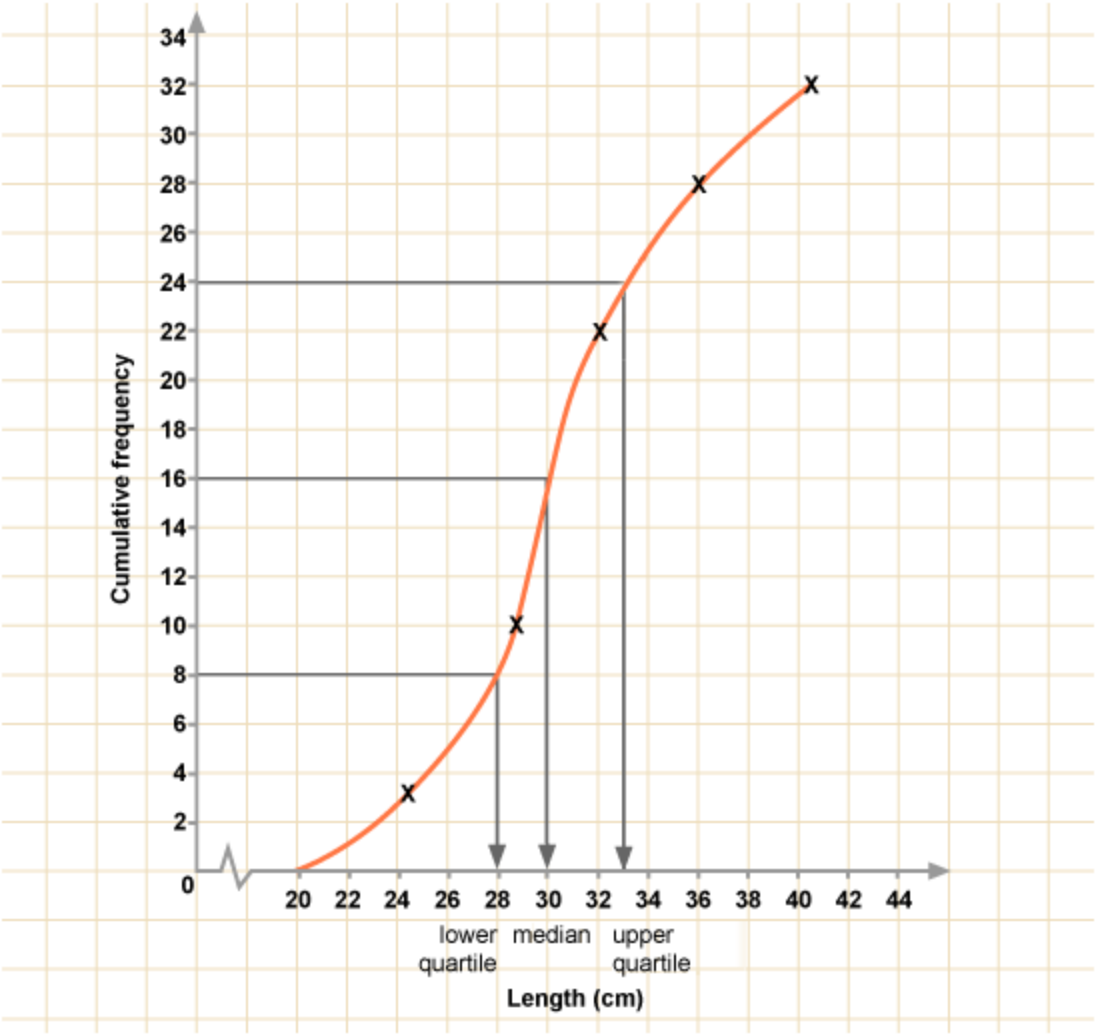


- There are no values below 20.5cm.
- Cumulative frequency graphs are always plotted using the highest value in each group of data, (because the table gives you the total that are less than the upper boundary) and the cumulative frequency is always plotted up a graph, as frequency is plotted upwards.
- Cumulative frequency diagrams usually have this characteristic S-shape, called an ogive.

Finding the Median and Quartiles

When looking at a cumulative frequency curve, you will need to know how to find its median, lower and upper quartiles, and the inter-quartile range.

By drawing horizontal lines to represent $^1/_4$ of the total frequency, $^1/_2$ of the total frequency and $^3/_4$ of the total frequency, we can read estimates of the lower quartile, median and upper quartile from the horizontal axis.



- Quartiles are associated with quarters. The inter-quartile range is the difference between the lower and upper quartile.
- From these values, we can also estimate the inter-quartile range: 33 - 28 = 5.
- Remember to use the total frequency, not the maximum value, on the vertical axis. The values are always read from the horizontal axis.

Cumulative Percentage Frequency Curve or Ogive

Length	Frequency	Cumulative Frequency	Cum.per.fre.
21-24	3	3	9.3
25-28	7	10 (= 3 + 7)	31.2
29-32	12	22 (= 3 + 7 + 12)	68.7
33-36	6	28 (= 3 + 7 + 12 + 6)	87.5
37-40	4	32 (= 3 + 7 + 12 + 6 + 4)	100

The cumulative percentage frequency curve or ogive is the graphical representation of a cumulative percentage frequency distribution such as given in the above table. It is essentially a line graph drawn on a piece of graph paper by plotting actual upper limits of the class intervals on the x-axis and their respective cumulative percentage frequencies on the y-axis. Ogive differs from the cumulative frequency graph in the sense that here we plot cumulative percentage frequencies on the y-axis in place of cumulative frequencies

Use of Cumulative Percentage Frequency Curve or Ogive.

1. The statistics like median, quartiles, quartile deviations, deciles, percentiles and percentile ranks may be determined quickly and fairly accurately.

2. Percentile norms (a type of norm representing the typical performance of some designated group or groups) may be easily and accurately determined.

3. We can have overall comparison of two or more groups or frequency distributions by plotting the ogives concerning these distributions on the same coordinate axes.

4. The difference lies in the fact that a frequency curve is used in the case when the total frequencies(N) in the distribution are the same; but when the total frequencies are different, we have to draw the frequency percentage curve or ogive.

Advantages of Graphical Representation of Data

1. The data can be presented in a more attractive and an appealing form.

2. It provides a more lasting effective on the brain. It is possible to have an immediate and a meaningful grasp of large amounts of data through such presentation.

3. Comparative analysis and interpretation may be effectively and easily made.

4. Various valuable statistics like median, mode, quartiles may be easily computed. Through such representation, we also get an indication correlation between two variables.

5. Such representation may help in the proper estimation, evaluation and interpretation of the characteristics of items and individuals.

6. The real value of graphical representation lies in its economy and effectiveness. It carries a lot of communication power.

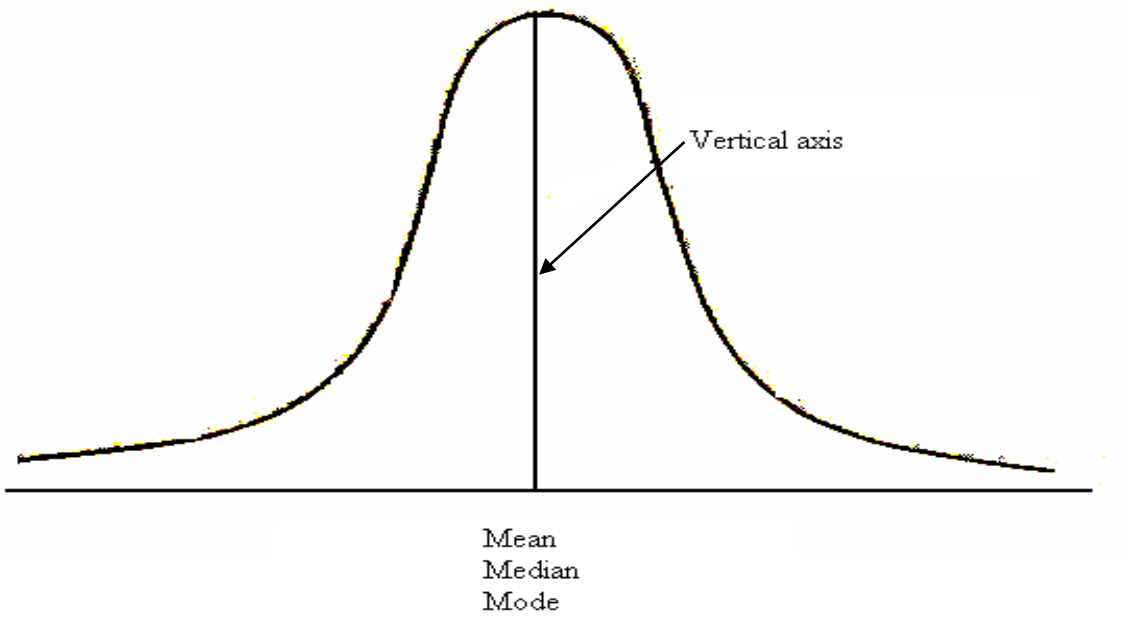
NORMAL PROBABILITY CURVE

The earliest mathematical analysis of the theory of probability dates to the eighteenth century. Abraham DeMoivre, a French mathematician, discovered that a mathematical relationship explained the probabilities associated with various games of chance. He developed the equation and the graphic pattern that describes it.

During the nineteenth century, a French astronomer, LaPlace, and a German mathematician, Gauss, independently arrived at the same principle and applied it more broadly to areas of measurement in the physical sciences. From the limited applications made by these early mathematicians and astronomers, the theory of probability, or the curve of distribution of error, has been applied to data gathered in the areas of biology, psychology, sociology, and other sciences.

The theory describes the fluctuations of chance errors of observation and measurement. It is necessary to understand the theory of probability and the nature of the curve of normal distribution in order to comprehend many important statistical concepts, particularly in the area of standard scores, the theory of sampling, and inferential statistics.

The law of probability and the normal curve that illustrates it are based upon the law of chance or the probable occurrence of certain events. When any body of observations conforms to this mathematical form, it can be represented by a bell – shaped curve with definite characteristics is known as normal probability curve which is drawn below.



The Normal Prabability Curve

1. The curve is symmetrical around its vertical axis.

2. The terms cluster around the centre (the median).
3. The mean, median, and the mode of the distribution have the same value.
4. The curve has no boundaries in either direction, for the curve never touches the base line, no matter how far it is extended. The curve is a curve of probability, not of certainty.

The operation of chance prevails in the tossing of coins or dice. It is believed that many human characteristics respond to the influence of chance. For example, if certain limits of age, race, and gender were kept constant, such measures as height, weight, intelligence, and longevity would approximate the normal distribution pattern.

But the normal distribution does not appear in data based upon observations of samples. There just are not enough observations. The normal distribution is based upon an infinite number of observations beyond the capability of any observer; thus there is usually some observed deviation from the symmetrical pattern. But for purposes of statistical analysis, it is assumed that many characteristics do conform to this mathematical form within certain limits, providing a convenient reference.

The total area under the normal curve may be considered to approach 100 percent probability. Interpreted in terms of standard deviations, areas between the mean and the various standard deviations from the mean under the curve show these percentage relationships.

ANNAMALAI UNIVERSITY

DEPARTMENT OF EDUCATION

LECTURE NOTES

Programme Name & Year: B.Ed., II- Year **Course Instructor: Dr.T.Manickavasagan**

Course Name: Pedagogy of Physical Science (Part-2) **Designation: Associate Professor**

Course Code: BEDO234 **Credits: 4**

UNIT-7: DIAGNOSTIC TESTING AND REMEDIAL TEACHING

DIAGNOSTIC TEST

- The diagnostic tests are purely meant for diagnosing the weakness, deficiency and difficulties of the students related to the specific areas and aspects of the formal and informal learning of the subject.

- These are constructed not to assess the level of achievements or gains in the learning experiences of the pupils but to reveal the weaknesses and learning difficulties.

- **Diagnostic test can easily be understood with the following example.**

A bottle contains milk. Two questions can be arisen.

1. How much milk is there in bottle and 2. Why is it full or empty?

- Question about the quantity of milk (how much milk) comes in achievement test while about quality, why the bottle is empty or full Comes in diagnostic test.
- Hence, from the following example, an easy understanding can be made that diagnostic test are qualitative not quantitative. It undertakes to provide a picture of strengths and weaknesses or pupils in learning.

TYPES OF DIAGNOSTIC TEST

Diagnostic tests are mainly classified into two classes

- 1. Educational Diagnostic Test
- 2. Physical Diagnostic Test

Educational Diagnostic Tests are related to study matter of education. These tests diagnose disorder of material according to level of class.

On the other hand, Physical or Clinical Diagnostic Test are related to hearing, vision and other things that cause hindrance in the course of a child's learning.

CHARACTERISTICS OF DIAGNOSTIC TEST

The diagnostic test should the following characteristics

- It finds out weakness or deficiency of a child in learning of a specific content.
- It is qualitative not quantitative.
- It is an effective tool for teachers that help in planning and organising remedial teaching.
- It is used to form tutorial group so as to help the poor student to develop their performance by removing their difficulties.
- It arranges the items in learning sequence so as to help the student in transferring of learning positions.
- It adopts objective type tests only.
- It fully emphasises on all learning and teaching points.8) In diagnostic test, no score is made for correct answers.
- Only wrong responses are taken into view in the sequence of contents.
- It needs an expert or specialist to identify the cause for wrong answers.

Important Steps of Diagnosis

There are five main steps of diagnosis using which, the process of diagnosis is forward.

- 1. First of all we try to know about the students who are facing this problem. For it, we use different methods (* Educational Testing Method, * Psychological Testing Method and * Clinical Testing Method).
- 2. We try to know about the area or type of questions where the child does mistakes.
- 3. After finding the nature of mistakes in step II we try to know the reasons of their mistakes.
- 4. After knowing the reason is step III, we think about its solution. There is not any certain rule prove it. It depends on the nature of the problem.
- 5. After solving the problem, the process is not yet completed. After it, a teacher should think what he should do so that these problems may not occur in Future.

Difficulty in Learning Physical Science-Planning for Reducing It

- Science subjects particularly physics and chemistry are technical in nature because they involve symbols, notations, derivations, equations, circuits, diagrams and calculations etc. it needs more appropriate concentration from the learner to study these subjects in meaningful way. Simply memorize the concepts in the science subjects will not useful for the learners.
- The difficulties in learning these subjects are caused by many factors like learner inability to understand the science concepts, lack of teacher involvement in making subjects easy to understand and over load of subjects as burden on both teachers as well as learners. Hence, it is essential to take this issue as serious account to find the difficulties of students in learning science subjects and to find remedy for reducing it.

Johnstone (1997a) and Sirhan (2000) have provided a list of key proposals to aid meaningful learning.

1. It is vital for the teacher to know what the learners already know and how they came to acquire the knowledge.

- Many students come to a class with wrong ideas, confused ideas or even a complete lack of background knowledge.
- Learning experiences need to be offered to prepare students to grasp new material by clarifying or correcting previously held concepts or by providing fundamental instruction on such concepts which can be shown to be highly effective in increasing meaningful learning.

2. It is important to take into account the way the learner gains knowledge and to present material in a way that is consistent with patterns of human learning.

3. The process of learning should allow for the development of links between "islands" of knowledge. The teacher must link concepts so that the learner can make a coherent whole of the key ideas.

4. Attitudes and motivation are both important aspects for the learning process.

- Success in learning, positive attitudes to learning and motivation to learn are linked.
- The two major factors influencing attitudes towards a subject are teacher quality and curriculum quality. The learner perceives what is taught being related to their lifestyle.

5. The place of assessment is critical in that, where the assessment does not reflect the aims of the course (usually because the assessment emphasizes knowledge recall too highly).

- Actually the learner motivation is to seek for meaningful learning, with understanding of concepts.
- Hence the teachers of physical science should be kept the above points while trying to remove the difficulties in learning physical science among the students.

Remedial Instruction

- Remedial measures or education involving corrective steps are to be undertaken for removing weaknesses, deficiencies and difficulties of the learner in order to obtain desired mastery level or optimum educational growth in terms of the specified learning objectives.
- Its aim is not confined to remove the learning difficulties and overcoming deficiencies but to provide such congenial environment, facilities and opportunities to the learners as to develop their potentialities to the maximum.

How to Plan Remedial Measures?

Remedy depends upon the diagnosis. Therefore one has to seek answer for the questions like following before planning any remedial education:

- What is the nature, extent and level of the weakness, deficiency of the learner?
- To which area and aspects of the subject matter, learning experiences and activities does it belong?
- What is the cause or causes of such weakness or deficiency?

Hence, from time to time during the classes, teachers should evaluate the progress of individual students and modify their learning plan as needed. Thus, teachers help each student improve their self-confidence throughout the course of the program.

ANNAMALAI UNIVERSITY

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UNIT-8: PROFESSIONAL DEVELOPMENT OF PHYSICAL SCIENCE TEACHERS

❖ TEACHER

According to F.A. Diesterweg, "A bad teacher teaches the truth, a good teacher teaches how to find it."

The Kothari Commission Report (1964 – 66) observed, "The most important factor in the contemplated educational reconstruction is the teacher, his personal qualities, his educational qualifications, his professional training and the place that he occupies in the school as well as in the community. The reputation of a school and its influence on the life of community invariably depends on the kind of teacher working in it."

A teacher is a

- decision maker and
- person who makes judgements pertaining to objectives, learning activities, evaluation procedures as also the quality of classroom environment.

Teaching is one of the essential jobs of a teacher, besides his other involvements with students, inside and outside the classroom.

❖ Importance of a Teacher

Sarvapalli Dr.Radhakrishnan says "A teacher has to help in the transmitting of higher values to his pupils, through his personality and through the goods of culture which are his instruments. A teacher has to help the bud into full bloom and not to make paper flowers to satisfy his whim. The growth of a morally autonomous personality is the aim and end of his endeavour.

❖ Characteristics of a Science Teacher

(i)The characters with respect to 'Competency'

(a) Mastery over the Subject

(b) Full Knowledge of Psychology

(c) Well Equipped with Methodology of Teaching Science

(d) Knowledge about Allied and Various Fields of Science

(e) Adequate General Knowledge

(f) Creative Imagination and Teaching

(g) Fluency in Expression

(ii)The characters with respect to 'Commitment'

(a) Faith in the subject

(b) Scholarly Interest in the Subject

(c) Well Equipped in Human Qualities

(d) He must have progressive and dynamic outlook and well integrated and effective personality.

(e) He should understand and motivate the students.

(f) Be a humble student of science throughout life: In the words of Tagore who says "A teacher can never truly teach unless he is still learning himself. A lamp can never light another lamp, unless it continues to burn its own flame."

(g) Artistic and Aesthetic outlook

(h) Sense of Humour

(i) Just, Fair and honest

(j) Self – analysis: Ryburn has correctly said, "self analysis on the part of the teacher is his initiation into the profession and should be regarded as a necessary equipment of a teacher".

(iii)The characters with respect to 'Performance'

1. Conscientious in performing his duties of teaching science to various classes assigned to him.
2. Special interest in arranging and performing demonstration relevant to science teaching in his classes.
3. Helping students to carry out practical work in the laboratory.
4. Organising science laboratory, science library etc.
5. Organising various co-curricular activities such as science fair, science exhibition, hobbies etc.
6. Organising the evaluation of students' progress and their achievements specifically in terms of realization of aims and objectives of science education.
7. Preparing and producing quality books in science.
8. Selecting and recommending good textbooks to his students.
9. Providing active assistance in improving science curriculum.
10. Assigning more appropriate and relevant home - work to his students.
11. Skill in using of various audio-visual aids to teaching of science.
12. Helping in setting up of audio-visual room in the school.
13. Preparing and collecting of audio-visual materials and improvised apparatus.
14. Showing interest in participating in Faculty meetings, Science club, Education fair, Science workshop, Science projects, Science exhibitions, Excursions to places of scientific interest, Essay competitions, Lectures on scientific topics.

❖ The Professional Development of Teacher

❖ The professional development of teachers is complicated:

- there is much for teachers of science to know and be able to do;
- materials need to be critiqued and questions need to be researched;
- a variety of information and expertise needs to be tapped; and

- many individuals and institutions claim responsibility for professional development.

❖ However, for an individual teacher, prospective or practicing professional development too often is a random combination of courses, conferences, research experiences, workshops, networking opportunities, internships, and mentoring relationships. More coherence is sorely needed.

The National Science Education encompasses the following changes in the professional development standards.

LESS EMPHASIS ON	MORE EMPHASIS ON
1. Transmission of teaching knowledge and skills by lectures.	Inquiry into teaching and learning..
2. Learning science by lecture and reading.	Learning science through investigation and inquiry.
3. Separation of science and teaching knowledge.	Integration of science and teaching knowledge.
4. Separation of theory and practice.	Integration of theory and practice in school settings.
5. Individual learning.	Collegial and collaborative learning.
6. Fragmented, one-shot sessions.	Long-term coherent plans.
7. Courses and workshops.	A variety of professional development activities.
8. Reliance on external expertise.	Mix of internal and external expertise.
9. Staff developers as educators.	Staff developers as facilitators, consultants, and planners.
10. Teacher as technician.	Teacher as intellectual, reflective practitioner.
11. Teacher as consumer of knowledge about teaching.	Teacher as producer of knowledge about teaching.
12. Teacher as follower.	Teacher as leader.
13. Teacher as an individual based in a classroom.	Teacher as a member of a collegial professional community.
14. Teacher as target of change.	Teacher as source and facilitator of change.

Finally, those who plan and conduct professional development programs must continually evaluate the attainments of teachers and the opportunities provided them to ensure that their programs are maximally useful for teachers.

❖ Need and Importance of In-Service Program for Science Teachers

- First the science teachers must be well equipped with science concepts the only they can capable of imparting science education to their students. For updating of science education they need to have programs which enable them to enrich their knowledge in science.
- In-service teacher professional development includes a wide variety of programs designed to promote and support the professional learning of teachers who are already employed and working in classrooms.

- The goal of in-service professional development is to improve the knowledge, skills, and commitments of teachers so that they are more effective in planning lessons, teaching, assessing students' learning, and undertaking other responsibilities in the school community.

❖ Types of Programs

- In-service program refers to professional development activities for teachers, ranging from continuous, comprehensive career-long programs of teacher learning to occasional, ad-hoc workshops.
- In-service programs help teachers acquire or deepen their knowledge about the subject matter content, teaching skills, and assessment methods required to implement an existing or a new curriculum as well as assist them in working effectively with parents and other community members.
- The following are the some example for in-service programs

Science Conference

- A scientific conference is a meeting of scientists of a certain research field, intended to bring them together to learn about recent developments.
- In which they present new data to each other and discuss it critically, and
- To socialize and get to know new colleagues with new ideas.

Merits

- An important advantage of presenting data at a conference in comparison to publishing them in a journal paper is that the feedback and critical evaluation can be given immediately.
- Nevertheless, all important results are also generally published later in paper form; most conferences result in the publication of a book of conference proceedings listing the abstracts (summaries) of the research projects that were presented.
- Some of the innovative ideas, concepts etc, which were presented in the conference are forwarded to publish in the standard scientific journals.
- Hence, the regular participation in conferences is considered as vital for a science teacher and being an invited speaker at conference is an important recognition of the influence of the teacher's work.

Seminar

- Teachers can attend seminars in science and other subjects related to teaching.
- The report is then read before the assembly.
- It can be held on co-curricular activities, new techniques for teaching, science curriculum improvement etc.

Workshop

- Science workshops are practical and exciting as well as educational and intuitive.

- They can be used as an incentive to get focus and determination levels excited or as a reward for some great work already done.
- It can be easily arranged on lesson planning, curriculum, test construction etc.
- The best bit is that whatever you choose it will be further education for your group of youngsters and this will only further encourage learning and development beyond what is learnt at school.

Finally, those who plan and conduct professional development programs must continually evaluate the attainments of teachers and the opportunities provided them to ensure that their programs are maximally useful for teachers.

Advantages of In-Service Programs

The following advantages accrue to teacher by in-service training:

1. He can reorient himself with the latest knowledge and developments in science.
2. He gets acquainted and acquires the latest strategies, techniques and methodology of teaching science.
3. He can develop proper scientific attitude, temper and interests and learn scientific method for solving the problems and discovering scientific facts.
4. He can acquire necessary competency in motivating the students for learning science and applying it to their day-to-day life.
5. He can acquire necessary skills to guide his students in the form of educational, personal and vocational guidance.
6. He can be in a position to take active part in reconstruction and revision of curriculum, in preparation and revision of textbooks, instructional material, teaching aids, evaluation scheme etc.

Science Teachers Association

The principles of Science Teachers Association should be as follow

- Model excellence;
- Champion science literacy;
- Value scientific excellence;
- Embrace diversity, equity, and respect;
- Enhance teaching and learning through research;
- Collaborate with partners; and
- Exemplify a dynamic professional organization.

The National Science Teachers Association Strategic Goals 2015 (US) has identified six overarching goals that will guide and prioritize the work of association. They are given below.

1. **Advocacy** – Raise the status of science education and science teaching as a profession by advocating for high-quality science education within national, state, and local contexts.
2. **Professional Learning** – Enhance the professional learning of science educators by providing a suite of tools, resources, and opportunities that support long-term growth within a collaborative learning environment.
3. **Next Generation Science Standards** – Revitalize science education to boost student achievement and science literacy, and bolster national economic standing.
4. **Elementary Education** – Nurture scientific curiosity among children in the earliest grades.
5. **Membership** – Enrich the NSTA membership experience through enhanced peer-to-peer engagement and differentiated benefits.
6. **Internal Organizational Goals** – Fulfilling the goals and objectives outlined in this plan requires updates in infrastructure, as well as certain tactical staff supports.

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UNIT-9: TEACHING GIFTED AND BACKWARD LEARNERS IN PHYSICAL SCIENCE

Concept of Individual Differences

- Every individual differ from one another in their physical as well as mental makeup.
- Generally the individuals differ in their reaction time, preferences, values and health etc, related behaviours.
- The individual differences are due to the factors such as personality, intelligence, memory, or physical factors such as body size, sex, age, and other factors.
- Importantly, individuals differ not only in their current state, but also in the magnitude or even in the direction of response to a given stimulus.

Individual differences in physical science

- In any study, significant variation exists between individuals.
- In physical sciences some students understand the science concepts by thorough reading of theory. Some from diagram, some from important notes, some from hearing information from others, and most from doing activities directly. Hence, the same content acquired by the individuals in different way. These are actually due to physical and mental factors.
- Therefore, science teachers must be very clear about the fact that a single method can not make all individuals to understand the science concepts.
- By identifying the individual differences with respect to capacity we can devise teaching methods accordingly.

Slow Learner

- Slow Learner may be called dull normal, low normal or borderline retarded. But we prefer the term Slow Learner.
- About 1 out of 5 children are Slow Learners. They often are delayed in walking or talking.
- Most Slow Learners are born with the problem. Severe head injuries, meningitis, or the mother's use of alcohol or cocaine during the pregnancy can cause a child to become a slow learner.
- Unfortunately these children are often "overlooked" since they do not have a Learning Disability and are not Mentally Retarded. A Learning disability is defined as a child who is not performing to their level of intelligence.

- Being a slow Learner is a life-long problem. A Slow Learner is a child whose IQ is low enough to cause considerable difficulty in keeping up in the classroom.
- An average IQ is 100. Slow learners score between 70 and 90 on IQ tests. Less than 70 is considered Mentally Retarded. Slow Learners are not Mentally Retarded.

Causes for slow learning in science

1. Disasters can disrupting classes for a long time e.g wind disasters.
2. Children are lowly motivated in science learning.
3. They have low self-esteem because of repeated failure in science subject.
4. They are dissatisfied with their school environment (class room and laboratory atmosphere).
5. They are irregular at school activities (home work and class work in science) and play truancy.
6. Some may consume drugs e.g alcohol and narcotics.
7. They do not concentrate on their work (reading science concepts and doing experiments in lab)
8. The teachers do not teach science in appropriate manner and learners are not learning as they ought to learn.
9. Some lack proper orientation and sense of purpose.
10. Some may not have their basic needs.

Remedial Measures for Backward Learners

1. Corrective Teaching:

- Divided the content in to smaller units (modules) or steps.
- Supervise study sessions
- Individualized tutoring
- Re-teach the lesson

2. Formative Evaluation:

Consistently give quizzes as you teach to find out if children are learning as expected and undertake to correct immediately.

3. Summative Evaluation:

- At the end of each unit give a test.
- Those who score 80% should be put in a group and give enrichment activities relating to that unit. This extends their knowledge.
- Those who score less than 80% should be put in another group and give corrective teaching at some extra time.
- At the end the teacher should give another summative test. Those who score more than 80% should join the enrichment group. Those who score less than 80% should continue with corrective teaching until they master the unit and score above 80%. At this point, a new unit can be introduced beginning with whole class coming together again.

Giftedness

- Indeed in most countries, everyone thinks giftedness means being able to do the existing curriculum faster, getting mastery of the content more quickly. But Prof. Gilbert suggests a radically different idea.
- “Giftedness surely has got to mean that you’re intellectually innovative,” he posits “Giftedness is about being creative!”

What does creativity have to do with excelling in science?

- "It is about being able to attack, or even identify problems that people have not identified before.
- Those who make progress with their problems, who show tenacity, who use skills – those are the gifted

Identifying Gifted Learners

- Unfortunately, there are no foolproof tests for identifying creative people. "You can do the tests, and it sort of narrows the field, but you can't tell who's creative."
- Prof. Gilbert says that the best way to identify creative people is to give people the opportunity to be creative.
- Prof.Gilbert suggests "Give them questions to solve – preferably increasingly open-ended ones – problems that people don't know the answers to," Provide extended opportunity to work on their own to solve a menu of problems with increasing difficulty. And that's where the real test begins.

The Gifted (Creative) Learner will Display the Following Characteristics:

- **Interest**: They will demonstrate an inclination towards problem solving.
- **Intrigue**: They will ask questions, difficult ones!
- **Imagination**: They will come up with creative solutions.
- **Persistence**: They won't give up, even in the face of difficulty. They are self-directed and motivated.
- **Purpose**: They will have tenacity of purpose and a sense of ownership.

This **"Gilbert recipe for giftedness"** may be exploratory and tentative, but it allows teachers to see how their students will perform. More importantly, it allows students opportunity to show us their creativity.

Teaching Gifted Learners

- Prof.Gilbert makes a distinction between teaching and mere instruction. "Teachers want answers, they want algorithms, they want things to do – that's not teaching, that's instruction!"
- "Teaching gifted children is very demanding," he warns. "It is very little about telling them things and an awful lot about asking them question, probing what they understand, and getting them to suggest where they might go. These are very high-level skills in a teacher."

Good Instruction for Gifted Learners in science:

- **Good science curriculum:**

- Highly able students should be treated with inspired curriculum and instruction.
- Because, they need rich learning experiences in science that are organized by key concepts and principles of science discipline rather than by facts.

➢ **Good science teaching:**

- Often, highly able students learn more quickly than others their age. As a result, they typically need a more rapid instructional pace than do many of their peers.
- They should be provided with higher "degree of difficulty" in science activities than for many students their age.
- Because, greater degree of difficulty in learning science calls on more skills-more refined skills-applied at a higher plane of sophistication.

➢ **Good teaching for gifted learners also include the following:**

- Allocating different assignments and experimental works in school as well as in home.
- Deputing them to science conference, workshop, seminar etc to excel their ideas.
- Motivating them to attend to summer programs in science in universities.
- Accelerating them to do innovations in solving problems in science.
- Allowing them to participate in college level programs to show their talents in science.

ANNAMALAI UNIVERSITY

DEPARTMENT OF EDUCATION

LECTURE NOTES

Programme Name & Year: B.Ed., II- Year **Course Instructor: Dr.T.Manickavasagan**

Course Name: Pedagogy of Physical Science (Part-2) **Designation: Associate Professor**

Course Code: BEDO234 **Credits: 4**

UNIT-10: RECENT DEVELOPMENTS IN PHYSICAL SCIENCE EDUCATION

I. Flipped Learning

- Flipped classroom is an instructional strategy and a type of blended learning that reverses the traditional learning environment by delivering instructional content, often online, outside of the classroom.
- It moves activities, including those that may have traditionally been considered homework, into the classroom.
- In a flipped classroom, students watch online lectures, collaborate in online discussions, or carry out research at home and engage in concepts in the classroom with the guidance of a mentor.

Traditional Vs Flipped teaching

Traditional Teaching:

1. In the traditional model of classroom instruction, the teacher is typically the central focus of a lesson and the primary disseminator of information during the class period. The teacher responds to questions while students defer directly to the teacher for guidance and feedback.

2. In a classroom with a radically traditional style of instruction, individual lessons may be didactic and content oriented. Student engagement in the traditional model may be limited to activities in which students work independently or in small groups on an application task designed by the teacher.

3. Class discussions are typically centered on the teacher, who controls the flow of the conversation. Typically, this pattern of teaching also involves giving students the task of reading from a textbook or practicing a concept by working on a problem set, for example, outside school.

Flipped Teaching:

1. The flipped classroom intentionally shifts instruction to a learner-centered and creates meaningful learning opportunities.

2. In a flipped classroom, content delivery may take a variety of forms. Often, video lessons prepared by the teacher or third parties are used to deliver content, although online collaborative discussions, digital research, and text readings may be used.

3. Flipped classrooms also redefine in-class activities. In-class lessons accompanying flipped classroom may include activity learning or more traditional homework problems, among other practices, to engage students in the content.

4. Class activities vary but may include: using math manipulative and emerging mathematical technologies, in-depth laboratory experiments, original document analysis, debate or speech presentation, current event discussions, peer reviewing, project-based learning, and skill development or concept practice.

5. Because these types of active learning allow for highly differentiated instruction, more time can be spent in class on higher-order thinking skills such as problem-finding, collaboration, design and problem solving as students tackle difficult problems, work in groups, research, and construct knowledge with the help of their teacher and peers.

6. Flipped classrooms have been implemented in both schools and colleges and been found to have varying differences in the method of implementation.

7. A teacher's interaction with students in a flipped classroom can be more personalized and less didactic, and students are actively involved in knowledge acquisition and construction as they participate in and evaluate their learning.

II. Spaced Learning

- Spaced Learning is a method of embedding information in our long-term memory through repetition.

- Fundamentally, this is no different from how we learn all the time. When we hear, see or do something once, it can be stored in our short-term memory. If we hear, see, or do it repeatedly, it can enter our long-term memory.

Significance of spaced learning

- Spaced Learning is significant because it deploys neuro-scientific research, which enables this process to take place very quickly – quickly enough to cover and retain a whole subject module's content in approximately an hour.

The Science behind Spaced Learning

- Repeated stimulation of the same neural pathway demonstrates its importance to the brain and makes it easier to locate when you need to access the information stored within it.
- Spaced Learning is a way of creating neural pathways at the start of a unit of work (memory acquisition), which can then be revisited at various intervals over time (memory retrieval). This will emphasize the pathway's importance and make it easier for you to 'locate' it when you need it.

The Structure of a Spaced Learning Lesson

- A Spaced Learning lesson consists of three 'inputs' separated by two 10-minute gaps, as follows:
  - Teacher input of key facts/information
  - 10-minute break
  - Student recall of key facts/information
  - 10-minute break
  - Student application of key facts/information.

- A Spaced Learning session consists of three 'inputs' divided by 10-minute breaks, which students spend doing a simple activity such as dribbling a basketball or playing with modeling clay.

Procedure:

- The first input is a lecture in which the teacher presents a large body of information, usually supported by a PowerPoint presentation.
- The second input focuses on recall, so students might be presented with the same PowerPoint presentation, now missing many key words, or they might carry out simple mathematics problems using the formulae presented in the first input.
- The final input focuses on understanding, so students should carry out a task that applies the knowledge or skills they have just acquired. This process of rapid structured repetition, separated by short breaks, embeds the information in the long term memory.

Conditions for Spaced Learning

1. Spaced Learning should work with students of any age.
2. Spaced Learning is appropriate for all abilities, as long as students are able to read.
3. We put on what we really want our students to know. That's the only guideline we use when we are making them.
4. The only time limit on the inputs is depends on your students' concentration, and you will know better than anyone how long that lasts.
5. By experience, 10 minutes is a good length for the first input (the absolute maximum time we would spend is fifteen minutes).
6. The second and third inputs are more flexible – it depends on the nature of the tasks you've set your class.

III. Team-Based Learning (TBL)

- The main purpose of TBL is to change the classroom experience from acquiring course content and concepts in a lecture-based format to applying course content and concepts in a team format.
- In other words, students spend their classroom time applying course materials rather than simply acquiring it. In a TBL course, classroom learning occurs in teams of 5 to 7 students. Teams are formed such that each group contains a variety of students in terms of skills and backgrounds.
- Students begin each TBL unit by studying assigned class material (readings, website tutorials, video demonstrations, etc.) prior to class.

Procedure

1. During the first class session of a TBL unit students take an individual readiness assessment test (iRAT) over the assigned material.

- Right after this individual test, students retake the same test as a team (tRAT), and immediately find out how they scored on both the individual and team test.
- Both grades are counted in terms of final grade calculations. The individual tests hold students accountable for learning the material before class and the team tests provide an exciting opportunity for students to learn from one another while working together on the test.
- Following the readiness assessment process, each team is assigned the same application exercise to solve.
- Application exercises are designed such that students use the materials they learned outside of class to solve challenging problems.
- Each team reveals their answer to the application exercise simultaneously, resulting in energetic conversation between teams, as each team to justify their answers.
- Teams are held accountable for their work by writing an explanation for their answer to application exercises, which is later graded by the course instructors.

2. Typical Timeline for a TBL Unit

- While most learning occurs amongst students in their teams, faculty are always present and available to provide a "mini lecture" over material that teams find difficult to master. Midterm exams are given several times throughout the semester of a TBL course.

Motivations and Benefits for using Team Based Learning in Education

1. Team Based Learning has been suggested to help students who seem uninterested in subject material, do not do their homework, and have difficulty understanding material.

2. Team based learning can transform traditional content with application and problem solving skills, while developing interpersonal skills.

3. Team based learning in education can also be important for developing skills and abilities that are useful for businesses, organizations, careers, and industries where many projects and tasks are performed by teams.

4. Learning how to learn, work, interact, and collaborate in a team is essential for success in this kind of an environment. Many of the medical schools have adopted some version of Team Based Learning for several of the benefits listed above, and also for greater long-term knowledge retention.

5. Many research shows that individuals who learned through an active team based learning curriculum had greater long-term knowledge retention compared to a traditional passive lecture curriculum.

IV. Jigsaw Technique

- The jigsaw technique is a method of organizing classroom activity that makes students dependent on each other to succeed.
- It breaks classes into groups and breaks assignments into pieces that the group assembles to complete the (jigsaw) puzzle. It was designed by social psychologist Elliot Aronson to help weaken racial cliques in forcibly integrated schools.

Procedure

- The technique splits classes into mixed groups to work on small problems that the group collates into a final outcome.
- For example, an in-class assignment is divided into topics. Students are then split into groups with one member assigned to each topic. Working individually, each student learns about his or her topic and presents it to their group.
- Next, students gather into groups divided by topic. Each member presents again to the topic group.
- In same-topic groups, students reconcile points of view and synthesize information. They create a final report. Finally, the original groups reconvene and listen to presentations from each member. The final presentations provide all group members with an understanding of their own material, as well as the findings that have emerged from topic-specific group discussion.

Benefits

1. Jigsaws had a more favourable view of the learning experience, stronger intrinsic motivation, greater interest in the topic and more cognitive activation and involvement than traditions.

2. Jigsaws were more involved and more interested in the material and were seen as more competent, more socially related to other students and more autonomous. Indirect effects on performance were implied because students viewed themselves as more competent, but without direct impact on achievement.

3. Students perceived the jigsaw procedure as being very positive especially as an alternative learning experience. Jigsaws rated the technique as more useful for practical purposes than for interpersonal purposes such as working with others or giving/getting help. Students appreciated the technique as a time-saver and viewed it is a change of pace.

4. Students in jigsaw classrooms showed a decrease in prejudice and stereotyping, liked in-group and out-group members more, showed higher levels of self-esteem, performed better on standardized exams, liked

school more, reduced absenteeism, and mixed with students of other races in areas other than the classroom compared to students in traditional classrooms.

V. Virtual Class Room

- A teaching and learning environment located within a computer-mediated communication system.
- All activities and interactions take place through the computer instead of face-to-face.
- Virtual classrooms may involve three overlapping scopes of interaction technologies: VC courses, meetings and presentations.

Definition

A virtual classroom is an online classroom that allows participants to communicate with one another, view presentations or videos, interact with other participants, and engage with resources in work groups.

Benefits

1. Non-Restricting

A virtual classroom allows both learners and instructors around the world to participate in live classes to collaborate and interact. 'MOOC' programs like 'Coursera' are a great example of this concept in action.

2. Affordable

The low costs of virtual classrooms are considered to be a major advantage. Learners can save money by not having to worry about travel expenses. Participants also save time since all that is needed is an internet connection.

3. Flexible Learning

Online classes also allow for the ability to record class as it happens, including any presentation audio and visuals. This means that the content is accessible even after being delivered, an added benefit for those who want a quick refresher, or perhaps did not fully understand the first time.

4. Practical and Proven

Synchronous learning is a learning environment where everyone takes part in the learning at the same time. A traditional lecture is an example of this type of learning, and has been used for hundreds of years. Online learning enables this same type of experience, but with far more conveniences and tools.

5. Accessible

Virtual classrooms can be used to deliver lectures or even tutorials online. They are also great options for impromptu meetings and group projects where members need to check-in on progress and bounce ideas of one-another. With the virtual environment, ideas and collaborators are never far away.

6. One characteristic/advantage is that the virtual classroom is also environmentally friendly. Unlike traditional classroom training where participants may travel to a location to join a training session, virtual classroom participants get together online from wherever they happen to be. And since virtual classroom materials are digital, paper use is reduced as well.

7. Virtual class or online education are effects that technology of e-learning is easy to do that cannot be done in a regular school and colleges, such as the operation and use of animation and self confident increase in learning. ''

8. Virtual Class rooms are supplied with text, mail and ppt messaging to allow you to confreres in real time with your friend and teacher.

9. In the virtual class room the Time of interaction: Synchronous / Asynchronous. The type of interaction: Student-student, Student-teacher, Student-content and Student-machine. The learning style: Group-based and Self-based learning.

10. Teacher's Electronic content can be updated more efficiently than printed material, and at a lower cost, which saves the teacher time and money when preparing and adjusting material to suit their lessons and courses within their virtual classroom.

VI. Blended Learning

- **Blended learning** is a term increasingly used to describe the way e-learning is being combined with traditional classroom methods and independent study to create a new, **hybrid teaching** methodology.
- It represents a much greater change in basic technique than simply adding computers to classrooms; it represents, in many cases, a fundamental change in the way teachers and students approach the learning experience.

Definition

No single, reliable definition of blended learning is exists, or even a universal agreement on the term itself. Many use terms like **hybrid**, **mixed**, or **integrative** to describe the same trend. But the trend is significant.

Model of Blended Learning

There is a general consensus among education innovators that blended learning has three primary components:

1. In-person classroom activities facilitated by a trained educator.

2. Online learning materials, often including pre-recorded lectures given by that same instructor.

3. Structured independent study time guided by the material in the lectures and skills developed during the classroom experience.

Procedure

- A course created in a blended learning model uses the classroom time for activities that benefit the most from direct interaction.
- Traditional education (especially at the college level) tends to place an emphasis on delivering material by way of a lecture, while in a blended learning model lectures can be videotaped ahead of time so the student can watch on their own time.
- The classroom time is more likely to be for structured exercises that emphasize the application of the curriculum to solve problems or work through tasks.

- An individual semester of blended learning may emphasize classroom time at the beginning, then gradually increase the amount of work that students do online or during independent study.

Benefits

1. Blended learning redefining teaching roles

- In some situations, the move to blended learning has inspired educators to redefine traditional roles. The word "**facilitator**" has emerged as an alternative to "teacher," bringing with it a slightly different focus.
- The facilitator places an emphasis on empowering students with the skills and knowledge required to make the most of the online material and independent study time, guiding students toward the most meaningful experience possible.

❖ **Facilitators focus on four key areas:**

(i) Development of online and offline course content.

(ii) Facilitation of communication with and among students, including the pedagogy of communicating content online without the contextual clues students would get in person.

(iii) Guiding the learning experience of individual students, and customizing material wherever possible to strengthen the learning experience.

(iv) Assessment and grading, not unlike the expectations for teachers within the traditional framework.

2. By putting an emphasis on learning through supervised activities, blended learning has proven to be very adaptable to what some corporations are calling blended training. Trainers can shift their focus from the delivery of knowledge to its application.