DIAGNOSTIC AND REMEDIAL TEACHING

Generally mathematics teaching is organized to facilitate average students. The individual variation of the students is taken in to consideration. Thus, the extreme case-bright students and poor students are ignored in the normal teaching of mathematic teaching. This chapter provides the awareness about diagnostic test in mathematic teaching and planning for remedial mathematics teaching.

Diagnostic Tests

Meaning of Diagnostic Test

It is a form of achievement test. A diagnostic test is one kind of educational test. It is designed to reveal specific weakness or failures to learn in some subject of study such as reading or arithmetic. The difficulties of students can not be easily identified from this test. The aim of diagnosis is to analyse the difficulties and weakness of a student in a particular phase of work. Through diagnostic devices, efforts are made get reliable informations and reasons concerning the weakness of the student in order to overcome them by concentrated action and for detecting needs for remedial teaching.

The word 'diagnosis' is extensively used in medical science. The patient is prescribed medicine on the basis of the diagnosis. If the diagnosis is proper, the medicine prescribed will cure the patient soon. In the same way, in the field of education, if the proper causes of not learning a subject matter correctly by the students are found out, remedy too can be done properly.

In a diagnostic test the main interest is the performance on individual item or on small groups of highly similar items. In this test score or marks is not assigned for the correct answer but wrong answer provide the basis for the causes of his failure. Diagnostic tests are qualitative not the quantitative. A diagnostic test does not yield the total scores of an individual in a subject which he has studied and taken the test.

Definitions :

According to **Good,** "Diagnosis means determination of the nature of learning difficulties and deficiencies."

According to **Ross,** "Prevention is the highest level of diagnosis."

Again **Ross say that,** "The diagnosis value of a test depends more upon the teacher than upon the test used."

According to **Yoakum and Simpson,** "Diagnosis is the art or act of recognizing a difficulty by its symptoms. It is an explanation of the difficulty based on an examination of the facts."

According to **Good & Brophy,** "Diagnostic teaching refers to the process of observing student responses carefully to diagnose the specific nature of difficulties in learning."

Hence, the diagnostic test is the test which is constructed in order to find out the short comings and hindrances coming in the way of learning a unit of a subject matter and on the basis of these findings provides remedial suggestions to do away these shortcomings and hindrances.

Purposes of Diagnostic Test

The main purposes of diagnostic test are :

1. To give suggestions in improving the teaching process of teachers.
2. To give suggestions for effective evaluation process.
3. To suggest to make the curriculum more useful.
4. To arrange the remedial teaching.
5. Make an effective teaching - learning situation.
6. To help in selecting the different type of questions for the construction of achievement test.

Functions of Diagnostic Test

The functions of diagnostic tests in schools can be as below :

1. To find out the bases for improvement in teaching process.
2. To suggest to make the text books more useful.
3. To identify the backward students in learning a specific subject, and to suggest remedies for them.
4. To change evaluation methods to make the evaluation process more effective.
5. To provide educational and vocational guidance on the basis of difficulties and hindrances of students.
6. To find out the hindring factors in learning process and affect necessary changes accordingly.
7. To find out the difficulties and hindrances of students in learning and to suggest remedies.

Characteristics of Diagnostic Test

The main characteristics of diagnostic test are :

1. These tests are both standardised and non-standardised.

2. There is no limitation of diagnostic test.
3. It is a main part of curriculum in diagnostic test.
4. These tests are constructed according to specific objectives.
5. These tests are analytical.
6. These tests specify the mental condition of the students.
7. The progress of students is tested objectively by these tests.
8. It is an effective tool for teachers that helps in planning and organizing remedial teaching.
9. It finds out weakness of a child in learning of a content.
10. In diagnostic test no scores is made for correct answers, only wrong responses are taken into view in the sequence of contents.

Construction of a Diagnostic Test

For a good or proper construction of diagnostic test there is need of proper planning. For this purpose we should keep in mind the following things :

1. Formulation of objectives and outline of the content or topic.
2. Content analysis is divided into sub-topic and its elements:
   (i) Sequence of sub-topics and elements within the sub-topic.
   (ii) Sequence of learning points.
3. Identify difficulty in order of sub-topic.
4. Deciding the types of the items.
5. Preparing items and tryout.
6. Item analysis of test items and modification of items.
7. Analysis of logical sequence of content by preparing scalogram.
8. Preparing the final draft of the test.
9. Preparing manual of the test.
10. Remedial devices or measures.

Process of Diagnostic Test

It is completed in five steps :

1. Selection of diagnostic students.
2. Identifying difficult points
3. Analysis of difficult points
4. Remedial process
5. Preventive measures

1. Selection of Diagnostic Students–In this step, those students are selected who are weak in one or more subjects, who have problem in adjusting with the school. Such students are selected by conducting, achievement tests, intelligence tests, interview and observation.

2. Identifying Difficult Points–In this step, the difficulties of the students are found out by interview, observation, intelligence tests or achievement tests. The teachers experience of informal tests conducted by them, observation and interview prove more effective in it.

3. Analysis of Difficult Points–In this step, the teacher finds out the causes of difficulties of the students. The teacher attempts to find out the causes of these difficulties by his experiences, conversation with the students, fellow teachers and guardians. The origin of these causes can be physical defect, mental instability, bad habits and mental retardation etc.

4. Remedial Process–After having diagnosed the weakness of the students, remedial measures are adopted. Suitable plan is made to eradicate them, which describes the causes of difficulties and the remedial measures. Besides, it also mentions whether the difficulty has to be remedied collectively.

5. Preventive Measures–The causes of difficulties are analysed, planned effort is made so that they commit less errors in the future. The preventive measures may include one or more measures out of improvement in school atmosphere, improvement in home atmosphere, amendment in the curriculum, improvement in the examination system, etc., which may reduce the errors in the future.

Precautions Regarding Construction of Diagnostic Test

Teacher should observe following precaution in the preparation of diagnostic test :

1. Teacher should construct the diagnostic test ownself.
2. Should give more emphasis on the typical or difficult words used in teaching process.
3. These test should construct the difficulty level of the content.
4. Students do not repeat the demerit of previous.

Remedial Teaching

Remedial measures should be adopted to remove the weakness and difficulties experienced by the student in a specific field of mathematics. It is selected the weaknesses of student through diagnosis. So, the diagnostic test is only a means of finding out the weakness of student and the reasons behind them. After eliminating the factors, remedial teaching should be done. The mathematics teacher may also prepare corrective material for this purpose. Thus, by remedial teaching the success can be achieved in removing the weaknesses of the students.

Definitions :

According to **Yoakum and Simpson Boserve,** "Remedial teaching

is actually old, since good teachers from times immemorial have always tried to correct the errors in children's reading and set them on the right track. The new remedial teaching has received as stimulus form the testing movement, however and has been given a name borrowed from the medical profession. It has for its purpose the development of effective techniques for the correction of errors in all types of learning. As yet, it has been more effectively used in the skill subjects than in the mathematics. This is probably because the errors in learning may be more easily detected in the former than in the later."

According to **Yoakum and Simpson,** "Remedial teaching logically follows diagnostic teaching."

According to **Mc Millan Co (1956) (Diagnostic & Remedial Teaching, New York),** "Remedial teaching is concerned with two types of deficiencies, the presence of bad habits and the absence of good habits."

According to **Blair, Jones & Simpson,** "Remedial teaching is essence, is just good teaching that takes the learner where is and through well motivated activities leads him to increased competence in his areas of weakness.

Functions of Remedial Teaching

Following functions of remedial teaching have been indicated :

1. To solve the learning difficulties of the poor students.
2. To assist the poor students to pace with his classroom teaching.
3. To avoid the wastage in education process.
4. To raise the standard of mathematics teaching.
5. To evolve the effective strategy of mathematic teaching.

Aims of Remedial Teaching

The main aim of remedial teaching are as follows :

1. It is used to remove weakness of the child.
2. Give personal and group discussion for knowing the errors of the students.
3. To avoid the learning-related defects and drawback.
4. To give proper direction.
5. To change the undesirable interest, ideals and point of view to desirable interest, ideals.

Yoakum and Simpson defined the aim of remedial teaching in this form :

"Remedial teaching has for its purpose the development of effective technique for the correction of errors in all types of learning."

—Yoakum & Simpson

Principles of Remedial Teaching

1. To improve the relation between the teacher and students.
2. In this the result of progress can be achieved fastly.
3. In the process of remedial teaching students are more active.
4. For this purpose teacher should be trained or expert in diagnostic test.
5. In this teacher should be broad point of view in his experiences.

Procedure for Remedial Teaching

Procedure for remedial teaching are :

1. Identify the poor students–First step is to identify poor students in mathematics subject by using achievement test, school marks, personal observation of teacher and interview technique.

2. Diagnostic Test–In second step, a diagnostic test in mathematics related to specific area, pronunciation, spellings, reading, grammar etc. is administered to locate the learning difficulties and its causes.

3. Remedial Teaching–In this step remedial instructions are to be prepared for remedial teaching.

4. Strategy–An appropriate strategy is used for remedial teaching. After this, a test is administered to ascertain, how for learning difficulties could be removed. It may suggest about reteaching or further remedy.

Remedial Teaching in Mathematics

In mathematics teaching gifted children and dull children give separate remedial teaching.

A. Remedial Work for Dull Students

Dull student concentrate his mind very less in any work. So he needs individual instruction. So, following remedial teaching should kept in mind for giving education to dull students :

1. He should sit infront in the class.
2. Pay more attention to solve the mathematical problems. For this purpose they should be taught the concept, theories etc.
3. To understand any concept, theories etc. teacher should use chart, model, diagram etc.
4. Give more emphasis on law of exercise.
5. Teacher should check the home work or any written work of dull student precautions and tell their mistakes.
6. Teacher should select the proper examples related to topic in a class room teaching.
7. Give more emphasis on practical work.

8. Teacher should use effective question-answer method in classroom to motivate the dull students.

B. Remedial Teaching for Gifted Children

Gifted children are more active. They are different to normal children, for this purpose they need the special education and training. They adjust in class with difficulty.

According to **Kolesnik,** "The term gifted has been applied to every child who, in his age group is superior in some ability which may make him outstanding contributor to the welfare and quality of living in our society."

Following points should be kept in mind for teaching of gifted children:

1. Separate schools should be made for these children with proper facilities which fulfil the development opportunities of these children. There can be provision of special schools for talented children.
2. Arrange special examinations for evaluation.
3. Use more effective method as question answer methods, group discussion method, project method etc. in teaching.
4. These children are interested in basic studies. To develop this interest libraries should be maintained.
5. Encourage these students to help the dull students.
6. Gifted children should be assigned special home work so that they may utilize their talents in a proper way.
7. These children are more thirsty for knowledge in comparison to the normal children. Since teacher should provide different facilities to the talented child for this purpose they provide library facilities.
8. Teacher should prepare the improvised apparatus related to mathematics.

Precautions Conducting for Remedial Measures

The following factors should be kept in view while conducting remedial measures :

1. The weak student should be asked to sit on the front seat in the class.
2. The development of the subject matter should be done with the solved examples and illustration.
3. The students should be given individual counseling even after the class, to help them in learning.
4. The fundamental concepts of mathematics and other subjects, such as factors, percentage, unit, square root, etc. should be taught carefully.

5. The exercises on each sub-topic should be such which the students can think about themselves.
6. The correction in the written work of the students should be done in their presence.
7. The student should be provided sufficient opportunity for thinking and reasoning in the class.
8. The attention of the students should be drawn to those concepts, principles and activities related to the subject matter in which they commit errors.
9. The concepts should be provided sufficient opportunity for thinking and reasoning in the class.

Organisation of Remedial Teaching

A teacher can organise remedial teaching in a school in a following ways :

1. Class Teaching
2. Group Tutorial Teaching
3. Individual Tutorial Teaching
4. Supervised Tutorial Teaching
5. Auto Instructional Teaching
6. Informal Teaching

1. Class-Teaching–In this, there is no change in the present structure and form in formal teaching organisation. In this teacher do work and teaching in a traditional way. In the class teaching, teacher shoud know that the students has difficulty of which branch, topic, content and process etc. Teachers should keep in mind that their new teaching is based on the previous knowledge of the students.

2. Group Tutorial Teaching–In this teaching students are divided in a group of a special characteristics. This division is based on their difficulty levels, similarity of problems and weakness. After this each group are taught by the teacher according to their difficulties. For each tutorial group an incharge is appointed, who select the intelligent students in these groups.

These tutorials are useful for an average student. These can satisfy the needs of less exceptional students. The teacher should have the background of mathematical and social psychology and group dynamic so that he can deal with group tutorial effectively in solving their problems.

3. Individual Tutorial Teaching–In this teacher pay attention individually to the students and solve the problems, difficulties etc. in individual.

4. Supervised Tutorial Teaching–It is also called supervised study method. In this method the teachers remove the defects of traditional methods as–lecture, exploration etc. In this teacher works as a supervisor. In this type of tutorial students and teacher's meeting are arranged regularly. A student reads an essay and defends it with arguments. This strategy can provide an opportunity to deepen his understanding of subject for able student. It stresses on the mastery over the basic skills of scholarship. Teacher can be use in the two form :

(a) Group form

(b) Individual form

In this teacher can supervise the students in a group or an individual

5. Auto Instructional Teaching–In this students remove their demerits and difficulties by auto instructional. The main characteristic of this are:

(i) Student is not to receive any supervision or guidance.

(ii) Give the programmed learning package to solve the difficulties related to subjects. This is a auto instructional material or aid.

(iii) This auto instructional aid can accept in a form of computer software programme.

In this way student solves his difficulties by self.

(b) Informal Teaching–In this there is no fix place, time, curriculum. The subject related knowledge are added into formal education. In the informal teaching include following programes:

- Educational excursions
- Organisation of Mathematic club
- Construction of science model
- Mathematics Museum
- The equal role of social and cultural programmes.
- Collection of different things related to mathematics.
- Participation in group decision and debates.

Construction of Diagnostic Test in Algebra

Name of Student : Abhishek Singh — Class - 7

Name of College : Government Inter college, Roorkee — Section - B

Date : 17 Nov. 1977

Instruction—

1. Write the value of 'a' based on simple equations.
2. Write the answer in appropriate place.
3. If appropriate place is short then you take another page to rough work.

Questions	Answers	Place of Calculation
1. a +6 = 28 a =	(1)	
2. 8a + 10 = 26 a =	(2)	
3. 3a + 23/5 = 74/9 a =	(3)	
4. 0.05 a + 0.6 = 6.8 a =	(4)	
5. 0.6 a + 8 = 5.3 a =	(5)	
6. 6a – 12 = 6 a =	(6)	
7. 8a – 0.14a = 43 a =	(7)	
8. 0.023a – 7 = 9a – 3 a =	(8)	
9. 12a + 4 = 4 – 4b a =	(9)	
10. 4a + 2 = 0.8a + 1 a =	(10)	
11. a/4 – 3a/5 = 6 a =	(11)	
12. 4a + 3/8a = 8 a =	(12)	
13. a + 2a/3 = 15 a =	(13)	
14. a + 10 = 22 a =	(14)	
15. 9a = 27 a =	(15)	
16. 4a = 1/9 a =	(16)	
17. 4a – 8 = a + 8 a =	(17)	
18. 6a + 7a = 33 a =	(18)	
19. a/2 + 1 + 1/2 =5/2 a =	(19)	
20. 4 (a + 4) = 16 a =	(20)	

All these questions are written on the basis of 'simple to complex' form. The main aim of this exam is to solve the difficulty level of the class 'Y' students that they solve how many questions and how many questions have they difficulty?.

Diagnostic Chart

	1	2	3	4	5	6	7	8	9
Name of Student	Subtration in Equation (2)	Multiplication (1)	Equation and simple diffrection (4)	Equation and decimal Bhire (3)	Equation and Simple Total (4)	Pakshantar (6)	Score	Absence in Class	Special Description
	(2)	(1)	(4)	(3)	(4)	(6)			
(1) Deepak Kumar	–	–	–	–	–	–	20	2	I
(2) Pratibha Rani	–	–	–	2	1	–	17	5	III
(3) Seema Sharma	–	–	–	–	–	1	19	3	II
(4) Imran	1	–	4	2	–	1	12	7	V
(5) Yasoda Kumari	1	–	–	1	2	6	10	12	VI
(6) Vinod Kumar	–	2	–	–	1	–	17	4	III
(7) Rashi Arora	3	–	–	–	–	1	16	6	IV
(8) Total Error of total Students	9	–	–	12	14	17			
(9) No. of correct question done by the 40 class students	46	32	58	43	86	74			
(10) Total of Questions	60	35	60	70	100	90			
(11) Percentage of correct questions	76	91	96	62	86	82			

Interpretation—Above chart analyses the weakness and difficulties of the seven students. In present chart Yasoda Kumari is a weak student in a class. The get 10 marks out of 20 marks, and they have more absence in the class.

Deepak Kumar is a good student of his class he got 20 mark out of 20 which slow that they understand the subject. Seema Sharma also a good student, they correct 19 questions out of 20.

Formative Evaluation

When the students are said to be in well state regarding knowledge the process of teaching applied to learn any thing is called formative. The methods of judging how much the reactions of teaching are made to students is evaluation. The purpose of formative evaluation is to monitor the instructional process to know that learning process is taking place or not. It is designed only to enhance the teaching-learning process and not designed to make final judgements.

Hence, in formative evaluation teaching process is made and learning is judged. The process works upon in a long term, so it is called continuous evaluation in which unit tests, class tests and assignments are the essential components.

Formative evaluation provides feedback to children, on the other it aparts feedback to teachers also, so as to, modify instructions to prescribe remedial work. Therefore it can easily be said that formative evaluation brings improvement in child's learning and also removes the drawbacks that are committed during teaching and learning process, hence teaching-learning process is better enhanced through this evaluation.

Formative evaluation can give the relevant information during class room teaching-learning process.

According to **Tanner, (1972),** "Formative evaluation refers to the use of tests and other evaluative procedures while the course and instructional programme is in progress."

Need and Importance of Formative Evaluation

1. It provides informations to teachers for modifying instruction and teaching.
2. Helpful in diagnosing child's strength and weakness.
3. It is helpful in monitoring pupil's learning progress.
4. It facilitates retention and transfer of learning.
5. It can also be used as a self-evaluation device by the children.
6. It helps to prescribe group and individual remedial programs.
7. It provides immediate feedback to the children.
8. It also reinforce the learning of high achievers.

Summative Evaluation

Summative test is given to the student after he has passed successfully all the formative tests given separately in the last of each unit of he content. Overall results of teaching-learning process can be obtained through this short of evaluation. Simple class test, unit tests, quizzes and learning tests are the parts of formative evaluation, then term test-annual tests and external examinations conducted by school or public agency are the essential parts of summative evaluation.

Hence, summative evaluation is either external type or Internal type evaluation. In other words, it can also be said that formative evaluation serves refinement purpose during teaching-learning process, but summative evaluation may be said the evaluation of refined product.

Summative evaluation becomes part and parcel with future point of view. It is identification document of failure and success of the class indicated. So, summative evaluation is inevitable and has to remain an integral part of the whole evaluation process.

Difference between Formative and Summative Evaluation

Formative Evaluation	Summative Evaluation
1. The process of this evaluation is to diagnose the strength and weakness of the pupils.	1. The process is for classification and promotion of student.
2. Its focus is an improvement of pupil's achievement.	2. Its focus is on measurement of pupil's achievement.
3. It refers to continuous evaluation by means of unit tests, assignments etc.	3. It refers to term tests, annual tests and external examinations.
4. It is an integral part of teaching-learning process.	4. It is treated as an end of the course activity.
5. It is done during the course of instruction.	5. It is done at the end of academic session/years.
6. It gives relevant informations which helps to improve classroom instruction.	6. It provides the overall results of the teaching-learning process.

Co-operative and collaborative strategies:

Collaborative Learning

This is a form of learning which shares the learning responsibility among the members of a group which works towards a common goal. The common goal can be achieved only when all the members perform their duties satisfactorily. The outcome of learning can be shared by all the members of the group. The teacher who facilitates learning need to clarify the responsibilities of each member. This can be done only through discussions with the members of the group. The situation where one person acts on behalf of the group can be avoided in this type of learning. Collaborative learning method can be followed only by a teacher who is prepared to share knowledge and authority with the students.

Collaborative activities are most often based on four principles:

- The learner or student is the primary focus of instruction.
- Interaction and "doing" are of primary importance
- Working in groups is an important mode of learning.
- Structured approaches to developing solutions to real-world problems should be incorporated into learning.

The benefits of collaborative learning include:

- Development of higher-level thinking, oral communication, self-management, and leadership skills.
- Promotion of student-faculty interaction.

Cooperative Learning

This is a mode of learning where the learners help each other to learn. Those who have better knowledge and experience help other students. It must be ensured that the help involves not a mere copying of the work of the other students. It is a need based interaction providing support for learning at all stages. All the members of the group will be ready to answer the questions on the common task and the group's achievement will be evaluated on the basis of the performances of the members of the group.

Why Use Cooperative Learning?

- Students who engage in cooperative learning learn significantly more, remember it longer, and develop better critical-thinking skills than their counterparts in traditional lecture classes.

- Students enjoy cooperative learning more than traditional lecture classes, so they are more likely to attend classes and finish the course.

Similarities and Differences between Cooperative and Collaborative Learning
Similarities:

1. Stress the importance of active learning.
2. The teacher acts as facilitator
3. Teaching and learning are experiences shared by both the student and the teacher.
4. Enhance higher order cognitive skills.
5. Greater emphasis is placed on students' responsibility for taking charge of her or his learning.
6. Involve situations where students must articulate ideas in small groups.
7. Help students develop social and teambuilding skills.
8. Increase student success and information retention and Utilize student diversity.

Differences

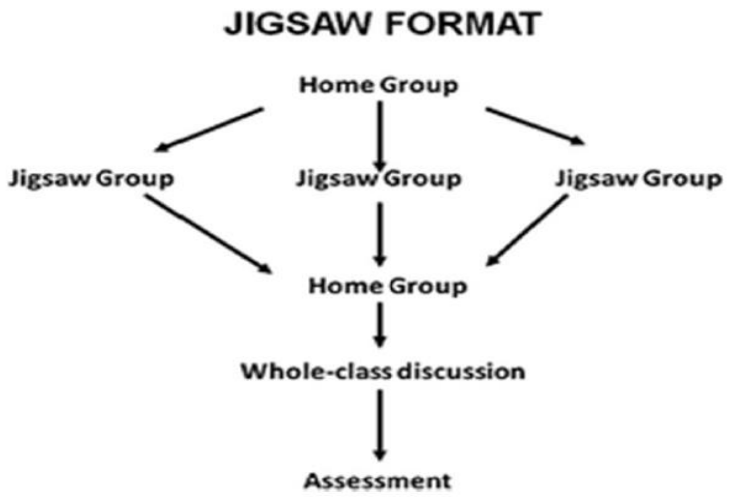
Cooperative	**Collaborative**
1. Students receive training in small group social skills.	**1.** There is the belief that students already have the necessary social skills, and that they will build on their existing skills in order to reach their goals.
2. Activities are structured with each student having a specific role.	**2.** Students organize and negotiate efforts themselves.
3. Activities are structured with each student having a specific role.	**3.** The activity is not monitored by the instructor. When questions are directed towards the teacher, the teacher guides the students to the information needed.
4. Students submit work at the end of class for evaluation.	**4.** Students retain drafts to complete further work.
5. Students assess individual and group performance.	**5.** Students assess individual and group performance.

Learning Together

The learning together method is a technique developed by D.W. Johnson and R.T. Johnson. The most important features of this technique are the existence of the group goal and sharing the opinion and materials, division of labour and the group reward. During the first applications to put out a single product working in groups, sharing ideas and materials, asking each other their questions before teacher have supplied to be rewarded.

Jigsaw method:

Jigsaw : Groups with 4/5/6 students are set up. Each group member is assigned some unique material to learn and become an "expert" on some aspect of a unit of study.



After reading about their area of expertise, theexperts from different groups meet to discuss their topic, and then return to their groups and take turns teaching their topics to their group mates.

Example:

Std : IX Topic: Measures Of Central Tendency

Learning Task :The students will be able to solve 2 problems that would require them to find the mean, median, mode and range from the given data.

Divide students into 4 member jigsaw groups.

The groups should be diverse in terms of gender, ethnicity, race, and ability.

Divide the lesson into 4 segments:

1. Solving for the mean from grouped, ungrouped data

2.Solving for median from the grouped, ungrouped data

3. Solving for the mode of the grouped, ungrouped data

4. Finding the range of the given data.

Assign each student to learn one segment, making sure students have direct access only to their ownsegment.

Form temporary "expert groups" by having one student from each jigsaw group join other students assigned to the same segment.

Give students in these expert groups time todiscuss the main points of their segment and to rehearse the presentations they will maketo their jigsaw group.

Bring the students back into their jigsaw groups. Ask each student to present her or his segment to the group. Encourage others in the group to ask questions for clarification.

At the end of the session, give a quiz or test on the material.

10.1 Test, Examination, Measurement, Assessment and Evaluation

In layman point of view, these words are often used more or less in same meaning (for example, test, examination) and of course all of them seem related to the process of judgement. Let us consider each of them separately.

Test and examination are used many a times interchangeably, or test is considered a mini examination, for example, monthly test/unit test/slip test and annual examination. But then 'TET' (Teacher Eligibility Test), that you will take after completing your B.Ed. programme or 'Admission Test,' you successfully cleared for getting into the programme, are also tests, which by any stretch of imagination cannot be called mini examinations.

For better understanding of these terms, let us see another example in day to day life: Suppose, you go to a doctor. Will s/he examine you or test you? Certainly, here the two words cannot be used interchangeably, and we say that doctor examines a patient and may prescribe certain tests. Thus, **test** is basically a tool (for example, intelligence test, aptitude test, achievement test, etc.) and **examination** is the process. **Measurement** as we are all familiar, is assigning to numerical value and the unit (if need be) in which a quantity is measured, i.e. 5 cm, 10 kg or 15g, etc. Let us now go back to our earlier example to understand the other two words, 'Assessment' and 'Evaluation'. After you get the tests conducted in a laboratory, you get a report which contains measurement(s) (numerals + units) of tested parameters. For example, your haemoglobin value is 16 gm/dl (deciliter). Along with these, there is another column in the report, which assigns certain meaning to these measurements, i.e. below normal, normal, above normal, etc. **thus, assigning meaning to a measurement is called assessment, which may be quantitative as well as qualitative, and final conclusion drawn on the basis of several assessments along with value judgement is called evaluation.**

- Test is used to gather information (a tool)
- That information is presented in the form of measurement
- That measurement is then used to make evaluation.

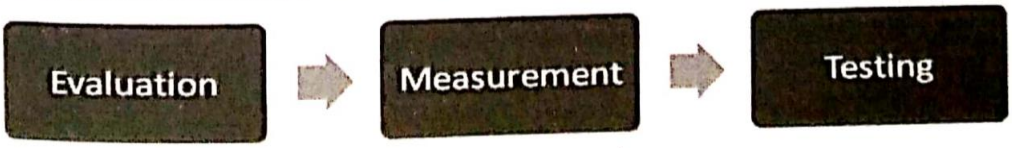


Fig.-10.2: Evaluation

Evaluation has wider meaning. It goes beyond measurement. When from useful information including measurement, we make a judgement that is evaluation.

Evaluation is a Scientific of providing information for decision making. It includes measurement, assessment and testing. It is a process that involves:

- Information gathering
- Judgement forming
- Information processing
- Decision making

Let us now see, **how assessment and evaluation are intertwined in classroom situations.**

i) **When the teacher starts any lesson,** the teacher needs to know the present status of knowledge of the students. To know this teacher may involve the learners in dialogue, conversation and inquiry. It helps to know about their prior knowledge. Varieties of learning opportunities are provided to know about their capabilities, interest and needs.

ii) **During teaching-learning process** the teacher needs to connect present knowledge with the previous knowledge. In this process what are their misconceptions and new concepts? Is there any modifications are required to improve the performance of the student as a learner and his/her own performance as a teacher? How is the class going on? How effective I have been using of approaches and strategies of teaching? In order to know all these, s/he again has to make some kind of evaluation. By asking questions s/he monitors process of their learning and concept development, provides continuous feedback and encourages them to reflect on their learning. The teacher facilitates them to construct and reconstruct the new knowledge.

iii) **At the end of the lesson/unit/session,** how can I know what I taught? To know this, the teacher has to make judgement of learning of the students and document their learning evidences. The teacher comes to know the extent of success of his/her teaching-learning processes, when the learner is passed and promoted to next class. Thus, s/he has to make a final assessment of the learners, for which s/he again has to take recourse to some kind of evaluation. Thus, we see that assessment and evaluation are ongoing processes. Therefore, the evaluation is the integral part of the teaching-learning process.

TYPES OF ASSESSMENT

Placement, Formative, Diagnostic and Summative:

Assessment is conducted in different phases of teaching-learning process. Some assessments are conducted before beginning of the teaching-learning process; some assessments are carried out during the teaching-learning process; and other kinds of assessment are conducted at the end of the instructional process.

Assessment can be classified into four types on the basis of their purposes:

1. Placement Assessment
2. Formative Assessment
3. Diagnostic Assessment
4. Summative

Assessment Each of four types of assessment serves different purposes. In the teaching learning process, it starts with placement assessment and ends with summative assessment. All four types of assessment are important, and are unique in their functions. The four types of assessment and their functions are presented in below the table for your understanding

Areas of Function	Types of Assessment and their functions
After Instructional Process	*Summative Assessment* (to certify the learner)
During Instructional Process	*Diagnostic Assessment* (to solve learning difficulties)
	Formative Assessment (to provide feedback on the teaching-learning process and to know mastery in content)
Before Instructional Process	*Placement Assessment* (to know entry behaviour)

Table represents different types of assessment which are conducted in the teaching-learning process. Generally, assessment starts with measuring the entry behaviour of learners to form judgement about their terminal behaviour. Let us discuss the main purpose and functions of different types of assessment:

1) Placement Assessment:

Placement evaluation is conducted before the organisation of **teaching-learning activities to measure the entry behaviour or previous knowledge of learners.** Another purpose is to know whether learner is able to acquire the new learning experience which

is related to the previous knowledge. The key word which is used for placement assessment is the "entry behaviour". Assessment of entry behaviour is done just before teaching starts. In the teaching-learning process, before teaching a new topic, a teacher should know the previous knowledge of students. This helps teacher to organise teaching-learning activities according to the previous knowledge of learners.

2) Formative Assessment:

For the first time in the year 1967, Michel Scriven used the concept of formative assessment in the field of curriculum evaluation. Scriven (1991) defined it as "Formative assessment is typically conducted during the development or improvement of a programme or product (or person, and so on) and it is conducted, often more than once, for in house staff of the programme with the extent to improve". If we analyse the definition, it is clear that the purpose of conducting **formative assessment is to monitor the learning progress of the learner; it is also conducted to know whether the learning objectives have been achieved or not and to provide feedback on the teaching-learning process.** The key word in formative evaluation is mastery of learning or learning progress. According to above table it is conducted during the instructional process. It is considered as the second stage of assessment which is conducted during the teaching-learning process. It is carried out from the very beginning of instruction and continues till the end of the course.

The examples of formative assessment are unit end examination, monthly examination, quarterly examination, half yearly examination, etc. It provides the teacher feedback about the progress of learners in the programme and about the effectiveness of the programme. It also provides data for diagnostic assessment. Let us discuss the diagnostic assessment.

3) Diagnostic Assessment:

It is the assessment which is conducted along with formative assessment during the instructional process. It is carried out based on the data obtained from formative assessment. **Diagnostic assessment is specially conducted for removing the learning difficulties of learner**. For example, if it is found that a learner has not understood certain concepts in a particular subject, then to help him/her understand these concepts, diagnostic assessment is conducted and remediation is provided. This is conducted by diagnostic remedial test. The key word in diagnostic assessment is assessment of learning difficulties. Diagnostic assessment not only solves learning difficulties of learners but also identifies and provides remedies for personal and psychological problems.

4) Summative Assessment:

Summative assessment is conducted to know the Assessment: Basics terminal behaviour of learner. The key word in summative assessment is "certification". **Summative assessment is conducted after completion of the whole course.** Feedback provided in summative assessment is terminal in nature and cannot be used for modification of learners' behaviour because it is conducted at the end of a term. Learners get certificate or are promoted to the higher class based on summative assessment. Different techniques and tools used in summative assessment are verbal or non-verbal tests, and teacher made or standardised tests.

EVALUATION AND MEASUREMENT IN MATHEMATICS

"Evaluation is relatively a new technical term, introduced to designate a more comprehensive concept of measurement than is implied in conventional test and examination."

—According to Encylopedia of Educational Research

The main and first point of teaching process is instructional objectives. When the teaching objectives are not decided we can not decide the direction of teaching. For achieving the teaching objectives teacher creates this type of situation, which are helpful to desirable behavioural change in teaching. For this purpose teacher should use the specific teaching aids, teaching methods etc. After this teacher evaluate the quantity of achievers objectives. Evaluation is that evidence which give the success or failure of teacher to his/her teaching objectives.

The effectiveness of instruction is usually determined by measuring achievements against objectives undertaken. An efficient programme of evaluation no longer comprises merely the effort to check the completed process but rather in the continual appraisal of the student's progress towards the attainment of preestablished aims. There is probably no more accurate barometer of the fundamental philosophy of any curriculum than a careful analysis of its evaluation programme.

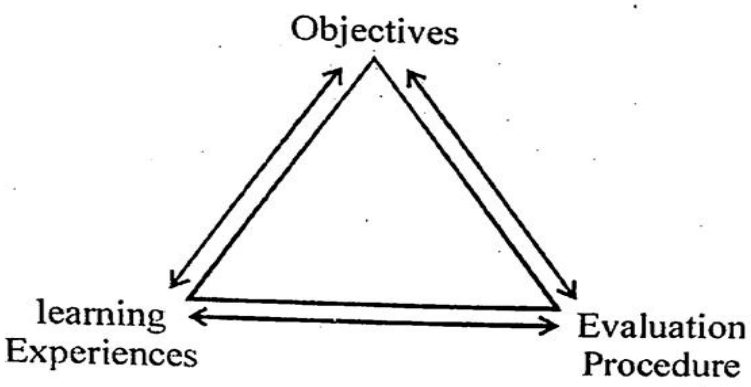
Concept of Evaluation

In the traditional examination system more emphasis is given by the content and its achievement by the students. According to concept of evaluation, the entire learning situations are responsible for the success and failure of students. Therefore, in the process of evaluation the effectiveness of teaching, method and techniques of teaching, teaching aids, curriculum and other learning situations are evaluated on the basis of achievement of learning objectives.

Meaning of Evaluation

Evaluation is defined as a process of collecting evidences of behavioural changes and judging the directions and extents of such

changes. This means that evaluation is free neither from instructional objectives nor from the teaching learning.



In fact, it is intimately related to objectives and learning activities on the one hand and improvement of instructions on the other. The evaluation procedures and learning experiences provided to children are the instruments or means related to these ends. These are interrelated to each other.

It is clear from the above triangular relationship that :

- All the three steps are inter-related.
- Evaluation is a natural step involved in teaching-learning process.
- The objectives of teaching constitute a pivotal step on which both learning experiences and evaluation techniques are based.
- Evaluation based on objectives of teaching and learning experiences evaluates the objectives also at the same time.

Hence, in classroom, teacher organizes suitable teaching learning activities in order to promote desired expected changes in behaviour. The learning experiences offered in class-room are directly related to the predetermined in functional objectives. Thus, the teaching-learning activities are objectives based not content or text-book based.

The evaluation may be defined as follows :

Evaluation ↔ Measurement + Value Judgement

Here, evaluation is both quantitative and qualitative process.

Measurement	Value Judgement
↓	↓
quantitative	qualitative

Definitions of Evaluation

Evaluation is a broad and goal oriented process. In the field of education the main work of this to make the education is goal or object centred. On the basis of this we can achieve the knowledge of development

of whole personality. Hence different educationist define the evaluation in many ways :

According to **Rammere and Gage,** "Evaluation assumes a purpose or an idea of what is 'good' or 'desirable' from the stand point of the individual or society or both."

According to **Vasely,** "Evaluation is the inclusive concept, it indicates all kinds of means to ascertain the quality, value and effectiveness of desired outcomes. It is a compound of objective evidences and subjective observation. It is the total and final estimate. It is valuable and indispensable guide to the modification of policies and to further action."

According to **Garrett,** "Evaluation is the group of that type of examination question, which are prepared for the treatment of any skill or ability."

According to **Kothari Commission,** "It is now agreed that, evaluation is a continuous process, forms an integral part of the total system of education and is closely related with educational objectives."

According to **T.L. Torgerson,** "To evaluate is to ascertain the value of some process or thing. Thus, educational evaluation is the passing of judgement on the degree of worth whileness of some teaching process or learning experience."

According to **Dandekar,** "Evaluation may be defined as a systematic process of determing extent to which educational objectives are achieved by pupils."

According to **Quillen and Hanna,** "Evaluation is the process of gathering and interpreting evidence on changes in the behaviour of the students as they progress through school."

According to **James M.Lee,** "Evaluation is the appraisal of pupil's progress in attaining the educational goals set by the school, the class and himself. The chief purpose of evaluation is to guide and further the students, learning. Evaluation is thus a positive rather than a negative process."

According to **Moffat,** "Evaluation is a continuous process and is concerne with more than the formal academic achievement of students. It is interested in the development of the individual in terms of desirable behavioural changes in relation to his feeling, thinking and actions."

On the basis of above definitions we can say that, evaluation is a continuous process, forms an integral part of the total system of education and is intimately related to educational objectives. It exercises a great influence on the pupil's study habits and the teacher's methods of

instruction and thus helps not only to measures educational achievement but also it improves it. Hence

- Evaluation is both qualitative and quantitative.
- Evaluation is a broad concept.
- It is a continuous process.
- It is the appraisal of student's progress, in attaining the educational goals set by the school, class and himself.
- Teaching-Learning process becomes dynamic and self-developing.

Factors of Evaluation

Two processes have to be undertaken in evaluation

(i) the measurement

(ii) analysis of the information or data obtained from measurement.

We aware that there are the following four factors of measurement:

(a) The object, person or activity any of which characteristics has to be measured.

(b) The characteristic of the object, person or process which has to be measured.

(c) The tools and devices of measuring such characteristic.

(d) The person who measures it.

Need of Evaluation

Basic needs of evaluation are as follows :

(a) Evaluation gives guidance to the teacher.

(b) It is necessary in the field of mathematics to classify the students on the basis of their achievement.

(c) It helps to make the body and mind disciplined.

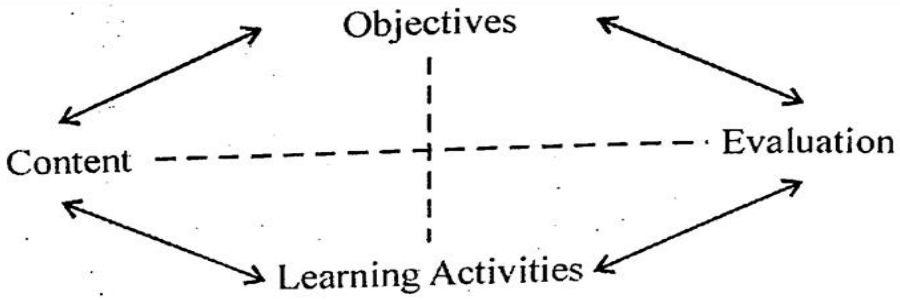
(d) It clarifies the objectives of teaching.

(e) Evaluation helps the teacher to identify the difficulties, problems and weakness of the students.

(f) It stimulates the students and gives them the inspiration to study.

Steps of Evaluation Process

Evaluation is a continuous process, which continues to birth and ends to his/her death. The concept of evaluation can clarify the objectives, content, learning activities and evaluation techniques and interrelationship between them.



Objectives, content, learning-experiences and evaluation techniques etc. are included into evaluation process. So these four are inter-related to each other. Achieving the objectives are very essential and it achieves directly whenever the content, learning-experience are jointed to indirect form. The steps of evaluation process in education is :

1. Formulation and definition of educational objectives
2. Planning Learning Experiences
3. Evaluating on the basis of behavioural change

1. Formulation and Definition of Educational Objectives–For this purpose we firstly determine the objectives, which are a typical job. After having determined it, he gives it a definite form and defines it. For example, if he has to provide educational guidance, he has to determine the traits that he has to measure, such as intelligence, interest, aptitude, attitude etc. In case he has to measure the educational achievements, then he has to determine the aims and objectives that he has kept in mind while teaching a subject or training in an activity and he has to determine the extent to which he has to achieve it.

2. Planning Learning Experiences–"Learning occurs when pupil has an experience, that is, when he reacts to the situation in which he finds himself. Hence, learning experiences are the means to attain educational goals." ***—The Concept of Evaluation in Education, NCERT***

The meaning of planning of learning is the construction of that aids, which are helpful to develop desirable behaviour in the child. For this purpose teacher should create that situation which activates the child. Teacher should keep in mind the educational objectives, age, maturity, child's behaviour etc. of the child, which are useful or helpful to create or develop a new knowledge in the child.

3. Evaluating on the basis of behavioural changes–The main and last objectives of education is the desirable change in the child's behaviour. This change is due to come about the teaching process which gives the knowledge of cognitive, affective and psychomotor domain to the child. All these domain are co-related to each other. These behaviours are included in external or internal behaviour the child.

Basic Assumption of Evaluation

The main assumptions of evaluation are as follows :

1. Human nature is complex so in that way the measurement of different dimensions are necessary to their evaluation.
2. The work of education is to change to the desired behaviour of child so evaluation is important.
3. The achievement level of objectives can be measured by only evaluation.
4. Evaluation can be preceded by teachers, parents and other persons.
5. Evaluation theories and moral values should be followed in correct ways.
6. Measurement and evaluating decision both are included in evaluation.

Purpose of Evaluation

The main purposes of evaluation in teaching process are :

1. The main purpose of this to evaluate the students than classified it.
2. Evaluation is helpful to change to desirable behaviour of the child.
3. With the help of this modification in curriculum can be possible.
4. Evaluation decides the limit or level of student's objectives.
5. Evaluation measures the purity of teaching methods.
6. Evaluation is helpful to understand the student's problems.
7. It is also helpful to knowing the progress of the students.
8. By the help of evaluation gives the proper direction or guideline of educational and vocational guidance.

Functions of Evaluation

The following are the main functions of evaluation :

1. It is helpful to knowing the ability, capability, interest etc. of the students.
2. It ascertains that how far could learning objectives be achieved.
3. The work of evaluation is the change and improvement in apparatus.
4. It improves in curriculum.
5. It diagnoses the weakness of instructional procedures and provides the basis for remedy.
6. It is helpful to all round development of the child.
7. It gives reinforcement and feedback to teacher and students.
8. It helps in developing a comprehensive criterion test.
9. It provides the empirical evidences about the effectiveness of teaching strategies, tactics and aids and suggests some modification improvement.

Importance of Evaluation

The importance of evaluation are as follows :

1. Knowledge about the relation of ability in the child–The first and important work of education is to develop the mental, physical and emotional development of the child. For the mental development develop the knowledge, understanding, application, analysis, synthesis etc. in the child. Due to lack of this the mental development is not possible.

2. Knowledge is related to the achieving of the goals–The knowledge of achieving goals can be measured by evaluation. Evaluation is a continuous process. It goes hand in hand with the teaching-learning process. Evaluation implies a systematic process which omits the casual uncontrolled observation of pupils or students.

3. Knowing to the relation achievement of students–Evaluation process is helpful to knowing the student's achievement. This opportunity is found only at examination time. At this time student expresses his knowledge in the form of oral or written test. Evaluation is more concerned with the growth which the student has made, than with his status in the group.

4. To know the knowledge of data limits–The knowledge of data limits is essential to give the learning experience. Development of child depends upon these learning experiences. On the basis of this we conclude that the limit of abstract development empowers in the student.

Characteristics of a Good Evaluation Programme

The main characteristics are :

1. It measures the direction and extent behavioural changes.
2. Evaluation is quantitative and qualitative estimation of specific changes in children's behaviour.
3. Evaluation is diagnostic so that it may provide basis for remedial teaching.
4. Evaluation is pupil-oriented.
5. Evaluation offers feedback to the entire educational system.
6. It is activity based.
7. It may be used to improve instructions, curriculum, methods and examinations etc.

MEASUREMENTS

Measurement is related to human race right from the drawn of civilization. Due to lack of measurement imagination of scientific progress can not be measured. Man's innate curiosity motivated him to make an attempt to know his surroundings and to define or describe these attributes.

Meaning of Measurement

In simple language, to measure and show the weight, length and volume of an object in a definite units is called measurement. for example– To show the weight of a person in kilograms, length of cloth in metres, volume of oil or milk in liters. But the field of measurement is very wide. Measurement is very essential in the study of science. Science is collection of information and observation about the natural or physical phenomena. Mathematics is a universal language which can be easily utilized by any science, its technology is unlimited yet well definite. It is easily possible to communicate, correctly and objectively through measurement.

For each measurement two type of knowledge is essential :

(i) Which quality or characteristics are measured.

(ii) Tool of measurement.

Definitions of Measurement

According to **Thorndike,** "Anything that exists at all, exists in some quantity, anything that exists in some quantity is capable of being measured."

According to **S.S. Stevens,** "Measurement is the process of assigning numbers to objects according to certain agreed rules."

According to **Gilford,** "Measurement means the description of data in terms of number."

According to **E.A. Peal,** "It's purpose to promote the development of a well integrated person, capable of exercising such responsibilities in society as is power allowed."

According to **Campbell,** "Assignment of numerals to objects or events according to certain rules is called measurement."

According to **James M. Bradfield,** "Measurement is the process of assigning symbols to the dimensions of phenomenon in order to characterize the status of phenomenon as precisely as possible."

In these definitions of measurement only the qualities of objects and activities have been included, and not the measurement of qualities of persons. Though the persons are included in the objects of the universe, however, the objects are meant to include only concrete materials, so it is necessary to show the measurement of qualities of the persons separately.

Measurement is a process of quantification. It means precision and quantification of a phenomenon or variable, but not a person or object.

Characteristics of Educational Measurement

The main characteristics of educational measurement are :

1. The units of measurement is not fixed.

2. There is no any absolute is zero point.
3. Measurement is based on proper direction but not direct.
4. Measurement is helpful to evaluate the person.
5. Measurement is more economical than subjective evaluation.

Limitations of Measurement

Some limitations of measurement are :

1. The area of measurement is narrow and fix.
2. It gives only information, not decisions.
3. The process of measurement is very complicated.
4. In the measurement, we measure those traits, which are abstract and very small or micro. By which the measurement is not correct.

Essentials of Measurement

Measurement in any field always involves three essentials :

1. Identifying and defining the quality, attribute or variable that is to be measured.
2. Determining the set of operations by which the attribute of variable may be made manifest and perceivable.
3. Establishing a set of procedure of definitions for translating observations into quantitative statement of degree, extent or amount.

Scales of Measurement

Measurement involves quantifications and assigning of numerals. **Stevens** has defined that measurement is a process of assigning symbols or numerals to the objects according to certain agreed rules.

According to **Helmstadha,** "Measurement is the person or thing processes some characteristics. A convenient scheme for classifying measurement scales according to the :

- Levels of refinement
- Degree of accuracy
- Complexity
- Sophistication

There are four scales of measurement known as:

- Nominal scale
- Ordinal Scale
- Interval Scale
- Ratio Scale

It is common to distinguish four levels or scales of measurement, which have been most clearly delineated by Stevens. From lower to higher levels we have nominal, ordinal, interval and ratio scale of measurement.

Difference between Measurement and Evaluation

Generally people understand measurement and evaluation as equal but actually they are different to each other. Measurement is the first step of the evaluation process. Evaluation includes analysis of results after measurement and prediction is made on the basis of this analysis.

According to **Wrighstone,** "The emphasis in measurement is upon single aspect of subject-matter achievement or specific skills and abilities but ..... the emphasis in evaluation is upon broad personality changes and major objectives of an educational programme. These included not only subject-matter achievement but also attitudes, interests, ideals, ways of thinking, work-habits and personal and social adaptability e.g. by testing a child in mathematics we may measure his mathematical ability and nothing else. We may not have any idea about the interests, abilities etc. of the child in maths by administering this single test."

In brief, we can say that, Measurement is quantitative while evaluation is qualitative.

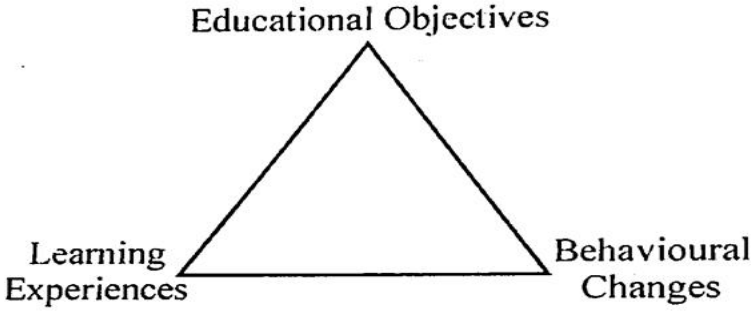
The differences between measurement and evaluation are as follows:

Measurement	Evaluation
1. Measurement is an old concept	1. Evaluation is a new concept.
2. It is narrow and less inclusive concept than evaluation.	2. It is wider and more inclusive concept.
3. It is a normal word.	3. It is a technical word.
4. It is quantitative process.	4. It is a quantitative as well as qualitative process.
5. It is a part of the evaluation process.	5. It is a continuous process.
6. Evidences are collected in the measurement process.	6. Evidences are analysed under the evaluation process.
7. There are four steps in this process.	7. There are six steps in this process.
8. Teaching-learning process can not be improved and modified.	8. The teaching-learning process can be improved and modified.
9. It is a short process.	9. It is a lengthy process.
10. Measurement is the first step of evaluation.	10. Under evaluation, the results are also analysed after having obtained result from measurement.
11. They can not be properly classified on the basis of results obtained from measurement.	11. They can be properly classified on the basis of results obtained from evaluation.

12. Only cognitive domain objectives can be measured. 13. Comparative study is not possible.	12. Objectives of all the three domain can be evaluated. 13. Comparative study is possible.

New Concept of Educational Evaluation

Educational objectives, learning experiences and behavioural changes are related to education process. In this firstly decided the educational objectives and then according to this objective we achieve the learning-experience, which are helpful to desirable behaviour change in the students. It is a triangle process bloom represent this with the help of graphic representation which are as :



New concept in educational evaluational give more emphasis in the following points :

1. The centre point of this is child not the subject-matter.
2. It gives more emphasis on learning than teaching.
3. It caters to the pupil's psychological needs, interests, ways of thinking, reasoning, personal and social ability of adaptation.

On the basis of above three points the educational evaluation can be defined in a following ways:

"Evaluation is any systematic, continuous process of determining– (a) The extent to which the specified educational objectives previously identified and defined are attained, (b) The effectiveness of the learning experiences provided in the class-room and (c) How well the goal of education has been accomplished."

On the basis of this it can be said that:

(i) Evaluation is a continuous process.

(ii) Evaluation is a systematic process. It omits the casual uncontrolled observation of the pupils.

(iii) Evaluation is not related to the subject matter achievement but it gives an important place in ideas, interests, capabilities, needs and reasoning.

(iv) Evaluation always assumes that the objectives are predetermined and defined.

(v) Evaluation gives more emphasis to learning than teaching.

Testing

The origin of psychological test is individual difference with psychology. Firstly it gives **Isqural** and **Saguine**. And Further **Caber, Frakner, Mullar, Alexjender Wage** work in this. In general language test is that aid or material to study the human's behaviour which are helpful to understand it.

According to **Cronbak,** "A test is a systematic procedurce for comparing the behaviour of two or more persons."

According to **Freeman,** "A psychological test is a standardized instrument designed to measure objectively one or more aspects of total personality by means of verbal or non-verbal responses or by means of other behaviour."

Difference between Evaluation and Test

In ancient period it comes. Today it is not related to education but also it is related to every field of life. Some disimilarties in evaluation and test are given below :

Evaluation	Test
1. Evaluation is a formal and informal process.	1. Test is only formal process.
2. It is a modern concept.	2. It is an old process.
3. It is a broad and lengthy process.	3. It is narrow process in comparison to evaluation.
4. It is a objective-centred.	4. It is content-centered.
5. It is a continuous process.	5. It is not.
6. It evaluates the cognitive, affective and psychomotor domain in the students.	6. Test evaluates only cognitive domain of the students.
7. Evaluation is less objective and reliable.	7. It is more objective and reliable in comparison to evaluation.
8. Result of evaluation is qualitatives and quantitative both.	8. The result are only quantitative.
9. It evaluate only broad quality.	9. It measures the specific ability of the child.

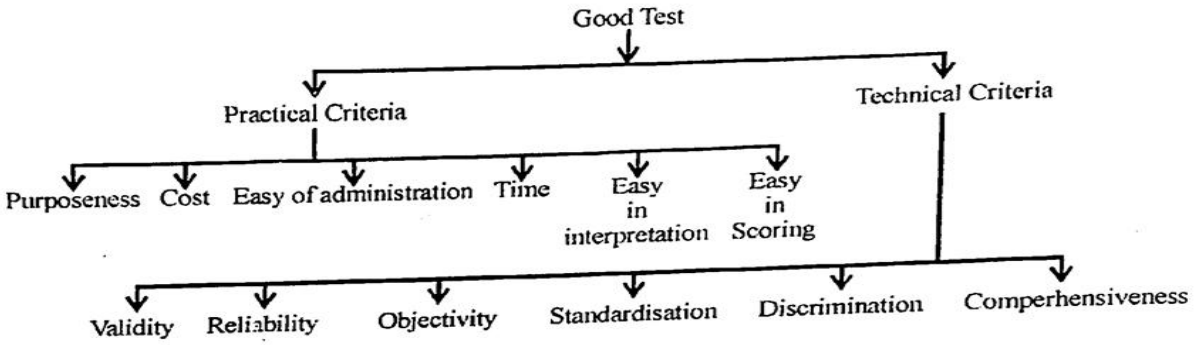
Characteristics of a Good Test

"A test is a systematic procedure for comparing the behaviour of tw or more persons."

According to **Klausmeier and Goodwin,** "Good standardized test must meet the criteria of validity, reliability and usability."

A good test can be classified in to two categories:

(i) Practical Criteria
(ii) Technical Criteria



(1) Practical Criteria

They are following type :

(i) Purposeness–It is essential to any test that what is the purpose of that test. Construction of any test is depend upon their purposeness. It is clear in itself. For example exam of mathematics is not the measure of the knowledge of english.

(ii) Cost–A good test should be economical. At the time of test construction it should be kept in mind that test is not high cost to a researcher. For this purpose only those steps should be taken in the test which are easily found the objectives.

(iii) Easy in Administration–"A good examination must possess a number of characteristics and these characteristics become the basic principles underlying the construction of each test."

—Douglas and Holland

A good test is that they easy to given answer, the situation of that given answer are easy, instructions are easy and clear and the scoring is objective.

(iv) Easy in Interpretation–Any test should be easy at the point of lecture or interpretation. A good test is that which is interpretated easily in the class by the teacher. For this purpose teacher does not use the high statistical formulas.

(v) Clearness–The direction given should be brief and definite so that children may avoid wrong performance due to miss understanding of

direction. The language of the items should be simple understandable and definite.

(vi) Easy in Scoring–A test should br easy at the scoring point of view. For this purpose objective type questions should be prepared because it is easy for scoring purpose.

(vii) Acceptability–Acceptability means, to administrated that test to that persons and that situations successfully which is useful to process of standardization of that test. In a good test the question is not very easy and nor tough.

According to **Frederic G. Brown,** "A test is a representative when the test items are similar to the behaviour, we are interested in measuring."

(2) Technical Criteria

(i) Validity—A test is said to be valid if it actually measures what is supposed to be measured. Validity is a truthfulness or purposiveness of a test. It is essential quality of any test. The test in the field of education are generally constructed to measure some specific qualities or abilities of the students. If a test measures the qualities or abilities for which it was constructed, then such a test is called valid and this quality of the test is called validity.

For example : we take an achievement test. If this test measures the knowledge, skill and sentiments for which it was made, then it will be called a valid test and its this quality will be called validity.

"In general, the term validity refers to the effectiveness of a test in achieving specified purposes." —***Stodala and Stordall***

"A valid test is one which measures the traits and qualities it is intended to measure." —***Kolesnik***

So, validity is an important characteristic of a good test. It is the extent to which a test measures what it purports to measure.

(ii) Reliability—Reliability implies accuracy and consistency in behaviour. In the field of education, the tests are constructed for the measurement of various qualities and abilities of the students. If a test measurable qualities correctly and there is no possibility of a measurable error then, such a test is called a reliable test, and this quality of test is called reliability.

Reliability = Sample size + Objectivity

For example: If we administer standardised intelligence test on a group of students today, and then administer it again after 10-20 days on the same group and the measurement results are identical, such a test will be called a reliable test and this quality is called reliability.

"Reliability refers to the faith that may be placed into a test."
—***Rizeland***

"Consistency thou art of the jewel." —***Sexpeyear***

"A test is reliable, if it measures consistently." —***Skinner***

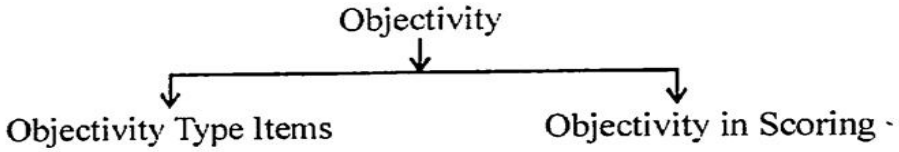
"Reliability-always refers to consistency throughout a series of measurement." —***L. J. Cronbah***

Hence, if a test measures the measurable qualities correctly for which it was constructed, this quality of the test is called reliability of the test.

(iii) Objectivity—The test whose measurement results are not influenced by personal proclivities or opinions as-like, dislike etc. of the measurer and the results are similar whoever the measurer might be, is called an objective test and this quality of the test is called objectivity. It is an important characteristic of a good test that affects both reliability and validity of the test. It means that the personal assumptions and pre-thoughts of the examiner should not affect the scores of the child.

Objectivity has two aspects:

(a) Objectivity type items
(b) Objectivity in scoring



(a) Objectivity Type Items–Items in the test should be as simple as possible. The pupil should be able to interprete the item correctly. These should not be influence on pupils mental status.

(b) Objectivity in Scoring–The variations in the examiner's mood, feeling of examiner, his attitudes and prejudices should not affect the scoring of the test.

"A perfectly objective measuring instrument must yield the same measurements or scores in the hands of all competent persons."—***Ruseland***

(iv) Standardisation–A standardized test is that test, in which procedure, apparatus and scoring are definite. It can be given different time and place at appropriate method or way.

"A standardised test is that in which the selection of content on the basis of experiences, the development of administration and scoring of equal method and the scoring has been done by objective method."
—***C. V. Good***

(v) Discrimination–A good test must pick out good and poor students from a population or a group. Each item of the test must discriminate between good and poor children. If an item is answered by an equal number

of intelligent and poor student it has no discrimination. But if only intelligent children are able to do an item and most of the children miss it it has highly discriminating value. After the administration and scoring of the test, each item of the test is analysed to calculate the level of difficulty.

(vi) Comprehensiveness–A test is comprehensive to the degree to which it samples sufficiently widely into the subject. It is said that a test should be comprehensive enough to be valid. It should include all units, sub-units and topics of the test content. Hence it should cover the whole syllabus.

(vii) Difficulty Level–Difficulty level is an important character of a question. Whole questions in a question paper can be divided on the basis of difficulty level. A good test consists of 66% normal difficult questions, 17% high difficulty level and 17% low difficulty level questions.

(viii) Usability–Those test while is easy to construction, easy to given answer and score of students, called a good test. In other words a good test is that which is convenient and practicable for both the teacher and student. A good test should be easy, attractive and interesting. Usability means no difficulty should come across which using a particular test.

"By usability we mean the degree to which the test or other instrument can be successfully employed by teachers and school administration without any undue expenditure of time and energy. In a word, usability means practicability." ***—C. C. Ross***

(ix) Norms–Norms are that average performance of the group in a test and it is based on the average achievement or capacity of the whole group. Norms indicate the present achievement. Generally norms of a test are determined on the basis of obtained scores of the test. These are the abbreviated form of obtained scores.

"Norms of a test describe how the members of a specific referenced group obtain marks in a test." ***—Ebel***

"A norm is the performance level got in a test by a defined group of students." ***—Remmers, Gage and Rummel***

Norms are calculated in the form of age, grade, percentile and standard score. It is an important characteristic of a good test.

General Principles of Test Construction

General principles of test construction are :

1. Construction of test should be comprehensive.
2. The language of question should be simple, clear and short in a test.
3. Bised or two way meaning question should not be include in a test.
4. The test should be reliable and valid.
5. The quantity of question is appropriate in a test.

6. Arrangement of questions in a systematic ways.
7. Nomenclature of a test should be proper.
8. General instruction related to test should be given in the starting of the test.
9. Construct those questions which can evaluate the capacity, ability of the students.

Types of Test

Generally test are of two type :

1. Teacher made test
2. Standardized test

(1) Teacher-made Test

These are tests prepared by the teachers themselves. Reorganised general objectives are the main things that help in the preparation of these tests. These tests are quite refined and objectives. Procedure of these tests is similar to standardised test to a great limit. These test are objective but not standardized.

Objectives of Teacher-made Test

The main objectives to construction of teacher-made test are:

1. With the help of these test teacher should evaluate the content successfully.
2. These tests are more important at the point of continuous evaluation.
3. These tests can prepare easily in a short time period.
4. The main objective of these tests to improve the demerit of essay type test.
5. These tests give opportunity to make the effective teaching of himself.
6. For the construction of this test teacher is not need of special training.

Characteristics of Teacher-made Test

The main characteristics are as follows :

1. The questions of these tests in an objective form.
2. These tests can construct to any subject teacher.
3. These tests are not standardized.
4. In these tests the questions are short and more in quantity.
5. This test present the whole curriculum.
6. In this type of test we can collect the different type of forms easily.
7. This test evaluates both teacher and student.

Limitations of Teacher-made Test

Besides of above characteristics it contains some limitations :

1. By these test difficult the study of whole personally.
2. Impossible to complete knowledge about the subject.
3. Construction of these tests is a difficult work.
4. This test is difficult to knowing the student's difficulties.
5. These tests are overloaded to the teacher.

(2) Standardized Test

The word standardization means the process of finding comparative norms and the literary meaning is "to bring to a level or standard" standardization of test involves the critical analysation of curriculum, careful selection to items and strict observation of standards. Intelligence test, Interest test, Aptitude test, Achievement test and Personality test etc. are the standardized tests.

"A standardised test is one in which the procedure apparatus and scoring have fixed so that precisely the same test can be given at different times and places." ***—Lee J. Combach***

Purposes or Functions of Standardized Test

The main purpose of standardized test are :

1. To diagnose learning difficulties.
2. To plan instructions activities.
3. To group students for instruction.
4. To evaluate the curriculum.
5. To appraise gains in achievement of groups.
6. To consult parents and teachers.

Utility and Importance of Standardized Test

For the study of human standardized test have some utility and importance. Some are these :

1. Standardized tests are objective and unsided.
2. It takes very less time to collect the information.
3. By this test we can find the personality and behaviour related factors directly.
4. This test is helpful to knowing the difficulty of students.

Demerits of Standardized Test

Demerits of standardized test are as given below :

1. Detail measurement is not possible by this test.

2. Only measurement process is continuous by this test.
3. It is only a part of guidance programme of work not a whole work.
4. Sometimes standardized tests are used that objectives whose are not useful for that.

Difference between Teacher-made Test and Standardized Test

Teacher-made Test	Standardiged Test
1. Lack of reliability in this test.	1. In this more reliability.
2. Teacher-made tests are concerned with the limited and specific field of knowledge of performance.	2. Standardized tests are concerned with the whole field of knowledge or ability tested.
3. This test is constructed by the teacher.	3. This test is constructed by scientist.
4. It take less time to construction.	4. It take more time in construction.
5. No much norms or standards are provided in the teacher made informal tests.	5. In standardized tests norms are given for various groups of persons on age, grade, rurality, sex or other basis.
6. It is easy to construction.	6. It is typical or tough in construction.
7. Validity of these tests is less	7. Validity to these test is more.
8. Analysis of the terms of these test is made later they used.	8. Analysis of the terms of these tests is made earlier they used.
9. It is related to broad knowledge.	9. It is related to specific content.
10. It may just be made on the basis of the personal experiences of the teacher.	10. It is use of sources such as the opinion of judge, articles, general books is made.
11. Teacher made tests are used to know whether the student has attained knowledge in specific fields.	11. Standardized tests are useful in comparing achievement of individual groups.
12. Teacher made informal objective tests are for local use for some particular institutions on small scale.	12. Standardized tests are based on uniform curriculum in many schools in the prariner or the whole nations.

Difference between Evaluation and Examination

Evaluation	Examination
1. Evaluation is a modern concept.	1. Examination is and old concept.
2. The field of evaluation is broad.	2. The field of examination is narrow in comparison to evaluation.
3. Evaluation is a technique.	3. Exam is one method in many methods of evaluation.
4. Evaluation is used oral and written both type of test.	4. Generally exam word is used only written type.

TECHNIQUES OF EVALUATION

The meaning of evaluation techniques is that by which we can evaluate the knowledge and desirable changes in behaviour in the students and it also evaluate the characteristics according to individual differences. All measurement some sort of instruments are needed. A tool may be defined as an implement which facilitates the work of hand and eye. Evaluation devices are for both tool and techniques. He has pointed out that in the evaluation of achievement of any subject, tools and techniques are needed to facilitate measuring and recording the characteristics of pupils. These techniques should be objective, reliable, practicable, comprehensive and valid. Each behaviour may need a different type of device.

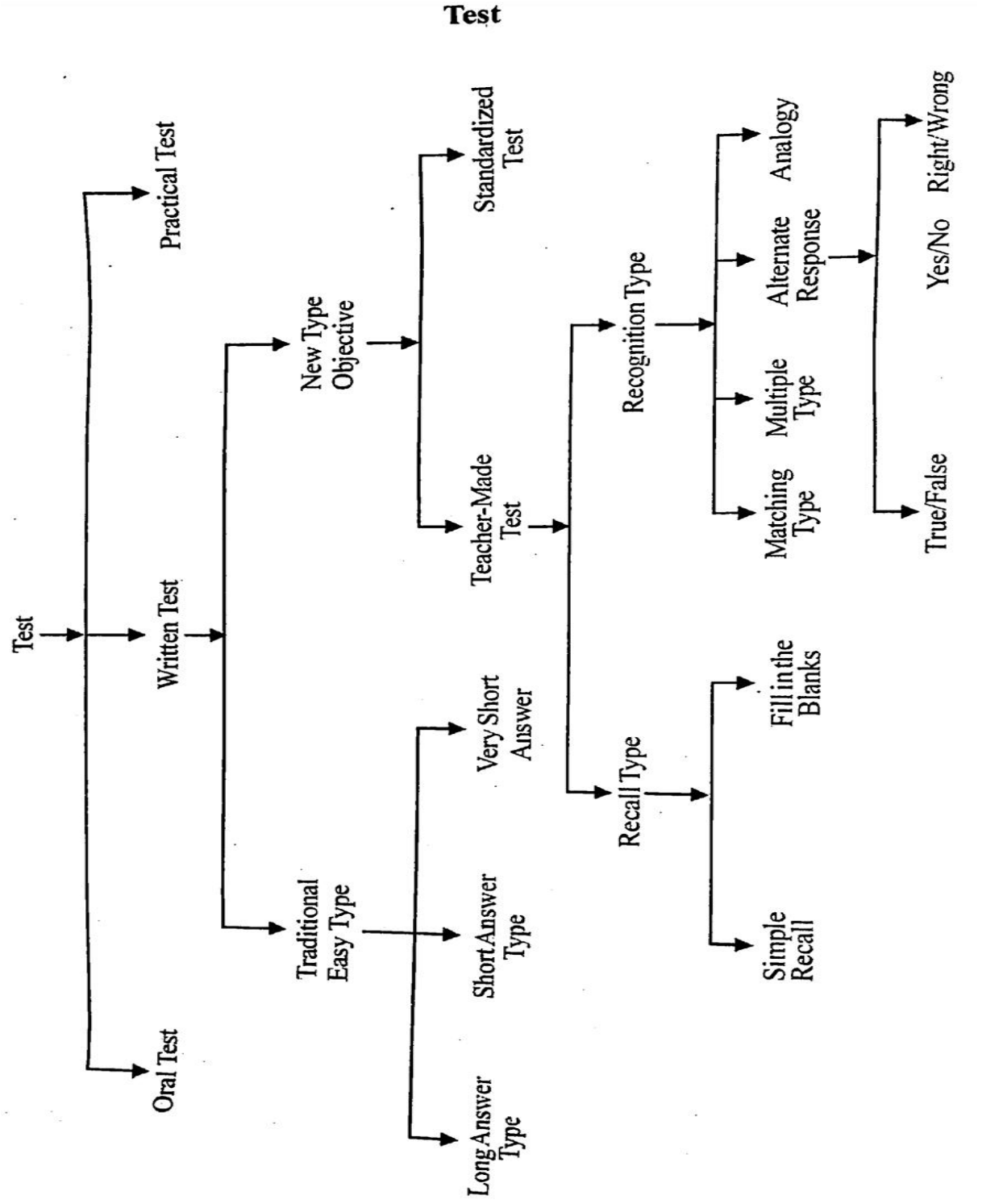
1. Oral Examination–In this technique oral questions, discussions and debates etc. are used. Questions are presented orally and answers are received in the same way. It is important for development of word-power and reasoning power. A larger number of students can be examined in a shorter time.

The aim of teaching of subject is not limited to impart knowledge of the related facts, it is also taught to bring about a change in the thinking and working style of the students. And its measurement is done by oral tests. These tests are used for ascertaining their knowledge and practical use of linguistic abilities, their confidence and their knowledge of other subjects.

Generally these exams are to evaluate the achievement level of the students, which are not possible by written exam. These exams are used to measure the recall, thinking, recognition power etc. of the students.

2. Practical Exam or Test–In this technique, some practical or hand work has to be performed by the student. This technique is useful in the evaluation of some topic of mathematics. The tests in which the measurement of skills and activities of the students is executed by asking them to display the skill or activity are called practical tests.

The chief characteristics of practical tests is that practical aspect of the examinees is measured. These tests alone can test the practical knowledge of arts and science. The practical skills can be tested only by practical tests.


Test
Test
Practical Test
Written Test
Oral Test
New Type Objective
Traditional Easy Type
Standardized Test
Teacher-Made Test
Very Short Answer
Short Answer Type
Long Answer Type
Recognition Type
Recall Type
Alternate Response
Multiple Type
Matching Type
Analogy
Fill in the Blanks
Simple Recall
Yes/No
Right/Wrong
True/False

3. Written Exam or Test–In this technique questions are presented in written form and their answers have to be written by the students. This test is used for the measure, the thinking power, language etc. of the students. They are of two type—

(i) Essay Type Test
(ii) Objective Type Test

(i) Essay Type Test

These type of examinations are being conducted since the ancient times. About 200 year ago, this method was utilized in selecting the rights in China. In 1854, Horack Mann, experimented this type of examination or test in America. This technique is subjective. It emphasises on roting power.

Eassy type techniques means that examination in which children have to write answers of some questions in fixed time. The construction of these questions is of such type that their answers take the form of essay. So it is called essay type examinations. The construction and administration of essay type test is simple and easy. It is economical technique.

In these tests some questions (8-10) are set from the whole syllabus and students are asked to answer any five questions. In these tests it is expected that students will present an explicit answer of every question. In essay type test student is free to express his views through his answers.

Types of Essay Type Test

Essay type tests are of following types :

(a) Organisational and Comparative–In this type of test comparison type, arrange in systematic order, organize type questions are included.

(b) Establish Relationship–Why? What? etc. type questions are include in this type of test.

(c) Selective Recall of Facts–Arrange the question in sequence, definition etc. are included in this.

(d) Problem Solving and Creative type Questions–In this type doing evaluation, proof it etc. are included.

But now essay type examinations are divided in this form :

(i) Long Answer Type Questions–The answer of this type of questions are in a broad way or long. No definite and fixed limit are to this. In this type of questions, the individual is asked to describe a thing, event, process for a particular person.

(ii) Short Answer Type Questions–Students give this type of questions in a definite limit. For example, what is Logarithm?

(iii) Very Short Answer Type Questions–The answer of this type of questions are in a word or in a sentence. For example, what is the sum of angles of a triangle? etc.

Merits of Essay Type Questions or Test

The followings are some major characteristics of essay type test :

1. Based on Broad Curriculum–In this the question can be asking the whole curriculum. These tests are helpful to decision to the knowledge and mental ability of the students.

2. Easy in construction and administration–These tests are easy in construction and also in administration. It is easy to formulate questions because the achievement of an individual is measured through the medium of one line question or two line question, as it takes very little time in formulating the questions, this is very useful in finding solution to immediate problems. Due to simplicity of the questions their administration is also easy.

3. Easy to check knowledge, interest and attitude–Teaching objectives of school subjects are divided into cognitive, affective and psychomotor domains. The students have to reply the essay type questions in detail, so their knowledge in the subject can be measured.

4. Evaluation of Personality–Essay type examinations are also very useful in evaluating the personality. With the help of the article we can measure the various aspects of personality as likes-dislikes, values etc.

5. Helpful in the development and preduction of writing power–With the help of essay type test we can measure the development and preduction of writing power of the student.

This also shows how well a person or student can compile his thoughts in a fixed time period. Thus, by these examinations a person's literary and writing ability can be measured.

6. Evaluation of Higher Mental Powers–By the help of essay type examination the high mental capabilities of an individual can be measured. This can be used successfully for problems where debating, review, point of view, analysis, synthesis etc. are required. This measures the thinking power, power of expression and intelligence.

7. Encouragement to Extensive Studies and Thinking–The answers to essay type questions have to be given in detail, so the students have to study extensively. Such tests encourage the students for extensive study and thinking.

8. Encouragement of Good and Detailed Study–This encourages detailed study with the help of various learning methods as the students have to give an answer of five to six pages to a question of two lines. Thus, he studies the subject-matter deeply. He prepares an outline for study, writes summary and tries to memorize important points.

9. Minimum Chance of Cheating–The answers of these tests are more lengthy. Due to the language style and compactness of the subject-matter the chances of cheating are minimised.

10. Practicability–We have been administering essay type tests from the beginning, so we have become habituated in the construction and administration of these tests and marking the answer books, and classifying the students on their basis. We do not face any difficulty in the administration. Thus, these tests are considered good from practical point of view.

Demerits of Essay Type Examination or Test

"..... bookish and mechanical, stereotyped and rigidly uniform and did not cater to the different aptitudes of the pupils."

—*Secondary Education Commission (1952-53)*

".....The whole systems of education is examination ridden. The frequency of examination and the manner of conducting them exercise an adverse effect upon the aims and methods of education. They suffer from a failure to define with any degree of exactness of the purpose."

—*The University Education Commission (1948-49)*

Some other demerits are as follows :

1. Obstructive in Physical and Mental Health–In these tests students study only during time of exam which are harmful to their physical and mental health. Too much emphasis an book-learning hinders physical growth from on early age. It does not take the account of day to day work of child.

2. Emphasis on Roting Power or Cramming–These questions develop the cramming power in the students. It gives emphasis on the memory power or cramming ability which do not develop the mental level and all round development. In other words it stimulates an unhealthy competitive spirit among children and encourage cramming of books and rote memorization rather than reflective thinking.

3. Time Consuming–Essay type examination is time consuming for students as well as for the teacher.

4. Lack of Reliability–The essay type questions do not give the same meaning. Different students understand them in different ways. It is but natural in such a case that there will be difference in their answers. And still further, the examiners too take their meaning differently. So it is almost necessary that difference in their measurement will creep in. It is evident that the results of such tests will not be subject to reliability. They are less reliable.

5. Lack of Validity–In essay type test there are no fixed objectives. There cannot be any validity about preduction because a student who gets

good marks in 10th class due to learning by heart may fail in successive classes. The teacher does not keep in mind the syllabus and level of the students while setting questions that is why there is absence of validity regarding syllabus. Thus, there is lack or absence of all types of validity.

6. Emphasis only on Expression–An important defect of the essay type examination system is that an outside examiner does not possess knowledge of the pupil's average work. Here expression effects the achievement of marks.

7. Emphasis on Writing and Speed–In essay type questions student has to write a lot. Taking an examination becomes an art, speed of writing is also an important factor.

8. Subjectivity–In essay type question, the subjective elements gain supremacy. The marking is influenced by the whims of the examiner. A number of researches have been conducted on it which have confirmed the subjectivity of essay type test or examination.

9. Half Representation of Curriculum–In essay type tests they do not represent the total or whole curriculum. Because in these tests 8-10 questions are included in the question paper which are the selected portion on the curriculum.

Hence about these demerit it is concluded that :

- It is an unclarity of objectives.
- Difficult in evaluation.
- Less Diagnosticity.
- Not Helpful in motivating the students.
- Effect of language and writing on the scores.
- It emphasises on memorisation of content matter rather than comprehension.
- Insufficient representation of syllabus.
- Actual evaluation of student's knowledge is doubtful.

Suggestion for Improvement in Essay Type Questions

The following suggestions are given for improvement in essay type examinations :

1. Increase the number of questions so as to cover the syllabus adequately.
2. The language of questions should be simple and their meaning should be unambiguous.
3. It should be used as projective technique to measure the higher mental abilities of students.
4. In this questions with their parts should be more clearly expressed and the distribution of marks for them should be made and shown.

5. The questions should be such on the basis of which the students can be classified into high, medium and low categories.
6. To improve its adıninistration. Administration of a test can be done perfectly only in a situation when the place is peaceful where execution of test is being done, the students have proper seating arrangement and the students are in normal physical and mental condition.
7. Further research may be made with trained examiners. Answer sheet can be examined by more than one examiner and average of marks given by them can be obtained.
8. There should be less choice of questions so that the actual knowledge of students could be tested.
9. The increase in number of questions and use of objective portions increase the reliability of the examination.
10. Advantages of well planned answer, instead of haphazard ones, may be emphasized and explained.

(ii) Objective Type Test

Objective type tests are new type tests. In these tests, short comings and limitations of essay type examinations were detalt by the educationists and psychologists. **Horace Mann** in 1845 A.D. developed the first objective test. **J.M. Rice** developed another objective test having only 50 words in 1897 A.D. **Afterward Starch** and **Thorndike** did commendable work in this direction.

In these tests, such questions are asked which have to be answered by making certain signs or writing a few words only. The answers to these questions are definite. The evaluators have not freedom in their evaluation. Because the answers and method of evaluation being definite, these tests are called objective tests.

According to **C.V. Good,** "Objective test is usually based on alternate response, multiple choice, matching or completion type questions and scored by means of a key of correct answers, any answer disagreeing with the key being regarded as wrong."

According to **Duglas and Holland,** "Objective tests are intended to obtain marks and grades that are relatively uninfluenced by the subjective factors."

Functions of Objective Type Examinations

- It provides help in educational and professional guidance and predicts future for them.
- It helps in classifying to the students.
- These tests defect the problems and weakness of the students and try to solve them

- It provides encouragement in the form of marks obtained and as this is objective it does not give a chance to anyone for cribbing.

Characteristics of Objective Type Test or Examinations

Following are the characteristics of objective type tests :

1. It takes lesser time to administer these test so the individual does not feel tired or bored.
2. There is no need to write in detail.
3. It is useful in selection, classification, promotion and other educational matter.
4. In these tests it is very easy and mechanical to award marks.
5. It is helpful to differentiate between the students.
6. It is based on educational objectives.
7. The number of questions in these tests is more so it is possible to take questions from the whole syllabus so the student's knowledge of the subject-matter can be measured in a proper manner.
8. It identifies quickness and of excellence of mind.
9. It is valid and more reliable.
10. It is a part from comprehensive knowledge.

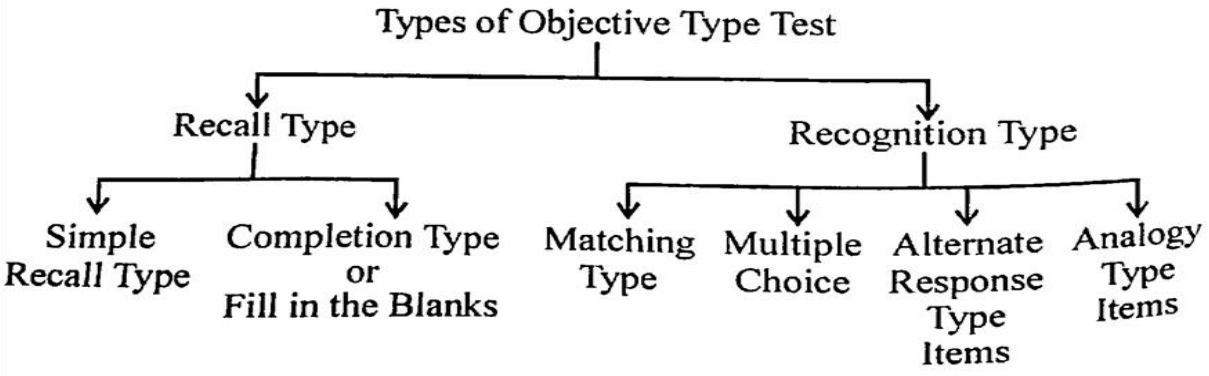
Kinds of Objective Type Test

Objective Type Test are classified into two categories :

1. Recall Type Questions
2. Recognition Type Questions

1. Recall Type Questions–In this type of questions there is repetition of previously learned facts thus they help in measuring the power of retention of the students. They are two types:

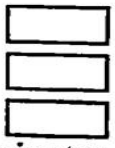
(a) Simple Recall Type Test or Questions–A simple recall type test is defined as one in which each item appears as a direct question. The nature of question is such that its answer is very specific and may be given precisely in a word or a number or a sentence. For examples :



(i) What will be the square root of 25?

(ii) What is the formula to calculate the area of circle?

(iii) What is the value of π?



This type of test measures familiarity and naturalness. It eliminates the guessing factor. One of the serious limitation of the simple recall item is that measures highly factual knowledge in bits or pieces.

(b) Completion Type Test or Fill in the Blanks–In this type of questions, the question is in the form of a sentence where one or more blanks are left for the student to fill in the answer. In this type there is no scope for guessing and the answer depends on understanding rather than memory. The main limitation of this test is that each item measures one or two bits of information. For examples:

(i) $\sqrt{3}$ is a ..... number.

(ii) The sum of all the interior angles in a triangle is ..... .

(iii) The ratio of circumference and diameter of a circle is ..... .

(iv) The point equidistant from the vertices of a triangle is ..... .

2. Recognition Type Item or Questions–In these questions, the question is to be recognized and answered accordingly. Although these help the examination in being objective, then too they are open to criticism because they promote guess work broadly. They are following type:

(i) Matching Type–A matching type item consists of two columns. Each statement in the first column is to be paired with a word in the second column. For example:

Match the Following

Column A	**Column B**
(a) Acute angle	(a) 90°
(b) Obtuse angle	(b) 180°
(c) Right angle	(c) 35°
(d) Straight angle	(d) more than 180°
	(e) more than 90° but less than 180°

Example II- Match the following :

Column A	**Column B**
(a) 4	(a) 64
(b) 8	(b) 81
(c) 5	(c) 144
(d) 9	(d) 16
(e) 12	(e) 25

(ii) Multiple Choice Questions–This type of questions include those questions of which several answers or solutions are presented and right answer has to be found out of these. For example :

(a) The average of 12, 14 & 16 is–

(i) 25 (ii) 14

(iii) 24 (iv) 36

(b) The value of $(a^2)^3$ is–

(i) a^5 (ii) a^{10}

(iii) a^6 (iv) None of these

(c) The value of tan (–150°) is–

(i) $-\sqrt{3}$ (ii) $-\frac{1}{\sqrt{3}}$

(iii) $\sqrt{3}$ (iv) $\frac{1}{\sqrt{3}}$

Multiple choice type items is most valuable and highly applicable type items. It is used to assess the judgment and discrimination power of the student. But in this type of items there is scope for guessing, cheating.

(iii) Alternate Type Items–These type of questions are asked in various ways as :

- True/False Questions
- Yes/No Questions
- Right/Wrong Questions

In this item only two possible responses are given. The pupil has to select one appropriate response from the given two alternate responses. This type of item makes the scoring, easy and objective. It is easy to construct and administer. But in this type of items there is much scope of guessing.

For example :

(a) $1 + \tan^2\theta = \sec^2\theta$ True/False

(b) Prime numbers include integers and fractions. True/False

(c) Pythagoras was an Indian mathematician. True/False

(iv) Analogy Type Items–It consists of two similar situations. One situation is incomplete. The pupil has to see the relationship in the first situation and on the basis of this relationship he has to complete the next situation. This test measures verbal reasoning. It may be recall as well as recognition type.

For example :

(a) 1 : 2 : : 50 : : .....

(b) $(a + b)^2 : (a^2 + b^2 + 2ab) : : (a - b)^2 :$ .....

(c) 4 : 16 : : 5 : .....

(d) sin θ : cosec θ : : ..... : cot (tan θ)

Selection Type Items–

(a) 49 : 81 : : ..... : 144

(i) 144
(ii) 64
(iii) 121
(iv) 100

(b) tan θ : cot θ : : ..... : sec θ

(i) sin θ
(ii) cot θ
(iii) cos θ
(iv) cosec θ

Merits of Objective Type Test

The major merits of objective type test are as below :

1. These tests are reliable. All the questions contained in them are clear and bear only one meaning, and their answers too are definite.
2. In these tests the student has to answer in a limited number of words so he cannot use ineffectual matter, chances of which are greater in essay type test or questions.
3. Due to reliable results, test is said to be scientific.
4. As these tests are prepared with a predetermined objective that is why they are more valid.
5. No need to go in detail, only brief and definite answers are required.
6. The questions asked in these tests are clear and have a single meaning, their answers are also definite and the evaluator has not any liberty to mark them. Whoever, the evaluator may be, the result of such tests is similar. It is evident that these tests are objective and therefore reliable.
7. In this test there is no effect of subjectivity of the evaluator.
8. Values to knowledge not efficiency and expertise in use of words.
9. Time consumption is not a problem hence test is absolutely economical.
10. Questions can be set from the whole syllabus, hence said to comprehensive.
11. Examiner can not be bluffed.
12. Free from complication, hence saves the students from misleading.

Demerits of Objective Type Tests

Despite having all the merits, these tests are not devoid of some shortcomings:

1. These tests examine the power of memory, the students have to hardly use the higher mental faculties such as logic and thinking.
2. Capabilities and talents of student can not be identified due to mechanical process of students mind.

3. It is difficult to find out the weaknesses and difficulties of the students through these tests.
4. Construction of objective tests are typical or difficult.
5. Lack of organization of thought in these tests.
6. The tests are prepared by those teachers who are already busy with their work, thus they have so much work that they cannot do justice to it.
7. Chances of cheating are more because answers are short and can be copied fast.
8. Their preparation requires a lot of labour, time and money.
9. Higher mental abilities cannot be measured by these tests.
10. It increases the burden on the teachers.
11. It does not provide knowledge about the student and his personality.
12. Possibility of correct answers only by guessing.
13. In these tests no opportunity for free expression of ideas.
14. Imagination and reasoning power also falls down due to short writing.
15. Extra-ordinary traits can not be exhibited.
16. In this tests language style and writing is completely ignored.
17. Standardization of objective test is a complex process.

Construction of objective based questions in behavioural Terms

Objective-1

Knowledge–To make the student that he can achieve the knowledge to scientific factors, steps, relations, concepts, techniques and theories.

Behaviour

1. They can recognise the steps, factors etc.
2. They can recall the steps, factors etc.
3. They can give the example of steps, factors etc.
4. They can give the definition of steps, factors and theories in his own words.
5. They can represent and explore the sign.
6. They can derive the simple results on the basis of facts, theories.

Objective-2

Understanding–To make the student that he can understand the scientific facts, steps, relations, concepts, formula, techniques, theories etc.

Behaviour

1. Student give examples.
2. Student found the errors.
3. Student found the relations.
4. Student classified them.
5. Student predicts the results.

Objective-3

Application–To prepare the student that he can use the scientific knowledge in new situations of daily life.

Behaviour

1. Student can achieve the known & unknown and can correlate in both of them.
2. Student can understand the use of data.
3. Student can understand the relation of data.
4. Student can assume the answers.
5. Student selects the proper method and theories.
6. Student solves the problem in a proper method.
7. Student can check the answer.

Short Answer Type Test

The tests in which such questions are asked, which can be answered briefly are called short answer type tests. The purpose of these tests is to test a large amount of knowledge, ability and understanding with in a short time. These questions are of two types:

(i) Short Answer Type Questions

(ii) Very Short Answer Type Questions

(i) **Short Answer Type Questions**–The questions which can be answered in comparatively less time and in less words than the essay type questions are called short answer type questions. For examples:

(a) What is the difference between measurement and evaluation?

(b) What are the steps of measurement?

(ii) **Very Short Answer Type Questions**–The questions which can be answered even more briefly and in shorter time than the short answer type questions are called very short answer type questions. For examples :

(a) What is the multiplicative inverse of (–5)?

(b) What do you mean by evaluation?

Merits of Short Answer Type Test

The merits of short-answer type test are :

1. The answers of these tests are generally definite, as such their measurement is objective and its is generally the case. It is evident that these tests are more reliable in comparison to essay type test.
2. It is more objective test.
3. Construction of these tests is easy.
4. Tests are generally used to measure change in the cognitive, affective and conative aspects. Though these tests can measure only cognitive aspects, yet they are so extensive that these are more valid.
5. They are more reliable than essay type test.
6. These questions give a vast sampling in lesser time.
7. These tests are administered just like essay type tests.
8. There is no possibility of guesswork.

Demerits of Short-Answer Type Tests

Some demerits of these tests are as follows :

1. These tests emphasise often on facts by which knowledge is chiefly tested. So, the students are inclined to learn by rote.
2. It takes more labour in reading the answer and awarding marks.
3. Inability to measure skills and attitude.
4. Inability to measure higher mental faculties such as logic.
5. The marking system is not objective as in objective type examination.

Suggestions for Improvement in Short Answer Type Tests

1. Their language should be simple and clear.
2. They have only one meaning.
3. The should instructions should be clear in the question.
4. The questions should be kept in proper ratio after a lot of thinking.
5. These question should be so framed as to have definite answers.

Difference between Essay Type and Objective Type Test

Essay Type Exam	Objective Type Exam
1. In this test the number of questions are less but their answers are long.	1. The number of questions are more but their answers are short.
2. Students give more time in thinking and writing.	2. In this students give more time in thinking and reading.
3. In this limited content are evaluated.	3. In this broad content are evaluated.
4. We can not standardize the norms of these test.	4. Standardized norms can fixed.
5. Construction of this test is easy but difficult to scoring marks.	5. Construction of this test is typical but easy in scoring.
6. Admnistration of this test is easy.	6. Administration method is difficult.
7. The validity and reliabity of these tests are of low level.	7. Reliability and validity are of high level.
8. In these tests teacher and student both are free.	8. In these tests teacher and students both are not free.
9. It is based on a small sample.	9. It is based on large sample.
10. These tests are more useful to achievement tests, selection and classification.	10. These tests are more useful to performance test, diagnosis, intelligence and aptitude test etc.

Suggestion or Recommendations of Various Commissions Regarding Improvement in Evaluation

(A) University Grant Commission (U.G.C.) (1948-49)

Commission gaves many suggestions to improve the exam :

1. University and education ministry should develop scientific method of the educational measurement and evaluation.
2. One or two experienced persons should be appointed.
3. Arrange the committee of examiners in each university.
4. Development of the appropriate psychological and performance tests for higher secondary examination.

(B) Secondary Education Commission (1952-53)

1. Decrease the number of external examinations and essay type questions.
2. School should be keep the whole progress report of the students.
3. Internal test should be important for progress of students.
4. Only one last external exam should be arranged in secondary curriculum.
5. Objective and short answer type questions should be arranged in place of essay type examinations.

ACHIEVEMENT TEST

Achievement test is tool for teachers for evaluation of students in school situation. With the help of achievement test we can measure the amount of success of an individual in specific field. In school environment it is used as an instrument to measure success of an individual in particular subject or group of subjects. It gives the knowledge about what an individual acquire by testing his abilities.

Definitions

- According to Waters, "Achievement test act as useful aids in diagnosing the student's specific learning needs for identifying his relative strengths and weaknesses".
- According to Super, "An achievement test or proficiency test is used to ascertain what and how much has been learnt or how well a task can performed".
- According to Free Man, "Achievement test is a test designed to measure knowledge, understanding and skills in a specified subject or a group of subjects".
- According to N.M. Downie, "Any test that measures the attainments or accomplishments of an individual after period of training or learning is called achievement test. It helps to permute the student to next class."

Uses of Achievement Test

1. For Administrator's Use:

1. Test helps to evaluate the extent to which the objectives of education are being achieved.
2. To evaluate, revise and improve the curriculum in the light of results obtained.
3. Tests help to classify school objectives.
4. Tests discover the type of learning experiences that will achieve these objectives with the best possible results.
5. To select talented pupils for special classes and courses.
6. To select students for the award of special merits or scholarships.
7. To discover backward children who need help and to plan for remedial instruction for such students.
8. To decide for proper classification of students.
9. To group students in a class, so that they will be put in such a way that individual differences are as little as possible.
10. To determine the general level of achievement of a class and thus to judge the teaching efficiency of the teacher. The level of achievement of a class may be

judged on the basis of the achievement of the class in the beginning and at the end of the school year.

11. To determine the efficiency of one school with the others.
12. To help the parents in recognizing the strengths and weaknesses of their children so that they direct their energies on suitable goals only and don't put heavy demands on them.
13. To get a better understanding of the needs and abilities of pupils.

2. The Teacher's Use:

1. The teacher will come to know the general range of abilities of students in the class.
2. In the light of the above, he will select appropriate materials of instruction, so that all individuals benefit from instruction to the maximum.
3. The teacher will determine and diagnose the weakness of the students in various subjects.
4. The teacher will spot brilliant and backward children.
5. He will determine the progress of the group in a particular subject over a period of time.

9.2 Construction of Achievement Test

If the test is to serve as an efficient and effective tool of evaluation, its preparation should be based on a number of careful considerations. The preparation of a good test is a systematic process having well-defined stages. The important steps envisaged in the preparation of a good teacher – made test are.

- Planning the test
- Preparation of a design
- Designing the test items
- Reviewing and editing
- Arranging the items
- Providing directions
- Preparing the scoring key and marking scheme
- Administering the test and scoring
- Evaluating the test

9.2.1 Planning the Test

"Test planning encompasses all of the varied operations that go into producing the test; but it must also involve careful attention to test item difficulty, to type of test items, to directions to the examiner". (Lindquist, E.F.). We shall cover most of these considerations under the heading; preparation of design for the test or blueprint of the test.

9.2.2 Preparation of Design

Designing is the first and most important step in the test construction. It is at this stage that we plan to build in the test the important qualities: validity, reliability, objectivity and practicability. In order to accomplish this, the test constructor has to take a number of decisions regarding selection of the objective, the selection of the content, form of questions, the difficulty level of tests items and the weightages to be allotted to the objectives, to the content and the form of questions. The set of those decisions will be called the *design of the test* from an analogy with the work of an architect. Important decisions have to be taken concerning the following.

i) Identification of the objectives and allotting weightage to the objectives

The most important step while planning a test, or any evaluation tool or technique for that matter, is the identification of the instructional objectives

and stating them in terms of specific observable behaviour. After the objectives are identified and stated, the test maker has to decide their relative weights in the test. The fundamental principle to be observed here is that the test should reflect the actual emphasis being given to various mental processes during instruction. Because of the intangibility of instructional process, there cannot be any fixed formula for assigning weights to various objectives. But these weights will be by and large a function of time, effort and resources spent on their acquisition as also for the importance for the society and the learning of the subject in terms of retention and transfer value. The simplest basis for assigning the weights could be to weigh them in terms of time devoted for their achievement. Weightages could, of course, be given in numerical terms, distributing 100 points over the objectives, giving the greatest number to those that are to receive the greatest emphasis.

For the sake of illustration, given below (table 9.3) are the objectives identified for teaching some units in mathematics and the weightage allotted to them.

Table-9.3: Showing the Weightage Allotted to the Objective

S.No.	*Objectives*	*Marks Allotted*	*Percentage*
1	Knowledge	6	24
2	Understanding	7	28
3	Application	10	40
4	Skill	2	8
	Total	25	100

ii) Selection of the content and allotting weightage to the content

Content being the means through which objectives are attained, it becomes very necessary to decide the weights to be given to its different parts. As the whole syllabus cannot be covered through any single test, a convenient number of units can be selected for testing. When this is done a decision about the weights to be given to these units has to be taken so as to represent the actual emphasis on them in instruction. In assigning relative weights to units a number of factors will have to be taken into account. How important is the unit in the total learning experience? How much time was devoted to it during instruction? Although there are a number of such considerations, the easiest method to decide weightages may be to base them on the time required to teach various units.

For the sake of illustration, given below is the table 9.4 indicating the weightages given to three units namely Polynomials, Functions and Quadrilaterals.

Table-9.4: Weightages given to Polynomials, Functions and Quadrilaterals

S.No.	*Unit*	*Marks Given*	*Percentage*
1.	Polynomials	10	40
2.	Functions	8	32
3.	Quadrilaterals (Construction)	7	28
Total		25	100

iii) Selection of the form of questions and giving weightage to the questions

The test-maker has to decide about the form of questions to be used, the number of questions to be chosen and the relative weightage to be given to each form. Perhaps a judicious combinations of the different forms will have to be used in achievement tests. However, among the objective type questions, multiple choice may be given more weightage.

In the question paper which is being taken for illustration, the weightage to different forms of questions could be as follows. (table.9.5)

Table-9.5: Weightages given to Different Forms of Questions

S.No.	*Form*	*Marks Given*	*Percentage*
1.	Essay (E)	6	24
2.	Short answer (S.A)	9	36
3.	Objective type (O)	10	40
Total		25	100

iv) Distribution of difficulty level

A decision also has to be taken concerning the distribution of difficulty level. The distribution of difficulty level in a test will depend upon the purpose of the test as also on the group of students for whom it is designed. To get optimum discrimination through a test, most of its questions should be of average difficulty level. A few easy questions, to motivate the below average students and a few difficult ones to challenge the gifted should find a place in the question paper If achievement can be assumed to be normally distributed, some weightages in terms of percentages can be suggested for easy, average and difficult questions as shown in table.9.6.

Table-9.6: Distribution of Difficulty Level for Questions

S.No.	*Difficulty Level*	*Percentage*
1.	Difficult Questions	15
2.	Average Questions	70
3.	Easy Questions	15
	Total	100

v) Preparation of Blueprint: (Table of specifications)

Preparation of the blueprint refers to the final stage of the planning of a test. The blue- print is a three dimensional chart showing the weightage given to the objectives, content and the form of questions in terms of marks. It is also called a table of specifications as it relates outcome to the content and indicates the relative weight given to each of the various areas. The units or the content spread along the vertical axis while the objectives are listed on horizontal axis. Each column is further subdivided into columns that indicate the forms of questions. Thus we get a number of cells, each cell having three dimensions, the objective, the content and the form of question. What is required on the part of the test maker is to fit in all the questions in different cells in such a way that the blueprint reflects the decisions of the design(er). When this is done, all rows and columns are balanced, and the blueprint is ready. It is illustrated in table.9.7

9.2.3 Designing the Test Items

When the blueprint is ready, the next step is to prepare or select the items. Write the test items according to the table of specifications. Take each cell of the blueprint and draft an item taking care of the various dimensions; the objective, the content and the form as laid down in the blueprint. Some other decisions taken while designing the test, particularly the one concerning the distribution of difficulty level has to be implemented at this stage itself. It is also desirable to prepare more items than the requirement of the cells of the blueprint since defects are likely to become apparent in some items during the later review. The additional items will make it easier to maintain the distribution of items reflected in the table of specifications.

9.2.4 Reviewing and Editing

The pool of items for a particular test after being set aside for a time can be reviewed with the help of experts. A more careful evaluation of the items can be made by considering them in the light of each of the following questions.

Table-9.7: Blueprint

Sl.No.	Objectives / Content	Knowledge			Understanding			Application			Skill			Total
		E	SA	O	E	SA	O	E	SA	O	E	SA	O	
1.	Polynomial			1(2)		3(1)	1(1)		3(1)	1(1)				10
2.	Functions			1(2)		3(1)	1(1)			1(2)				8
3.	Quadrilateral			1(1)				4			2			7
	Total	5			8			10			2			25

Note: The number inside the bracket indicates the number of questions and the number outside the bracket indicates the marks allotted to each question.

Uses of Blueprint

The preparation of the blueprint serves the following purposes. The blueprint

- helps to improve the content validity of the test.
- defines as clearly as possible the scope and emphasis of the test.
- relates objectives to the content.
- gives greater assurance that the test will measure learning outcomes and course content in a balanced manner.
- lays before the tester a complete picture of the test he is going to prepare.

- Does each item measure an important learning outcome included in the table of specifications?
- Is each item appropriate for the particular learning outcome to be measured?
- Does each item present a clearly formulated task?
- Is the item stated in simple, clear language?
- Is the item free form extraneous clues?
- Is the difficulty of the item appropriate for the students to be tested?
- Is each item independent and are the items, as a group, free from overlapping?
- Does each item fit into one of the cells of the blueprint?

9.2.5 Arranging the Items

When the final selection of the items has been completed and they are ready to be assembled into a test, a decision must be made concerning the best item arrangement. The following suggestions provide guidelines for this purpose.

- The items should be arranged so that all items of the same type are grouped together.
- The items should be arranged in the order of increasing difficulty.
- It may be desirable to group together items which measure the same learning outcomes or the same subject matter content.

9.2.6 Providing Directions

Directions constitute an inseparable part of a test. The directions for an achievement test should be simple and concise and yet contain information concerning each of the following:

1. purpose of the test
2. time allowed to complete the test
3. how to record the answers
4. whether to guess when in doubt about the answer
5. marks allotted for each question as also for each section of the test.

9.2.7 Preparation of Scoring Key and Marking Scheme

When the test has been assembled and ready to administer, it becomes necessary to prepare some other important accessories in the form of a

scoring key for objective type questions and marking scheme for supply-type questions, such as short answer and essay type questions.

Scoring key

Scoring key refers to the prepared list of answers to a given set of objective questions. The examiner compares the answers given by the students with those in the scoring key and thus arrives at the marks to be awarded to the students.

Correction for Guessing

The test constructor while preparing the scoring key may feel like reducing to zero the gain in the score expected to result from guess work. This is popularly called correction for guessing.

The generalized formula for correcting for guessing is.

$$S = R - \frac{kw}{n-k}$$

where

S = Score,

w = Number of wrong responses,

R = Number of right responses.

n = Number of suggested responses for a single item.

k = Number of responses to be selected or marked for each item.

In the case of True or False items,

$S = R - W$ (since $n = 2$, $k = 1$)

In the case of multiple choice questions where only one correct answer is expected, the generalized formula reduces to $S = R - \frac{W}{n-1}$

Marking Scheme

In the preparation of marking scheme in mathematics it will be desirable not only to analyse the solution into important stages and to distribute marks over them but each stage may be looked upon from the point of view of the method involved as also from expected accuracy. The marks for each stage, therefore, may be divided into two components: marks for the method and those for accuracy. A marking scheme is essential because it indicates:

i) The number of steps or learning points expected in the answer

ii) The outline of each point or step expected in the answer

iii) The weightage to each point or each step

iv) The level of accuracy expected of each step

9.2.8 Administering and Scoring the Test

At this step, it is important to make sure that all students know exactly what is expected of them and to provide them with the most favourable conditions for taking the test. After the administration of the test, the scoring can be done with the help of the scoring key and marking scheme. An illustration for the scoring key and marking schemes are given in tables 9.8 and 9.9

Table-9.8: Illustration for the Format of Scoring Key

Q.No	1	2	3	4	5	6	7	8	9	10
Expected Right Answer	A	B	B	C	A	25.Sq.cm	$(x+2)(x+1)$	—	—	—
Marks Allotted	1	1	1	1	1	1	1			

Table-9.9: Illustration for the Format of Marking Scheme

Q.No.	*Value Point Expected Answer*	*Marks allotted for each step*	*Total marks*
1	For writing the definition of the set correctly	1 mark	3
	For writing at least one example for the set	1 mark	
	For writing the Set in the:		
	(i) roaster form	½ mark	
	(ii) set builder form	½ mark	

9.2.9 Evaluating the Test

Evaluating the test helps the teacher to ascertain the following:

- Was the test very easy or very difficult?
- Was the test too long or too short?

- Were the directions clear and specific?
- Was the test practicable and feasible?
- Did the items measure the intended objectives?
- Did the difficulty level of the questions match the level of the students?
- Were the items clear and unambiguous?
- Were the distracters effective?
- Do the items discriminate among the different levels of achievers?
- What are the misconceptions formed by the student?
- How effective were the learning experiences provided during the instruction?

Evaluation can be done at two levels:

i) Question-wise analysis

ii) Item analysis

Question-Wise Analysis

Question-wise analysis is done by analysing each question according to objective, specification, content, question type, estimated difficulty level and time required. Format for the question-wise analysis is given in table-9.10. This helps the teacher in assessing the effectiveness of the test item with reference to the objectives and other requirements in the blueprint. This also gives an insight into the difficulties encountered by students in taking the test.

Table-9.10: Format for Question-wise Analysis

Q.No	*Objective*	*Specification*	*Form of Question*	*Unit*	*Marks allotted*	*Time in Minutes*	*Difficulty Level*
1.	Knowledge	Recalls	Objective (MC)	Set Theory	1	1	E*
2.	Understanding	Identies	Objective (MC)	Simultaneous Equation	1	1	A*
3.	Application	Selects	Objective	Set Theory	1	1	D*

***E=Easy; *A=Average; *D= Difficulty**

Item Analysis

Item analysis is the process by which the test maker evaluates the effectiveness of the test item in terms of (i) the difficulty level of the test items (ii) discriminating power of test items and (iii) the effectiveness of the distracters. For item analysis the teacher arranges the test papers in the

ascending order of marks and analysis is done for 27% of the students on the high and low end of the scales and making sure that there are an equal number of students in both the groups. Students' responses to each item is analysed for the students in upper and lower groups. Other than the purposes mentioned above, item analysis has several other benefits too.

- It provides useful information for class discussion of the test.
- It provides data for helping the students to improve their learning.
- It provides insight and skill which lead to the preparation of better tests on future occasions

ITEM ANALYSIS:

The test is evaluated with the help of scoring key. It is assumed that the test was very easy for the class, if the scores seem extremely high. Similarly, the test was probably very difficult if the scores are very low. It is advisable to review the question paper in following steps:

1. Question wise analysis -before the test
2. Critical evaluation of the test -before the test
3. Item analysis -after the test
4. Preparation for Final Draft

Question wise analysis helps to find out the weakness and strength of the test; to relate the question paper with the blueprint; and to inquire the content validity of the test. Each question is analyzed according to the objective specification, topic, question form and type, estimated difficulty level, time needed, and marks allotted.

Critical evaluation of the test helps to bring out any replication, spelling errors, ambiguities in the paper. A qualitative and quantitative assessment of the test must be done.

Item analysis enables the teacher to determine the difficulty value of each item; the discriminating power of each item; and the effectiveness of distracters in the given item.

Preparation for Final Draft: Test constructor analyses the responses of students for each test item. The whole data is gone through a statistical procedure. For the final draft, appropriate items are selected and inappropriate items are removed. A systematic arrangement of questions is done in the final draft, so that a clear identity of test is appeared. A final look of test is given by mentioning instructions to attempt the test, time allotment and responder's particular filling spaces or boxes at the top.

COMPREHENSIVE AND CONTINUOUS EVALUATION IN MATHEMATICS

Assessment of performance is an integral part of any process of learning and teaching. As a part of sound educational strategy, examinations should be employed to bring about qualitative improvement in education.

—The NPE, 1986

There is an urgent need to make evaluation an integral part of the whole teaching-learning process. The traditional examinations take cognizance of the scholastic area only, the attention and efforts of both teachers and children goes primarily to this area. Therefore, present school programmes also neglect many vital areas of a child's personality by starving them from the required inputs. Infect, if teaching-learning process is continuous, the examination or evaluation should also be continuous. The Comprehensive and Continuous Evaluation (CCE) provides accomodation for individual differences. It aims at fostering individual ability of children and helps them to realize their potentialities. The CCE also aims at making up the deficiency by laying adequate emphasis on the development of non-scholastic areas. Thus, it helps to develop all aspects of child's growth to his/her optional potential. Therefore, the comprehenive and continuous evaluation presents a combination of external and internal evaluation. In a system of comprehensive and continuous evaluation both scholastic and non-scholastic aspects of education are to be kept in view.

Comprehensive Evaluation

One of the main defects of the present examination system is that its coverage is very limited to academic aspects. The non-academic aspects. The non-academic aspects are not attempted for the allround development of the child's personality. All the efforts for instruction are focused on this limited area. So, the education remains confined to the cognitive domain alone and even there it covers very little beyond memorisation. Hence, the objective of the harmonious development of child's personality, remains unfulilled.

The several areas have been added to the curriculum, which facilitate the development of children in non-academic areas. The several areas are : work experience course, health education, physical education and other specially planned co-curicular activities. Child's growth in non-cognitive areas should be evaluated and guided

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continuously and it may not be the part of a formal examination. In this context the concept of comprehensive evaluation covering different aspect of a child's growth had conceived.

Continuous Evaluation

It is likely possible to obtain valuable data about the strength and weaknesses of the children through continuous evaluation. Continuous evaluation helps in providing remedies and enriched instruction with a view to realising the objectives of education in the optimum growth and development of various aspects of child's personality. The feedback helps teachers in improving the level of achievement and proficiency among children.

More over, the comprehensive and continuous evaluation will be a part of a teacher's duty. The scheme of comprehensive and continuous evaluation can work only, when there is healthy teacher-taught relationship. Hence, comprehensive and continuous evaluation is not an end in itself. It provides opportunities for teachers to make suitable changes in their efforts. Continuous feedback also provides direction to children and parents in their efforts. The **National Policy on Education** (1986), has also accepted that assessment of performance is an integral part of any process of learning and teaching. As apart of sound educational strategy; examinations should be exployed to bring about qualitative improvement in education. Evaluaion will be streamlined and the predominance of external examinations will be reduced in education.

Objectives of Comprehensive and Continuous Evaluation

The main objectives of CCE are as follows :

- To foster individual abilities of the children.
- To help the children to realize their potentialities and capacities.
- To enable teacher to evaluate those attitudes. Abilities and skills which are impossible to evaluate through traditional examinations.
- To help teacher in improving the level of achievement.
- To emphasise the development of non-scholastic areas.
- The elimination of excessive element of chance and subjectivity.
- The elimiation on emphasis of memorization.
- To help the children to have periodical feedback to judge their achievements.
- To help teachers to constinuously update their judgement in respect to the progress of the children in the cognitive, affective and psychomotor domains.
- To provide remedial and enriched instructions.
- To develop all the aspects of child's growth to his/her optional potential.
- To motivate both the teachers and children to improve the teaching-learning process.
- To evaluate comprehensively the more important abilities like; affection, certain values, attitudes, interests, habits, etc.
- To obtain valuable data about the strengths and weaknesses of the children regularly.

- To provide opportunities for teachers to make suitable changes in their efforts.
- The continuous feedback also provides direction to children and parents in their efforts.

Scope/Areas of Comprehensive and Continuous Evaluation

- The scheme of comprehensive and continuous evaluation covers the following aspects and areas of personality of a child.
- Academic achievement of the child.
- Personal and social qualities; such as : regularity, responsibility, punctuality, habit of cleanliness, Co-operation, initiative, sense of social service etc.
- Desirable attitudes; such as: socialism, secularism, democracy, attitude towards teachers, school, studies national integration etc.
- Interests; such as : Cultural, artistic, literary, scientific etc.
- Proficiency in co-curricular activities; such as: games, sports, scouting-guiding. First aid, Red-cross etc.
- Health status (heigth, weight, chest expansion, cleanliness, freedom from disease etc.,) which a teacher can observe and record.

Components of CCE

Various tools and techniques such as observation of pupil behaviour in different situations, checklists, inventories, rating scales, records of interests, initiative, and creativeity etc., may be used for evaluation in non-academic areas. Cumulative records will show growth charts of the children. The evaluation attempted on these lines will also be more revealing and are of better use for childern, parents and teachers. Various components of comprehensive and continuous evaluaton may be as follows :

- **Quizes**—Scheduled or unscheduled.
- Assignments—Class Assignments & home assignments.
- Written and oral tests—objective, short-answer, essay type, problem-solving.
- Practical/Field/Laboratory/Project work.
- Term papers/Dissertation/Thesis/Survey reports.
- Tutorial group activities/Seminar/group discussion.
- Weightage to attendance—distribution of marks on the basis of presence/ absence.

Advantages of Comprehensive and Continuous Evaluation

- CCE based on the assumption that the abilities and capacities of childern are evaluated continuously at every stage.
- It develops the habit of library consultation.
- It develops the habit of self study as well as regular study.
- It helps to develop confidence in the child.
- It provides the opportunity for mutual consulation.
- It also helps to develop the habit of advanced preparation of the lesson/ topic.
- Seminars, group discussion, tutarials etc. lead to a matter of interaction between the teacher and pupil and also between students and student.

- It helps to remove the weakenses or deficiencies in teaching-learning process.
- With the remedial programms and projects the foundation of concrete and constructive teaching-learning may be laid down.
- CCE incorporates both cognitive and non-cognitive aspect of the child's personality.
- It eliminates the excessive element of chance and subjectivity.
- It provides periodical feedback to the child and teacher both.
- It provides valuable data about the strengths and weaknesses of the children regularly.
- It provides opportunities for teachers and children to make suitable change in their efforts.
- It provides opportunities for remedial teaching and enriched instructions.
- It develops all the aspects of child's growth for his/her optimal potential.
- It also helps teachers to continuously and comprehensively update their judgements in respect of the progress of the children in all the three domains of behaviour.
- CCE motivates both the teachers and children to improve teaching and learning process.
- CCE fosters individual abilities of the children.

Limitations of Comprehensive and Continuous Evaluation

- The CCE may work only when there is happy and healthy teacher-taught relationship.
- Some teachers and examiners threaten their students and make then insecure as well as mutinous.
- It is not possible for a teacher to do CCE without knowing his students and their background.
- Favoritism, biases and prejudices of teacher can make the CCE subjective rather than background.
- The CCE may not be successful in a crowded class-room.
- It is more laborious and time consuming.
- This can be done by a true and devoted teacher.
- The observations and judgements of teacher may be free from favourites, prejudices and partiality. *i.e.* Teachers may fail to maintain objectivity in their role.
- It teacher fail to demonstrate integrity, sense of impartiality and resistance to pressure, CCE may become a mockery.

Present Examination System

The **Radha Krishanan Commission** (1948) was of the opinion that the prevailing system of the worst features of Indian education and stated : *"If they were to suggest one single reform in university education, it would be that of examination."* The influence, both positive and negative, of the examination system on education in general and secondary education in particular has been discussed in the reports of several committees and commissions. Reviewing **the defects of examination, at the secondary stages, the secondary education commission noted.**

"The examinations today dictate curriculum instead of following it, prevent any experimentation, hamper the proper treatment of subjects and sound methods of teaching, faster a dull uniformity rather than ***originality,*** *encourage the average pupil to* ***concentrate*** *too rigidly upon too narrow field and thus help him to develop wrong values in education."*

Defects of Present Examinations System

All educationist and administrators have bitterly denounced the present system of examination. The wholly unsatisfactory characteristics of our method of testing students has been underlined by may authorities. The painful effect of all examinations is that we have made a nation memorizers and crammers. So, education becomes examination **Centred** instead of student-centred. The major defects in the present system of examination can be outlined as follows :

(i) Subjectivity—Subjective attitude of examiners influences the marks obtained by an individual and leads to startling variability in marking. Therefore, a deserving student may fail and an undeserving one may pass. Thus, the results are declared in terms of raw marks which suffer from a number of inadequancies.

(ii) Element of Chance—The fate of large number of students is decided through examinations. It is often found that some children prepare a few selected questions and totally depend on chance. If **by-chance,** these selected questions appear in the examination, they get through the examination excellent credits and such children are considered superior to those who sincerely study the whole year, but unable to do well in the examinations due to many reasons.

(iii) Ignoring Quality of Character—The present examinations do not provide measure to test the originality, initiative, truthfulness, honesty, and sociability of the children. Without these qualities the true objectives of education cannot be achieved.

(iv) Lowering of Moral Standards—Existing examination system adversely affects the moral standards of the children. The high ambition to get through the examination in spite of basic efficiency prompts the children to resort to immoral practices, unsocial behaviour, indiscipline and use of unfair means.

(v) Glorification of Memory—The present examinations test only artificial and superficial layers of facts. They give the children neither breadth of vision nor foster historical thinking in their minds and test the intelligently learning of facts that are related to daily-life in the same manner.

(vi) Heavy Mental Stress and Strain—Present examination system exercises a heavy mental stress and strain on the children. The children get panic and fear struck. This fear rot their originality. Clear thinking and imaginativeness. **Kothari Commission** (1964-66) has also remarked that present examinations cause unhealthy rivalries among the children. The fear of failure some times leads to extreme measures like suicide.

(vii) Present examination system focuses on one aspect of children's achievement *i.e.* academic aspect and ignores the non-cognitive aspects which are a vital component of human personality.

(viii) It covers a small fraction of the course content that the pupils strive to learn over a period of one year.

(ix) It resorts to the use of written tests.

(x) It does not provide opportunities for the application of multiple techniques of evaluation like: oral, observations, assignments, projects, supervised study etc.

(xi) It also suffers from an unhuman rigidity which allows little flexibility of any kind.

(xii) The teachers who teach, have no opportunity to asses their own teaching.

(xiii) It fully based an external assessment of the child.

(xiv) It does not test the creative and construction ability of the children.

Advantages of Examinations

Therefore, on the basis of the defects and short commings of the present examination system, many educationists are so much disgusted that they have advocated it complete abolition but we can not abolish it altogether. Examination in one form or the other is essential. Teachers, presents, students, or one claim that the whole society feels it utmost need. **There are incidental advantages of examinations :**

- Examination does motivational work.
- It serves as an incentive to pupils in their work.
- It discloses defects in teaching and learning.
- It provides training in organising and using knowledge.
- It is an important function of our educational system.
- It provides us with a measuring instrument, measurement and evaluation that are essential part of education.
- The whole society feels its needs and importance.

Suggestions for Improving the Existing Examination System

On the basis of above shortcomings of existing examination system, it is clear that present system of examination in our country is not capable of measuring the real abilities of children and needs comprehensive reforms. The major suggestions are as follows :

(A) Improving External Examinations

- Content coverage should be in accurate form and overall options should be eliminated as they lead to selective study.
- Questions should be made specific, objective and exacts.
- The content should be consisted of a representative sample of every aspect of the domain in which achievement is to be assessed.
- The content and the organisation should make it possible for a consistent evaluation of the achievement of each candidate.
- To eliminate subjectivity in marking scoring procedures should be improved.
- Teachers should adopt the new techniques of evaluation.
- Model questions should always be prepared for each exam.

(B) Improving Internal Examinations

- The teachers should be trained for objective and impartial evaluation.
- Continuous evaluation throughout the year may be supplemented through an annual examination, that will minimize the chance factor in examinations.

(C) Improving Written Examinations

- The proportion of the essay type, short-answer type and objective type questions in any paper may vary from subjects to subject.
- It is desirable to introduce the short-answer type questions increasingly.
- Elements of subjectivity in examinations should be reduced through objectivity.
- All the major areas of content should be covered in the question papers.
- The chances of copying, using unfair and illegal means should be minimised.
- The method of spot evaluations should be adopted *i.e.* checking answer book/copies at one central place.
- In final examination certificate, the results should be in two columns : Internal assessment and external assessment.

(D) Introducing Continuous and Comprehensive Evaluation

- It may be helpful for a better insight into the personality of the children.
- Over all continuous and comprehensive evaluation of a child should be done on the basis of his complete sessional work/assignments.
- Sessional assessment which provides a measures for number of important abilities *viz;* derives and capacities for hard work, motivation, imagination institution and speculation leadership and team work etc.
- Sessional work/assignment may include writing of essays, project reports, home assignments, Group discussions, seminars field work, laboratory work, tutorial activities, survey reports, etc.
- Grading system should be introduced in place of marking.
- A cummulative record of profit should be maintained in every school for the proper assessment of physical, mental, moral, social and emotional aspects of the children.
- Question Bank should be developed in all the subjects.
- The system of the called 'final examination' should be replaced by assessments over all well distributed intervals.

Recommendations of Kothari Commission (1964-66)

The Education Commission (1964-66), critically examined the present examination system and recommended that :

- Evaluation should be considered as an integral process and part of teaching-learning process.
- The new approach of evaluation should be attempt to improve the written examination.
- For improving the nature of questions, there should be adoption of scientific procedures of scoring and processing of results.

Compre...

- The internal assessment should be shown seperately form the external examination marks.
- Written examinations should be improved.
- External examination should be improved by raising the technical competence of paper-setters, objective-oriented question papers etc.
- The internal assessment of school should be comprehensive and evaluate all aspects of student growth including those not measured by external examinations.

Keeping all these factors in view, it will be appropriate and very timely for the country to pay need to the Recommendation of the Programme of Action, 1992 that *"the predominance of the external examinations should be reduced."* Hence, evaluation must facilitate all-round development of children. It will be, therefore desirable to have report-based system of child's evaluation.

Examination Reforms

Examination is necessary exercise in the process of education. It is a measure of educational achievement as an indication of the level of fulfillment of the objectives of education as a guide to employment examinations are indispensable. Examinations have been referred to as the central nervous system of education. This is because examination has a determining effect on carriers and hence attract the emotional environment of the students. Examination Reform, has somehow come to occupy the most central position in the public eye. The urgency of the need for reforming examinations has also evoked the active interest of the Govt. of India with a view to getting some tangible results in the quickies possible time in this crucial area of education. It focuses attention on the two following major goals :

- Improving examinations so as to make them reliable and valid measures of pupil's growth.
- Improving examinations so as to make them powerful instruments of improving teaching and learning.

The above major goals of examination reform are relevant for both external examinations and evaluation in schools. In functional terms these goals would mean continuous and comprehensive evaluation incorporating both the scholastic and Non-scholastic aspects of pupil's growth.

Areas of Examination Reforms

There are many areas of examination reform, Some of these are as follows :

[I] Reforms in Written Examinations

- Improvement of questions and question papers.
- Improvement of scoring procedures

Through the measures like :

(a) Developing detailed marking scheme by the paper setters
(b) Introduction of innovations like centralized evaluation and randomizations of scripts for purposes of evaluation.
(c) Ensuring uniformity of assessment standards; evaluation of a sample of scripts by a member of examiners followed by a discussion among them.

Improvement in the Mechanics of Conducting Examination Through Steps Like :

(a) Deciding cut scores for awarding grades.
(b) Scaling of results for ensuring uniformity of standards.
(c) Devising improved methods of collecting, compiling, tabulating an analysing data for effective feed back.
(d) Introducing grades in place of marks.
(e) Conducting functional research into the examination problems.
(f) Provision of fictitious roll members to answer sheets before sending ther for evaluation.
(g) Including various type of questions like objective type, short-answer, very short-answer fixed response type, etc.

[II] Reforms in Practical Examinations

(a) Evaluating the proficiency in a wider variety of skills.
(b) Evaluating both the process and product of performance.
(c) Developing a detailed marking scheme, *i.e.* minimising inter-examiner and intra-examiner variability in scoring.

[III] Reforms in Oral Examinations.

- Oral examinations in language subjects.

(a) identification of linguistic abilities of oral expression
(b) comprehensive covrage of various linguistic abilities of oral expression
(c) improvement of objectivity in the assessment of these abilities.

- Oral examination in subjects other than languages.

(a) general questions of create a report
(b) specific to judge the level of accuracy of the acquired knowledge
(c) cross-questionning to judge the depth of knowledge of the pupils.

[IV] Steps towards making evaluation continuous and comprehensive to cover both the scholastic and non-scholastic areas of pupils growth.

- **Academic Operations**

(a) identification of different aspects of personality
(b) development of evaluative criteria for the assessment of these areas.
(c) preparing tools for evaluating various identified aspects
(d) developing procedures for organising programmes and activities
(e) developing guidelines for collecting, recording and interpreting the evidences
(f) improving the proficiency of the teacher *i.e.* feedback.

- **Administrative Operations**

(a) providing a separate certificate of internal assessment along with external examinations
(b) developing and enforcing effective built in methods
(c) ensuring the equivalence of school standards.

Hence, models of examination reform developed in India by the NCERT have admirably succeeded, where appropriate inputs have been invested into the programme in adequate measure and at appropriate manner.

9.3 Statistical Measures

Item analysis and item-wise analysis carried out after administering the tests, help the teacher in assessing the effectiveness of the test items and in assessing the overall performance of the students. However, the test scores should be subjected to statistical treatment for further interpretation and drawing valid inferences.

The statistical analysis of the scores helps the teacher to describe or summarise the test score which facilitates objective comparison of student performance. For this purpose the teacher has to make use of descriptive and inferential analysis. Descriptive analysis aids in describing an entire set of scores with a single score. For example, mean (M) and standard deviation (SD) are two frequently used methods of descriptive analysis. Means provide representative score for an entire set of scores while SD is an index of the variations of the test scores from the mean value. By comparing the values of SDs the teacher can compare the groups in terms of their homogeneity or heterogeneity. Thus statistical analysis and interpretation help in drawing some meaningful conclusions.

9.3.1 Steps Involved in Statistical Analysis and Interpretation

- *Collection of Data:* The data has to be collected using the primary and secondary methods depending on the purpose for which data is collected. In order to use statistical methods of analysis, data collected should be tabulated in the numerical form.
- *Classification of Data:* Classification is the process of arranging data according to certain points of similarities or dissimilarities. Data can be classified on the basis of certain attributes or according to class intervals. Classification according to class intervals leads to formation of frequency tables.

- *Organisation and Presentation:* The data should be organised and presented in a concise form. The presentation of data in the form of class intervals and frequencies is known as a *frequency table.* The presentation of data in the form of a frequency table is very suitable for further statistical analysis.
- *Selecting Appropriate Statistical Technique for Analysis:* An appropriate method of analysis should be selected. The appropriateness of technique depends on the purpose for which data is collected and the level of accuracy required or expected.
- *Applying Selected Method of Analysis:* The data should be subjected to statistical treatment by applying the methods selected for analysis. At this step the computations are done and results are obtained.
- *Interpretation of Results:* This is the most important and crucial step. At this stage the results are interpreted and conclusions are drawn. Many vital decisions are taken based on the conclusions drawn by interpreting the results. Therefore, extreme care should be taken to draw right conclusions by meaningful interpretation of the statistical results.

Since the scope of the present topic does not include a detailed presentation of a statistical methods and analysis, only a brief account of descriptive analysis is presented.

9.4 Types of Descriptive Analysis

Measures of Central Tendency

When we observe any data, we find that most of the items are gathering together or clustering around a particular point. This point is called *point of central tendency.* This method of central tendency or averages give us a point which is most representative of the entire data. There are two main objects for the study of measures of central tendency.

- To get one single value that represents the entire data.
- To facilitate comparison.

There are three measures of central tendency or averages in common use. They are:

i) Arithmetic Mean
ii) Median and
iii) Mode

9.4.1 Arithmetic Mean

The most commonly used and familiar index of central tendency for a set of raw data or a distribution is the mean. The mean is simple arithmetic average. The arithmetic mean of a set of values is their sum divided by their number. The elementary procedure for obtaining a mean is to add all the values and divide the total by the total number of values, N. Consider the following scores or measurements, 8, 14, 23, 0, 12, 5. The sum of these scores is 72. The arithmetic mean is, therefore, 72 divided by 6 i.e. 12 (72/6 = 12). If N measurements are represented by the symbols X_1, X_2, X_3 .....X_n the arithmetic mean is

$$M \text{ or } (\overline{X}) = \frac{\text{Sum of the item}}{\text{Number of items}}$$

$$= \frac{X_1 + X_2 + X_3 ..... X_n}{N} = \frac{\Sigma X}{N}$$

ΣX. describes the summing of N measurements. Generally the arithmetic mean is written as $\overline{X} = \frac{\Sigma X}{N}$

Calculation of Mean From Frequency Distribution

Table-9.11: Calculation of Mean from the Grouped Data

Scores X	*Frequency* f	fx	*Computation formula* $\overline{X} = \frac{\Sigma fx}{N}$
16	2	32	
15	3	45	$\overline{X} = \frac{266}{20}$
14	4	56	
13	5	65	$= 13.3$
12	3	36	
11	2	22	
10	1	10	
	$\Sigma f = 20$	$\Sigma fx = 266$	

In the above frequency distribution each X is multiplied by the corresponding frequency and the product fx is obtained. The sum of the

product fx is taken and is denoted as Σfx. When we divide Σfx by Σf or N, the sum of the frequencies, we get the value of the arithmetic mean.

$$\text{Thus } = \frac{\Sigma fx}{N}$$

Calculation of Mean from Frequency Distribution

There are two methods of computing mean from frequency table.

- Arithmetic Mean by Long Method
- Arithmetic Mean by Short Method

Arithmetic Mean by Long Method

Table-9.12:Calculation of Mean from Frequency Distribution (Long Method)

(1) Class Interval	*(2) Frequency f*	*(3) Midpoint X*	*(4) fX*	*Computation formula*
80-90	1	85	85	
70-80	2	75	150	
60-70	6	65	390	$\overline{X} = \frac{\Sigma fx}{N}$
50-60	10	55	550	$= \frac{1890}{40}$
40-50	8	45	360	$= 47.50$
30-40	6	35	210	
20-30	4	25	100	
10-20	3	15	45	
	N = 40		$\Sigma fX = 1890$	

Table 9.12. illustrates the computation of Mean by long method. It follows the following steps.

- Calculate the mid points of each class interval and denote by X (col. 3)
- Multiply each X and the corresponding frequency f.(col,4)
- Find the sum of the product fX and denote it by ΣfX
- Substitute the values of ΣfX and N in the formula $\overline{X} = \frac{\Sigma fx}{N}$

Arithmetic Mean by Short Method **(Assumed Mean Method)**

The long method of calculating mean as illustrated above, very often involves the handling of large numbers and requires tedious calculations. Hence to overcome these difficulties the "Assumed Mean Method" or simply the 'Short Method' is devised. The same is illustrated below.

Table-9.13: Calculation of Mean from a Frequency Distribution by Short Method or Assumed Mean Method

(1) Class-interval	(2) f	(3) Midpoint x	(4) $d=\frac{X-AM}{i}$	(5) fd
80 – 90	1	85	3	3
70 – 80	2	75	2	4
60 – 70	6	65	1	6
50 – 60	10	55	0	0
40 – 50	8	45	-1	-8
30 – 40	6	35	-2	-12
20 – 30	4	25	-3	-12
10 – 20	3	15	-4	-12
	N = 40			$\Sigma fd = 31$

Formula $\overline{X} = AM + \left(\frac{\Sigma fd}{N}\right)i$ where AM is the assumed mean.

$$d\text{ (deviation)} = \frac{X - AM}{i}$$

X = midpoint, AM = Assumed Mean

i = class interval size

fd – product of the frequency and the corresponding deviation.

$$\overline{X} = AM + \left(\frac{\Sigma fd}{N}\right)i \qquad \overline{X} = 55 + \left(\frac{-31}{40}\right)10$$

$$= 55 - \left(\frac{31}{40}\right)\times 10 = 47.25$$

Steps in computation

- Find the midpoints (X) of the class intervals (col.3)
- Take one of the midpoints preferably the midpoint of an interval somewhere near the centre of the frequency distribution as assumed mean (A.M). In the present case AM = 55
- Find the deviations (d) of the assumed mean from the midpoints using the formula $d = \frac{X - AM}{i}$ (col.4). However, 'd' values can be assigned almost mechanically. Starting with d = 0 for the class interval having the AM, go up assigning 'd' values of +1, +2, +3 etc. till the upper most class interval is reached. Once again starting at 'd' = 0, go down assigning d values of –1,–2,–3,.. etc. till the lowest class interval is reached. This is possible because all class intervals are of uniform size.
- Find the product of the frequency (*f*) and the corresponding deviation (d) (col.5)
- Find Σfd by adding up the product *fd*
- Substitute the value of AM, Σfd, N and i in the formula.

$$\overline{X} = AM + \left(\frac{\Sigma fd}{N}\right) i$$

Merits of Arithmetic Mean

- It is easy to understand and simple to compute
- Its value is based on each and every item of the data with the result that a change in any item would mean a change in the average itself
- It is most commonly used in further statistical computations.
- Arrangement of data is not required for computing mean.

Demerits

- It is unduly affected by the extreme items, i.e.: very small and very large values pull up or pull down the values of the average.
- In certain cases mean may give absurd results. For example, if we are finding out the average size of a family in a certain district it may come out to be 6.7 or 5.3. It is absurd because persons cannot be in fractions.
- Its value cannot be determined graphically

- Mean cannot be calculated for open-end class intervals like below 50, 100 and above.etc.

9.4.2 Median (Md)

The median (Md) may be defined as that value which divides a distribution into two parts such that an exactly equal number of scores fall above and below the point. In other words 50 per cent of the scores will be above the median and the remaining 50 per cent below it.

Computation of Median

Ungrouped Data

a) when there is an odd number of items

Computing the value of the median involves the following procedure.

- First arrange the data in the ascending or descending order of magnitude
- Take the value of the middle item. *For example*, consider the series 7, 6, 9, 10, 4. (N = 5, an odd number)

Arranging the scores in an ascending order: 4, 6, (7), 9,10, we find that 7 is the middle item and therefore 7, is the median. There are two items on either side of 7

b) When there is an even number of items

When there is an even number of items the average of the middle two scores is taken as the median. The scores must be arranged in the ascending or descending order.

For example consider the following sores. 6, 9, 3, 4, 10, 5.

Arranging the scores in the ascending order. 3, 4, (5, 6) 9, 10

$$\text{Median} = \frac{\text{sum of the middle two scores}}{2}$$

$$= \frac{5+6}{2} = 5.5$$

A formula for finding the median of a series of ungrouped scores is.

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

Calculation of Median from a Frequency Distribution

In calculating the median from data grouped in the form of a frequency distribution, the fundamental logic of calculation remains the same as described in relation to ungrouped data. The method is illustrated in the table 15.14. given below.

Table-9.14: Median from Frequency Distribution

(1) Class – interval	(2) Frequency f	(3) Cumulative Frequency F	(4) Exact limits
80-89	1	40	79.5-89.5
70-79	2	39	69.5-79.5
60-69	6	37	59.5-69.5
50-59	10	31	49.5-59.5
40-49	8	21	39.5-49.5
30-39	6	13	29.5-39.5
20-29	4	7	19.5-29.5
10-19	3	3	9.5-19.5
	N = 40		

A formula for calculating the Md when the data have been classified into frequency distribution is

$$\text{Median} = l + \left(\frac{\frac{N}{2} - F}{fm} \right) i$$

Where, l = exact lower limit of the CI in which Median lies (or the CI in which the $\frac{N^{th}}{2}$ item lies)

F = Cumulative frequency up to the lower limit of the CI containing median

fm = Frequency of the CI containing median

i = Size of class interval

Here, $l = 39.5$, F = 13; fm = 8; i = 10.

$$\text{Median} = 39.5 + \left(\frac{\frac{40}{2} - 13}{8} \right) \times 10$$

$$= 39.5 + \left(\frac{20 - 13}{8} \right) \times 10$$

$$= 39.5 + \frac{7 \times 10}{8}$$

$$= 48.25$$

Steps in Computation

- Write down the exact limits of the class intervals
- Compute the cumulative frequency as shown in col.3.
- Determine $\frac{N}{2}$, one half of the number of cases, in this example $\frac{40}{2} = 20$
- Identify the CI in which the $\frac{N^{th}}{2}$ item lies. In the present example it is the CI (40-49) with exact limits 39.5-49.5.
- Find the value of l the exact lower limit of the median class
- Find the cumulative frequency F, up to the lower limit of the C.I. which contains the median. In this example F=13, which is the cumulative frequency up to the lower limit of C.I. (40-49).
- Read the frequency fm of the interval which contains the median.
- Substitute the values of l, F, fm, $\frac{N}{2}$ and i in the formula Median = $l + \left(\frac{\frac{N}{2} - F}{fm} \right) i$

Merits of Median

- Like mean, median is simple to understand.
- Median is not affected by extreme items.
- Median is specially useful in qualitative phenomena like honesty, intelligence, efficiency etc.
- Median is the most appropriate average for distribution with open end classes. (Example: Below 40, 40-60, 60-80... above 100)

Demerits

i) It is not always rigidly defined

ii) It is generally not used in further statistical work.

9.4.3 Mode

The mode is strictly defined as the point on the scale of measurement with maximum frequency in a distribution. It is a point of maximum concentration on a scale of values. Usually it is the item of the variable which occurs the largest number of times.

Mode from Ungrouped Data

Case (i)

For determining mode, we have to ascertain how many times the various items have repeated themselves. The item which has repeated the maximum number of items would be referred to as the Mode.

Scores: 100, 120, 120, 100, 124, 132, 120

Mode = 120, Since 120 occurs the largest numbers of times (f = 3) , it is the value of the mode.

Case (ii)

It two adjacent scores have the same frequency and the frequencies are the highest in the distribution, then the mode is the sum of the two scores divided by two.

Example:

Scores: 100, 120, 101, 109, 102, 103, 101, 104, 101, 102, 105, 102

Mode = $\frac{101+102}{2} = 101.5$, since the adjacent scores 101 and 102 have the largest but equal frequency of 3 each, the average of these values is the mode.

Case (iii)

Scores: 100, 101, 110, 111, 113, 101, 113, 115

Modes = 101 and 113. The non adjacent values of 101 and 113 have the largest but equal frequency of two each. Hence this set of scores has two modes 101, and 113. It can thus be called bimodal. Thus we can have more than one mode for a given distribution.

Case (iv)

When all values occur with the same frequency, calculation of mode is not possible. In such cases, mode is indeterminate.

Calculation of Mode in a Frequency Distribution

When scores are grouped in frequency distribution, the mode is the midpoint of the interval with the largest frequency. Consider the following frequency distribution in table 15.15.

Table-9.15: Mode from Frequency Distribution

Class interval	*Frequency*	
35-39	3	Mode is the midpoint of class
30-34	4	interval 15-19 which has the
25-29	6	highest frequency of 9.
20-24	7	Hence Mode $= \frac{15+19}{2} = 17$
15-19	9	
10-14	6	
5-9	5	

This is also called the *crude mode* or the empirical mode. The crude mode is approximately equal to the *true mode* and serves most of the practical purposes. A formula for approximation of the true mode from the symmetrical or not badly skewed distributions is Mode = 3 Median –2 Mean.

However, a more accurate value of mode can be computed for the data presented in a frequency table using the formula

$$\text{Mode} = l + \left(\frac{f_2}{f_1 + f_2} \right) i$$

where l is the actual lower limit of the Mode class (Mode class is the C.I having the highest frequency).

f_1 is the frequency of the class interval preceding the Mode class

f_2 is the frequency of the class interval succeeding the Mode class

i is the size of the C.I.

Note: CI_s are arranged in the ascending order. The values of f_2 and f_1 will be interchanged if CI_s are arranged in the descending order.

From table 15.16, the mode class is 15-19 as it has the highest frequency

$$\therefore l = 14.5; f_2 = 7; f_1 = 6; i = 5$$

$$\therefore \text{Mode} = l + \left(\frac{f_2}{f_1 + f_2}\right) i$$

$$= 14.5 + \left(\frac{7}{7+6}\right) 5$$

$$= 14.5 + 2.69$$

$$= 17.19$$

Merits of Mode

- It is simple to understand because it is the most typical value of the series
- Its value is not affected by the presence of extreme items
- Mode can be determined graphically
- Mode is useful in such cases where it is desired to find out the most popular value of the series.

Demerits

– It is a measure having very limited practical value.

– It does not lend itself readily to further algebraic manipulations.

– It is not used for further statistical measures.

Guidelines for the use of Various Measures of Central Tendency

The following general rules may be helpful to the student so as to decide when to use the various measures of central tendency.

Mean is useful

- when scores are symmetrically or nearly symmetrically distributed around a central point.
- when the situation warrants a measure of central tendency, having the greatest stability.
- when one wants to compute S.D. and other statistics which are based upon the mean.

Median is useful

- when the exact midpoint separating the distribution into two equal halves is wanted.
- when extreme scores are present in the distribution which would markedly affect the mean.
- when it is desired that certain scores should influence the central tendency, but all that is known about them is that they are above or below the median.

Mode is useful

- when a quick and approximate measure of central tendency is all that is wanted.
- when only the most typical value is required.

For example- the most typical size of the shirt or shoes worn by an average man

9.5 Measures of Dispersion or Variability

A measure of dispersion is designed to state the extent to which individual items differ from their arithmetic mean.

Objects of Measuring Variation

Measures of variation can be utilised for the following.

i) To test the reliability of an average

ii) To serve as a basis for the control of variability.

iii) To compare two or more groups with regard to their variability i.e., a high degree of variation would mean little uniformity or consistency whereas a low degree of variation would mean great uniformity or consistency.

iv) To facilitate the use of other statistical measures.

Methods of Studying Variation

The following are the measures of variability and each of these provides a numerical index of the variability of the scores.

i) Range
ii) Semi Inter Quartile Range or Quartile Deviation (Q)
iii) Mean Deviation or Average Deviation (M.D) or (A.D.)
iv) Standard Deviation (S.D.)

9.5.1 The Range

Range is the indicator of the variability that is easiest and most easily ascertained, but is also the most unreliable. It is defined as the difference between the highest and lowest scores.

$$R = H - L$$

As evident from the formula, range takes into account the extreme values of the scores only and ignores others. Hence it suffers from the following limitations.

Limitations

- It is unreliable when N is small or when there are gaps in the distribution.
- A change in the value of either of the extreme scores leads to a change in the value of the range.
- It does not consider the value of the scores between the extreme scores.
- Range cannot be calculated for open end class intervals.
- Further statistical analysis are difficult to make.

Uses

Range can be used in the following situations.

- When the data are too scattered to justify the computation of a more precise measure of variability.
- When a knowledge of total spread is all that is wanted.
- When a quick and crude estimate of variability is all what is desired.

9.5.1.1 The Semi-Inter-Quartile Range or Q

From the above discussion, there is every reason to believe that if the dispersion of extreme items is discarded, the limited range thus established might be more instructive. For this purpose there has been developed a

measure called inter-quartile range, the range which includes the middle fifty per cent of the distribution i.e. one quarter of the observations at the lower end and another quarter of the observations at the upper end are excluded in computing the inter-quartile range (see fig.15.5). In other words inter-quartile range represents the difference between the third quartile and the first quartile. In notation, Inter-Quartile range = Q_3-Q_1.

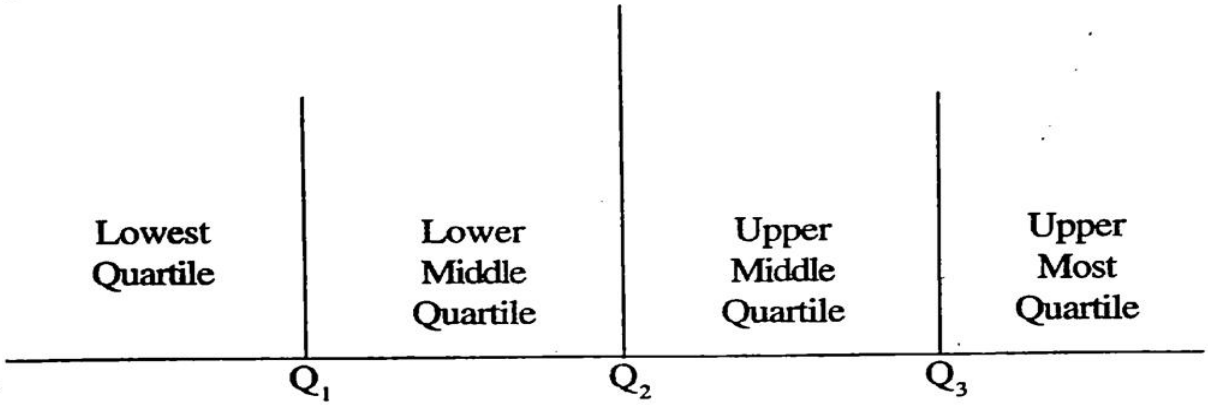

Fig.9.3: Diagrammatic Representation of the Quartiles

Half of the inter-quartile range or semi-inter-quartile range is called the *Quartile Deviation* (Q).

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

Thus the Quartile Deviation is one half of the scale distance between the first and third quartiles in a frequency distribution. The first quartile (Q_1) on the score scale is the 25th percentile and the third quartile (Q_3) is the 75th percentile. Hence this first quartile is the point below which lies 25% of the scores and the third quartile is the point below which lies 75% of the scores.

Since Q measures the average distance of the quartile points from the median it is a good index of score density at the middle of the distribution. If the scores are packed closely together the quartiles will be near one another and Q will be small. If scores are widely scattered, the quartiles will be relatively far apart and Q will be large.

When the distribution is symmetric around the mean, or when it is normal Q marks exactly the 25% of the cases just below the median. The median thus lies just half way between the two quartiles Q_1 and Q_3.

To find out Q, it is essential to calculate values of Q_3 (or P_{75}) and Q_1 (or P_{25}). Their calculation follows the same procedure as the calculation of median as in table 15.14. The only difference is that $\frac{1}{4}$ of N is counted off

from the low end of the distribution to find Q_1 and that $\frac{3}{4}$ N is counted off to find Q_3.

The formulae are: $Q_1 = l_1 + \left(\frac{\frac{N}{4} - F_1}{f_1}\right) \times i$

$$Q_3 = l_3 + \left(\frac{\frac{3N}{4} - F_3}{f_3}\right) \times i$$

where l_1 = the exact lower limit of the interval in which the lower quartile falls.

i = the size of the interval

F_1 = the cumulative frequency up to the interval which contains the lower quartile.

f_1 = the frequency of the interval containing the lower quartile.

l_3 - The exact lower limit of the interval in which the upper quartile falls.

F_3 - Cumulative frequency up to the lower limit of the upper quartile class.

f_3 - The frequency of the upper quartile class.

Table-9.16: Calculation of Q_1, Q_3 and Q

Class-Interval	Frequency (f)	Cumulative frequency (F)	
45-49	2	50	
40-44	3	48	
35-39	2	45	
30-34	6	43	Q_3 lies in the C.I.
25-29	8	37	
20-24	8	29	
15-19	7	21	
10-14	5	14	Q_1 lies in the C.I
5-9	9	9	
	N = 50		

Calculation of Q_1

Here $l_1 = 9.5; F_1 = 9; f_1 = 5$

Substituting these values in the formula for Q_1, we have

$$Q1 = 9.5 + \left(\frac{\frac{50}{4} - 9}{5} \right) \times 5$$

$$= 9.5 + \left(\frac{12.5 - 9}{5} \right) \times 5 = 9.5 + 3.5 = 13.00$$

Calculation of Q_3

Here $l_3 = 29.5; F_3 = 37; f_3 = 6;$

$i = 5; N = 50$

Substituting these values in the formula for Q_3

$$Q_3 = 29.5 + \left(\frac{\frac{3 \times 50}{4} - 37}{6} \right) \times 5$$

$$= 29.5 + \left(\frac{37.5 - 37}{6} \right) \times 5$$

$$= 29.5 + 0.42 = 29.92.$$

Calculation of Q

Substituting the values of Q_1 and Q_3 in the formula $Q = \frac{Q_3 - Q_1}{2}$, we get

$$Q = \frac{29.92 - 13.00}{2} = \frac{16.92}{2} = 8.46.$$

Use the Q when

- the median is the measure of central tendency.
- there are scattered or extreme scores which would influence the SD disproportionately.

- the concentration around the median – the middle 50% of the cases – is of primary interest.

Merits of Q

- Superior to range as a rough measure of dispersion.
- Specially useful in case of open end classes.
- Not affected by the presence of extreme values.

Limitations

- As the value does not depend upon every item of the series, it cannot be regarded as a good method of dispersion.
- Affected by sampling fluctuations.
- It gives only a position on the scale rather than the scatter.

9.5.2 Average Deviation (AD)

The average deviation (or Mean deviation) is the average distance between the mean and scores in the distribution. In other words average deviation is the mean of the deviation of all the separate scores in a series taken from their arithmetic mean (occasionally from Median or Mode.). The deviation is defined as the distance of the score from the mean of the distribution. Algebraically, deviation can be defined as $\chi = X - M$, where X = original score, and M = arithmetic mean.

The sum of the deviations (with algebraic signs) from the arithmetic mean is always zero. Hence their average will always be zero and thus, useless for measuring and describing dispersion. Hence in averaging the deviation to find AD. no account is taken of signs and all deviations, whether plus or minus are treated as positive. The formula for average deviation is:-

$$AD = \frac{\Sigma|\chi|}{N}$$ where Σ = sum of; $|\chi|$ = absolute value of deviation and N = Total number of scores or observations.

Calculation of Average Deviation from Ungrouped Data

Table-9.17 illustrates the calculations of Average Deviation from ungrouped data.

Table-9.17: Calculation of AD from Ungrouped Data

X	$\chi = X-M$	$\lvert\chi\rvert$	
6	-4	4	
8	-2	2	$AD = \frac{\Sigma\lvert\chi\rvert}{N}$
10	0	0	
12	2	2	$= \frac{12}{5} = 2.4$
14	4	4	
$M = \frac{50}{5} = 10$	$\Sigma\chi = 0$	$\Sigma\lvert\chi\rvert = 12$	

Calculation of A.D. from Grouped Data

The table-9.18. illustrates the method of calculation of the AD from grouped data.

Table-9.18: Calculation of AD from Grouped Data

(1) Class Interval	(2) f	(3) Mid point X	(4) $\lvert\chi\rvert=\lvert X-M\rvert$	(5) $\lvert fx\rvert$	
195-199	1	197	26.20	26.20	
190-194	2	192	21.20	42.40	Mean (M) = 170.80
185-189	4	187	16.20	64.80	
180-184	5	182	11.20	56.00	
175-179	8	177	6.20	49.60	$AD = \frac{\Sigma\lvert fx\rvert}{N}$
170-174	10	172	1.20	12.00	
165-169	6	167	3.80	22.80	
160-164	4	162	8.80	35.20	$= \frac{502}{50} = 10.04$
155-159	4	157	13.80	55.20	
150-154	2	152	18.80	37.60	
145-149	3	147	23.80	71.40	
140-144	1	142	28.80	28.80	
	N=50			$\Sigma\lvert fx\rvert$=502.00	

In column (4) are entered the deviations (x) of each midpoint (X) from the Mean (M). In this case M=170.80. The deviation (x) for each midpoint (X) from the Mean (170.80) is calculated using the formula |X–M| and entered as shown in column (4). Each x deviation in column (4) is now multiplied by the frequency to get the entries |*fx*| in column (5). The first |x| of 26.20 is multiplied by 1; the second |x| of 21.20 by 2 and so on The sum of the |*fx*| (column 5) is taken and divided by N to give the AD. The formula is

$$AD = \frac{\Sigma|fx|}{N}$$

Substituting for $\frac{\Sigma|fx|}{N}$ in the formula,

$$AD = \frac{502}{50} = 10.04$$

Note: Mean is always subtracted from the midpoints i.e.(X–M = x)

The A.D when measured on the scale, above and below the mean includes 57.5% of the cases. Hence A.D. is always somewhat larger than the Q which includes the middle 50% of the items.

Steps in computing A.D

- Compute arithmetic mean (M) using either the direct or short method.
- Calculate deviation χ using the formula $\chi = \times - M$
- Find the absolute values of χ ie $|\chi|$; (Col.4)
- Multiply $|\chi|$ with the corresponding frequency to get $|f\chi|$; (Col. 5)
- Find the sum of $|f\chi|$ ie $\Sigma|f\chi|$
- Substitute the value of $\Sigma|fx|$ in formula $AD = \frac{\Sigma|fx|}{N}$

Use the A.D.

- When it is desired to weigh all deviations from the mean according to their size.
- When extreme deviations would influence S.D .unduly.

9.5.4 Standard Deviation (SD or σ)

The standard deviation or S.D. is the most reliable and stable index of variability. This concept was introduced by Karl Pearson in 1893. Its significance lies in the fact the it is free from those defects which the earlier methods suffer and satisfies most of the properties of a good measure of dispersion.

Like A.D, the S.D. is also a kind of average of all the deviations about the mean in a sample, though it is not a simple arithmetic mean. In computing the AD, we disregard signs and treat all deviations as positive, whereas in finding SD we avoid the difficulty of signs by squaring the separate deviations. Again the squared deviations used in computing the SD are always taken from the mean, never from the median or mode. The convention symbol for the SD is the Greek letter sigma. Standard deviation has been termed so because it provides a standard unit for measuring distances of various score from their mean.

In verbal terms, standard deviation is the square root of the arithmetic mean of the squared deviations of measurement from their mean. It has been often called as Root- Mean Square Deviation.

Calculation of the SD from Ungrouped Scores

We may illustrate the calculation of the SD for an ungrouped set of data with the same 5 scores used to demonstrate the computation of AD. The mean of the 5 scores 6,8,10,12 and 14 is 10 and the deviation of the separate scores from the mean are –4, –2, 0, 2, and 4 respectively. When each of these 5 deviations is squared, we get 16, 4, 0, 4 and 16; the sum is 40 and N, of course is 5. The formula for σ when scores are ungrouped is

$$\sigma = \sqrt{\frac{\Sigma x^2}{N}}$$ and in our example

$$\sigma = \sqrt{\frac{40}{5}}$$ or 2.83.

The table.9.19 illustrates the method of computation

Table-9.19: Computation of SD from Ungrouped Score

X	$\chi = X - M$	χ^2	$\sigma = \sqrt{\frac{\Sigma x^2}{N}}$
6	-4	16	
8	-2	4	
10	0	0	Where $x = X - M$
12	2	4	
14	4	16	$\sigma = \sqrt{\frac{40}{5}} = 2.83$
M = 10		$\Sigma x^2 = 40$	

Calculation of SD from Grouped Data: (Short method)

You may recall the short method of calculating the mean. This method consists essentially in "guessing" or assuming a mean and later applying a correction to give the actual mean. The short method may also be used to advantage in calculating the SD. The short method of calculating σ is illustrated in table15.20.

The formula for σ by the short method is.

$$= i\sqrt{\frac{\sum fd^2}{N} - C^2}$$

in which 'fd²' is the sum of the squared deviations in units of class interval taken from the assumed mean. C^2 is the squared correction (ie: $c^2 = \left(\frac{\sum fd}{N}\right)^2$ in units of class interval and i is the size of the class interval

Table-9.20: Computation of S.D. from Grouped Data by the Short Method (Deviations taken from Assumed Mean)

Class Interval	*Midpoint X*	*f*	$d = \frac{X - AM}{i}$	*fd*	fd^2
(1)	(2)	(3)	(4)	(5)	(6)
45-49	47	2	5	10	50
40-44	42	3	4	12	48
35-39	37	2	3	6	18
30-34	32	6	2	12	24
25-29	27	8	1	8	8
20-24	22	8	0	0	0
15-19	17	7	-1	-7	+7
10-14	12	5	-2	-10	+20
5-9	7	9	-3	-27	+81
		N = 50		Σfd = 4	$\Sigma fd^2 = 256$

$$\sigma = i\sqrt{\frac{\sum fd^2}{N} - C^2}$$

where *i* stands for the size of class interval and C for correction.

In the given data $i = 5$; $\Sigma fd^2 = 256$; $N = 50$; and $C = \frac{\Sigma fd}{N}$;

$c^2 = \left(\frac{4}{50}\right)^2 = .6664$ substituting the values in the formula

$$\sigma = 5\sqrt{\frac{256}{50} - .0064}$$

$$= 11.31$$

Computational steps

- Find out the midpoints (X) of all the class intervals
- Take a midpoint as an assumed mean.(A M)

- Find deviation (d) using the formula $d = \frac{X - AM}{i}$
- Multiply columns (3) and (4) to obtain fd and sum up to obtain Σfd
- Multiply columns (4) and (5) to obtain fd^2 and sum up to obtain Σfd^2
- Find out the value of C^2 using the formula $C^2 = \left(\frac{\Sigma fd}{N}\right)^2$
- Substitute these values in the formula $\sigma = i\sqrt{\frac{\Sigma fd^2}{N} - C^2}$ and find the value.

Use S.D.

- When the measure of dispersion having the greatest stability is required.
- When extreme deviations should exercise a proportionally greater effect upon the variability.
- When coefficients of correlation and other statistics are subsequently to be computed.

GRAPHICAL REPRESENTATION OF DATA

Introduction

Graphical representation of data is for the purpose of easier interpretation. Facts and figures as such do not catch our attention unless they are presented in an interesting way. Graphical representation of data is the most commonly used interesting modes of presentation. The purpose of this unit is to make you familiar with this interesting mode of presentation.

Meaning of Graphic Representation of Data:

Graphic representation is another way of analysing numerical data. A graph is a sort of chart through which statistical data are represented in the form of lines or curves drawn across the coordinated points plotted on its surface.

Graphs enable us in studying the cause and effect relationship between two variables. Graphs help to measure the extent of change in one variable when another variable changes by a certain amount.

Graphs also enable us in studying both time series and frequency distribution as they give clear account and precise picture of problem. Graphs are also easy to understand and eye catching.

General Principles of Graphic Representation:

There are some algebraic principles which apply to all types of graphic representation of data. In a graph there are two lines called coordinate axes. One is vertical known as Y axis and the other is horizontal called X axis. These two lines are perpendicular to each other. Where these two lines intersect each other is called '0' or the Origin. On the X axis the distances right to the origin have positive value (see fig. 7.1) and distances left to the origin have negative value. On the Y axis distances above the origin have a positive value and below the origin have a negative value.

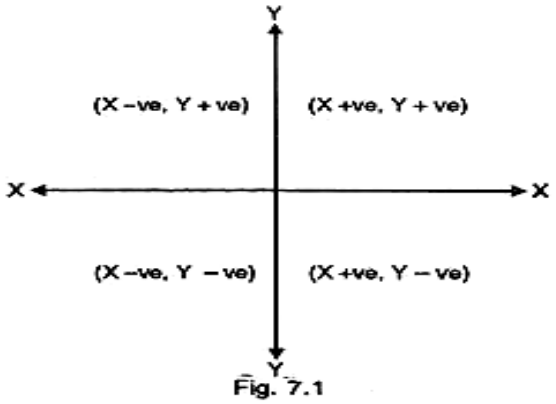

Fig. 7.1

Methods to Represent a Frequency Distribution:

Generally four methods are used to represent a frequency distribution graphically. These are Histogram, Smoothed frequency graph and Ogive or Cumulative frequency graph and pie diagram.

1. Histogram:

Histogram is a non-cumulative frequency graph, it is drawn on a natural scale in which the representative frequencies of the different class of values are represented through vertical rectangles drawn closed to each other. Measure of central tendency, mode can be easily determined with the help of this graph.

How to draw a Histogram:

Step—1: Represent the class intervals of the variables along the X axis and their frequencies along the Y-axis on natural scale.

Step—2: Start X axis with the lower limit of the lowest class interval. When the lower limit happens to be a distant score from the origin give a break in the X-axis n to indicate that the vertical axis has been moved in for convenience.

Step—3: Now draw rectangular bars in parallel to Y axis above each of the class intervals with class units as base: The areas of rectangles must be proportional to the frequencies of the corresponding classes.

Illustration No. 7.2

Plot the following data by a histogram.

c.i.	f
20—24	2
25—29	2
30—34	5
35—39	10
40—44	6
45—49	2
50—54	3

Solution: In this graph we shall take class intervals in the X axis and frequencies in the Y axis. Before plotting the graph we have to convert the class into their exact limits.

c.i.	f
19.5—24.5	2
24.5—29.5	2
29.5—34.5	5
34.5—39.5	10
39.5—44.5	6
44.5—49.5	2
49.5—54.5	3

Histogram plotted from the data.

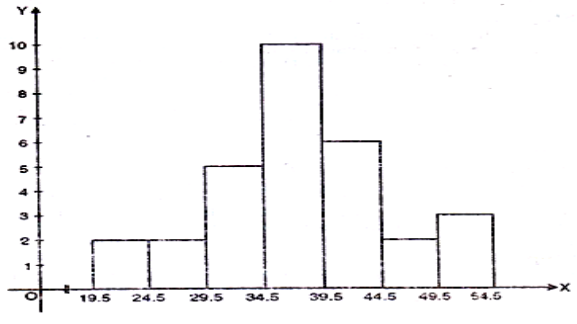

Fig. 7.2

Advantages of histogram:

1. It is easy to draw and simple to understand.
2. It helps us to understand the distribution easily and quickly.
3. It is more precise than the polygene.

Limitations of histogram:

1. It is not possible to plot more than one distribution on same axes as histogram.
2. Comparison of more than one frequency distribution on the same axes is not possible.
3. It is not possible to make it smooth.

Uses of histogram:

1. Represents the data in graphic form.
2. Provides the knowledge of how the scores in the group are distributed. Whether the scores are piled up at the lower or higher end of the distribution or are evenly and regularly distributed throughout the scale.
3. Frequency Polygon. The frequency polygon is a frequency graph which is drawn by joining the coordinating points of the mid-values of the class intervals and their corresponding frequencies.

Let us discuss how to draw a frequency polygon:

Step-1: Draw a horizontal line at the bottom of graph paper named 'OX' axis. Mark off the exact limits of the class intervals along this axis. It is better to start with c.i. of lowest value. When the lowest score in the distribution is a large number we cannot show it graphically if we start with the origin. Therefore put a break in the X axis () to indicate that the vertical axis has been moved in for convenience. Two additional points may be added to the two extreme ends.

Step-2: Draw a vertical line through the extreme end of the horizontal axis known as OY axis. Along this line mark off the units to represent the frequencies of the class intervals. The scale should be chosen in such a way that it will make the largest frequency (height) of the polygon approximately 75 percent of the width of the figure.

Step-3: Plot the points at a height proportional to the frequencies directly above the point on the horizontal axis representing the mid-point of each class interval.

Step-4: After plotting all the points on the graph join these points by a series of short straight lines to form the frequency polygon. In order to complete the figure two

additional intervals at the high end and low end of the distribution should be included. The frequency of these two intervals will be zero.

Illustration: No. 7.3:

Draw a frequency polygon from the following data:

Marks in Mathematics	40–45	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–95	95–99
No. of students	1	3	2	4	5	6	10	8	5	6	2	1

Solution:

In this graph we shall take the class intervals (marks in mathematics) in X axis, and frequencies (Number of students) in the Y axis. Before plotting the graph we have to convert the c.i(class interval). into their exact limits and extend one c.i. in each end with a frequency of O.

Class intervals with exact limits:

c.i.	f.
34.5–39.5	0
39.5–44.5	1
44.5–49.5	3
49.5–54.5	2
54.5–59.5	4
59.5–64.5	5
64.5–69.5	6
69.5–74.5	10
74.5–79.5	8
79.5–84.5	5
84.5–89.5	6
89.5–94.5	2
94.5–99.5	1
99.5–104.5	0

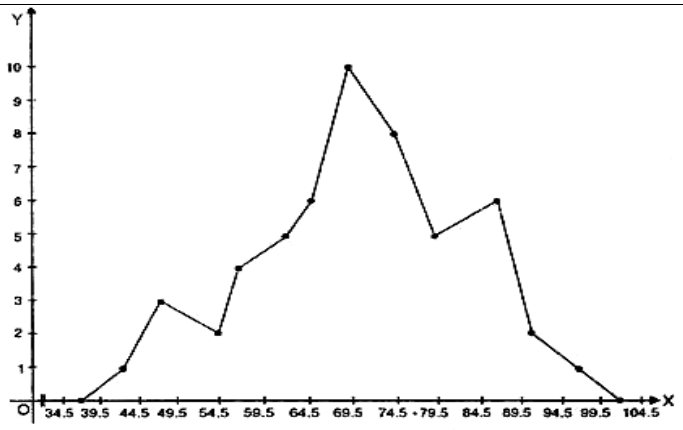

Fig. 7.3 Frequency polygon plotted from the data.

Advantages of frequency polygon:

1. It is easy to draw and simple to understand.
2. It is possible to plot two distributions at a time on same axes.
3. Comparison of two distributions can be made through frequency polygon.
4. It is possible to make it smooth.

Limitations of frequency polygon:

1. It is less precise.
2. It is not accurate in terms of area the frequency upon each interval.

Uses of frequency polygon:

1. When two or more distributions are to be compared the frequency polygon is used.
2. It represents the data in graphic form.
3. It provides knowledge of how the scores in one or more group are distributed. Whether the scores are piled up at the lower or higher end of the distribution or are evenly and regularly distributed throughout the scale.

2. Smoothed Frequency Polygon:

When the sample is very small and the frequency distribution is irregular the polygon is very jig-jag. In order to wipe out the irregularities and **"also get a better notion of how the figure might look if the data were more numerous, the frequency polygon may be smoothed."**

In this process to adjust the frequencies we take a series of 'moving' or 'running' averages. To get an adjusted or smoothed frequency we add the frequency of a class interval with the two adjacent intervals, just below and above the class interval. Then the sum is divided by 3. When these adjusted frequencies are plotted against the class intervals on a graph we get a smoothed frequency polygon.

Illustration 7.4:

Draw a smoothed frequency polygon, of the data given in the illustration No. 7.3:

Solution:

Here we have to first convert the class intervals into their exact limits. Then we have to determine the adjusted or smoothed frequencies.

c.i. (with exact limit)	f	Smoothed frequency
34.5—39.5	0	0 + 0 + 1 ÷ 3 = .33
39.5—44.5	1	0 + 1 + 3 ÷ 3 = 1.33
44.5—49.5	3	1 + 3 + 2 ÷ 3 = 2.00
49.5—54.5	2	3 + 2 + 4 ÷ 3 = 3.00
54.5—59.5	4	2 + 4 + 5 ÷ 3 = 3.67
59.5—64.5	5	4 + 5 + 6 ÷ 3 = 5.00
64.5—69.5	6	5 + 6 +10 ÷ 3 = 7.00
69.5—74.5	10	6 +10 + 8 ÷ 3 = 8.00
74.5—79.5	8	10 + 8 + 5 ÷ 3 = 7.67
79.5—84.5	5	8 + 5 + 6 ÷ 3 = 6.33
84.5—89.5	6	5 + 6 + 2 ÷ 3 = 4.33
89.5—94.5	2	6 + 2 + 1 ÷ 3 = 3.00
94.5—99.5	1	2 + 1 + 0 ÷ 3 = 1.00
99.5—104.5	0	1 + 0 + 0 ÷ 3 = .33

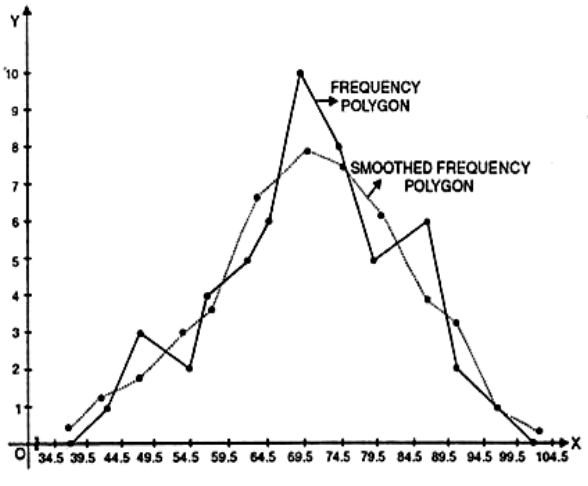

Fig. 7.4. Smoothed frequency polygon plotted from the data.

3. Ogive or Cumulative Frequency Polygon:

Ogive is a cumulative frequency graphs drawn on natural scale to determine the values of certain factors like median, Quartile, Percentile etc. In these graphs the exact limits of the class intervals are shown along the X-axis and the cumulative frequencies are shown along the Y-axis. Below are given the steps to draw an ogive.

- **Step—1:** Get the cumulative frequency by adding the frequencies cumulatively, from the lower end (to get a less than ogive) or from the upper end (to get a more than ogive).
- **Step—2:** Mark off the class intervals in the X-axis.
- **Step—3:** Represent the cumulative frequencies along the Y-axis beginning with zero at the base.
- **Step—4:** Put dots at each of the coordinating points of the upper limit and the corresponding frequencies.
- **Step—5:** Join all the dots with a line drawing smoothly. This will result in curve called ogive.

Illustration No. 7.5:
Draw an ogive from the data given below:

Marks in History	0—9	10—19	20—29	30—39	40—49	50—59	60—69	70—79	80—89	90—99
No. of Students	3	5	9	12	18	17	10	3	2	1

Solution:

To plot this graph first we have to convert, the class intervals into their exact limits. Then we have to calculate the cumulative frequencies of the distribution. Now we have to plot the cumulative frequencies in respect to their corresponding class-intervals. **Ogive plotted from the data given above:**

c.i.	f	c.f. (cumulative frequencies)
0—9.5	3	3
9.5—19.5	5	8
19.5—29.5	9	17
29.5—39.5	12	29
39.5—49.5	18	47
49.5—59.5	17	64
59.5—69.5	10	74
69.5—79.5	3	77
79.5—89.5	2	79
89.5—99.5	1	80

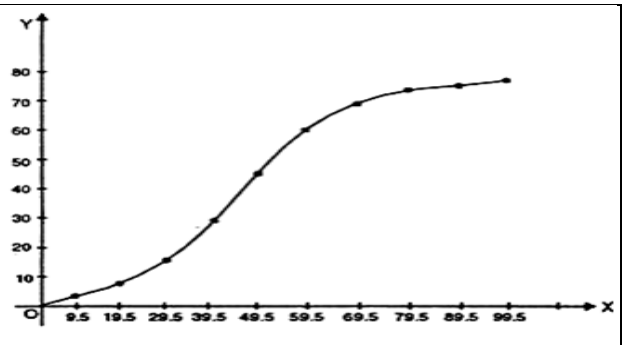

Fig. 7.5.

Uses of Ogive:

1. Ogive is useful to determine the number of students below and above a particular score.
2. When the median as a measure of central tendency is wanted.
3. When the quartiles, deciles and percentiles are wanted.
4. By plotting the scores of two groups on a same scale we can compare both the groups.

4. The Pie Diagram:

Figure given below shows the distribution of elementary pupils by their academic achievement in a school. Of the total, 60% are high achievers, 25% middle achievers and 15% low achievers. The construction of this pie diagram is quite simple. There are 360 degree in the circle. Hence, 60% of 360′ or 216° are counted off as shown in the diagram; this sector represents the proportion of high achievers students.

Ninety degrees counted off for the middle achiever students (25%) and 54 degrees for low achiever students (15%). The pie-diagram is useful when one wishes to picture proportions of the total in a striking way. Numbers of degrees may be measured off **"by eye"** or more accurately with a protractor.

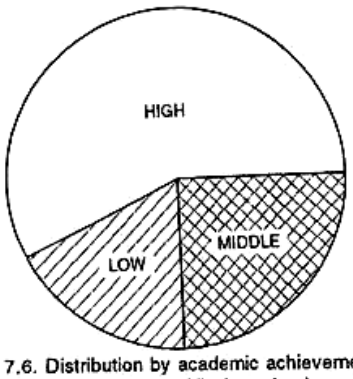

Fig. 7.6. Distribution by academic achievement of pupils in Class VI of a school.

Uses of Pie diagram:

1. Pie diagram is useful when one wants to picture proportions of the total in a striking way.
2. When a population is stratified and each strata is to be presented as a percentage at that time pie diagram is used.