

# UNIT 4 EVALUATION IN MATHEMATICS

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## Structure

- 4.1 Introduction
- 4.2 Objectives
- 4.3 Role of Evaluation in the Mathematics Classroom
  - 4.3.1 Meaning of Evaluation
  - 4.3.2 Evaluation for Improvement of Instruction
  - 4.3.3 Evaluation for Enhancement of Learning
- 4.4 Techniques of Evaluation in Mathematics
  - 4.4.1 Tests
  - 4.4.2 The Unit Test
  - 4.4.3 Planning a Unit Test
  - 4.4.4 Constructing Test Items
  - 4.4.5 Assembling, Administering and Scoring the Test
- 4.5 Use of Observational Methods
- 4.6 Let Us Sum Up
- 4.7 Unit-end Activities
- 4.8 Points for Discussion
- 4.9 Answers to Check Your Progress
- 4.10 Suggested Readings

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## 4.1 INTRODUCTION

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The word "evaluation" is generally understood as some kind of assessment which means estimating the value of something. When the term evaluation is mentioned in the context of mathematics education, the first thought may perhaps be of tests and grades. But that is not all. Evaluation is much more than just tests which are only one of the many ways of assessing pupil performance. As a student, most of you would have perhaps thought that teachers used evaluation only to find out how their students had performed. Now, as a teacher of mathematics, you will understand how evaluation helps you to improve your own performance as a teacher as well.

This unit discusses the role of evaluation in the teaching and learning of mathematics. It also presents various techniques of evaluation with suitable illustrations.

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## 4.2 OBJECTIVES

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At the end of this unit, you will be able to :

- explain the meaning of evaluation;
- illustrate the use of evaluation in improving mathematics instruction;
- infer the effect of evaluation on students;
- explain various levels of learning in mathematics;
- describe different techniques of evaluation in mathematics;
- plan a unit test in mathematics.

- illustrate various types of questions used for evaluation;
- construct essay type and objective type test items in mathematics; and
- illustrate the use of check lists and rating scales.

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## 4.3 ROLE OF EVALUATION IN THE MATHEMATICS CLASSROOM

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The term evaluation is quite frequently used in the context of teaching and learning. It has an important role to play in the mathematics classroom. Let us first try to understand what evaluation means.

### 4.3.1 Meaning of Evaluation

We, as teachers of mathematics, aim at making sure that our pupils learn mathematics and learn it well. The final test of a curriculum is its effectiveness in fostering learning. Every teacher has to find out the progress pupils have made towards accepted objectives.

How well have the pupils mastered the content and acquired necessary skills?

How well are the pupils able to explore and think and how well have they acquired the ability to solve problems?

Thus evaluation is concerned with the improvement of instruction. It involves decisions regarding the effectiveness of the total instructional programme.

What is the meaning of evaluation?

Your answers may include some or all of the following activities:

- giving tests,
- asking questions in the classroom,
- checking homework assignments, and
- organizing a quiz programme in mathematics.

All these activities are included in evaluation, but that is not all.

When we talk of evaluation in the mathematics classroom, we try to determine the amount and quality of pupil understanding and achievement in mathematics based upon clearly defined objectives. This means that a comprehensive range of objectives are evaluated rather than just the imbibing of the subject matter.

What constitutes the quality of mathematical learning?

A mathematics student is expected to learn facts, develop concepts, use symbols, master processes and procedures, learn to develop generalizations, apply mathematical ideas in real life situations, be able to reason deductively and so forth. It is likely that one student scores high marks through rote memorization while the other has acquired the ability to think and solve problems. Then who is a better learner? Obviously, the second one.

Thus, a wise teacher should evaluate the modes of learning employed by his pupils and not just what has been learnt. Modes of learning are as important as the content. High performance achieved through rote memorization is not preferred in evaluating the growth of the pupils. We use some procedures and techniques to collect data about pupil progress and growth to determine the extent to which these varied mathematical learning objectives have been achieved.

These procedures and techniques also form a part of evaluation. It will be useful to consider the distinction between evaluation and measurement. Measurement is the process of collecting data for the purpose of evaluation.

You may have thought of some or all of the following purposes or reasons of evaluation.

- to find out how much mathematics our students have learnt,
- to identify which students are weak in mathematics,
- to keep a record of their progress for reporting to the principal and to parents, and
- to recommend promotion to the next class or detention in the same class.

But this is not an exhaustive list. Evaluation not only says something about student performance, it reflects on the teaching also. Evaluation is important for both the teacher and the student. Let us find out how evaluation helps a teacher to teach better.

### 4.3.2 Evaluation for Improvement of Instruction

By now you know that before you teach you have to plan your lessons. While planning for instruction you have to keep in mind both the content as well as the students who have to learn. The students in your class are likely to have a wide range of previous knowledge and experience. They may also be operating at different levels of learning in the content you are planning to teach. For example, you want to teach applications of logarithms and one such application is simplification of exponential expressions of the type  $(ab)^n$ . You will have to assess whether your students can use a table of logarithms, recall laws of indices or solve a linear equation before you plan the learning experiences. Not only this, you will also have to assess the levels of understanding of your students. Levels of understanding are associated with structures of mathematical relationships.

For example, while solving  $(8 \times 5\frac{1}{2})^{12}$  the student who chooses  $(8 \times \frac{11}{2})^{12} = (4 \times 11)^{12} = 44^{12}$

is better than the student who solves it as  $(8)^{12} \times (5\frac{1}{2})^{12}$

The first student has a higher level of insight into the relationship than the one who sticks to the original structure. This information about the individual student will help you design meaningful learning experiences for him. The teacher should be concerned about the identification of the levels of learning of his/her students before teaching a new unit. This kind of evaluation is called **diagnostic evaluation**.

As far as planning the content is concerned, evaluation again can serve as a useful guide to you because for sequencing your content you need to know how long it takes to master a given concept, the relative ease or difficulty of tasks and the support material or teaching aids that are suitable for teaching a particular concept or topic.

During the period of instruction you need to monitor the learning progress of your students and diagnose their learning difficulties. Again you will be evaluating to get a systematic feedback about how your students are progressing with the lesson as well as about how your plans are working. This is called **formative evaluation**. You evaluate content a little more comprehensively by asking oral questions, giving classwork and using observation during the instructional phase.

After you finish teaching the unit you will be interested to determine the extent of your students' achievements and competence in the unit taught. In other words, you will evaluate their achievement. This is called **summative evaluation** and is done at the completion of a unit, term or year. It helps you to grade your students to provide data for school records as well as for reporting to parents. Again evaluation helps you to discharge your responsibility of reporting pupil progress.

Thus, you have seen how evaluation helps you to become effective at all the three stages of instruction. viz., planning, instructional and evaluative stages.

Let us try to see how evaluation helps our students.

### 4.3.3 Evaluation for Enhancement of Learning

For the student, an experience of evaluation is an exercise in learning also. For example, while a student is taking a test he has to think as well as perform operations. He/she usually experiences a feeling of concern and increased concentration. Therefore, his/her test responses are likely to be remembered longer than those given in a casual learning experience. In order to establish good records, students prepare well for their tests and besides reinforcing much of the earlier learning this exercise helps them in acquiring some new learning. A good revision for a test not only provides added practice but also a better understanding of the elements learned as well as their relationship with one another. Sometimes we evaluate students by informal methods like a quiz or an oral examination or interview. Such evaluation helps in determining a student's mental ability, his/her emotional maturity, his/her determination and background of experiences.

When students participate in scoring their own or their classmates' work, e.g., test paper, home work assignment or a scrapbook, they gain an additional learning experience. The process of discussing a class test when the test papers are finally returned gives the students an opportunity to discover their sources of error and then proceed to correct misunderstandings of facts, concepts, mathematical principles as well as errors in computations, etc. Evaluation thus has the potential to provide reteaching of weak links in the learning.

Students can also prepare items for tests or a quiz. Certainly, it will be an effective learning experience and the teacher can get information about the level of mastery of learning of individual students.

#### Check Your Progress

- Notes : a) Write your answers in the space given below.  
b) Compare your answers with those given at the end of the unit.

1. What do we evaluate?

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2. How does evaluation help in improving the quality of teaching?

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## 4.4 TECHNIQUES OF EVALUATION IN MATHEMATICS

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An evaluation programme for a mathematics course or a unit has to be planned as an integral part of the curriculum during curriculum planning. It is only after the objectives of the course or the unit are stated in terms of student behaviour and appropriate learning experiences have been designed to bring about the desired changes in behaviour that decisions about evaluation can be taken. To assess the progress of students towards the accepted goals, a variety of evaluation techniques are applied. Broadly speaking, these are classified as testing and non-testing techniques.

The most common instruments that are used for evaluating student performance in a mathematics class are tests. The majority of instructional objectives pertain to the cognitive domain and can be appropriately evaluated with the help of direct test items. For example, tests can evaluate the knowledge of basic concepts, terms, processes and relationships in mathematics, the application of mathematical knowledge and skills in problem-solving, skills of computation.

of using instruments, of drawing figures, graphs, etc., and analytical thinking as well. But there are other important aspects of mathematical learning which cannot be evaluated with the help of tests. We will talk about their assessment later in this unit. First let us know more about tests.

#### 4.4.1 Tests

You have had the experience of being given tests by your teachers. Try to think of the purposes that tests can serve. You may be thinking of some or all of the following situations for which a test could be used :

- To predict a student's likely success in a mathematics course, we administer an aptitude test in mathematics.
- To assess readiness for learning a new unit, we administer pre-tests to measure the previous knowledge and experience of the students. The pre-tests forms a prerequisite for new learning. Such tests are also called **inventories** or surveys.
- Students use self-administering practice tests to check their own progress during an instructional period.
- We administer unit tests or achievement tests to assess the attainment of specific instructional objectives at the conclusion of a unit of instruction or a course.
- We administer diagnostic tests to identify the specific operational difficulties of a student who has persistent learning problems.

For a detailed treatment of the above mentioned tests, refer to Course 4 on Evaluation and Measurement.

All these tests may be both teacher-made or published tests. Both are being used in schools and they have their own advantages and disadvantages. Published tests are prepared by experts, are usually easy to score and analyze and provide norms which help comparisons of individual and group performance at state or national levels. Teacher-made tests have certain advantages over published tests. They are constructed keeping in mind the local context of teaching-learning situation. They can be constructed to keep pace with curriculum changes and are, therefore, likely to be more up-to-date than the published ones. They are comparatively inexpensive and provide a real learning experience to the teacher who constructs them. Such tests may also provide teachers with a basis for re-evaluating their instructional objectives. Such a process invariably helps them improve their instruction. Moreover, since teachers need to test quite frequently, they will have to construct their own tests.

The most commonly used teacher-made tests are achievement tests. These include unit tests, term tests and annual tests. Since you will be conducting a unit test most frequently, we describe the procedure for constructing a unit test in mathematics.

#### 4.4.2 The Unit Test

The purpose of a unit test, administered at the end of a unit of instruction, is mainly to measure the extent to which the intended learning outcomes of the unit have been achieved. These tests can also be used for providing feedback to pupils about their learning progress and assigning remedial work. They also provide feedback to the teacher about how well the instruction of the unit has gone. Thus unit tests serve the purposes of both formative, as well as summative evaluation. In a sequential subject like mathematics these tests serve the functions of pre-tests also; for example, a unit test on percentage can serve as a pre-test for the unit on profit and loss.

The construction of a unit test involves the following steps:

- Planning the test.
- Item writing for the test.
- Assembling, administering and scoring the test.

### 4.4.3 Planning a Unit Test

While planning a unit test you will need to make decisions about the following:

- objectives of the unit,
- number of items in the test, and
- type of items to be constructed

A unit is usually a class test and the time available for such a test is limited to about 40 minutes. You may therefore cover only two or three important objectives in one unit test. Once you have decided which objectives are important for the content of the unit, list them. Thereafter, write out the behavioural specifications of these objectives in terms of student behaviour. You have learnt how to write behavioural specifications of instructional objectives in Unit 3 of this course. Once the objectives are specified in terms of student behaviour you have to decide how many questions or items you need to set for the test.

To ensure that the desired number of items are set for each objective, you must develop a table of specifications or the test blueprint. In this table, we usually write behavioural specifications horizontally to head the columns and content areas vertically to head rows. The specifications represent the number of items to be used for each objective. An example of a table of specifications is given below:

**TABLE OF SPECIFICATION  
UNIT : TRIGONOMETRY**

**CLASS : IX**

Behaviour/Content	recall	identify	change	find	verify	
Magnitude of an angle	4	4	-	-	-	8
Unit measure of an angle	2	-	4	-	-	6
Trigonometric ratios	4	-	2	-	4	10
Variations in trigonometric ratios for $0 \leq \theta \leq 90^\circ$	2	2	-	-	-	4
Trigonometric ratios of specific angles	2	2	-	4	4	12
Angles of elevation and depression	2	-	-	2	-	4
Simple cases of heights and distances	-	-	-	4	2	6
	16	8	6	10	10	50

Here, the teacher has decided to set four items for recall of facts about the magnitude of an angle, two items for a comparison of the variations of trigonometric ratios as  $\theta$  changes from  $0$  to  $90^\circ$ , four for verification of identities involving trigonometric ratios and so on. There are no set rules for determining the number of items that are enough to cover an objective but relatively more important objectives need to be covered by more items. In the illustrated table of specifications, more items, forty per cent, are set to cover the application objective because, for an elementary course on trigonometry, application is an important objective. The general rule is that the more the number of items the better the reliability of scores.

#### 4.4.4 Constructing Test Items

For constructing test items you will need to decide first what type of items to prepare. For this you will primarily be governed by the kind of student behaviour that is specified in the objectives. Let us turn to the aforementioned table of specifications. For demonstrating the achievement of the objectives of knowledge, understanding and application, the teacher expects a student to be able to do the following:

- recall, e.g., values of trigonometric ratios of specific angles, fundamental identities like  $\sin^2 \theta + \cos^2 \theta = 1$ , the definition of an angle of elevation, etc,
- identify, e.g., the position of a revolving line after tracing out a given angle, variations in the values of trigonometric ratios as  $\theta$  changes from  $0$  to  $90^\circ$  and so on;
- change, e.g., angles from degrees to minutes to seconds and vice versa or one trigonometric ratio to another and the like;
- find, e.g., values of expressions involving trigonometric ratios of  $0^\circ$ ,  $30^\circ$ ,  $45^\circ$ ,  $60^\circ$ ,  $90^\circ$ , heights and distances of inaccessible objects and so on; and
- verify, e.g., trigonometric identities, etc.

To assess the achievement of these objectives we can use either essay type items or objective type items or both. The details of the characteristics of these item types and their relative advantages and disadvantages are given in Course 4 on Evaluation and Measurement.

In a mathematics test, we use essay items only when we want to assess communication skills besides logical ability and precision in thinking. In these items students are required to select, organize and integrate information before writing out the answers as you can see in the following examples of essay items.

**Item 1 :** From an external point construct a tangent to a given circle.

This item requires the student to draw the construction, discuss the steps of construction and write out the proof.

**Item 2 :** Prove that  $\sqrt{3}$  is an irrational number.

In this item, the student is expected to show an understanding of deductive proof as well as demonstrate the skill to communicate each step logically.

**Item 3 :** A boat is being rowed away from a cliff 150 metres high. From the top of the cliff the angle of depression of the boat changes from  $60^\circ$  to  $45^\circ$  in two minutes. Find the speed of the boat.

This item requires the student to translate the given information correctly into symbolic form and then write out the solution giving the rationale for each step.

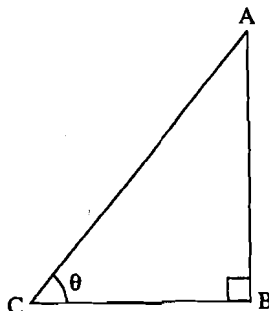
Essay items are no doubt valuable exercises for students but they consume a lot of testing time. For a unit test, therefore, we may have very few of these items if it is necessary to have them at all. Moreover, scoring of these items objectively is also difficult because there are wide variations in answers as far as accuracy and completeness are concerned.

**Objective type items :** Objective type items are used when we want to test students' knowledge and understanding of facts and relationships in mathematics. These include completion, true/false, multiple choice and matching items. Completion items are suitable for testing the recall of terms, facts and relationships as well as for computational skills. The student has to write out the answer but it has to be very short and can be a word, symbol, number or phrase. Its scoring can be fairly objective. Objective type test items are useful and convenient for unit tests. We therefore illustrate these items for the table of specifications on the trigonometry unit given earlier.

Examples of completion items:

Write the answers to the following questions 1 to 10 in the blank space provided on the right hand side of each question.

Answer questions 1 to 5 in respect of  $\Delta ABC$  given below :



1. The value of  $\cos A$  = .....
2. The value of  $\tan B$  = .....
3. The value of  $\operatorname{cosec} A$  = .....
4. The value of  $\tan A$  = .....
5. The value of  $\sin B$  = .....
6. If  $\theta$  is acute and  $\tan \theta = 5/12$  then  $\sin \theta + \cos \theta =$  .....
7. If  $\theta$  lies between  $0^\circ$  and  $90^\circ$ ,  $\sin \theta$  lies between .....
8.  $\sec 45^\circ + \operatorname{cosec} 45^\circ =$  .....
9.  $1 + \tan^2 \theta =$  .....
10. The maximum value of  $2 \sin \theta + 3 \cos \theta =$  .....

In all these items the focus is on the answer and if we want to assess the method of solution as well as the answer we use short answer items. These items can be solved in limited steps, usually three to five steps, and with a properly defined scoring procedure they can be scored quite objectively.

Examples of short answer items

Solve the following questions using the minimum number of steps.

1. If  $x = 30^\circ$  and  $y = 60^\circ$ , verify that  $\cos (x + y) = \cos x \cos y - \sin x \sin y$
2. If  $\sin \theta = p/q$  find  $\cos \theta$  in the simplest form.
3. If  $\sin \theta - \cos \theta = 1$ , find the maximum value of  $\sin \theta + \cos \theta$ .
4. A straight iron rod leaning against a vertical wall makes an angle of  $60^\circ$  with the ground at a distance of 5 m. from the wall. Find the length of the rod.
5. If  $\tan \theta = k/1$ , determine the value of

$$\frac{a \cos \theta - b \sin \theta}{a \cos \theta + b \sin \theta}$$

True/false items or alternate response items are based on statements which are either clearly true or false. Students are required to select the response from true or false, right or wrong, yes or no. These items provide students opportunities for guessing the right answer. They can, however, be scored quickly and objectively. Since they normally take little time to answer they can be used for testing a large amount of subject matter in a relatively shorter testing time.

Examples of true/false items

In the following statements 1 to 7 some are true and some false. Write 'T' against each true statement and 'F' against each false statement in the blank space provided for the answer.

1. Counter-clockwise rotation of a revolving line yields a negative angle .....



2. As  $\theta$  increases from  $0^\circ$  to  $90^\circ$ , the value of  $\cos \theta$  decreases from 1 to zero.
3. If  $\tan x = 1$ , then  $x$  is equal to  $90^\circ$  .....
4.  $\sin A + \cos B = \sin (A + B)$  .....
5. If  $\tan \theta + \cot \theta = 2$  then  $\tan^2 \theta + \cot^2 \theta = 2$  .....
6. If the length of the shadow of a pole is equal to its height then the angle of elevation of the sun is  $90^\circ$  .....
7. The angle of elevation is numerically equal to the angle of depression .....

Multiple choice items require a student to select an answer from three, four or five given response options out of which only one is the correct answer and the rest are distractors. This type of item can be used for a wide variety of objectives and can be scored quickly and objectively.

### Sample multiple choice items

In each of the questions 1 to 6 there are four possible answers marked at A, B, C and D. Only one of these answers is correct. Write the letter given against the correct answer in the bracket on the right hand side of each question.

1. A revolving line starts from OX and traces an angle of  $520^\circ$ . In which quadrant will it lie?  
(A) First, (B) Second, (C) Third, (D) Fourth ( )
2. What is  $1 - \sin^2 30^\circ$  equal to?  
(A)  $\cos^2 30^\circ$ , (B)  $\sin 60^\circ$ , (C)  $-\cos^2 60^\circ$ , (D) None of these ( )
3. When  $0^\circ < \theta < 90^\circ$  the maximum value of  $\sin \theta + \cos \theta$  is ( )  
(A)  $\frac{1}{\sqrt{2}}$ , (B) 1, (C)  $\sqrt{2}$ , (D) 2
4. Which one of following is possible? ( )  
(A)  $\sin \theta = 2\sqrt{2}$ , (B)  $\cos \theta = -2$ , (C)  $\sec \theta = 20$ , (D)  $\operatorname{cosec} \theta = 1/20$
5. If  $\tan \theta = 3/4$ , then which one of the following is true ( )  
(A)  $\sin \theta = 3$ ,  $\cos \theta = 4$   
(B)  $\sin \theta$  and  $\cos \theta$  can have many values  
(C)  $\sin \theta = 3/7$  and  $\cos \theta = 4/7$   
(D) The values of  $\sin \theta$  and  $\cos \theta$  cannot be found out from the given information.
6. A flagstaff stands on a horizontal plane and from a point on the ground at a distance of 90 metres its angle of elevation is  $45^\circ$ . The height of the flagstaff is ( )  
(A) 45 m, (B)  $\frac{90}{\sqrt{2}}$  m, (C)  $90\sqrt{2}$  m, (D) 90 m.

Matching type items, like multiple choice items, require a student to select an answer from a set of given options. To make these items effective try to make the responses as homogeneous as possible.

### Sample matching items

Match the trigonometric ratios of column I which are equal to those in column II like N - X where N = 1,2,3,4, X = A,B,C,D,E, and write the answers in the space provided on the right and side

Col. I	Col. II	Answers
1. $\tan 45^\circ$	A. $\cos 60^\circ$	
2. $\sin 30^\circ$	B. $\sec 45^\circ$	
3. $\tan 60^\circ$	C. $\cos 0^\circ$	
4. $\operatorname{cosec} 45^\circ$	D. $\cot 30^\circ$	
	E. $\sin 90^\circ$	

In column I are given statements which are true for the ranges of values of  $\theta$  given in column II. Match them like N-X, where N = 1,2,3,4, and X = A,B,C,D,E,F.

Col. I	Col. II	Answers
1. $\tan \theta \geq 1$	A. $0^\circ < \theta < 90^\circ$	
2. $0 < \sin \theta < \frac{\sqrt{2}}{2}$	B. $0^\circ \leq \theta < 90^\circ$	
3. $0 < \cos \theta \leq 1$	C. $0^\circ < \theta < 45^\circ$	
4. $\tan \theta > 0$	D. $0^\circ < \theta \leq 90^\circ$	
	E. $45^\circ \leq \theta < 90^\circ$	
	F. $\theta \geq 90^\circ$	

After having decided the number and type of items to be included in the unit test, you have to write the test items. These include some basic rules like avoiding the use of long and ambiguous statements, extraneous clues that lead to the answer, negative statements, etc.

### Check Your Progress

- Notes : a) Write your answers in the space given below.  
 b) Compare your answers with those given at the end of the unit.

3. List some of the purposes that a test can serve.

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4. Write down the important points a teacher should consider before preparing a test.

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### 4.4.5 Assembling, Administering and Scoring the Test

Once the items are prepared you have to organize them into a test in such a manner that students find it easy to understand how the questions are to be answered and where they have to record their answers. You should also be able to locate the answers and score them conveniently. For this you may find the following guidelines useful :

- Group the same type of items together, i.e., all multiple choice items at one-place; all true/false items together and do the same with short answer and matching items.
- Arrange each set of items of one type from easy to difficult, that is, among the multiple choice items the easiest item should be the first and most difficult the last. Do the same with all other types of items.
- Number all items starting from the first, i.e., 1,2,3, ..., etc., to the last item.
- Write all items legibly and avoid splitting an item on two pages, i.e., writing a part of an item in the bottom line of the page and the other part on the next page should not be done.
- Before each group of items, write simple and clear instructions for students telling them how and where to write the answer and read directions in sample items given earlier. Each set of items needs different directions.

**Administration :** It is better if you give each student a copy of the test to work on rather than make them copy the test written on the blackboard. Make sure that all the students are seated in a manner that they have reasonable elbow room and desk space and also ensure sufficient light and ventilation in the room where the test is conducted.

**Scoring the test :** Prepare an answer key for all the objective type items of the test in advance. For short answer items write out the solution steps and marking procedure for each step. For essay items also prepare model answers in advance and use the same uniformity in scoring each paper.

After the answer sheets are scored it is desirable to tabulate and analyse the scores to get information about the level of performance of the class as a whole as well as of individual students. The analysis of test results can also provide you information about the individual items, viz., their difficulty value and discrimination index, as well as the total test, viz., reliability of the test, etc.

Now let us talk about other techniques of evaluating mathematical learning besides tests.

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## 4.5 USE OF OBSERVATIONAL METHODS

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There are some important aspects of mathematical learning which cannot be evaluated with the help of tests. Try to think of such aspects and list them in your note book. You are right if you have listed the following :

- Interest in mathematical activities and computations and in reading mathematical material other than the prescribed ones.
- Curiosity about new mathematical ideas, short cuts and alternative methods of solution.
- Work habits of neatness, accuracy and speed in doing computations or drawing figures, graphs, etc.
- Appreciation of the contribution of mathematics to daily life and to civilization.

Evaluation of these behaviours is not easy because they cannot be measured by direct questions. They can, however, be assessed indirectly by using observational methods carried out both inside as well as outside the class. Mathematics teachers do observe their students at work and gain impressions like "student x likes geometry more than algebra", "student y is quite an active participant in the mathematics club", "student z works very neatly and systematically" and so forth. Such chance observations, though carried out in natural situations, suffers on two counts: one, that we remember only a part of what we happen to see by chance and, two, our own attitudes tend to influence such chance observations making them biased. You can, however, correct this bias if you do the following :

- Plan what student behaviours are to be observed and make a list of them well in advance.
- Concentrate only on one or two behaviours.
- Carefully record and summarize the observation soon after it is made.
- Observe students at scheduled times.

The observational methods that you will find useful are rating scales and check lists. For details about their use, interpretation, advantages and limitations, etc., refer to Course 4 on Evaluation and Measurement. We shall only illustrate their use here.

**Rating scales :** A rating scale consists of a set of behavioural attributes that are to be assessed and some kind of a scale indicating the degree to which each attribute is present. For example, if you want to assess the extent to which a pupil takes interest in mathematical activities, then you have to do the following :

- Write out the specific behaviours that a student should demonstrate so as to indicate his interest in mathematical activities.
- Frame items based on these behaviours for the rating scale.
- Indicate the rating categories and scale.

You can have a three-category or a five-category scale or more categories if you want finer distinctions. A five-category rating for the above mentioned scale would be, for example, never, seldom, sometimes, usually, always, where never is 1, seldom is 2, sometimes is 3, usually is 4 and always is 5. Indicate the strengths of these categories

**SAMPLE RATING SCALE**

**Directions :** Indicate the degree to which the pupil takes interest in mathematical activities by encircling one option on the right side of each item.

1. Contributes articles, games, puzzles, etc., for the wall magazine or school journal	Never	Seldom	Sometimes	always
2. Participates in activities of mathematics club	Never	Seldom	Sometimes	always
3. Uses short cuts for solving problems	Never	Seldom	Sometimes	always
4. Seeks clarification of doubts in problems attempted from sources outside the prescribed books	Never	Seldom	Sometimes	always
5. Brings applications of mathematics to class	Never	Seldom	Sometimes	always
6. Solves mathematical puzzles	Never	Seldom	Sometimes	always

**Check lists :** A check list is a simple method of recording whether a particular characteristic is present or absent. It provides only two categories, yes or no. We can use check lists to assess procedures as well as products, e.g., to assess whether a pupil is able to use geometrical instruments effectively as well as to assess whether the figure drawn is neat and accurate. Suppose we want to assess if pupils can use geometrical instruments effectively. Here also we first specify what should the student do to demonstrate effective use of geometrical instruments. List the behaviours as : selection of appropriate instruments, quick and correct use of instruments, measuring accurately, drawing neatly, putting back instruments in the geometry box.

**Directions :** Circle Yes or No to indicate whether the skill of using geometrical instruments has been demonstrated.

- |  |     |    |
|--|-----|----|
| 1. Selects appropriate instruments           | Yes | No |
| 2. Uses them correctly and with speed        | Yes | No |
| 3. Measures accurately                       | Yes | No |
| 4. Draws neatly                              | Yes | No |
| 5. Puts instruments back in the geometry box | Yes | No |

We can observe the pupils while they are doing the class assignment "construct a tangent to a given circle from a point outside it" and record entries on the check list.

Also, you can involve your students in the process of developing check lists or rating scales. A discussion with the students about what, after all, indicates interest in mathematical activities or effective use of geometrical instruments will cause them to think more of the standards they have to strive for. Their involvement in setting goals can motivate them to work harder towards the achievement of these goals.

**Check Your Progress**

- Notes :** a) Write your answers in the space given below.  
 b) Compare your answers with those given at the end of the unit.

5. Write two aspects of mathematical learning which can be evaluated only by observational methods.

.....  
 .....

6. What are the two observational methods? Specify the areas/attributes which can be evaluated by using those methods.

.....  
 .....  
 .....

**4.6 LET US SUM UP**

This unit attempted to deal with concepts pertaining to the role of evaluation in the teaching and learning of mathematics. It plays a dual role in the teaching-learning process by helping teachers to make their instruction in mathematics more effective and helping students by enhancing their mathematical learning. For measuring and judging various kinds of learning in mathematics, there are a variety of techniques and instruments. Teachers have to choose the ones that are appropriate for purposes of their evaluation. For evaluating a large number of outcomes pertaining to the cognitive domain we use tests of various kinds. The most frequently used tests are the unit tests. Teachers must acquire skill in planning unit tests, preparing test items, assembling tests and administering as well as scoring them.

For assessing interest, appreciation, work habits, etc., we use observational methods like rating scales and check lists. Whatever evaluation technique the teachers decide to use, they should involve their students in the process of developing the evaluation instruments because it will focus their attention on the qualities they have to strive for. Also, their involvement in setting goals can motivate them to work harder to achieve those goals.

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## 4.7 UNIT-END ACTIVITIES

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1.
  - a) Prepare a table of specifications for the unit "logarithms".
  - b) For a test on this unit, prepare three items each in true/false, short answer, multiple choice and matching formats. Write clear and precise directions with each type of item.
  - c) Write the scoring procedure for each one of the three short answer questions so as to make their scoring as objective as possible.
2. Obtain a teacher-made test on any unit of mathematics and write a critique of this test in terms of the guidelines provided for developing a unit test.
3. Develop a check list to evaluate a project which required students to collect independently ten samples, each illustrating the concepts of similarity and symmetry.

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## 4.8 POINTS FOR DISCUSSION

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1. Why do teachers use only tests to evaluate mathematical learning?
2. What are the advantages of using a table of specifications?
3. How do we involve students in the evaluation process?

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## 4.9 ANSWERS TO CHECK YOUR PROGRESS

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1. We evaluate :
  - a) how much mathematics our students have learnt;
  - b) whether the desired objectives have been achieved or not;
  - c) the quality of learning experiences organized; and
  - d) the effectiveness of the method used for imparting instruction.
2. Evaluation helps us in :
  - a) determining the level of learning of pupils so that proper learning experience may be created;
  - b) planning the lesson, keeping in view the levels attained by the students;
  - c) differentiating the students between weak and intelligent students, slow and fast learners, their interest in the subject.

All the above mentioned factors help us in improving the quality of teaching.

3. Tests are conducted to serve any one or several of the following purposes :
  - a) to predict a student's likely success in a mathematics course;
  - b) to measure previous knowledge before beginning a new unit;
  - c) to identify the specific difficulties of a student who has persistent problems in learning;
  - d) to assess the attainment of specific instructional objectives; and

- e) to assess the student's achievement after the completion of a unit.
4. Before preparing a test, the teacher should decide about the following important points :
- The purpose for which the test is being prepared.
  - Behavioural specifications of the objectives to be evaluated.
  - Number of items to be set for each objective.
  - Types of test items to be prepared.
  - Time specification.
  - Weightage of different test items.

In short a blueprint of the test containing the information about the above mentioned points should be prepared before writing out a test.

5. The two aspects of mathematical learning which can be evaluated only by observational methods may be :
- interest in mathematical activities ;and
  - appreciation of the contribution of mathematics to civilization.
6. The two observational methods are check lists and rating scale. The areas/attributes which can be evaluated by using these methods are :
- Check lists — Ability to use mathematical instruments effectively, neatness and accuracy in drawing figures, graphs, etc.
  - Rating scale — Contribution of articles, puzzles, etc. for the wall magazine, interest in the history of mathematics, participation in quiz contests, etc.

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#### 4.10 SUGGESTED READINGS

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Aggarwal, S. M., (1994) : *Teaching of Modern Mathematics*, Dhanpat Rai & Sons, Delhi.

Carey, L. M. (1988) : *Measuring and Evaluating School Learning*, Allyn and Bacon, Boston.

Gronlund, N. E. and Linn, R.L., (1990) : *Measuring and Evaluation in Teaching*, MacMillan, New York.