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Lesson No.

- 2.1 : Methods of Teaching: Lecture method, Lecture-cum-demonstration method, Heuristic method, Problem solving method and Unit Planning
- 2.2 : Lesson planning in Science: concept, objectives, importance and steps.
- 2.3 : Evaluation: Concept, importance and types, qualities of a good test, tools of evaluation, various types of questions and construction of an achievement test in science.
- 2.4 : Continuous and comprehensive evaluation (CCE)- Concept, merits and demerits

Department website : www.pbidde.org

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6.0 Objectives

1. Understand the methods of teaching
2. Importance of problem solving method in teaching of science
3. Use of Unit planning in teaching of science.

6.1 Introduction

Teaching was considered as an art, but as per the emerging concept of microteaching it is a very complex process and consists of many skills. In simple words, teaching constitutes a number of verbal and non-verbal teaching acts, like questioning, accepting pupils response, rewarding, smiling, nodding to pupil response, movement, gestures etc. These acts in particular combination facilitate the achievement of objectives in terms of pupil growth. A set of related teaching acts or behaviours performed with an intention to facilitate pupil's learning can be called as a teaching skill.

From the experience we feel that there is a lot of teaching in our schools, but there is a very little good teaching in our schools. The teaching of physics and chemistry at the school level suffers from many defects. The most important defect in the teaching of physics and chemistry is the obsolete methods of teaching. Kothari Education Commission reported, "If Science is poorly taught and badly learnt, it is little more than burdening the mind with dead information and it could degenerate even into a new superstition."

The above saying of Dr. D.S. Kothari remains true if we look at the present position of teaching of physics and chemistry in the schools. This is the result of traditional teaching methods followed by the teachers. Again a very little research has been done on the nature of teaching. We have not formulated the theories of teaching, laws of teaching and principles of teaching to match with various theories, laws and principles of learning.

Again a skilled teacher will not know a wide variety of methods of teaching but also know how and when to use each of these most advantageously. A teacher

should not be a slave of a particular single teaching method. He should use a variety of teaching methods according to his own abilities, interests and experiences and also that of the students working under particular circumstances. A method 'best' for one teacher and applicable for a class under same circumstances may totally be a failure for another teacher to teach the same or other class under the same or different circumstances.

A "method" is careful thought-out plan to achieve definite goals, using one or more techniques of teaching. As applied to science education, methods refer to techniques used to provide the best kind of a learning environment possible wherein the pupil's behaviour can be shaped and directed.

6.2 LECTURE METHOD

This is the method which is generally followed in colleges and in schools with big classes. In this method only the teacher talks; the students are passive listeners and they do not take any active part. Pupils listen, get bored, yawn and sometimes go to sleep as well. The teacher acts like a chatterbox, talking and talking all the time without ascertaining whether the students are following him or not. The students are spoon-fed and their powers of observation and reasoning, the exercise of which is so essential in the learning process, are not stimulated.

Perhaps this method originated in very ancient times, when printing press had not been invented and hand-written manuscripts were very few, is hardly of much use for teachers in today's class rooms.

According to L. Ghanshayam Das, "The lecture method is very attractive and easy method of teaching. It gives both teacher and pupil a great sense of satisfaction with their progress." For past several decades, this method has been vogue in the teaching of science. In those days, it was believed that teacher could impart knowledge only with the help of the text-books and by delivering lectures. Now, with the information of psychology in the field of education, this practice has been given up to some extent. It is believed that this method can be useful at the college level only. In primary, junior high school and secondary classes, this method is not very useful.

No doubt this method is very useful in completing the course of the curricula. The teacher and the taught, both may feel satisfied that they have completed the course but one lacuna remains. It is that teacher remains active in the process of education. The faculties of the pupils remain dormant. There is no scope for observing and reasoning. In science teaching observation and practical training must occupy an important place in a unit but in this method the students has no scope for learning these.

Merits

1. It is very attractive, speedy, concise and very easy to follow without much botheration on the part of the teacher and the taught. The teacher feels secure and satisfied.
2. It is economical because no laboratory is needed and one teacher can

teach a large number of students at a time.

3. Lengthy syllabi can be covered in a short time by this method.
4. Factual information and historical anecdotes can be easily imparted by this method.
5. The logical sequence of the subject matter can be easily maintained. Since the teacher has to plan the lectures in advance, there cannot be gaps or over-lapings in the development of the lesson.
6. Good lectures have high inspirational value, sometimes students pick up motivation, inspiration, instigation, zeal, ambitious ideas and do some-things creative in life.
7. It visualizes ideas which too often appear cold and impersonal when printed in the pages of books. They say, that spoken words are frequently far more effective than the printed one. While lecturing, the teacher can indicate by tones, gestures and facial expression.
8. It provides better opportunity for clarification of concepts and emphasis upon important meanings.
9. It can be adapted to the abilities, interest, previous knowledge and needs of the pupils.
10. It can be organised in accordance with the principles of educational psychology rather than the logical organisation of the text book materials.
11. Lecture serves a pattern of good oral expression, which may tend to counteract careless and incorrect speech of the pupil. Good lectures can stimulate even brighter pupils.

Demerits

1. It lays too much stress on memory work. Experimental work is neglected and the power of observation of a child is seldom exercised.
2. It does not encourage independent thinking, discovering, exploring and taking initiative. It is a type of spoon feeding and all the faculties of the child are not allowed to develop.
3. When the teacher lectures and talks there is no guarantee whether the pupils are concentrating and understanding all what the teacher is teaching.
4. The rate of imparting knowledge and information may be too rapid and the students may not get necessary connections of thought in the learning process.
5. In this method the teacher is active participant while the students are passive listeners which is opposed to the principles of psychology. The interest, aptitudes and capabilities of the pupils are ignored.
6. It does not help to inculcate scientific attitude and training in scientific

method among the pupils.

7. There is no place for 'learning by doing' in this method. The very root of science is cut when practically nothing is done, for 'science is something which must work.'
8. This method is undemocratic. Rather it is authoritarian. The pupils are encouraged to depend upon one authority i.e., the teacher. They cannot challenge or question his verdict. Obviously, to develop critical thinking and reasoning power, so essential for democratic living, is ignored altogether. For the success of lecture method, the teacher should choose occasion for his lectures with great care. It is always better to prepare a synopsis of the lecture. The teacher must be very careful about the delivery of the lecture. Lecture should often be followed by written test.

At the school stage lecture method should be used to the minimum. It can be used to motivate to clarify, to review or to expand the contents. While using this method efforts should be made to make it interesting so as to keep the students involved in the teaching-learning process.

6.3 LECTURE-CUM-DEMONSTRATION METHOD

This method combines the merits of lecture method with that of demonstration method. So it is named as Lecture-cum-demonstration method. In a lecture method the teacher merely talks whereas in a lecture-cum-demonstration method he really teaches. The teacher performs experiments before the class and meanwhile goes on asking relevant questions from the class. The students are encouraged to observe carefully, because they have to describe each and every step of the experiment accurately and draw inferences. The students are questioned and cross-examined concerning the problem in hand and their inferences are discussed in the class. Thus, unlike in a lecture, they are active participants in a demonstration and their faculties of observation and reasoning are properly exercised.

Demonstrations are useful in helping children to understand the way of doing something, such as the proper way to remove insulation from wire or how to connect two batteries in series. They are also of value in providing experiences which extend the meaning of a concept, principles, or theory. For example, a teacher helps the class to understand—Newton's third law of motion 'to every action there is an equal and opposite reaction', by having pupils observe the direction of motion of a wagon as he steps from the rear of the wagon.

In this method, the practical application of the theoretical knowledge is demonstrated. This method can very easily act as a complimentary method of lecture method. The teacher gives a demonstration and the students observe it carefully. Students are expected to be active participants in the demonstration.

This method is very useful for physics & chemistry teaching. The lecture method

without demonstration is like still picture with sound and the demonstration method without lecture a picture is motion without sound. Mere lecture would make the students passive listeners. While presenting the experiments of demonstration, new facts are also presented. In order to make this method successful, the following precautions must be taken.

1. While demonstration is going on, questions should also be posed to students. These questions help the students to understand the underlying principles.
2. While giving demonstrations, the teacher should try to illustrate the facts and the principles with the help of pictures, models, films etc.
3. The teacher should present the demonstration in a very exact lucid manner. There should be perfect accuracy in demonstration and explanations, being made by the teacher.
4. The demonstration should be bright and interesting. As far as possible attempt should be perfect accuracy.
5. Demonstration should be simple and speedy.
6. The teacher should prepare the demonstration thoroughly well. He should not come to demonstrate without thorough preparation.
7. Demonstration should be properly spaced and it should be striking clear and convincing.
8. In order to develop originality in the students, as far as possible, only the demonstrations and experiments given in the text books should not be repeated. Attempt should be made to present similar experiments.
9. The students should be made active participants in these demonstrations. They should be asked to observe the things and answer the questions.
10. Background and the class arrangements should be scientifically planned. Demonstration should be such that the students may be able to see things clearly.
11. A big black-board behind the teacher's table in class-room is essential for drawing necessary sketches and diagrams and noting readings, observations etc.

Conduct of a Demonstration Lesson

There are following six essential steps to be followed in a demonstration lesson.

1. Planning and preparation
2. Introducing the lesson
3. Teaching
4. Experiments
5. Black-Board work

6. Copying and supervision

A vast majority of the science teachers follow demonstration method. So there is a need to discuss the above six steps in detail.

I. Planning and Preparation

Demonstration method is in fact an acid of the teacher's ability and therefore he must be thoroughly prepared for it. While preparing he must bear in mind the following points.

- (a) Subject matter;
- (b) Lesson notes including the type of questions to be asked;
- (c) Rehearsal of experiments;
- (d) Collection and arrangement of apparatus required.

The teacher may be fully conversant with the topic concerned. Still it is a wise policy to go through the relevant pages of the text book of the students. This will enable him to be exact and to the point. Drawing up a lesson-plan is equally necessary and this should include a list of the principles to be explained, a list of the experiments to be demonstrated and the type of questions to be put to the students. This will make his teaching very systematic. Nothing discourages a student more than a badly prepared demonstration where nothing works. Each and every experiment, therefore, should be rehearsed under the same conditions that prevail at the time of demonstration. Rehearsal of experiments will enable the teacher to collect all the requisites for the demonstration work. But it is all the more important that each and everything is arranged on the demonstration table in a wise and proper manner for the lesson as thoroughly as a girl prepares for her wedding.

2. Introducing the lesson

It is useless to start a lesson without properly motivating and preparing the minds of the students for it. The lesson should be introduced in a problematic manner so that the students can appreciate and realise the importance of the topic in hand. For, when a teacher is able to awaken the keenness and enthusiasm of his pupils, half the game is won. Much depends upon starting a lesson in the right way. The teacher should begin the lesson with some personal experience or incidents, a simple and interesting experiment, a familiar anecdote or by telling a story. He should keep in mind the value of an interesting experiment, the experiment which will set his pupils talking in school and out of it, about the wonderful things they have seen or done in the science lesson. Not to speak of the start, it should be the constant enthusiasm of the teacher to maintain interest and enthusiasm of the pupils alive through the lesson. He should, on every suitable occasion, introduce an experiment which will arrest their attention by its striking results.

Examples

- (i) The anecdote of Guericke's experiment with hemispheres of 18 inches

radius being pulled apart by a team of sixteen horses can be related to create interest in a lesson.

- (ii) To start the topic of carbon dioxide, the teacher may open a soda water bottle in the class and ask about the visible gas coming out of that.
- (iii) To introduce various methods of transmission of heat, the teacher may bring a few toffees in the class and tell the students that he wants to distribute the toffees before starting the lesson. Let them give three possible methods of distribution in which the teacher does not move from his seat. These methods may then be related to conduction, convection and radiation.
- (iv) The story of the shepherd boy and his crook is very suitable for introducing a lesson on magnetism.
- (v) Hydrogen can be introduced by bringing two balloons of equal shape, size and colour, one filled with air and the other with hydrogen. When both are left, one goes up and the other comes down. Why?

3. Teaching

- (a) Lesson should not consist of 'dry bones' of an academic course but a breath of treatment is essential. Teaching, in fact, should be kept on as broad basis as possible. The actual lesson may be concerning some prescribed topic, but the teacher is at liberty to treat it in narrow sense or to introduce into his teaching material and illustrations from a wide field of knowledge and experience. For example, in a lesson on the principle of Archimedes, "the narrow academician" will feel content when he has demonstrated two or three experiments, the results of which prove the law. On the other hand a better teacher will describe his pupils many and varied illustrations and applications of the principle met within different phases of life. Such as ships, floating bodies, diving and rising of submarines, the use of balloons and air-ships. Even if the lesson deals with a particular branch of science, a widely read and well-informed teacher will draw illustrations from all branches of science. In addition to this wherever practicable, reference should be made to the names of great scientists and their works. The lives and achievements of great men are always sources of inspiration and an acquaintance with their early difficulties encourages the young pupils.
- (b) Teaching, as far as possible, should be through well thought out and judicious questions. The questions should be so arranged that their answers form a complete teaching unit.
- (c) For effective teaching the lesson should be properly delivered. In the delivery of a lesson the voice of the teacher plays an important role.

The teacher should speak slowly, deliberately and with correct pronunciation.

While delivering the lesson the teacher should keep an eye on each and every pupil and absent minded student should be made attentive.

4. Experimentation

The work at the demonstration table should be a model for the students to copy. An unclean and untidy demonstration will lead to bad work in the practical class. The main points about experimentation are summarised below.

- (a) The experiments must work and their results should be clear and striking. The teacher should never try to make an experiment succeed by illicit means. Every time the teacher has to say, "Well, this is what should have happened." Otherwise the confidence of the pupils is lessened in learning.
- (b) Experiments should be simple and speedy. Long drawn-out experiments with complicated apparatus defeat the purpose of demonstration.
- (c) Experiments should be well-spaced throughout the lesson. It is wrong teaching to complete all the experiments at an early part of the lesson or rushed in at the end.
- (d) Large number of experiments do not always make the topic very clear. In fact one big convincing and striking experiments is of more value than half a dozen experiments not closely related.
- (e) Reserve apparatus should always be kept near the demonstration table so that much time is not wasted in collecting the apparatus in case of breakage.
- (f) Apparatus should be arranged in an order in which experiments are to be shown.
- (g) It is a wise policy to store the demonstration apparatus intact until it is to be used again. This results in much economy of time for the busy science teacher.

5. Blackboard work

As the face is an index of mind, blackboard work is an index of teacher's ability. The writing on the blackboard should be neat, clean and legible. Blackboard is a very useful aid in demonstration lesson. It is mainly used for two purpose :

- (a) for writing important results and principles in a summarized form.
- (b) for drawing necessary sketches and diagrams.

6. Copying and supervision

The demonstration lesson will remain incomplete if the students do not copy the blackboard summary and the sketches drawn on the blackboard. A record of the blackboard is that of the student and there is no harm in copying it. The students are not mature enough to make their own notes and sketches and therefore copying of

the blackboard summary is useful for them. The teacher should go to the seats of the students and see if they are copying properly.

Check your progress

1. What do you mean by lecture method? What are the merits and demerits of lecture method?

6.4 THE HEURISTIC METHOD

Prof. Armstrong of the Imperial College, London advocated Heuristic Method half a century ago, by which the pupil was to find the answer to his problems by his own unaided efforts. When science first became a school subject, it was often taught without the laboratory practice which provides first-hand contact with concrete things. Consequently, it became a list of facts and technical terms to be memorised and discovery and experiment played little part. The Heuristic method attacked the evil boldly instead of the pupil being told everything, they were to be told nothing. The teacher was to set a problem for them in the laboratory and then stand aside while they discovered the answer. It was presumed that if knowledge is to acquire genuine meaning it must be experienced if it is to be conserved and used as a passive recipient of information he become a discover of knowledge, an active independent agent.

It is contended that acquiring of knowledge is to be a pursuit after truth, an outcome of personal experience. The purpose is to utilise the instinct of curiosity in children and prompt them to make a fact finding approach to all aspects of learning. A spirit of enquiry and adventure is to be awakened through self-observation and experimentation. The pupils are trained to discover facts, principles and laws to systematise the knowledge learnt and to arrive at generalisation, all through self-efforts. The main aim of teaching by the Heuristic method is not so much to teach facts of Physics & Chemistry, but to teach how knowledge of these may be obtained, systematised and used. In short, process is considered more important than the product.

Meaning

The term 'heuristic' has been derived from a Greek word 'heuristic; means to 'find out or discover'.

Prof. Armstrong defines it in these words : Heuristic Methods of teaching are methods which involve our placing students as possible in the attitude of the discover. "So any method which excites children to work and think for themselves can be called 'Heuristic Method'".

The method requires that the pupil should approach his scientific studies from the position and in the spirit of a research worker, for science is not a subject and the correct way of learning is by doing. Armstrong believed in doing and not in observing what was being done. So this method is opposed to the Demonstration Method in this respect.

Again to learn science is to do science is the concerned view of veteran man of science as well-known Indian educationist Dr. D.S. Kothari. He further says, there is no other way of learning science. This must be learnt at the beginning of the study of science, even at the school stage.

It may be concluded that any method is opposed to dogmatic methods of teaching in which the observing and reasoning powers are most exercised; in which the pupils work and think for themselves; in which habits of self-activity and self-dependence are fostered is called the 'Heuristic Method' of teaching.

Procedure

Each student is given a sheet of instructions and is required to perform the experiment concerning the problem in hand. The students perform the experiments following these instructions and may sometimes get a bit of guidance from the teacher. Some people are of the opinion that the students are to be told nothing. They should follow the instructions and to everything themselves. But there are situations when even a little of guidance from the teacher can do not of good.

The students are to work according to instructions, perform experiments and keep a record in their note-books. They also put down the conclusions arrived at and the bearing which these conclusions have on the problems in hand.

Regarding the selection of the problem there is a view that the problem must be suggested by the pupils themselves, as far as possible. The students cannot take a lively interest if the problems are imposed from above. For, it is demand for activity rather than receptivity, for discovery rather than dogma.

Method of training

An eminent educationist pointed out that the objective of Heuristic Method is "to make pupils more exact, more truthful observant, thoughtful, dexterous, to lay the solid foundations for future, self-education and to encourage the growth of a spirit of enquiry and research'. In their daily life, the students face so many social problems and they try to solve them by gathering information from different sources. There is no spoon-feeding on the part of the teacher and in this way the students get a training in the scientific method of attacking and solving a problem. Westway has aptly remarked." Essentially, therefore, the heuristic method is intended to provide a training in method, knowledge is secondary consideration altogether".

Again the importance of the Heuristic Method has been given as "If the Almighty were in the one hand to offer me truth and in the other search after truth I would humbly but firmly choose search after truth. "Even Huxley said, "The great end of life is not knowledge but action."

Merits

1. It develops a scientific and a critical attitude among the pupils so that they may learn how to arrive as truth and make important decisions

- through trial and error method.
2. Pupils become self-dependent, self-reliant and self-confident as they learn through self-activity.
 3. Pupils becoming attention seekers of the teacher through their activities is possible and the relation between the teacher and the taught becomes more intimate.
 4. Habits of industry and hard-work are encouraged.
 5. The facts learnt are retained for a much longer time because they are the result of child's own efforts. He learns from direct experience.
 6. It prepares the child for life by giving him training in scientific method. He can solve any social problem that may arise in his future life by attacking it scientifically.
 7. The problem of home-work is solved. The students carry out all the work in the school and if they felt it necessary to read and consult some references at home they are free to do so. The teacher has no worry to give home-work to the students.
 8. The method is based on the psychology of the child and the principle of learning. The maxim "learning by doing" forms the basis of this method.

Difficulties and demerits of Heuristic Method

In spite of the several advantages this method has also certain difficulties in it :-

1. This method presupposes a very small class and a gifted teacher. It is, therefore, not suited to our country because the number of students in each class is quite large in our country. It cannot work very well if the class is large and the teacher is not very gifted.
2. The progress is very slow when this method is employed because when we make an investigation or discovery, we take enough time. The heavy syllabi cannot be covered smoothly in due course of time.
3. Since this method takes a lot of time the teacher as well as the taught do not have the satisfaction of having accomplished something worthwhile in the given framework of existing school conditions.
4. Heuristic treatment can be applied to certain branches of science more as compared to other branches. Due to this, sometimes we find that the great stress is laid on those branches of the subject that involve measurement and quantitative work. This work is sometimes not suitable for a particular group of students or a particular branch.
5. This method sometimes leads to mechanical carrying out of the experiments. Experiments are carried out only for the sake of carrying out the experiments.
6. No text-books are available for this method. Hence students as well as

the teacher feel a sort of difficulty in adopting this method.

7. It is very costly method and it requires well-equipped laboratories and big libraries.

However, inspite of all the difficulties and drawbacks, this method is useful for the teaching of science under certain circumstances.

6.5 PROBLEM-SOLVING METHOD

Problem solving approach is meaningful, developmental and based on the discovery generalisations. It involves the thought process that results from a doubt, a perplexity or a problem. The approach leads to the formulation of generalisation that there are useful in future situations involving the solution of problems. It is an important contribution to learning and teaching.

Problem solving is characteristic of any thorough going effort at reflective thinking. Reflective thinking is regarded by many as the type of mental activity towards which all simpler types of learning lead. It is the highest form of thought. The reflective thinking is interwoven with the problem solving process of mind. This process of the mind comes into play when the learner is confronted with a real problem.

The problem solving method consists of continuous, meaningful and well-integrated activity. This method aims at presenting the knowledge to be learnt in the form of a problem, the solution of which requires activity on the part of the pupils and indirectly they also require the needed knowledge. Knowledge gained is useful and real and it comes in its natural setting in a correlated manner. Problems set to the student must be of such a nature that the students are genuinely interested to solve them.

Steps in the method

Some such steps can be followed in this method :

- (i) Sensing the problem
- (ii) Defining the problem
- (iii) Analysing the problem
- (iv) Collecting the data
- (v) Interpreting the data
- (vi) Formulating tentative solutions or hypotheses
- (vii) Selecting and testing the most likely hypotheses
- (viii) Drawing conclusions and making generalisations.
- (ix) Application of generalisation to new situations.

Essential qualities in a problem

The problems should have the following essential qualities :

1. The problems should be in line with the needs and interests of a particular group of pupils.
2. The problem should be valuable and timely.

3. The problem should impart functional and rich learning.
4. The pupils should feel that the problem is their own the teacher should motivate the pupils in such a manner as to make the pupils think out the problem for study themselves.
5. Pupils should be definite and clear about the problem, its means of execution so that unnecessary waste of time is avoided.
6. Conclusions and generalisation once found should be stated very clearly so that these can be further used in solution of new problems.

Major approaches in Problem solving

In problem solving four different approaches inductive, deductive, analytic and synthetic may be followed :-

1. Inductive Approach

Here the child is enabled to arrive at the general conclusions, establish laws or formulate generalisations through the observations of particular fact and concrete examples. A universal truth is proved by showing that if it is true for a particular case and is further true for a reasonably adequate number of cases, it is true for all such cases. The formula or generalisation is thus arrived at through a convincing process of reasoning and solving of problems, after a number of concrete cases are understood, the student can successfully attempt the generalisation. It is very suitable method for the teaching of physics since all the conclusions or principles are the result of induction. For instance, the students are conducting a number of experiments to arrive at conclusion that air carries weight. Again if we drop a piece of chalk, it falls on earth. These instances lead us to generalise that all substances are attracted by earth.

Merits of this approach

It is a scientific method and helps us to develop scientific attitudes. It is used on actual observation, thinking and experimentation, it reduces dependence on memorisation and homework. It is logical as well as psychological. There is ample scope for self-activity of the pupils. It develops self-confidence and self-reliance.

Drawbacks

It is limited in range. It contains the process of discovering the formula with the help of a sufficient number of cases, but 'what next' is not provided in it, the discovery of a formula does not complete the study of the topic. A lot of supplementary work and practice is needed to fix the topic in the mind of the learner.

Inductive reasoning is not absolutely conclusive. Three or four cases are picked up to generalise an observation. Therefore, the process establishes a certain degree of probability which can, of course be increased and made more valid by increasing the number of cases.

It is likely to be laborious and time-consuming.

2. Deductive Approach

It is the opposite of the inductive approach. Here the learner proceeds from general to particular, abstract to concrete and formula to examples. The pre-constructed formula, or definition is told to the students and they are asked to solve the relevant problem with the help of that formula. The formula or definition is accepted by the pre-established and well-established truth.

This approach too has advantages and disadvantages. It can be tried with lower classes. It saves time. The teacher feels happy and confident. After giving some scientific principles he desires students to apply them to certain situations. It is possible to cover a lengthy syllabus by applying this method. Some of its disadvantages are that it is based on already existing truths or facts and does not allow to check their tenability. It does not develop scientific attitude. It is not activity based because students do not find all the facts themselves. This approach is authoritative and not developmental. However, it is advisable that both inductive and deductive methods should be employed for effective teaching-learning.

3. Analytic Approach

Analysis means the breaking up of the problem in hand in to smaller units so that it ultimately gets connected with something obvious of already known to us. It is the process of the unfolding of the problem or conducting its operation to know its hidden aspects. We start with, what we have to find out. Then we think of further steps and possibilities which may connect the unknown with know and lead us to find out the desired result. The original meaning of analysis is to loosen or separate things that are together. About analysis Thorndike says that all the highest performance of the mind is analysis.

It is a logical method that leaves no doubt and convinces the learner. It is a suitable method for understanding and discovery. The steps in its procedure are developed in a general manner. No cramming of fixed steps and a set pattern is necessitated. Each step has its reason and justification. The students are throughout faced with questions and thus the students increase their power of critical thinking at every step.

It is a lengthy method. It is difficult to acquire efficiency and speed with this method. It may not be applicable to all topics of study equally well.

4. Synthetic Approach

It is the opposite of analytic approach. Here we proceed from known to unknown. Synthesis is to place together things that are apart. It begins from something already known and connects it with unknown part of the statement. It begins with the data available or known and connects them with the conclusion. It is the process of putting together known bits of information to reach the point where unknown information

becomes obvious and true.

The pupil taught through synthesis is just like a man being led blind-fold to the desired goal. The analysis being a lengthy method needs the help of synthesis for the removal of this defect. It will not be useful if it is not followed by synthesis. Synthesis is the complement of analysis and they should always go together. Analysis leads to synthesis and makes the purpose of analysis clear and complete.

6.6 UNIT PLANNING

A unit was considered to be block of subject-matter but the present concept of a unit includes the procedure of presentation of the subject matter also i.e., it is both block of content as well method. According to Preston, "A unit is as large of related subject-matter as can be over-viewed by the learner."

Sameford says that a unit is in "outline of carefully selected subject-matter which has been isolated because of its relationship to pupil's needs and interests."

Sometimes back the use of teaching unit was also called as 'unit method' to distinguish it from other methods of teaching but not no distinction exists between teaching unit and other methods.

The unit plan with teaching unit may include the use of other methods like laboratory, project, recitation methods etc.

Teaching unit has the following four characteristics :

1. It is an organisation of activities around a purpose.
2. It has significant content. It is comprehensive enough to have scope and unity.
3. It involves pupils in learning activities through active participation intellectually and physically.
4. It modifies the pupils' behaviour to the extent that he is able to cope with new problems and situation more competently.

Types of units

Units are of three types-subjects matters units, experience units and resource units.

When a unit is used with a subject-matter curriculum or a broad-field curriculum usually it can be labelled as subject-matter unit.

When units are used with a developmental-activity curriculum, the units are called experience units. An experience unit is what happens in the class-room. It can only be described after the fact. It is developed by an individual teacher and his students in their class-room. It utilizes the useful resources in the physical and social environment to the end that the objectives of school may achieved.

A resource unit is a collection or set of suggested objectives, teaching and learning activities, evaluating procedures, materials, references and all the other aspects of a unit that may be suggested before hand. Briefly a resource unit outlines

man's possible activities and experiences and suggests how they may be implemented and developed into productive learning experiences.

Criteria of a good unit

1. The aims should be clear and well defined. These aims in the first place, should be derived from and related to the aims of secondary education in general. Secondly, these aims or objectives should be an expression of the purposes of the over all curriculum of the particular subject or course which the students are taking.

2. A good unit incorporates a good body of instructional materials and the procedures to be adopted to carry out these activities to a successful completion and the realisation of the objectives. Some of these activities will be predetermined by the teacher. Some of them will be decided as the teacher-pupil planning takes place and some of them will emerge as the work on the unit progresses.

3. A good unit incorporates a good body of instructional materials and their sources to be used. These materials are essentially related to the aims, activities and procedures. The sources may consist of text-books, supplementary readers or reference works, news-papers, magazines, brochures, pictorial and graphic materials, films and filmstrips besides the content of the unit.

4. One of the very important elements and characteristics of a good unit is the provision of evaluation and follow-up. All the culminating activities of the unit, the partial reports and tests given at various stages are a part of the total procedure of evaluation and follow-up in a unit.

5. A good unit is 'unified' and with its emphasis on the series of related and meaningful activities, suggests wholeness in organisation. The relationship between various activities is natural and inherent.

6. A good unit provides a place of beginning and ending. This means that it starts with a definite problem situation or question. Once the problem has been solved or question has been answered, the pupil sees clearly when his goal is reached.

7. An effective teaching-learning unit is generally comprehensive. It provides learning situations which are large and unified rather than small learning situations which can be completed in a couple of class periods. A large and comprehensive unit tends to ensure unitariness in the total learning experience of the pupil.

8. As far as possible a good unit is practicable and useful for pupil attack. It is connected with the life and environment of the child and plays a vital role in his day-to-day life. If the unit is relevant to the life experiences of pupils, it becomes very practicable and easy for pupils. Therefore, it is suggested, that a good unit should take its clue from local needs.

9. An ideal unit is one which involves both teachers and pupils in its planning and development in a co-operative manner.

Following steps are involved in developing manner.

- (i) Preparation or motivation.
- (ii) Knowing the previous experiences.
- (iii) Presentation.
- (iv) Organising of learning.
- (v) Summarization.
- (vi) Review and drill.
- (vii) Evaluation.

There are two proforms for a unit planning which are given below :

PROFORMA 'A'

Subject.....

Class.....

Name of the unit.....

Major Objectives of the unit

Sr.No.	Concepts (Topics)	Number of Lessons required	Time required (period)	Scope of Subject Content	Procedure to be adopted (indicate the method of teaching)	Teaching Aids
1.						
2.						
3.						
4.						

After completing proforma 'A' detailed unit plan should be prepared according to proforma 'B'.

PROFORMA 'B'

Concepts : (From proforma (A).....

Lesson No.....

Sr.No.	Sub-Concepts	Behavioural Objectives	Procedure (Teacher Pupils activity)	Pupils Assignments	Evaluation
1.					
2.					
3.					
4.					

6.7 SUGGESTED QUESTIONS

1. Compare and contrast the lecture-cum-demonstration method with heuristic method.
2. "If the Almighty were in the one hand to offer me truth and in the other search after truth. I would humbly but firmly choose search after truth, "Explain the same and write your views on the heuristic method.
3. What is Problem-Solving Method? Discuss the various approaches in the Problem-Solving Method.
4. What do you understand by unit planning? What steps should be followed in preparing a unit plan? What are its merits and demerits?

6.8 Books for Further Study

1. Armstrong. H.E. The teaching of Scientific Method, Macmillan Co., New York.
2. Duggal, S.D. Teaching Chemistry in Indian School.
3. Heiss, E.D., Obours, E.S., Hoffman, C.W. Modern teaching, Macmillan Co., New York.
4. Kothari, D.S. Report of Education Commission 1964-66.

- 7.0 Objectives
- 7.1 Introduction
- 7.2 Advantage of Lesson Plan
- 7.3 Steps involved in a lesson plan
- 7.4 Criteria of a good lesson plan
- 7.5 Suggested Questions
- 7.6 References

7.0 Objectives

1. Understand the concept of lesson planning
2. Importance of lesson planning in teaching of science.

7.1 Introduction

In literature, one encounters many definitions of 'Lesson Plan'. Some of these are : 'A blue print', 'a creative piece of art', 'a plan or guide for action in the near future', 'a systematic and elastic approach to the development of scientific concepts and skills', etc. employed by the teacher to realize both the general and specific objectives of science teaching. We can say that a lesson plan is a teacher's own guide to control the teaching-learning process under the conditions he finds himself in. So there are as many lesson plans as there are teachers on a single topic. It hardly matters if they are either short or long ones. We can, then say that there are no such thing as the Ideal Lesson Plan. Secondly, a Lesson plan is for the personal use of the teacher and, thirdly it is as good as he can make it. Lastly, teachers should be helped to frame lesson plans, which provoke productive thought and action among students.

Cater V.Good defines a lesson plan as, "a teaching outline of the important points of a lesson arranged in order in which they are to be presented, it may include objectives, points to be asked, references to materials, assignments etc."

According to Bossing "A lesson plan is an organized statement of general and specific goals together with the specific means by which these goals are to be attained by the learner under the guidance of the teacher on a given day."

7.2 Advantages of Lesson Plan

1. Lesson plan fosters self-confidence, persistence, security and individual pride in one's work. This further reduces fatigue, fear and even strain.
2. The teacher can present material in a logical, systematic and effective way, keeping in mind, at the same time, the mental

development of those for whom he plans to teach.

3. It keeps the teacher to be systematic and orderly in the treatment of the subject matter, so he does not go haphazard.
4. It ensures suitable use of aids at the proper time.
5. It enables the teacher to know the most desirable method of teaching for that lesson.
6. It stimulates the teacher to introduce necessary questions and illustrations.
7. The student get a better understanding of the subject and from some desirable attitudes and habits which would otherwise have been impossible in the same period. Moreover, it encourages the continuity in the teaching process and needless repetition is avoided.
8. The teacher can obtain the adequate sampling of subject matter to be taught and the instructional objectives to be achieved.
9. A lesson plan provides opportunities to the teacher to experiment with his own idea. He learns to improve his professional effectiveness through well thought out and carefully conducted self-activity in which trial and error only plays a nominal role.
10. It reveals teacher's personality.

7.3 Steps involved in a Lesson Plan

Six formal steps are suggested by J.F. Herbert in lesson planning. The steps are known as Herbartian steps. They are :

1. Preparation or introduction.
2. Presentation.
3. Comparison or Association.
4. Generalisation.
5. Application.
6. Recapitulation.

Preparation

The teacher should first of all prepare the students to get new knowledge. Preparation, in fact, means the exploration of the pupil's knowledge, which leads to the aim of the lesson. The teacher should excite the students in such a way that they feel the need of learning new things.

This can be done :

- (i) By testing student's previous knowledge.
- (ii) With the use of charts, models and pictures.
- (iii) Through skilful conversation.
- (iv) By asking questions that may reveal their ignorance, arouse interest and curiosity to learn the new matter.

Presentation

The aim of lesson should be clearly stated, before the presentation of the

subject matter. The subject-matter should be presented in simple and familiar way. Both the teacher and pupils should be the active participants in the teaching-learning process. A sort of heuristic attitude should prevail in whole of the teaching process. Questions asked should be relevant, according to the mental level of students and evenly distributed. Teaching aids should be used.

Comparison

Some examples are given to the students and they are asked to compare them with other set of examples.

Generalisation

With this step, the aim of the lesson is achieved. The step involves reflective thinking because the whole knowledge learnt in presentation is to be systematised which leads to generalisation, formulas, rules etc., through comparison or association. The step completes the enquiry by providing the answer to the problems with which it began. Thus, the students get a new knowledge which is ready for use.

Application

Whatever the students learn it should be applied to new and unfamiliar situations so that there is a transfer of training and knowledge gained becomes permanent.

Recapitulation

This is the last step. The understanding and comprehension of the subject-matter taught by the teacher is tested by putting some suitable questions on the topic to the students. This helps the teacher to find out whether his method of teaching is effective or not along with finding out the deficient areas in learning. Through the successive lesson plans, the teachers enables the students to move from 'simple to complex', 'concrete to abstract' and 'understanding to reflective' 'levels' in teaching-learning process.

7.4 Criteria of a Good Lesson Plan

1. Lesson Plan should be written and well prepared assuming that teacher has gone through the matter from all aspects.
2. Objectives of the lesson plan—general as well as specific—should be very clear.
3. Teaching aids should be used at the proper time.
4. Physical conditions should be checked by the teacher, seating arrangement, chalk, duster etc. should be well-planned.
5. Previous knowledge should be tested to arouse the curiosity of students.
6. A good lesson plan should reveal the type of activities to be undertaken.
7. There should be active participation of the students while doing demonstrations.
8. Black Board work should be clearly shown.
9. Questions should be well-planned and in clear familiar language.

10. There should be provision for individual attention also.
11. There should be occasional recapitulation to check the student understanding of the subject matter explained.

Sample Performa for Lesson Plan

Lesson Plan No. 1

Chemistry

Date..... P.T.Roll No.....
 Class..... Section.....
 Av.Age of the pupils.....
 Duration of period.....
 Subject..... Chemistry.....

Topic : Solution and its Properties

- Class-room Equipment : Black-board, chalk, duster etc.
- Illustrative aids : CuSO₄, sugar, Filter paper, Funnel, Tripot Stand, Beaker Spirit lamp, Common Salt, BaCl₂, Test Tubes, Wire Gaze, glass rod etc.
- General Aims : 1. To inculcate scientific attitude among the students.
 2. To develop the habit of keen observation and clear thinking among the students.
- Specific Aims : To enable the students to understand the solution and its properties.
- P.K. Assumed : It is assumed that students know about mixture and compounds.
- P.K. Testing : In order to test the previous knowledge of the students the P.T. will ask the following questions :
 1. What is this?
 2. What is its taste?
 3. What is formed when when you mix sugar in tea?
 4. What will you call this mixture?
- Announcement of the Topic** : The P.T. will announce the topic by saying, "Well students today we well study the topic- solutions and its properties.
- Presentation : The Lesson will be developed with the active participation of the students.

Subject matter	Pupil-Teacher Activity	Student's Activity	B.B Summary
<p>When a sugar is dissolved in water a solution of sugar and water is formed. The dissolved sugar is called the solute and water is called the solvent.</p> <p>The clear uniform, homogeneous mixture obtained after dissolving a solute into the solvent is called solution.</p> <p>Properties of Solution</p> <p>1. The properties and composition of every part of the solution is the same.</p>	<p>The P.T. will ask the student to prepare the solution of sugar in water and will ask the following questions: -</p> <ol style="list-style-type: none"> 1. What has been formed? 2. What is sugar in the case? 3. What is water? 4. How will you define a solution? <p>The P.T. will ask three students to divide the solution into three parts and taste them</p> <ol style="list-style-type: none"> 1. What differences do you find in taste? Another student will be asked to prepare the solution of Cu, SO₄ and divide its into two parts. 2. What is the change in colour. Then a students will be asked to add BaCl₂ sol. in both test tubes 1. What has formed in both the test tubes? 	<p>Students will do as asked by teacher.</p> <p>Students will answer these questions.</p>	<p>Sugar solution is formed when sugar is dissolved in water. Sugar = Solute Water = solvent.</p> <p>The Clear uniform, homogeneous mixture obtained after dissolving a solute into a solvent is called a solution.</p> <p>Properties and Composition of each part remain the same.</p>

	<p>2. What does this experiment show?</p>		
<p>2. It is impossible to detect the solute particles in a solution and they can not be seen with lens.</p>	<p>The P.T. will ask one student to dissolve common salt in water and will ask; can you see the solute particles in a solution?</p>	<p>Students will do as asked by teacher.</p>	<p>It is impossible to detect solute particles in solution even with a lens.</p>
<p>3. A solution retains the properties of a solute.</p>	<p>1. What is the taste of solution? 2. What is sweet solute or solvent?</p>	<p>Students will answer these questions. Students will do as asked by teacher.</p>	<p>Solution-sweet; Sweet is the property of solute (Sugar)?</p>
<p>4. A solute can not be filtered off-but can be recovered by heating.</p>	<p>A student will be asked to filter the solution of common salt and P.T. will ask; What do you see on filter paper? Another student will be asked to heat that solution on spirit lamp. What do you see in the china dish?</p>	<p>Students will answer these questions.</p>	<p>A solute can not be filtered off. Solute particles can be recovered by heating.</p>
<p>5. In solution the solute can be dissolved to a certain limit.</p>	<p>A student will be asked to dissolve sugar in water till a stage is reached when no more of the solute is dissolved. What do you conclude from this?</p>	<p>Students will do as asked by teacher.</p>	<p>In a solution solute can be dissolved to a certain limit.</p>

Recapitulation:

1. What is solute?
2. What is solvent?
3. What are the properties of a solution?

Home Work :

What do you understand by solution? Describe its properties.

7.5 Suggested Questions

1. What are the advantages of preparing the lesson plan? Draw up a lesson plan for class on any topic of physics, which is included in the syllabus.
2. Write a lesson plan for a period of 40 minutes (for high class) on Acids bases and salts.

7.6 References

1. Siddiqi & Siddiqi. Teaching of Science Today & Tomorrow.
2. R.C. Sharma, Modern Science Teaching.
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4. Vaidya Narinder The Impact Science Teaching.
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6. Richardson, Johns. Science Teaching in Secondary School.

**Concept of Evaluation, importance, types,
Qualities of a good test, Tools of evaluation,
Various types of Questions and Construction
of an achievement test in Science**

LESSON NO. 2.3**AUTHOR : DR. S.K. BAWA**

- 8.0 Objectives
- 8.1 Concept
- 8.2 Importance of Evaluation
- 8.3 Defects in the present system of examination
- 8.4 Suggestions to improve the system
- 8.5 New Concept
- 8.6 Types of Evaluation
- 8.7 Technique of Evaluation
- 8.8 Criteria of a good test
- 8.9 Types of questions
- 8.10 Construction and Standardization of an achievement test in Science.

8.0 Objectives

1. Understand the concept of evaluation
2. Understand the tools of evaluation
3. Know the different types of tests and their importance.

8.1 The Concept

Evaluation of the progress made by the students is one of the very difficult tasks. It means to determine the value of something with regard to students' performance. It is a process that demands resourcefulness, ingenuity and ability to measure objectivity on the part of the teacher. Evaluation does not mean only assigning scores to students but it also required gathering and weighting evidence which will reveal changes in the behaviour of the pupils as they progress. Therefore, evaluation is a continuous process which takes place in the school, outside the school and involves teachers, pupils and community as well.

Evaluation is the process of judging the worth of learning outcome as a result of teaching-learning process. A teacher should know the drawbacks of his teaching and students should also know their weaknesses and try to improve them. Evaluation helps the teacher in diagnosing pupil's difficulties, their potentialities and interests in every sphere of life. It also provides information which is required for effective guidance programme. Evaluation of teaching-learning process includes day-to-day progress of students in school or outside school, his growth towards the desirable goal and given the information to know the present status of the students.

8.2 Importance of Evaluation

Evaluation not only aims at knowing the achievement but also helps in improving the curriculum and method of teaching. It is a dynamic method and changes according to the needs of the individual and society. Education is a process of growth and development and its aims change from time to time. Therefore, the techniques of evaluation also change to improve the whole process of education. The purposes of evaluation are-

1. To judge the effectiveness of teaching techniques

Evaluation helps in knowing the effectiveness of teaching techniques in terms of objectives

of teaching. If found ineffective, these can be modified to help in achieving the objectives.

2. Soundness of teaching material

The purpose of evaluation is to find out the psychological and logical soundness of the material to be taught. It is essential that the curriculum should be dynamic and broadbased and should be modified according to changing objectives.

3. Prediction of Success

Evaluation helps in testing the alround development of the child and in predicting the future success of the students in a particular field. It serves both diagnostic and prognostic purposes and serves as basis of guidance to teacher and taught.

4. Modification of tools and techniques

The different tools and techniques should not be static. These should be modified in the light of the changing aims and objectives of education and should be improved from time to time. Therefore, the purpose of evaluation is also to modify and improve different tools and techniques of evaluation.

5. To measure the objectives

To test the genuineness of objectives and help in their modification, evaluation is important. If the objectives are not achieved, it tries to find out the reasons for that. It may also help to know that the objectives are ambitious or below the standard. Therefore, to modify them in the light of needs of the individual and society, evaluation is necessary.

6. The Teaching Process

It includes assessment of the effectiveness of methodology of teaching, different teaching methods used by the teachers and use of models of teaching etc.

7. Learning Process

It means assessing the quality of learning environment, diagnosing the causes in the learning process as well as determining the need for remedial work.

8. The Curriculum

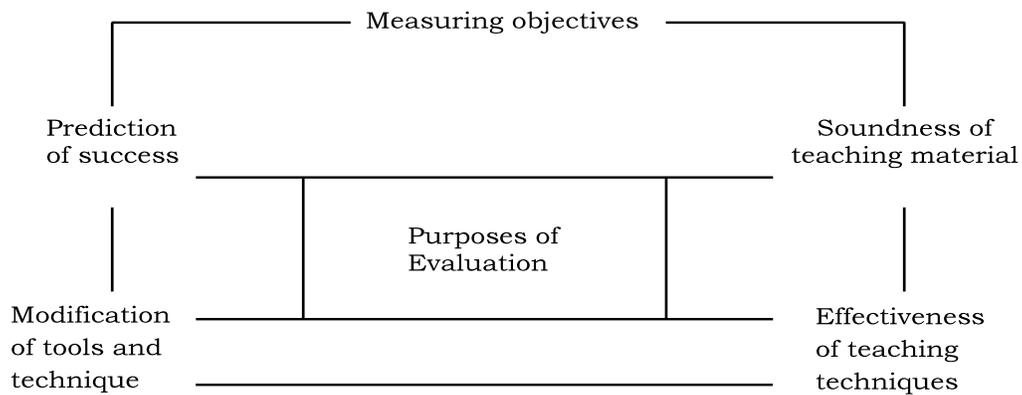
It includes improvement in curricular and co-curricular activities.

9. Society

It involves assessing the requirements of a particular society, resources of the society, contribution of parents and other systems in the field of education.

Every system of a society has its own purposes and objectives of evaluation. These may vary with the changing needs of every society.

All the purposes of evaluation are important and are interrelated. They can be shown by the following diagram.



8.3 Defects in the present system of Examination

Examination system is part and parcel of every system of education. To know the achievement of the students, to motivate them, to know the effectiveness of curriculum and method of teaching, examinations are conducted. Earlier, only essay-type examinations were commonly in use with the changing pattern in education system and looking into defects in essay-type examinations, short answers questions and objective type items were also included. Even then, looking into the present system of education, there are many defects in examination system, which are as

1. Invalid : A test is valid when it measures what it claims to measure. But in the present system of examination the tests are mostly invalid.

2. Unreliable : Most of the tests in the present system of examination are unreliable. They do not measure accurately for which they are prepared.

3. Subjectivity : It means personal bias of the examiners. When the same paper is checked by different examiners, the marks vary to a large extent. Even if same examiner checks the same paper at different times, the marks vary many a times.

4. Much Emphasis on Rote Learning : Reflective thinking is not examined but the memory work is encouraged much.

5. Quantitative Assessment : These examinations take an account of quantitative assessment of students rather than their qualitative assessment of daily routine work.

6. Not Comprehensive : They do not cover whole syllabus but a part only so students are not encouraged to study the whole syllabus with full comprehension.

7. Theoretical : They are theoretical in nature and are far away from the realities of practical life. It means they do not cover the realities of societal life.

8. Not Related to Objectives : They do not assess the scientific attitudes, resourcefulness, creativity and other qualities which are necessary for a balanced personality. The objectives of biology focus on development of the abilities of thinking, reasoning, observation and critical analysis. But these tests do not take into account the fulfilment of these objectives.

According to Dr. Bloom "India's Education system consisting of examinations, curricula, text books and methods of teaching, has formed a conspiracy wherein every body concerned with education has come to believe that learning is to be equated with rote memorisation."

8.4 Suggestions to Improve the System

1. Efforts should be made minimize the external examinations and replace

- them with continuous and comprehensive assessment by the teachers.
2. Efforts should be directed to make the system objective part of the examiners.
 3. Introduction of grading system in place of marking.
 4. Use of system of examination to improve the achievement rather than mere assessment of pupils.
 5. Monitoring of the standard of examinations throughout the country through a regular review of testing materials and procedures in different states.
 6. Development of question banks in all subjects starting from the secondary level.

8.5 New Concept

According to the new concept there is a lot of difference between examination and evaluation. Evaluation is wider term as compared to examination and measurement. The former assesses all the dimensions of personality of learners. Evaluation is a continuous and comprehensive process that takes place in the school, outside the school and involves the participation of the pupils, teachers, parents and other community members to make improvements in the intellectual, social and emotional development of child and whole educational process. So evaluation is integrated with the whole process of education. It brings out the factors that are inherent in student' growth such as proper attitude and habit, manipulative skills, appreciations and understanding in addition to conventional acquisition of knowledge. It makes an assessment of every pupil's day-to-day progress in all spheres. In this way pupils come to know their drawbacks at an early stage so they can improve. On the basis of pupil's daily records it becomes easy to know the present status of every student and his development towards the desirable goal.

Evaluation aims at knowing the achievement as well as help in improving the curriculum and methods of teaching also. It tests the genuineness of objectives and also provides directions to modify these objectives according to the changing needs of the individual and society. It helps in judging the effectiveness of curricular and co-curricular activities according to needs, interests and attitudes of the students. As it can predict the future success of the students in a particular field so it serves as a basis for guidance to the teacher and learners. It also helps in the improvement and modification of the evaluation tools and techniques. Thus, we can say evaluation aims at appraising and appreciating all the dimensions of the child's personality.

In life science, evaluation of the students regarding their achievement include learning outcomes in different fields. Some of these are as follows :

- (i) Knowledge and comprehension of terms, facts, concepts and formulae used in biology;
- (ii) Application of theoretical knowledge gained of biology subject practical situation.
- (iii) Development of skills of manipulation, dissection, observation and drawing.
- (iv) Modification in techniques of collection, culturing, preservation and preparations of different microscopic slides.
- (v) Inculcation of the interest in plants, animals and their environmental conditions;
- (vi) Understanding of biological phenomenon and analysis of different situations.

8.6 Types of Evaluation

Evaluations may be diagnostic, formative or summative type depending upon its purposes.

1. Diagnostic Evaluation :

It means to diagnose the weaknesses in the beginning stage of the teaching-learning process in a biology class and also to find out particular strengths. From the results of this diagnosis modifications can be made in curricular as well as co-curricular programmes according to the capabilities, interests and attitudes of the learners and also to provide remedial/curricular enrichment programme to enhance learning level of students.

2. Formative Evaluation :

Its function is to collect data about educational programmes while they are still being developed. The evaluative data can be used by developers to form and modify the programmes. In some cases the evaluation findings may lead to a decision to abort further development so that resources are not wasted on a programme because of the weakness found out at an earlier stage. Formative data tend to be collected through observation questionnaire and interview schedule.

3. Summative Evaluation

It is conducted to determine how worthwhile the final programme is, especially in comparison with other competing programmes, Summative data tend to be collected with standardized instruments having validity and reliability. Research control and generalizability of results are built into the design of the summative evaluation study. The results of summative evaluation can be useful to educators who must make adoption of decisions concerning particular programmes in the particular subject. Cumulative assessments where they are undertaken for the purposes of selection, promotion, prediction, recording and

such other administrative purposes, should be considered as a series of summative evaluation. Maintaining a progress report in the biology subject is an example of summative evaluation which gives students an overall indication of how well students have performed in the biology.

8.7 Techniques of Evaluation

In the subject of biology different techniques may be used to evaluate pupils' performance. Some of these may be as follows :-

1. Use of Different Diagnostic and Formative Tests :

Different types of tests may be used to evaluate the students' learning performance in a periodically continuous manner during academic session.

(a) Achievement Tests

It includes essay type, short answer type, objective type tests for terminal assessment of student's performance.

(b) Personality Tests

Personality can be assessed through subjective, objective and projective techniques.

(c) Intelligence Tests

It can be tested by individual or group tests of intelligence or one can say intelligence can be tested through verbal tests as well as non-verbal.

(d) Aptitude Tests

It includes tests of vision, hearing and mechanical aptitude test etc.

(e) Interest inventories

Interest inventories are used to test the interest of students in collection, preservation, dissection of plants, animals and specimen, culturing and mounting the pictures in the subject of biology.

(f) Counselling Interview

This is the face-to-face relationship between the teacher and the pupils to understand their problems in learning process. For good result it may be held in biology laboratory.

(g) Teacher's Observation

It includes teacher's day-to-day observation in the period of theory and practical of biology as well as in the library, playground and outside the school.

(h) Records

Biology teacher may have cumulative records, anecdotal records and case-histories of his students to have overall assessment of students in school.

Biology teacher can evaluate his pupils by using above mentioned tests and procedures of assessing pupils' performance. The detailed description of these evaluation techniques may be studied by consulting any book of educational psychology.

8.7.1 Tools of Evaluation

For the purpose of proper evaluation no single test or tool is sufficient. There are a number of tools or tests or techniques for evaluation being used depending upon the purpose or need of evaluation. These are given below :

1. Tests
2. Questionnaire
3. Observation
4. Interview
5. Cumulative Record Cards
6. Case Study
7. Rating Scales.

1. Tests

The various types of tests can be used for evaluation which are classified according to their forms, function and of administration. These are :

(a) Educational tests

To measure the results or effects of learning or teaching instruction, such tests are used e.g. Achievement tests.

(b) Diagnostic tests

To inquire the nature of problems or difficulties of students such tests are used. Achievement tests are also used as diagnostic tests.

(c) Psychological tests

To measure inborn abilities or different aspects of behaviour these tests are used e.g.

1. Intelligence tests
2. Aptitude tests
3. Personality inventories
4. Interest inventories
5. Tests of emotional adjustment etc.

1. Power and Speed Tests

Power test is the one in which items are arranged from easy to difficult and test is given as much time as one requires to answer all the items.

Speed test has almost all the items of same difficulty level but tests has limited time to answer all the items.

2. Verbal, Non-verbal and performance tests

Verbal tests may be oral or may require identification of physical objects and material presented.

In non-verbal tests pupils do not use the words in attaching meaning to or in responding to test times. These tests involve only the use of numbers, graphical representations or three-dimensional objects and other such material. Performance

tests are also non-verbal but they may require use of pencil and paper in responding. Such tests are used with persons having serious languages handicaps and where certain skills are of greater importance than verbal ability.

3. Omnibus and sub-test form

The omnibus form is that in which tested proceed through the test to time limit set for the whole test. Such test form is divided in smaller tests in which each sub-test has its own time limit and items of which are separately arranged in order of difficulty.

Tests according to administration are given as under :

Individual and group test

Individual tests are administered only to one person at a time e.g., individual intelligence test, whereas group tests are administered to many persons at a time e.g. achievement tests and group intelligence tests.

2. Questionnaire

Questionnaire is one of commonly used devices for evaluation. It consists of several questions of which respondent writes the answer. It is a simple device and requires good deal of training for preparing a good questionnaire.

1. It should be used when a large number of students are to be evaluated.
2. The questionnaire should have a definite purpose.
3. Due care should be taken to prepare a right type of questions for a questionnaire e.g. words like usually, properly, frequency should be avoided. Double negative should not be used. Double barrelled questions should be avoided. The question should be appropriate for all the respondents etc.
4. The format of the questionnaire should be given due consideration.
5. The questionnaire should be administered properly.
6. The respondents should be taken into confidence to given honest and reliable responses.

There are two types of questionnaires :

- (i) Closed form-where the answer is restricted to yes or no or a structured response.
- (ii) Open form-where respondent is free to write the detailed answer as he desires.

The questionnaire may have both types of questions depending upon the need of it.

3. Observation

Observation is a data gathering device which is handy for the teacher and the evaluator.

This can be used for evaluating human behaviour, but it requires the observational techniques which permits the data collection without disturbing the normal activities of groups or individual being observed. Two or more teachers should observe the same behaviour independently. Recording should be done simultaneously. The teacher try to write the observation objectively.

4. Interview

Interview is a useful device for collection of the required data. The difference between questionnaire and interview is only that the response is in written form in questionnaire and verbal in interview. The advantage of the interview is that many people don't like to give response in written form. Secondly, external observation while giving interview also adds to collection of data. Thirdly interview allows greater flexibility of clarification of the questions and follow-ups from the interview. In case the problem detailed information then, too interview is a suitable device.

There are two types of interview (i) structured and (ii) unstructured, when an interview schedule is prepared to ask the questions from the interviewer it is a structured interview (ii) when the conditions are least controlled and there is flexibility and informality then it is unstructured interview.

The limitations of this type of device is that it is time consuming and involves bias of interviewer. It can also affect the result of the problem.

5. Cumulative record cards

To know the pupil's interests, hobbies, personality traits and other activities in which he participates, a record is needed which can be maintained by the teachers. For proper evaluation of the progress of the students such cards are prepared.

6. Case study

For diagnosing and finding a solution of the problem, for evaluation, guidance and interpreting conduct of the individual, a case study is prepared. During preparation of the case study, many data gathering devices discussed above can be used, e.g. in schools, case studies can be prepared of backward children, low achievers or problems children etc.

8.8 Criteria of a good test

The purpose of testing is to obtain the accurate and relevant data necessary to make important decisions with the least amount of error. Tests can be used to make decisions related to selection, placement, remediation, feedback, motivation, programme improvement, theory development etc. But according to educationists and researchers, a good test should be-

(i) Reliable

It should rate the same student at the same score even if it is examined by the same or different examiners at the same or different times. The difference in scores should be negligible. It means that test should measures as accurately as possible.

(ii) Valid

A valid test measures what it is supposed to measure. A test of science meant for measuring scientific knowledge should only measure knowledge of science and not language or mathematical skills.

(iii) Objective

The test should yield the same or nearly the same results irrespective of the person who scores it.

(iv) Practicable

The test should be neither too long nor too short. It should keep the students busy all the time which is sound from disciplinary and administrative point of view.

(v) Scoreable

The test should have less boredom caused by the routine of scoring. It should have the provision to check it without subjectivity. It should save time and simplify the work of the teacher.

(vi) Clear

The test should be so constructed that the students should not suffer due to misunderstanding of directions. Therefore, the language of the questions should be simple, under-standable, definite and unambiguous.

(vii) Comprehensive

The test should cover the whole syllabus. Each topic should be given due importance and minimum choice should be given. The test should cover all the educational objectives.

(viii) Graded

The test should be prepared according to the age and intelligence of the students.

(ix) Interesting

The test should be interesting so that the students are able to put forth their efforts in a congenial environment.

(x) Due Weightage to Different Types of Questions

Due weightage should be given to short answer, objectives type and essay type questions to provide variety of questions in the test by making an effort to cover the whole syllabus.

(xi) Emphasis on Reflective Thinking

The test should be so constructed that it encourages reflective thinking and not mere reproduction of what the student has learnt. It should also test knowledge, application and creativity of the student.

8.9 Types of questions

For evaluation in science achievement different types of questions can be used. These are discussed below :

1. Essay type questions
2. Objectives type questions

(a) Recognition type

- (i) Multiple choice
- (ii) Alternative response
- (iii) Matching
- (iv) Classification

(b) Re-call type

- (i) Simple re-call
- (ii) Competition

Essay type Questions

Essay type Questions are used to rank the students in their achievements, to discover the difficulties, to assess the effectiveness of a particular teaching procedure and to arouse an interest for stimulating pupils to work. But there are some limitations in using such type of questions i.e. (i) rote memorization, (ii) unreliability of written examinations, (iii) lack of validity in essay type tests and examinations, (iv) bluffing factor, (v) the whole syllabus is not covered, (vi) lack of objectivity. The advantages of using such questions are (i) ease of construction and administration, (ii) Measurement of higher mental abilities and (iii) adaptability to school subjects, (iv) writing skill is measured.

Objective type questions

The main types of objective type questions commonly used are :

1. Recognition Type

(a) Multiple choice

It consists of question or incomplete statement followed by several possible answers.

It has four kinds :

1. One right answer
2. One best answer
3. Analogy type
4. Reverse multiple choice.

(b) Alternative response or true-false

The true-false items consist of a declaratory statement or a situation that is either true or false. These are of two types :

1. Regular true false-the simple statements which are either true or false.
2. Modified true false-the statements which are to be modified in either

the true or false form.

Matching type

This type of item requires the matching of two or more sets of material in accordance with given directions.

Classification type

In such items the students are to classify the items by recognition from a group of similar items.

Recall type

The cases where the students give response in their own words or groups of words directly are recall type questions such as :

1. Simple recall-Which type of balance is used for measuring the mass of a body.....
2. Completion recall-Plants take in..... and give out.....during night.

8.10 Construction and standardization of an achievement test in Science

The construction of a standardised achievement test consists of the following steps (i) Determining test rationale and objectives (ii) writing test items that meet these objectives (iii) analysing items (iv) constructing final form the test and (v) standardising the final form.

The first step is to develop a test rationale and measurable objectives e.g. in science test rationale and objective can be to develop scientific attitude and scientific thinking. Specifically, the knowledge of the topics which are to be covered in each sub-test e.g. in physics if the subject matter is to have the knowledge of matter, heat, electricity, force etc. This content can be included in each sub-test keeping in mind the educational objectives and the aims of teaching science.

Writing the test items

Item writing for standardised achievement tests is usually a co-operative effort of subject matter specialists and resting experts. With their help 20 to 50 percent items more than required for the final form are collected. All items are administered to the students to estimate difficulty levels-adequacy of time requirement and the functional value of each option given in the test items. All items are then revised again until appeared clear, unambiguous and justifiable.

Analysing items

The items are analysed on small groups of students to measure their effectiveness. Then items analysis is done for students of each level.

Constructing the final form

Constructing of final form is a compromise between item sampling and administrative convenience. The time allotment to the test is decided according to

the number of items and their difficulty level, irrelevant items are deleted and all other items are given the final shape.

Standardizing the final form of test

To standardise the final form again a bigger sample is selected from the same level of students. Norms are also decided and final form of test is again administered to find out the reliability and validity of the test. There are four methods of testing reliability (i) Test-retest, (ii) parallel form, (iii) split-half method and (iv) rational equivalence.

Mostly standardised achievements tests use such norms as percentiles, standard scores, grade, quotients of standard scores. In recent years only percentiles and standard scores are being used as norms.

Use

1. Selection and placement

Achievement tests can be used either as predictors or criteria. As predictors, they serve as aptitudes tests but they may be less-efficient than scholastic aptitudes tests because they contain more sub-tests.

2. Diagnosis

Achievement test can be used for diagnosis but for more accuracy additional items on a specific topic required.

3. Feedback

Percentile or standard scores will have to be interpreted to parents and students. But percentiles are easier to understand to know their performance.

4. Programme Evaluation

Standardised achievement tests can be used for formative and summative evaluation provided that the programme's objectives are comparable to the types of items contained in the test.

8.12 SUGGESTED QUESTIONS

1. Discuss the various types of evaluation tools.
2. Discuss different types of questions used in tests.
3. How will you construct and standardize an achievement test?
4. Discuss the concept of continuous and comprehensive evaluation in detail.

8.13 REFERENCES

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