

---

# UNIT I NATURE AND SCOPE OF SCIENCE

---

*Nature and Scope of  
Science*

## **Structure**

- 1.1 Introduction
- 1.2 Objectives
- 1.3 Nature and Scope of Science
  - 1.3.1 Meaning and definition of science
  - 1.3.2 Nature of Science
  - 1.3.3 Scope of Science
- 1.4 Science as a Process and Product
  - 1.4.1 Science as a Process
  - 1.4.2 Science as a Product
- 1.5 Science as a Body of Knowledge
  - 1.5.1 Science as a way of Investigation
  - 1.5.2 Science as a Way of Thinking
- 1.6 Inter-Disciplinary Approach
  - 1.6.1 Relationship Between Science and Other Subjects
  - 1.6.2 Relationship of Science Subjects with one another
  - 1.6.3 Relationship of General Science with other subjects
  - 1.6.4 Advantages for Implications
- 1.7 Globalization and Science
  - 1.7.1 Role of Teacher in Globalization
- 1.8 Let Us Sum Up
- 1.9 Unit- End- Exercises
- 1.10 Answer to check your Progress
- 1.11 Suggested Reading

## **NOTES**

---

## **1.1 INTRODUCTION**

---

The progress and prosperity of a country depends upon the quality of its citizens. The critical measure of the quality of its citizens is the quality of education. Education is rightly held, the key to the economic development of a nation. No investment is likely to yield greater returns than the investment on human resources. If this is to happen, then it is necessary that a system is put in place which will help the festering of talented individuals and the maximum utilization of their potentials for the economic prosperity of the nation. The economic prosperity and development of a society is based on science and

technology and its impact on society. Science and technology contribute solutions to the problems of the country by developing desirable understanding of attitudes, skills and abilities. The role of teaching-learning science is of utmost importance in the process of development a transformation of society.

## NOTES

To achieve the goals of Education **Dr. AR. Saravanakumar (2006)** research study emphasized that science education involves all types of experiences both in the school and outside. The objectives of science teaching are to build up scientific precision, scientific attitudes and science process skills like measurement, observation and so on. Science is one of the human activities that man has created to gratify certain human needs and desires. Science has become one of the compulsory subjects in the school curriculum because of its following multifarious values.

1. Intellectual value
2. Vocational Value
3. Moral value
4. Utilitarian value
5. Cultural Value
6. Aesthetic Value
7. Inculcation of scientific attitude and
8. Psychological Value

The skills and processes of science education are therefore a central issue for all those with an interest in science education.

---

## 1.2 OBJECTIVES

---

After studying this unit, you will be able to:

- Know the nature and scope of science.
- Distinguish science as a process and product
- Identify the inter-disciplinary approach.
- Learn and understand the new development and implication.
- Know the meaning of Globalization and science.

---

## 1.3 NATURE AND SCOPE OF SCIENCE

---

### NOTES

We can do no better than quote Gandhi: “True education is that which draws out and stimulates the spiritual, intellectual and physical factors of the children”. Implicit in this aim is the belief that education has the potential to transform individuals and societies. What then are we looking for, as we particularize our thoughts on science education? Clearly, any discussion of the aims of science education presupposes a view of science. Before we dwell on science education, we must, therefore, briefly comment on the nature and scope of science. Humans have always been curious about the world around them. The inquiring and imaginative human mind has responded to the wonder and awe of nature in different ways. One kind of response from the earliest times has been to observe the physical and biological environment carefully, look for any meaningful patterns and relations, make and use new tools to interact with nature and build conceptual models to understand the world. This human endeavor is science.

### 1.3.1 Meaning and Definition of Science

Science is defined in several different ways by different individuals. Let us examine a few definitions as below:

1. Science is a subject that explains the cause and effect relationship of many incidents
2. Science is a subject that explains various components and the characteristics of nature
3. Science is both a body of knowledge and the process of acquiring and refining knowledge

From the various definitions of science, a comprehensive view is “Science as a body of knowledge, a way of investigation and a way of thinking in the pursuit of an understanding of nature.

### 1.3.2 Nature of Science

Science is a dynamic, expanding body of knowledge covering ever new domains of experience. How is this knowledge generated? What is the so-called scientific method? As with many complex things in life, the scientific method is perhaps more easily discerned than defined. But broadly speaking, it involves several interconnected steps: observation, looking for regularities and patterns, making hypotheses, devising qualitative or mathematical models, deducing their consequences: verification or falsification of theories through

## **NOTES**

observations and controlled experiments and thus arriving at the principles, theories and laws governing the physical world. There is no strict order in these various steps. Sometimes, a theory may suggest a new experiment; at other times an experiment may suggest a new theoretical model. Speculation and conjecture also have a place in science, but ultimately, a scientific theory, to be acceptable, must be verified by relevant observations and /or experiments. The laws of science are never viewed as fixed external truths. Even the most established and universal laws of science are always regarded as provisional, subject to modification in the light of new observations, experiments and analysis.

The methodology of science and its demarcation from other fields continue to be a matter of philosophical debate. Its professed value neutrality and objectivity have been subject to critical sociological analyses. Moreover, while science is at its best in understanding simple linear systems of nature, its predictive or explanatory power is limited when it comes to dealing with non linear complex system of nature. Yet, with all its limitations and failings, science is unquestionably the most reliable and powerful knowledge system about the physical world known to human. But science is ultimately a social endeavor. Science is knowledge and knowledge is power. With power can come wisdom and liberation. Science has the potential to be beneficial or harmful emancipative or oppressive. History, particularly of the twentieth century, is full of examples of this dual role of science. How do we ensure that science plays an emancipative role in the world? The key to this lies in a consensual approach to issues threatening human survival today. This is possible only through information transparency and a tolerance for multiple view points. In a progressive forward- looking society, science can play a truly liberating role, helping people out of the vicious circle of poverty, ignorance and superstition. In a democratic political framework, the possible aberrations and misuse of science can be checked by the people themselves. Science, tempered with wisdom, is the surest and the only way to human welfare. This conviction provides the basic rationale for science education.

### **1.3.3 Scope of Science**

Science is a way of making sense of the natural world. Scientists seek to describe its complexity, to explain its systems and events, and to find the patterns that allow for predictions. Science is the basis for the design of the technologies that solve real world problems. Not all students will become scientists or engineers. But science and technology occupy ever- expanding places in our everyday lives. As

citizens, we are asked to make decisions about social issues that involve science and technology. In the 21<sup>st</sup> century, adults will need to be comfortable and competent in a complex scientific and technological world.

Schools have the responsibility of preparing students for the future. Schools must prepare all students- regardless of their future aspirations- to be scientifically literate. Therefore, all science teachers of our schools should be as follows:

- Knowledgeable about the important concepts and theories of the three major branches of scientific study. Earth life and physical sciences.
- Able to think scientifically and use scientific knowledge to make decisions about real world problems.
- Able to construct new knowledge for themselves through research reading and discussion
- Familiar with the natural world and respectful of its unity diversity and fragility
- Able to make informed judgments on statements and debates claiming to have a scientific basis
- Able to reflect in an informed way on the role of science inhuman affairs.

People today are faced with an increasingly fast changing world where the most important skills are flexibility in adapting to new demands and creativity in taking advantage of new opportunities. These imperatives have to be kept in mind in shaping science education.

**Check your progress**

**Notes:** a) write your answer in the space given below

b) compare your answer with the one given at the end of the unit

1. Write the comprehensive definition of Science.

.....  
.....

2. What should Science Education aim at?

.....

**NOTES**

NOTES

---

## 1.4 SCIENCE AS A PROCESS AND PRODUCT

---

### 1.4.1 Science as a Process

Scientists have more overemphasized the product of science than the method of acquiring this knowledge. In scientific method, observation and systematic control of variables have been the most important ones. Observation is a basic process in science. The scientist first observes the events or facts happening around him. The observations then form the theory. Another basic process is controlling the variables. For the purposes of experiments, an experiment is done in which all factors is the essentially scientific approach to an experimental investigation. Harlan defines a process as any cognitive process involving interaction with content. Processes are certain ways for investigation problems. For example, observing, making hypotheses, designing and carrying out experiments, evaluating data, measuring, and so on.

Prof. Arthur Livermore has given a list of process of science for the AAAS (American Association for Advanced of Science) commission of science Education published in JRST. They are as follows.

- 1. Process of observation:** Observation may be made in a variety of ways using different senses. On the basis of observations, data are collected and inferences are drawn.
- 2. Process of classification:** Objects and events may be classified on the basis of observations. Classification schemes are based on the similarities and differences of objects. It provides basis for and order of nature.
- 3. Process of measuring:** Measuring gives us useful information in our exploration. Measuring properties of objects and events can be accompanied by direct comparison or by indirect comparison. There are many devices to help the scientists to make accurate measurements.
- 4. Communication process:** Communication is a valuable skill with the help of which pupils communicate observations. It is essential to keep accurate records which can be checked when needed. Complete experimental reports are essential to scientific communication.
- 5. Space-Time relation process:** This process involves the investigation and use of shapes, distance, motion and speed.

## **NOTES**

**6. Experimenting process:** It is process of gathering data for the purposes of testing a hypothesis. Experiments are conducted to make observations. In an experiment, variables may be identified and controlled as much as possible.

**7. Hypotheses Evaluation process:** Questions are framed on the basis of observations to evaluate an event. The formulation of hypotheses depends directly upon these questions. The process consists of devising a statement which can be tested by experiment. A workable hypothesis is stated in such a way that upon testing, its credibility may be established

**8. Data Interpreting process:** Interpreting data requires the application of other basic process of skills, in particular the processes of inferring, predicting, classifying and communicating. It is through this process that the usefulness of data is determined in answering the question being investigated. Interpretations are always subject to revision in the light of new or more refined data.

**9. Process of making operational definitions:** Operational definitions are made in order to simplify communication. They are based upon the observable characteristics of the phenomenon. Mostly, they are precise.

**10. Model formulation process:** Models, whether physical or mental are derived on the basis of acceptable hypothesis. Models are used to describe and explain the inter-relationships of ideas. In many cases, the models imply new hypothesis.

### **1.4.2 Science as a Product**

The product is obtained at the end of a process. All the modern developments, gadgets, ideas, principles, concepts, theories, laws, are the results of scientific process. The body of knowledge accumulated through the process leads to new inquiry which leads to a new discovery. Thus, this is a continuous cycle. Facts, concepts, principles, theories and scientific gadgets are the basic products of science.

**1. Facts:** They are the specific verifiable pieces of Information, obtained through observations and measurements. They can be verified at different times at different places. Some facts are universal and they do not need the time and place to verified. For example, ‘the sun rises in the east is a universal fact. But some facts need certain conditions, space and time. For example, the solar eclipse occurs at a particular place and time, if certain conditions are satisfied.

**NOTES**

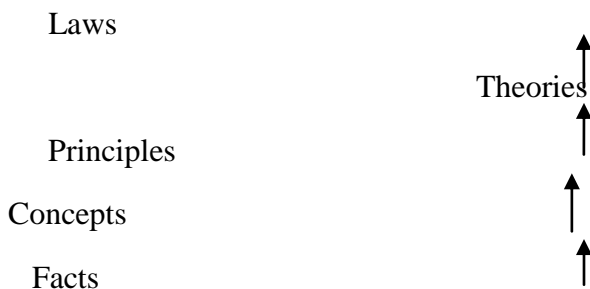
**2. Concepts:** A concept is a generalized idea suggested to the individual by object, situation or symbol. It is an understanding of almost indefinable something. The concepts about different objectives and phenomena are different for different people according to their age and experiences. A flower, animal, book etc. are some concepts. They have some common attributes.

**3. Principles:** The word principle signifies a generalized statement. The unrelated data are systemized and interpreted. So, the principle is a broad generalization which means the same for all the people irrespective of their age and experience, and holds good in different situations. Eg. Pauli's Exclusion principle, and Gravitation principle.

**4. Theories:** The broadly related principles, that provide an explanation for phenomena are known as theories. These are used to explain, predict and relate various facts and phenomena. Theories confirmed by various scientific experimentations by scientists over a period of time become laws. Eg. Theory of Relativity, Newton's laws of motion.

**5. Scientific gadgets:** By applying the principles, laws and discoveries, a number of gadgets have been invented. Radio, Television, Car, Aero plane, Nuclear energy etc. are the result of Science. Actually, most of the people know or identify science by the gadgets only.

The hierarchy of the products of science is given below:





**NOTES**

**Check Your Progress**

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

b) Compare your answer with the given at the end of the unit

3. Write the various processes of Science.

.....  
.....

4. Write the hierarchy of the products of Science.

.....  
.....

2. Write the hierarchy of the product of science

-----  
-----

---

**1.5. SCIENCE AS A BODY OF KNOWLEDGE**

Science has been characterized as a body of knowledge obtained by scientists. This body of knowledge includes facts, concepts and theories that are subject to error and change. Various types of scientific knowledge exist in the form of a. facts b. concepts, principles and laws c. hypotheses and theories. Knowledge is tentative (subject to change), empirically based (based on and /or derived from observations of the natural world), subjective (theory laden and a function of a person's prior experiences/knowledge) necessarily involves human inference imagination and creativity. Besides, students should aware of the crucial distinction between observation and inference. Observations are descriptive statements about natural phenomena that are directly accessible to the senses. The idea of science as a body of accumulated knowledge is true. However, science is dynamic in nature- the changes taking place are both substantial and peripheral. Scientific information is constantly being rearranged and reoriented in the light of latest developments. Thus, the dynamic nature of science should be made clear to students to enable them to use this knowledge in their daily life. A science teacher should stress the dynamic nature of the changes that take place. Scientific information is constantly being rearranged and reoriented, in the light of new knowledge.

**NOTES**

### **1.5.1 Science as a way of investigation**

Efforts to define scientific method have been a major preoccupation of philosophers in the 20<sup>th</sup> century. According to Karl Pearson, the scientific method involves the following six steps:

1. Identification of the problem
2. Gathering observations relevant to the problem on hand
3. Statement of a hypothesis based on observations gathered
4. Testable predictions of other related observable phenomena are developed from the hypothesis
5. The hypothesis is tested through observations
6. As a result of empirical observations the hypothesis is supported, rejected or modified

Science teachers should emphasize to their students that scientists do approach the solution of any specific problem in an organized manner. While the steps defined by Pearson are helpful guidelines in solving a problem, true scientific solve problems with inspiration, imagination and insight.

### **1.5.2 Science as a way of Thinking**

Science can also be regarded as an attitude to life. The acquisition of a scientific attitude is one of the most important outcomes of science. A person with scientific attitude will have the following characteristics:

- Open-mindedness
- Objectivity
- Freedom from belief in superstitions
- Belief in cause- effect relationship
- Accuracy and truthfulness in reporting observation
- Methodical way of solving problem on hand
- Up- to- datedness

- Respect for other people's opinion, though he may not agree with them
- Ability to distinguish between scientific evidence and scientific proof
- Ability to discern between fact and fiction.

## **NOTES**

---

### **1.6 INTER-DISCIPLINARY APPROACH**

---

Science is one of the important subjects in school. It can be taught in relation to many other subjects. Physics, Chemistry and Biology are the three branches of science. Now-a-days there are separate teachers to teach each branch of Science in Schools. So, when we teach one subject, its relationship to other subjects may also be taught. Each and every subject is related to other subject in many ways. There are different teachers in the schools to teach different subjects. While teaching, each subject teacher cannot confine himself/herself to his/her own subjects. We cannot understand each and every thing about a particular subject without the help of other subject. So, each subject should be taught in relation to other subjects for achieving unity of knowledge. It makes study easier, more interesting and natural. It develops knowledge by combining with each other the bits of similarities existing in the diversity of subjects and compounds them into such a complex whole, which the mind of the students are willingly ready to accept.

#### **1.6.1 Relationship between Science and other subjects**

Inter-disciplinary approach makes the teaching learning process easier. As applied to the world of education this means the interrelation of studies so that the material of each lesson is made interesting and intelligible through its connection with the points involved in others. Three reasons for correlating science with other subject are as follows:

- Inter-disciplinary enables the child to comprehend better the meaning and bearings of what he/she studies. The more through the correlation, the better the ideas that are presented. Without correlation, study is irrational. It becomes a case of rote memory. The proper interrelation of the material of instruction makes it intelligible, more easily memorized and retained, and more significant.
- Inter-disciplinary is held to make study interesting, for it connects the lesson with what the child already knows and is interested in. To find in the new, the familiar is ever a source of pleasure. To be able to explain, perhaps discover the work of

## NOTES

the new lesson, as a result of applying what is already learned, is a source of delight to the pupil.

- Inter-disciplinary makes the application of the knowledge gained in school to practice both within and without that environment far more easily and so far more likely. This is due to the fact that it cultivates in the child the tendency to apply his knowledge to the comprehension of new ideas and the solution to new problems as well as to the increased power of recall because of the many associations which it establishes.

### 1.6.2 Relationship of Science subjects with one another

- **Astronomy and Physics:** knowledge of the movement of stars, distance between planets, and their revolution round the sun are all connected with Physics. The time that light takes in travelling from one star to another and calculation of the velocity of light calculated by Roemer is based upon Astronomy. Physics and Astronomy are deeply related. All telescopic study of stars and moon: the thermometric study of temperature of Moon, weather study of Moon etc. relate the correlation between the two.
- **Physics and Chemistry:** These two branches of science are uniquely related to one another. All the metallurgy, electroplating, electrolysis, and study of the atmosphere involve both Physics and Chemistry. Spectrum Analysis in Physics has established the structure and formulae of so many chemical compounds and has thus placed their correlation on firm footing, intimately related to each other through the following:
  1. atomic structure
  2. energy of particles and role of energy in chemical bond formation
  3. ionization
  4. electroplating
  5. study of atmosphere
  6. spectrum analysis
  7. crystallography
- **Chemistry and Hygiene:** All sorts of medicines are a result: of the chemicals mixed in a fixed proportion. The effect of certain chemicals on bacteria is a part of Chemistry. Even the common soap used for hygienic cleanliness is a chemical product.

- **Geology and Physics:** Location of certain minerals and ores are done with the help of Physics. Heat and atmospheric effects on rocks are studied with the help of Physics.
- **Chemistry and Physiology:** The composition of blood, the changes that it undergoes in our bodies due to respiration, the action of enzymes on our food, the nature of excretions etc. are based on knowledge of Chemistry. A chemist is a half physiologist. Heredity operates through nucleic acids.

-Genes are chains of amino acids that regulate the growth of different organs. Animal behavior is controlled by chemicals.

- Chemistry is correlated with medicine. Again industrial chemistry is the commercial preparation of various medicines, hormones and antibiotics.

## NOTES

### 1.6.3 Relationship of general Science with other subjects

The history of scientists and their inventions provides useful background for the teaching of science and history. The correlation between science and history is best sought in topics like the history of the earth, evolution of life, e.g. history of human *civilization* can be divided into different epochs on the basis of major sources of power and fuel. Use of coal on a large scale led to the industrial revolution which in turn led to the use of petroleum and petroleum products. Carbon dating which is now such a vital part of history to get information on the age of bones, wood, clothes etc.

- **Science and Mathematics:** Science without Mathematics is incomplete. All mathematical derivations establish the theoretical facts of science. It scarcely needs to be pointed out that the science teacher who also teaches mathematics in her/his class is in an advantageous position. All branches of mathematics have direct application in chemistry and physics: arithmetic in numerical calculations, algebra in balancing equations and finding the number of isomers: geometry in structure of atoms, orbits and so on.
- **Science and Geography:** A look at a modern textbook of practical geography clearly indicates that geography is fast becoming a branch of science. Along with mathematics, geology and economics. Study of science could help get an all round picture of the world.
- **Science and Language and Literature:** The science teacher in order to cultivate clear concepts among her/his students has to be fluent at communication. The teacher has to be specific and direct in her/his language and judicious in use of word/terms in

## NOTES

various contexts and help the students to increase the scientific vocabulary. The student should also be encouraged to develop the habit of reading science fiction and help to develop a scientific culture. To strengthen the language of science students, teachers can help a lot. Scientific pieces can be taken for translation purposes. The teachers of language and composition might occasionally be asked to look at a set of science essay or descriptive accounts of experiments, so that both teachers and taught feel that there is co-operation in the development of conciseness and precision in writing. It should be remembered that some science books, for example on natural history and biography, are also valuable contribution to literature.

- **Science and the Social and Physical Environment:** Today if any, country wants its comparison with others, she considers how much science has developed in her/his own country and not how much history has developed Science has given a setback to culture and religion even. At every step the child utilizes science. If he/she is debarred from the gradual knowledge of science, his/her existence may be impossible. Science creates interest and gives lives to many. Without science the world will plunge into darkness of illiteracy.

### 1.6.4 Advantages for Implications

**Motivation:** Through correlation, the application of a subject in a number of situations can be assessed. Thus, the student realizes the importance of a particular topic or subject and may become interested in learning.

**Integration of knowledge:** Through correlation the student realizes the basic unity of knowledge and similarity in the methods of investigation. This leads to confidence in the use of the scientific method.

**Mental horizon:** Correlation helps widen the mental horizon of students. For instance, a chemistry student becomes familiar with geography, history, economics and metallurgy, if the study of minerals is properly correlated.

**Practice:** Correlation can lead to more effective learning as the same topic is dealt with in several different situations and viewed from different angles.

**Economy of effort:** A topic involving relationship of a number of subjects may be placed under one particular subject and dealt with exhaustively.

**Transfer of training:** The student becomes capable of transferring learning from one situation to the other, if there is a particular learning common to both. This makes the subject more meaningful.

**Correlation with life:** A teacher by correlating various subjects can clearly justify unity of all knowledge and its usefulness in daily life.

## NOTES

### Check your Progress

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

b) Compare your answer with the given at the end of the unit

5. Write any four characteristics of Scientific Attitude

.....  
.....

6. What are the advantages of inter-disciplinary approach in Science?

.....  
.....

---

## 1.7 GLOBALIZATION AND SCIENCE

---

Within this context, we need to ask how science and globalization are linked. Science and technology are often assumed to lead to social and economic change-yet there are hotly contested questions around who really benefits, when and where. Science and Technological development will change the way of life, because science and technology are themselves increasingly globalized- they involve global institutions, international organizations, multi-national corporations, as well as global communications and networks of scientists and policy makers. We need to re-think many of the established debates about democratic participation for the globalised world. Science plays a central role in process of globalization. At the same times, it is clear that both in industrial and developing country contexts there is often a gap between policies and initiative aimed at promoting innovation and industrial growth on the one hand, and social development on the other.

**NOTES**

### **1.7.1 Role of Teacher in Globalization**

The role of teacher is very important in modernization and globalization of science. Teachers should have faith in modernization and should be cooperative in the exchange of different science courses and their attitude should be liberal. They should have a wide knowledge and interest in the new techniques of teaching science and dedicated towards their duties and be an expert in adopting their new techniques of experimentation, observation and supervision. As a result of globalization, we could achieve international standards in science education.

---

### **1.8. LET US SUM UP**

---

In this unit, you have learnt about science, nature of science, and what is the basic nature of science. You have studied that science is a process and product as well. Observation, classification, measurement, communication, space-time relationship, experimentation, evaluation of hypotheses, data interpretation, making operational definitions, and model formulation are some of the major science processes. Facts, concepts, principles, theories and scientific gadgets are some of the major products of teaching science. At the last, we discussed globalization and science and the role of teacher in globalization.

---

### **1.9. UNIT- END- EXERCISES**

---

1. Define Science
2. What are the multifarious values of education?
3. Explain the nature and scope of Science.
4. Science as a process and product-Justify.
5. In what ways Science as a body of knowledge?
6. Describe the Inter-disciplinary approach in Science.
7. Briefly discuss about the Globalization and Science.

---

### **1.10 ANSWER TO CHECK YOUR PROGRESS**

---

1. Science as a body of knowledge, a way of investigation and a way of thinking in the pursuit of an understanding of nature.



**NOTES**

2. Science Education should aim at the potential to transform individuals and society.
3. Observation, classification, measurement, communication, space time relationship, experimentation, evaluating hypotheses, data interpretation, making operational definitions and model formulation.
4. Facts → Concepts → Principles → Theories →  
Laws
- 5 Open-mindedness  
Objectivity  
Accuracy and truthfulness in reporting observation  
Up- to- datedness
- 6 Motivation, integration of knowledge, mental horizon, practice economy of effort, transfer of training and correlation with life.

---

### 1.11 SUGGESTED READINGS

---

- Dr.K.S.Ramakrishnan & Dr.C Barathi (2009). *Teaching of Science*, TNOU B.Ed., course material, Chennai.
- Mathew.T.K &T.M Mollykutty (2006). *Teaching of Science*, TNOU B.Ed study material, Chennai.
- Radha Mohan, (2010). *Innovative Science Teaching*, PHI Learning pvt. ltd, New Delhi.
- Radhamohan (2010). *Innovative Science teaching for Physical science teachers*. PHI Learning Private Ltd, New Delhi.
- Saravanakumar.AR (2014). *Enhancing Achievement in Science through Metacognition*, KVS Printers, Karaikudi.
- Sharma, R.C (1999). *Modern Science Teaching*. Dhapat Rai Publishing Company Pvt. Ltd, New Delhi.
- Venugopal, G.N Nithyasri & Prof K.Nagarajan (2013). *Teaching of Biology*. Sriram Publishers, Chennai.

---

## **UNIT II AIMS AND OBJECTIVES OF TEACHING SCIENCE**

---

### **NOTES**

#### **Structure**

- 2.1 Introduction
- 2.2 Objectives
- 2.3 Aims of Teaching Science
- 2.4 Objectives of Teaching Science
  - 2.4.1 Major objectives
  - 2.4.2 Specific objectives
- 2.5 BLOOM'S Taxonomy of Educational Objectives
  - 2.5.1 Cognitive Domain
  - 2.5.2. Affective Domain
  - 2.5.3 Psychomotor Domain
- 2.6 Aims and Objectives of Teaching Science at Different Levels
  - 2.6.1 Primary Level
  - 2.6.2 Secondary Level
  - 2.6.3 Higher Secondary Level
- 2.7 Let Us Sum Up
- 2.8 Unit- End- Exercises
- 2.9 Answers to Check your Progress
- 2.10 Suggested Readings

---

### **2.1 INTRODUCTION**

---

Science is one of these human activities that man has created to graffiti certain human needs and desires. Science has been pursued for so many centuries and attracted the attention of great scholars. Science affords knowledge of certain facts and laws and an insight into method's and data. The rapid advancement of science and technology has made it all the more important to provide for science education in the Schools. The great value of science is that it has introduced us to new ways of thinking and reasoning. It helps developing consciousness. It has given us a real insight of ourselves and the things around us. It sharpens our intellect and makes us intellectually honest and critical in observation and reasoning. It teaches to ermine at conclusions without any braes or prejudice. This unit deals with the fundamental aims of teaching science. Then, the Educational objectives of science are discussed. These educational objectives are classified in many ways.

Bloom's Taxonomy is the most popular and widely used one. Bloom's Taxonomy classifies the objectives into cognitive, affective and psychomotor domains. All these domains are explained in detail. The meaning and Scope of educational objectives based on Bloom's taxonomy are also indicated.

---

## 2.2 OBJECTIVES

---

## NOTES

After studying this unit, you will be able to:

- Learn the aims and objectives of teaching Science
- Identify the major and specific objectives of teaching Science
- Describe Bloom's Taxonomy
- Learn and understand the objectives of teaching science at different level's – Primary, Secondary and Higher Secondary
- Apply them in daily activity practice of teaching Science.

---

## 2.3 AIMS OF TEACHING SCIENCE

---

The aims of teaching science are broad in nature. They are mentioned briefly here.

- Providing practical knowledge of the subject matter
- Providing fundamental skills and processes for proper understanding
- To satisfy the natural interests in things and forces of nature with which man is surrounded
- To contribute specific ideals like concepts of accuracy, truthfulness, honesty, open mindedness, ordered system, neatness, etc.
- To stimulate spirit of inquiry, investigation & invention
- To educate, regarding the application of Science in the physical and social environment
- To develop observation capacity
- To develop the capacity to solve day- to- day problems

**NOTES**

- To develop scientific attitude, appreciation and scientific temper among students
- To develop understanding of inter- relationships of science and society
- To develop the ability to reach generalization and apply them in everyday problems.

---

## **2.4 OBJECTIVES OF TEACHING SCIENCE**

---

In major, the objectives of teaching Science are the same as those of teaching any other subjects. Scientific precision and personality building of the student are the inherent objectives of teaching science. Its main objectives are to develop scientific attitudes and skills of the students. The modern education is known for all round development of the child.

The objectives of teaching science can be classified into two types:

- (i) Major Objectives            (ii) Specific Objectives

### **2.4.1 Major Objectives:**

They specify the general objectives with which the goal should be achieved.

Eg.

To develop interest in science

To remove superstitions

### **2.4.2 Specific Objectives:**

To achieve the major objectives, some technique or activity or method should be adopted so that the attainment of the objectives can be observed and measured. The following statements are the specific objectives to perform an experiment for demonstrating heat conduction.

E.g.

To conduct an experiment on conduction of heat

To explain the reason for isolating small pox patients

The objective of learning science is also all-round development. The specific objectives of teaching science are given below.

- To develop interest towards study of Science
- To think and reason scientifically
- To write, speak and work with accuracy
- To remove superstitions
- To develop interest in study of nature in a Scientific manner
- To recognize and appreciate individualistic reasoning, of problems and developing ability to solve them
- To develop mental and reasoning power of students
- To obtain knowledge of scientific facts in scientific manner and utilizing these in day to day life
- To impart knowledge of concepts and principles of science
- To achieve objectives related to occupation and earning of livelihood
- To utilize vacation properly and to obtain recreation
- To make the students disciplined.

## NOTES

---

## 2.5 BLOOM'S TAXONOMY OF EDUCATIONAL OBJECTIVES

---

Just as in Biology, the plants and animals are categorized into species, the educational objectives are also classified by B.S. Bloom and his associates in a hierarchical order. The educational objectives are classified under three domains; Cognitive, Affective and Psychomotor. It was agreed by the team that the objectives should be stated in behavioral form which can be observed and described. The taxonomy is based on educational, logical and psychological basis.

### 2.5.1 Cognitive Domain

Bloom identified six levels within the cognitive domain, from the simple recall or recognition of facts, as the lowest level, through increasingly more complex and abstract mental levels, to the highest order, which is classified as evaluation. Descriptions of the six levels as well as verb examples that represent intellectual activity are listed here.

## **NOTES**

### **Knowledge**

It is defined as remembering of previously learned material. This may involve the recall of a wide range of material, from specific facts to complete theories, but all that is required is the bringing to mind of the appropriate information. Knowledge represents the lowest level of learning outcomes in the cognitive domain.

### **Comprehension**

It is defined as the ability to grasp the meaning of material. This may be shown by translating material from one form to another (words to numbers), by interpreting material (explaining or summarizing), and by estimating future trends (predicting consequences or effects). These learning outcomes go one step beyond the simple remembering of material, and represent the lowest level of understanding.

### **Application**

Refers to the ability to use learned material in new and concrete situations. This may include the application of such things as rules, methods, concepts, principles, laws, and theories. Learning outcomes in this area require a higher level of understanding than those under comprehension.

### **Analysis**

Refers to the ability to break down material into its component parts so that its organizational structure may be understood. This may include the identification of the parts, analysis of the relationships between parts, and recognition of the organizational principles involved. Learning outcomes here represent a higher intellectual level than comprehension and application because they require an understanding of both the content and the structural form of the material.

### **Synthesis**

Refers to the ability to put parts together to form a new whole. This may involve the production of a unique communication (theme or speech), a plan of operations (research proposal), or a set abstract relations (scheme for classifying information). Learning outcomes in this area stress creative behaviors, with major emphasis on the formulation of new patterns or structures.

## Evaluation

It is concerned with the ability to judge the value of material (statement, novel, poem research report) for a given purpose. The judgments are to be based on definite criteria. These may be internal criteria (organization) or external criteria (relevance to the purpose) and the student may determine the criteria or be given them. Learning outcomes in this area are highest in the cognitive hierarchy because they contain elements of all the other categories plus conscious value judgment based on clearly defined criteria.

### 2.5.2 Affective Domain

The affective domain includes objectives which describe changes in interest, attitudes and values, and the development of appreciations and adequate adjustment. This domain has a pattern of development similar to the cognitive domain. At the lowest level, the child is merely aware of the fact that other people have particular attitudes and values. As children progress through personal experience, they slowly develop affective ideas which are uniquely their own. Again, it is felt that teaching should be directed towards this end rather than merely indoctrinating the child with the attitudes and values held by the teacher. Although some people would hold that there are some values which must be indoctrinated – respect for others' rights, honesty etc. – there is a school of thought which would seek to have these attitudes and values achieved by the child without this approach, through a process of development and clarification.

This domain relates to objectives concerned with interest, attitudes and values. The five levels of the affective domain from the simplest to the most complex are as follows:

- Receiving sensitivity to certain stimuli and a willingness to receive or attend to them
- Responding: Involvement in a subject or activity or event to the extent of seeking of out, working with it or engaging in it
- Valuing: Commitment to or conviction in certain goals, ideas or beliefs
- Organization: Organization of values into a system, awareness of reverence of and relations between appropriate values and the establishment of dominant personal values
- Characterization by a value complex: Integration of beliefs, ideas and attitudes into a total philosophy of world view.

## NOTES

NOTES

Category	Example and Key Words
<p><b>Receiving Phenomena:</b> Awareness, Willingness to hear, selected attention.</p>	<p><b>Example:</b> Listen to others with respect. Listens for and remember the name of newly introduced people. <b>Keywords:</b> Asks, choose, describes, follows, gives, holds, identifies, locates, names, points to, selects, sits, reacts, replies, uses.</p>
<p><b>Responding to Phenomena:</b> Active participation on the part of the learners. Attends and reacts to a particular phenomenon. Learning outcomes may emphasize compliance in responding, willingness to respond, or satisfaction in responding (motivation).</p> <p><b>Valuing:</b> The worth or value a person attaches to a particular object, phenomenon, or behavior. This ranges from simple acceptance to the more complex state of commitment. Valuing is based on the internalization of a set of specified values, while clues to these values are expressed in the learners' overt behavior and are often identifiable.</p>	<p><b>Examples:</b> Demonstrates belief in the democratic process. Is sensitive towards individual and cultural differences (value diversity). Shows the ability to solve problems. Process a plan to social improvement and follows through with commitment. Informs management on matters that one feels strongly about.</p> <p><b>Keywords:</b> completes, demonstrates, different, explains, follows, forms, initiates, invites, joins, justifies, proposes, reads, reports, selects, shares, studies, works.</p>
<p><b>Organization:</b> Organizes values into priorities by contrasting different values, resolving conflicts between them, and creating a unique value system. The emphasis is on comparing, relating, and synthesizing values.</p>	<p><b>Examples:</b> Recognizes the need for balance between freedom and responsible behavior. Accepts responsibility for one's behavior. Explains the role of systematic planning in solving problems. Accepts professional ethical standards. Creates a life plan in harmony with abilities, interest,</p>



**NOTES**

	<p>and beliefs. Priorization time effectively to meet the needs of the organization, family and self. Keywords: adheres, alters, arranges, combines, compares, completes, defends, explains, formulates, generalizes, identifies, integrates, modifies, orders, organizes, prepares, relates, synthesizes.</p>
<p><b>Internalizing values (characterization):</b> Has a value system that controls their behavior is pervasive, consistent, predictable, and most importantly, characteristic of the learner. Instructional objectives are</p>	<p><b>Examples:</b> Shows self – reliance when working independently. Cooperates in group activates (displays teamwork). Uses an objective approach in problem solving. Displays a professional commitment to ethical practice on a daily basis. Revises judgments and changes behavior in light of new evidence. Values people for what they are, not bow they look. Keywords: acts, discriminates, displays, influence, listen, modifies, performs, practices, proposes, qualities, questions, revises, serves, solves, verifies.</p>

**2.5.3 Psychomotor Domain**

Simpson built this taxonomy on the work of Bloom and others:

- Perception: Sensory cues guide motor activity
- Set: Mental, physical, and emotional dispositions that make one respond in a certain way to a situation
- Guide Responses: First attempts at a physical skill. Trial and error coupled with practice lead to better performance
- Mechanism: The intermediate stage in learning a physical skill. Response is habitual with a medium level of assurance and proficiency
- Complex Overt Response: Complex movements are possible with a minimum of wasted effort and a high level of assurance they will be successful

**NOTES**

- **Adaptation:** Movements can be modified for special situations
- **Origination:** New movements can be created for special situations

The classification of educational objectives in the Psychomotor domain.

**Dave** developed this taxonomy:

- **Imitation:** Observing and copying someone else
- **Manipulation:** Guided via instruction to perform a skill
- **Precision:** Accuracy, proportion and exactness exist in the skill performance without the presence of the original source
- **Articulation:** Two or more skills combined, sequenced, and performed consistently
- **Naturalization:** Two or more skills combined, sequenced, and performed consistently and with ease. The performance is automatic with little physical or mental exertion
- **Harrow developed this taxonomy:** It is organized according to the degree of coordination including involuntary responses and learned capabilities.
- **Reflex movement:** Automatic reactions
- **Basic fundamental movement:** Simple movements that can build to more complex sets of movements
- **Perceptual:** Environmental cues that allow one to adjust movements
- **Physical activities:** Things requiring endurance, strength, vigor, and agility
- **Skilled movements:** Activities where a level of efficiency is achieved
- **Non – discursive communication:** Body language.

The following list is a combination of the above taxonomies.

<b>Psychomotor Domain</b>		
<b>Levels</b>	<b>Definition</b>	<b>Example</b>
• Observing	Active mental attending of a physical event.	The learner watches a more experienced person. Other mental activity, such as reading may be a part of the observation process.
• Imitating	Attempted copying of a physical behavior	The first steps in learning skill. The learner is observed and given direction and feedback on performance. Movement is not automatic or smooth.
• Practicing	Trying a specific physical activity over and over	The skill is repeated over and over. The entire sequence is performed repeatedly. Movement is moving towards becoming automatic and smooth.
• Adapting	Fine tuning Making minor adjustment in the physical activity in order to perfect it.	The skill is perfected. A mentor or a coach is often needed to provide an outside perspective on how to improve or adjust as needed for the situation.

**NOTES**

Reflex movements are actions elicited without learning in response to some stimuli.

Example include: Flexion, extension, and stretch, postural adjustments.

Basic fundamental movement is inherent movement patterns, which are formed by combining of reflex movements and are the basis for complex skilled movements.

Examples are: walking, running, pushing, twisting, gripping, grasping, manipulating.

Perceptual refers to interpretation of various stimuli that enable one to make adjustment to the environment. Visual, auditory, kinesthetic, or tactile discrimination. Suggests cognitive as well as psychomotor behavior.

**NOTES**

Examples include: coordinated movements such as jumping rope, punting, or catching.

Physical activities require endurance, strength, vigor, and agility which produces a sound, efficiently functioning body.

Examples are: all activities which require a) strenuous effort for long periods of time b) muscular exertion c) a quick, wide range of motion at the hip joints and d) quick, precise movements.

Skilled movements are the result of the acquisition of a degree of efficiency when performing a complex task. Examples are: all skilled activities obvious in sports, recreation, and dance.

Non – discursive communication is communication through bodily movements ranging from facial expressions through sophisticated choreographic.

Examples include: body postures, gestures, and facial expressions efficiently executed in skilled dance movement and choreographic.

**Check Your Progress**

**Notes:** a) Write your answer in the space given below

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

1. Write three domains of classification and the educational objectives  
.....  
.....

2. Write the appropriate general objectives for teaching Science  
.....  
.....

---

## 2.6 AIMS AND OBJECTIVES OF TEACHING SCIENCE AT DIFFERENT LEVELS

---

### 2.6.1 Primary School Level

- Arousing and maintaining interest in nature and in the physical and social environment, arousing love for nature and the habit of nature and its success
  
- Developing the habit of observation, exploration, classification and systematic way of thinking

- Developing the child's powers of manipulative, creative and inventive faculties
- Developing neat and orderly habits
- Inculcation of habits of healthy living.

### 2.6.2 Secondary level

The course offered at this stage is aimed at developing scientific and technological attitudes and skills among children. The aims and objectives are:

The student:

- Understands the nature of science and technology
- Understands the basic principles, concepts and laws of science
- Applies basic scientific principles in finding solutions to problems related to agriculture, energy, health, nutrition etc.
- Develops problem solving and decision – making skills
- Includes values that underlie science and technology
- Develops an understanding of the various processes of environment and concern for its preservation and conservation
- Understands and appreciates the joint enterprise of science, technology, and society
- Develops rich and satisfying views of the universe
- Develops an attitude, which would equip them to continue science and technology education throughout their life
- Acquire process skills, which form part of the attitude for developing a scientific temper
- Develops certain manipulative skills, which are required in day-to-day life situations.

There is widespread agreement within the education and broader community that the primary purpose of science education is to develop scientific literacy. The momentum of technological development is itself a source of pressure for teaching science.

**NOTES**

**NOTES**

The third important need in our society is the need for leadership inculcated with the habits of critical thinking that are characteristic of the method used by scientists in solving problems.

**2.6.3 Higher Secondary Level:**

At higher secondary stage science will not be studied by all students on a compulsory basis. Those who want to opt for specialization may choose three electives from the science group only or may choose two subjects from science group and one from arts group. The science group includes:

- Physics,
- Chemistry
- Biology,
- Geology and
- Mathematics.

One can either opt all the three electives from the above subjects or can take two subject from the above and one arts subject. Similar, it should be possible for an arts student to take up the study of physics, chemistry, or biology or any other subject in the science group.

**Check Your Progress**

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

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

3. What are the steps for writing the performance objectives?

.....  
.....

4. What are the goals of science teaching framed by NSF?

.....  
.....

Bloom had classified the objective into three major domains, via; cognitive, affective and psychomotor domains. This is called Bloom's taxonomy. Knowledge, understanding, application, analysis, synthesis and evaluation are the categories in cognitive domain. Receiving, responding, valuing, organization and characterization are the objectives of affective domain. Psychomotor domain consists of

imitation, manipulation, precision, articulation and naturalization. By combining all the three domains, we have finally derived asset of objectives which are suitable for teaching science. Then, you have learnt the action verbs which will help in writing instructional objectives. While we are writing the objectives we may readily use these verbs which indicate the behavior of students. Finally, you have learnt the meaning and scope of writing instructional objectives. Deciding what the child should do under what conditions and the levels of performance are the points you have to consider before writing the objectives.

## NOTES

---

### 2.8 UNIT- END- EXERCISES

---

- Write the aims of Science
- Define objectives of Science
- Write the objectives of Science as prescribed by NPE 1992.
- Write objectives under Cognitive Domain

---

### 2.9 ANSWERS TO CHECK YOUR PROGRESS

---

1.
  - Cognitive
  - Affective
  - Psychomotor Domain
2. Knowledge, understanding, application, skills, attitudes and interest
  - Decide what the child should be doing when the instruction has been successful. Decide under what conditions these behaviours will be developed.
  - Decide what will be the expected level of performance
4. Science must enhance each learner's personal development
  - Learner must understand the interrelationship of science technology and society
  - Science must develop each learners academic and process skills
  - Science must help to expand each learner's career awareness.

NOTES

---

## 2.10 SUGGESTED READINGS

---

- Kulshreshtha S.P & Harpal Pasricha (2005). *Teaching of Science*. Meerut, R.Lall Book Dept.
- Mathew.T.K & T.M Mollykutty (2006). *Teaching of Science*. TNOU B.Ed Study Material, Chennai.
- NCERT: *Instructional Objectives of School subjects*
- Panneerselvam A & Rajendran K (2005). *Teaching of Physical Science*. Chennai: Shantha Publishers.
- Radhamohan (2010). *Innovative Science teaching for Physical Science teachers*. PHI Learning Private Ltd, New Delhi.
- Rajasekar S (2005). *Methods of teaching Physical Science*. New Delhi, Neelkamal Publications Pvt. Ltd.
- Saravanakumar.AR (2014). *Enhancing Achievement in Science through Metacognition*. KVS Printers, Karaikudi.
- Sharma R.C (1999). *Modern Science Teaching*. New Delhi, Dhanpat Raj Publishing Company Pvt. Ltd.
- Venugopal, G, N Nithyasri & Prof K.Nagarajan (2013). *Teaching of Biology*. Sriram Publishers, Chennai.



---

# UNIT III STRATEGIES FOR TEACHING SCIENCE – I

---

Learning Resource in  
Science - II

## Structure

- 3.1 Introduction
- 3.2 Objectives
- 3.3 Criteria for Selecting the Method of Teaching Science
  - 3.3.1 Level of the class
  - 3.3.2 Size of the class
  - 3.3.3 Time availability
  - 3.3.4 Subject Matter
- 3.4 Methods of Teaching Science
  - 3.4.1 Heuristic approach
  - 3.4.2 Historical approach
  - 3.4.3 Biographical approach
- 3.5 Let Us Sum Up
- 3.6 Unit – End – Exercises
- 3.7 Answers to Check Your Progress
- 3.8 Suggested Readings

## NOTES

---

### 3.1 INTRODUCTION

---

“Science Education programmes will be designed to enable the learner to acquire problem solving and decision making skills”

**- National Policy on  
Education (1986)**

“If science is poorly taught and badly learned, it is little more than burdening the mind with dead information, and it could degenerate at even into a new superstition”.

**- Kothari Commission Report  
(1964-66)**

The main aim of teaching is to bring about socially desirable behavior change in the students and this can only be achieved if the teaching is effective and based on the principles at teaching. How the pupils will learn effectively, depends on the method the teacher adopts. There is the great world outside and the mind within, and it is the duty at the teacher to bring the two together. This process of interpreting the world of knowledge to the child’s mind is called the “Methods of

**NOTES**

teaching” It is just a way at teaching method is the style at presentation of content in classrooms.

---

### **3.2 OBJECTIVES**

---

- Identify the criteria for selecting a method of teaching
- Learning about the various methods of teaching
- Describe the various approach / methods of teaching Science
- Elaborate the merits and demerits of each approach
- Identify when to use certain approaches / methods

---

### **3.3 CRITERIA FOR SELECTING THE METHOD OF TEACHING SCIENCE**

---

There is no such thing as the best method of teaching. A method ‘best’ for one teacher and applicable for a class under some conditions may totally be a failure for another teacher to teach the same classes or other under the same or different conditions. Teaching methods are like the tools in the kit of a carpenter. An efficient carpenter chooses his tool from the kit, depending upon the purpose, availability of time and helpers, and the nature of wood he had to deal with. Similarly has to select the method of teaching, based on the following factors.

#### **3.3.1. Level of the class**

E.g. For; lower classes, lecture method is highly inappropriate, pupil-centered methods in the class-room setting will be appropriate.

#### **3.3.2. Size of the class**

For large class’s teacher–centered methods are preferable. In higher classes, when the strength of students is more, pupil-centered methods in socialized classroom-setting are more preferable.

#### **3.3.3. Time Availability**

When the time available is short, lecture method or demonstration be employed in preference to methods demanding socialized classroom-setting.

### 3.3.4. Subject matter

Depending on the resources available, methods involving instructional technology could be used. Choice of selection of teaching method is also influenced by the nature of the topic to be dealt.

On the whole it can be said that teacher should try to select the method which facilitates for greater pupil- participation and individualized learning with the optimum use of available resources in the School.

**NOTES**

---

## 3.4 METHODS OF TEACHING SCIENCE

---

Methods of teaching of Science can be classified into two types:

- (i) Teacher – centered and (ii) Pupil – centered
- **Teacher – centered teaching:** The teacher – centered approach of teaching is mainly expository type in which the focus is on telling, memorization and recalling information. The students are just passive recipients of knowledge. The participation is restricted to only asking and answering questions on what teacher has taught. The teaching environment is very much formalized and teacher occupies a central position in the classroom.
- **Pupil – centered teaching:** In pupil-centered teaching, the whole teaching-learning process is geared to the needs, requirements, capabilities and interest of the pupils. The purpose is to develop the learner's skills and abilities in independent learning and problem solving. The classroom climate is flexible and psychologically open. The students and teachers jointly explore aspects of the problem rather than teacher telling the students about the solution of the problem.

### Teacher – centered methods

1. Lecture 2. Lecture- demonstration and 3. Historical

### II. Pupil – centered methods

4. Heuristic 5. Assignment 6. Project 7. Discussion. 8. Inductive and Deductive 9. Role playing

### 3.4.1 Heuristic Approach

While giving the biographical sketch of great scientists, the students imagine or identify themselves as scientists. The teacher may suggest the students to role play great scientists also. This leaves

## NOTES

indelible remark in the minds of the pupils. The successes and the frustrations of the scientists may create interests within the students and prepare them to take up a career in scientific research.

This method was propounded by H.E. Armstrong. The basic idea is that the student should discover everything he learns about his own observations and experiments. The teacher provides activities in which the students work independently and by this way get training in scientific method. In this method, observing and reasoning powers are most emphasized. The pupils' work and think for themselves; the habits of self-activity and self-dependence are fostered. In their daily life, 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 a way the student gets a training in the scientific method of attacking and solving a problem. This method is intended to provide a training in method; knowledge is a secondary consideration altogether.

### **How to use this method**

A problem is assigned to the class and each child is made to feel responsible for finding out something for him. Each child is free to work and they collect information from different sources. The teacher guides them. He tries to get everything out of the students by inductive method. As many questions as possible should be allowed to arise from the child's own observation and at times the teacher should also put questions which will stimulate the pupils to know more about a particular problem. They learn to attack a problem, gather data, interpret it, formulate solutions and then arrive at desired conclusion.

**Role of the teacher:** The teacher is a guide, working partner, and a friend of pupils. He should tolerate the mistakes committed by the students. He should possess curiosity, interest and a spirit of scientific investigation. He should try to instill these qualities into his students. He should be an expert in the art of questions unless, a teacher is a discoverer. He cannot expect the children to form an attitude of a discoverer. He should provide an atmosphere of freedom in the classroom in order to encourage self-development, spontaneity and self-expression.

### **Merits and Demerits**

It develops a scientific and a critical attitude among the pupils. Habits of industry and hard work are encouraged. The learners retain

what they have learnt for a much longer time, as they are the result of the learners' own efforts. It prepares the child for life by giving him training in scientific method. It is time consuming and can't be used for a big class. The teachers well trained in this method are scarce. It is not economical.

### Check your Progress

**Note** a) Write your answer in the space given below

b) Compare your answer with the one given at the end of the unit

1. Write different categories of teaching methods.

-----  
-----

2. Write the common characteristics of activity methods.

-----  
-----

3. What are the factors influencing the methods of teaching?

-----  
-----

### NOTES

#### 3.4.1 Historical approach

In this approach, the topic is developed from the very beginning and carried through various stages of evolution. Science has its own history. Every invention or discovery has a historical background. The students are very much fascinated by these stories. So the 'teacher may introduce such episodes in an interesting way in the classroom'. For example, to prove that there is no electric field inside a hollow metallic sphere, a scientist made a big metallic hollow sphere and put a wooden bench inside and went into the sphere. Then, the sphere was charged into few million volts. After some time, it was discharged and the scientist came out of the sphere intact. Similarly, Kekule discovered the Benzene structure from a dream he had in which there were 6 snakes at the vertices of a hexagon and in every alternative vertex, there were two snakes. The second snake constantly changed its position to the adjacent vertex. This gave Kekule the idea that Benzene might have 3 single bonds and 3 double bonds between the carbon atoms positioned at the vertices of a regular hexagon.

Similarly, while teaching many scientific discoveries, the teacher may give a historical sketch of each. This arouses the interest of the students for learning science and scientists.

This approach is useful mainly for primary classes where the students are much interested in listening to the stories.

## **NOTES**

### **3.4.2 Biographical Approach**

Generally young students are very much attracted by the stories and interesting episodes about the scientists and interesting scientific discoveries. The prime aim of the science teacher is to create an interest in the students about science. The teacher may use this fact for teaching science. The lives of the great scientists may be described in an interesting manner and simultaneously their discoveries discussed in the classes. The important episodes that happened in the lives of the scientists and the struggles they had encountered in their efforts may create an interest in the students and they will understand the real worth of science and scientific discoveries. The life history of scientists will inspire the students to pursue a career as a scientist. Dr. A.P.J Abdul Kalam, former President of India had noted that his science teachers had told a number of stories related to the episodes of the great scientists. He got inspiration to take up a career in Aeronautical Engineering due to them.

---

## **3.5 LET US SUM UP**

---

In this unit, you have learned the definition of teaching methods and their historical background. Comenius, Pestalozzi, Froebel, and Herbart were the forefathers of given shape to various methods of teaching. Later, John Dewey and others developed it. You have studied the factors deciding the method of teaching. Teaching methods are generally classified as Oral, Activity and Self Learning categories. Each method has its own pros and cons depending upon the educational objective to be achieved, the age of the learner, his stage of learning and the content, the teacher has to decide a suitable teaching method.

---

## **3.6 UNIT- END- EXERCISES**

---

- Discuss the meaning of teaching method given by various experts.
- Write a brief on the historical background of teaching methods.

- Discuss the historical approach of teaching Science

---

### 3.7 ANSWERS TO CHECK YOUR PROGRESS

---

1.
  - Useful to tell interesting episode about great discoveries is or scientists. Mainly arouse the interest of the students for learning science
  - Used to arrange the interest of the students for learning science.
2. Heuristic Method is a method of teaching which involves our placing the students as far as possible in the attitude of the discoverer.
3. It combines both lecture and demonstration methods. In it limitation of lecture method are removed and are combined with the merits of demonstration method, thus making it more impressive.

### NOTES

---

### 3.8 SUGGESTED READINGS

---

- Aggarwal, J.C. (2007). *Essentials of Educational Psychology*. Delhi: Vikas Publishing House Private Limited.
- Chaube, S.P. (1997). *Educational Psychology*. Agra: Lakshmi Narain Agarwal Publishing Ltd.
- Crow and Crow. (1993). *Educational Psychology*. Delhi: Eurasian Publishing House.
- Dutt N.K. (1974). *Psychological Foundation of Education*. Delhi: Doaba House.
- Mangal, S.K. (2004). *An Introduction to Psychology*. Delhi: Sterling Publishers Private Limited.
- Mangal, S.K. (2003). *Advanced Educational Psychology*. Delhi: Prentice Hall of India.
- Mathew, T.K & T.M Mollykutty. (2006). *Teaching of Science*. TNOU B.Ed Study Material, Chennai.
- Nagarajan, K (2002). *Educational Psychology*. Chennai: Ram Publishers.
- Podhu, K.S, K.S.Premila, T.Sampathkumar & D.Vinodhkumar (2009). *Educational Psychology*. B.Ed., Course Material, TNOU, Chennai.

**NOTES**

- Radhamohan. (2010). *Innovative Science teaching for Physical Science teachers*. New Delhi: PHI Learning Private Ltd.
- Santhanam S. (1993). *Educational Psychology*. Chennai: Santha Publishers.
- Saravanakumar.AR. (2014). *Enhancing Achievement in Science through Metacognition*. Karaikudi: KVS Printers
- Saravanakumar.AR. (2010). *Essential of Educational Psychology*. M.A. Education Course Material, DDE, Alagappa University, Karaikudi.
- Sprinthall, C, Richard and Sprinthall, A, Norman (1990). *Educational Psychology: A development approach*. Newyork: Mc Graw Hill.
- Tromburgy.D.Hershel. (1984). *Introduction of Educational Psychology*. New York: West Publishing Company.
- Venugopal, G.N Nithyasri & Prof K.Nagarajan. (2013). *Teaching of Biology*. Chennai: Sriram Publishers.



---

# UNIT IV STRATEGIES FOR TEACHING SCIENCE – II

---

*Learning Resource in  
Science - II*

## **Structure**

- 4.1 Introduction
- 4.2 Lecture method
- 4.3 Lecture cum demonstration method
- 4.4 Individual practical method
- 4.5 Analytic and Synthetic method
- 4.6 Scientific method
- 4.7 Project method
- 4.8 Let Us Sum Up
- 4.9 Unit- End- Exercises
- 4.10 Answer to check your Progress
- 4.11 Suggested Reading

## **NOTES**

---

### **4.1 INTRODUCTION**

---

“Science Education programmes will be designed to enable the learner to acquire problem solving and decision making skills”

**- National Policy on  
Education (1986)**

“If science is poorly taught and badly learned, it is little more than burdening the mind with dead information, and it could degenerate even into a new superstition”.

**- Kothari Commission Report  
(1964-66)**

The main aim of teaching is to bring about socially desirable behavior change in the students and this can only be achieved if the teaching is effective and based on the principles of teaching. How the pupils will learn effectively, depends on the method the teacher adopts. There is

the great world outside and the mind within, and it is the duty at the teacher to bring the two together. This process of interpreting the world of knowledge to the child's mind is called the "Methods of teaching" It is just a way at teaching method is the style at presentation of content in classrooms.

## NOTES

---

### 4.2 Lecture Method

---

Lecture method is an educational presentation usually delivered by an instructor to a group of students with the use of instructional aids and training devices. Lectures are useful for the presentation of new material, summarizing ideas, and showing relationships between theory and practice. In this method the teacher orally presents the material of the course in an organized way to the students, going from theory to examples and back again. Lectures may contain a varying level of student participation, and notes are generally taken.

The lecture is one of the oldest and most basic pedagogic tools. Although experience and educational research show that the lecture is less effective than activity methods at school level, many teachers find themselves spending at least 30 to 50 per cent of their teaching time in lecturing.

This method lays emphasis on the penetration of contents. Teacher is more active and students are passive but s/he also uses questions answers to keep them attentive in the class. It is used to motivate clarity, expand and review the information.

The lecture as a method of instruction does place enormous weight and attention on the teacher. Unlike other methods, there is no hiding place for the teacher. The spotlight is on the teacher. He or she is the centre of attention; and for many students it is the lecturer, rather than the lecture content, that is of greatest interests. If the lecture method is to be one that is successful, the teacher must be aware that the lecture requires great attention, hard work, creativity, and a certain type of personality on the part of the performer.

The use of lecturing depends on the subject matter, the teaching philosophy of the teacher and the overall learning situations. Formal lecturing is used largely to build up basic theoretical knowledge, which must be gained before practice of skills, If the number of students in a class is large, teaching resources are scarce or a limited number of periods are available on the timetable, lecturing may be the only alternative.

---

### 4.3 Lecture cum demonstration Method

---

This method includes the merits of lecture method and demonstration method. The teacher performs the experiment in the class and goes on explaining what he does. It takes into account the active participation of the students and is thus not a lop-sided process like the lecture method. The students see the actual apparatus and operations and help the teacher in demonstrating the experiment and thereby they feel interested in learning. It is difficult to talk about things which the pupils have to imagine. It is always easy for the students to understand and remember the concrete things. And so, this method is also in accordance with the maxim of teaching “**From Concrete to Abstract**”. The students observe the demonstration critically any try to draw inferences. Thus, their powers of observation and reasoning are also exercised.

When science teaching was first introduced into the curriculum of secondary school, it was felt necessary to carry out a number of series of demonstrations in order to arouse interest and wonder in the pupils and to convince them that the statement of the teacher is true. This also made it easier for the pupils to remember what they see by appealing to several senses at a time. Later on it was thought by some of the science educators that individual laboratory work by the students is more effective instead of demonstration. A number of investigations were made to find out superiority of one over the other. And it was found out that the students taught by either method fared equally well, the only difference is that ‘**demonstration**’ pupil scored higher marks on the immediate tests while the ‘**individual laboratory**’ pupils scored more on delayed tests; but the difference in score was very small. It may thus be said that these experiments prove that neither method is superior to the other. The lecture-demonstration method can prove to be one of the best methods if the demonstrations are well-planned and rehearsed by the teacher. And if the demonstration fails, it creates a very undesirable effect upon the moral and attitude of the students. If failure is too frequent, confidence of pupils in the teacher is lost. But if the demonstration is successful it will form a desirable effect on the students and will achieve of teaching science.

---

### 4.4 Individual practical method

---

Individual practical method is a system in which the students are doing the experiments individually. This method is further divided into Even System and Rotation Method.

NOTES

**NOTES**

- **Even Front Method**

This is a method in which all students will be doing the same experiment simultaneously and individually. In this method supervision will be easy for the teacher. Students can compare the result. They can rectify the mistake if at all any, happens in the course of the experiments. It is easy for the teacher to give the procedure for the experiment. The apparatus can be kept ready since they are the same. The time required for the experiment can be fixed very easily.

This is the most expensive method since it requires more number of apparatus. The space required for storing so many sets of apparatus will be enormous. The experiments are not based on the interest and aptitude of the students. Lazy students may copy the results from other students without actually doing the experiment.

- **Rotation Method**

Different experiments as per the syllabus are arranged and the students are asked to do the experiments one after the other in rotation.

**Merits**

- The apparatus required for the experiment can be left in the place ready for doing the experiment.
- The apparatus are cleaned immediately after the experiment.
- This method avoids repetition of experiments by the students.
- It is easy to pay individual attention to the student.

**Check your Progress**

**Note** a) Write your answer in the space given below

b) Compare your answer with the one given at the end of the unit

1. What is lecture method?

-----  
-----

2. What are the two systems in Lecture cum demonstration method?

-----  
-----

## 4.5 Analytic and Synthetic Method

- The terms analysis and synthesis come from (classical) Greek and mean literally “to loosen up” and “to put together” respectively. These terms are used within most modern scientific disciplines – from mathematics and logic to economics and psychology – to denote similar investigative procedures.
- In general, analysis is defined as the procedure by which we break down an intellectual or substantial whole into parts or components. Synthesis is defined as the opposite procedure: to combine separate elements or components in order to form a coherent whole.
- Analysis and synthesis, as scientific methods, always go hand in hand; they complement one another. Every synthesis is built upon the results of a preceding analysis, and every analysis requires a subsequent synthesis in order to verify and correct its results. In this context, regard one method as being inherently better than the other is meaningless.
- There are, however, important situations in which one method can be regarded as more suitable than the other. This concerns the question of which method is most appropriate as the primary method or chief point of departure for the study of a given system or object of scientific inquiry.
- The analytical approach – drawing conclusions about causes on the basis of effects – is appropriate when a system’s overall behaviour is known, but when one does not have clear or certain knowledge about the system’s internal processes or the principles governing these.
- Both the methods of analysis and synthesis by themselves have their advantages and disadvantages. In order to ensure the complete understanding of science in the learners both the methods must be used together to teach science. By using a combination of these two methods the teacher can ensure that effective teaching learning takes place.

### NOTES

Parameters	Analytic method	Synthetic Method
Definition	Breaking up into components	Combining elements to get something new
Direction of process	From unknown to known	Known to unknown
Type of Method	Method of discovery and thought	Method of presentation of fact

Time factor	Time consuming	Economic
Learning	Meaningful	Rote
Application	Inductive reasoning	Deductive reasoning
Role of learner	Active	Passive

## NOTES

### 4.5 Scientific Method

Scientific method means the method of procedure adopted by scientists in their investigation of natural phenomena, the way in which scientific generalizations are arrived at and made use of. The scientist mostly arises out the instincts of wonder and curiosity, and they aim at bringing an event or a phenomenon into an intelligent system into which it fits.

Scientific method involves reflective thinking, reasoning and results from the achievement of certain abilities, skills and attitudes. A problem may arise in connection with the desire to meet a practical need.

The three steps in this and in all work in science method are

- Observation
- Guess
- Experiment

#### 4.5.1 Process of scientific method

Scientific method consists of two processes

##### 4.5.1.1 Technical Process

It comprises of experimentation, measurement and manipulation. Technical operations may vary in differed fields of science.

##### 4.5.1.2 Logical Process

Logical process is more important than technical process, because it is the mind of the scientist that conclusion originate. It is common to all sciences.

They more or less follow the steps of problem method. Logical aspect is made by comparison as simile – complete act of thought.

### 4.5.1.3 The steps involved in the scientific method

#### a) Feeling the Problem

A problem is felt difficulty, awareness of the problem. The first essential step in reasoning is the presence of a problem. The individual must be aware of difficulty. Unless and until there is awareness of the difficulty, there is no problem. "A problem is a felt difficulty".

The problem may be of many kinds. It may be a practical problem, such as method of constructing a television or availability of water in a village. It is found that higher areas do not get water. So we approach Panchayat or Municipality to solve the problem.

#### b) Location and definition of the problem / comprehending the problem

Following the awareness of the problem, the individual must be able to isolate it, define it, and understand it. This requires the ability to recall the related past experiences and an attitude of interest in overcoming the obstacle. If an individual has some understanding of the situation at the outset, he is likely to attack it with vigour and success.

### 4.5.2 Suggestions to the cause of the problem

#### a) Locate, evaluate and organize information

To provide the basis of formulating hypotheses or tentative solution of a problem it is sometimes sufficient to assemble the information one already possess. Usually, difficult situations call for the collection of new data. These facts, however, need to be evaluated and classified.

#### b) Discovery of relationship and formulation of hypotheses

The comprehension of the problem, gathering and evaluation of data give to tentative inferences or preliminary hypotheses. These hypotheses are based upon the perception of relationship among the data.

Any type of relationship among facts and principles will not be helpful in arriving at inferences. The particular relationships which are useful are determined by the nature of the problem, by the question to be answered and hypotheses to be formulated.

#### c) Evaluating hypotheses: accepting or rejecting hypotheses

Three important steps in evaluating hypotheses:

NOTES

## NOTES

- One should determine whether the conclusion completely satisfies the demand of the problem.
- One should find out whether the solutions are consistent with other facts and principles which have been well established.
- One should make deliberate search for negative instances which might, throw light upon the conclusion.

It is wise to evaluate many leads in some situations, a hundred or more before the right hypothesis is formed.

### **d) Apply the solution – accepting or rejecting conclusions**

The final step in “a complete act of thought” is the application of the solution. If the problem as be one of the practical type, then construction of a television, application is done in due course. Conclusions concerning intellectual problems should apply to the specific situations.

### **4.5.3 Characteristics of Scientific Method**

The scientific method is an elaboration of thought process and its distinguishing characteristics are the following:

- A problematic situation that finds no ready solution is the starting point of scientific method. Most of the scientific problems are concerned with cause and effect relations and lead to the discovery of new generalizations or laws or even application of known generalizations to new examples or facts (Deduction). As such problems of scientists are more difficult and complicated
- Careful and extensive observation, accurate measurement, critical distinguishing of likeness and differences, and generalization are necessary to locate and define the problem.
- Elaborate and deep thinking involving analysis, synthesis, careful methodical inference and imagination lead to several hypotheses or suggestions of problem solution. All available hypotheses are taken up for consideration without prejudice or personal influence.
- The implication of each hypothesis are reasoned out logically [eg:- Metals expand on heating. Test whether Zn or Cu expands on heating and tested by comparison with facts through



observation and experiment. If the derivations from the hypotheses do not agree with observed experiment facts it is rejected (or sometimes modified). This process is repeated until that suggestion which is imperfect agreement with facts is obtained.

- The most important characteristics is the tendency to discourage hasty or rash judgment. The scientists subject his conclusion to repeated, rigorous tests. So the conclusions in science possess a high degree of certainty than those in other fields. Nevertheless the scientist keeps his ideas and generalizations in a semi-fluid state and is always ready to alter or enlarge them in the light of new experiences.

## NOTES

### 4.6 Project Method

Project method was propounded by W.H.Kilpatrick. It is based on the philosophy of pragmatism. This method was perfected by J.A.Stevenson and was one of the predominant methods of teaching in schools in the U.S.S.R. till very recently, but has now been abandoned in favour of 'Polytechnization' the reason being that when the students arrived of the university or technical high school they were insufficiently equipped theoretically to follow the courses offered. It gave the children a superficial knowledge of great many things, but no proper groundwork of the foundation of education.

This method consists chiefly of building a comprehensive unit around an activity which may be carried on in the school or outside. The essence of the method is to carry out a useful task in a group in which all the students work co-operatively. The **curriculum, content and technique** of teaching are considered from child's point of view and demand the students should think and select their studies for themselves. 'Learning by Doing' and 'Learning by Living' are the two cardinal principles of this method. Children learn through association, co-operation and activity.

The term project has been defined by a number of people. It usually implies the separate following of individual problems by students or a small group of students over a period of few days or a few weeks and such problems may include several sub – problems. It may involve a variety of activities and generally it results in some physical outcome – '**product**', written report or a display.

**NOTES**

#### **4.6.1 Definitions of project**

- “A project is a unit of activity in which pupils are made responsible for planning and purposing”  
- **Parker**
- “A project is a problematic act carried to completion in its natural setting”.  
- **Stevenson**
- “A project is a whole-hearted purposeful activity proceeding in a social environment”.  
- **Kilpatrick**
- “A project is a bit of real life that has been imparted into school”.  
- **Ballard**

By analyzing these definitions, we see that a project has some purpose and there is planning to achieve that purpose which is achieved in social, real and natural situations created in the school.

#### **4.6.2 Principles of the Project Method**

- The Principle of freedom.
- The Principle of reality.
- The principle of purpose.
- The principle of activity.
- The principle of experience.
- The principle of social experience(or sociability)
- The principle of utility.
- The purpose of correlation.
- The principle of interest.

#### **4.6.3 Types of Project**

According to W.H.Kilpatrick Projects are of following four types:

- **Producer Projects:** In such projects, emphasis is directed towards the actual construction of a material object or article.
- **Consumer Projects:** Here the objective is to obtain either direct or vicarious experience, such as reading and learning stories, listening to a musical delectation etc.
- **Problem Project:** In problem projects the chief purpose is to solve a problem in involving the intellectual processes, such as determining the density of a certain liquid.
- **Drill Projects:** The objective of drill projects is to attain a certain degree of skill in a reaction as learning a vocabulary.

## NOTES

### 4.6.4 Steps involved in a project

#### a) Providing a situation

The teacher should provide such situations to the students which may create some problems for them and in which they feel interested to work.

#### b) Choosing and Purposing

The children should be tempted to choose a project. The teacher should stimulate discussions by suggestion. While choosing the project, the teacher should bear in mind that it should be of real need pupils. The purpose of the project should be clearly defined and well understood by the pupils. The project should be common and acceptable to all. In case of wrong choosing, the teacher tactfully guides them to see that their project is not good and should allow them to choose another project. They should be asked to write down reasons for selection.

#### c) Planning

Planning in a project is very important for the success of a project depends upon good planning. The students should plan out the whole scheme under the guidance of the teacher. The teacher should prepare two to three plans in his mind and guide the students in the light of those thought out plans. Every child should be encouraged to participate in the discussion and to make his suggestions. All the pupils are taught to write down the plan properly.

#### d) Executing

The teacher should assign duties and distribute work among the pupils of a group according to their interests and abilities. Every child should

**NOTES**

contribute actively towards the execution of the project. It is no use assigning a work to a wrong student, say, to give the work of painting or drawing to a student who cannot draw a straight line even, will be a folly. Student interested in reading should be given an assignment on referring books and collecting data, one interested in physical work may be assigned a similar work and so on. It is the longest step in the project and requires patience. A single project promotes great many activities of knowledge. The teacher should guide, encourage and watch the progress of students and should give instructions wherever need be.

**e) Evaluating**

The students review the project and find out the mistakes if there are any. Self-criticism is an important training and should not be neglected. The teacher will see to it that the objectives of the project have been achieved.

**f) Recording**

The students keep a complete record of work – how they planned, what discussions were held, how duties were assigned etc. and finally criticism of their own work and some important point for future reference.

<p><b>Check your Progress</b></p> <p><b>Note</b> a) Write your answer in the space given below</p> <p>b) Compare your answer with the one given at the end of the unit</p> <p>3. What are the two process of scientific method? ----- -----</p> <p>4. List out the principles of project method. ----- -----</p>
--

---

**4.7 LET US SUM UP**

---

In this unit, you have learnt the teaching methods as lecture, lecture cum demonstration, scientific and project. Each method has its own pros and cons depending upon the educational objective to be achieved,

the age of the learner, his stage of learning and the content. The teacher has to decide a suitable teaching method.

---

## 4.8 UNIT END EXERCISES

---

- Discuss the lecture method and its uses.
- Write a brief on lecture cum demonstration method.
- Differentiate analytic and synthetic methods.
- On what considerations should a teacher choose a project method? Explain.

## NOTES

---

## 4.9 ANSWERS TO CHECK YOUR PROGRESS

---

1. Lecture method is an educational presentation usually delivered by an instructor to a group of students with the use of instructional aids and training devices.
2. Lecture cum demonstration method is divided into Even System and Rotation Method.
3. The two process of scientific method are technical process and logical process.
4. The Principle of freedom, the Principle of reality, the principle of purpose, the principle of activity, the principle of experience, the principle of social experience(or sociability), the principle of utility, the purpose of correlation and the principle of interest.

---

## 4.10 SUGGESTED READING

---

- Aggarwal, J.C.(2007), *Essentials of Educational Psychology*, Delhi: Vikas Publishing House Private limited.
- Chaube,S.P.(1997), *Educational Psychology*, Agra: Lakshmi Narain Agarwal.
- Crow and Crow (1993), *Educational Psychology*, Delhi: Eurasian Publishing House.
- Dutt N.K. (1974), *Psychological Foundation of Education*. Delhi: Doaba House.
- Mangal, S.K.(2004), *An Introduction to Psychology*. Delhi: Sterling Publishers Private Limited.

**NOTES**

- Mangal,S.K.(2003), *Advanced educational psychology*. Delhi Prentice Hall of India.
- Mathew.T.K &T.M Mollykutty (2006) teaching of Science TNOU B.Ed Study Material , Chennai .
- Nagarajan,K(2002) , *Educational Psychology*. Chennai: Ram Publishers.
- Podhu,K.S,K.S.Premila,T.Samathkumar&D.Vinodhkumar(2009). *Educational Psychology*,B.Ed.,Course Material,TNOU,Chennai.
- Radhamohan (2010)Innovative Science teaching for Physical science teachers PHI Learning Private Ltd, New Delhi
- Santhanam, S.(1993), *Educational Psychology*. Chennai: Santha Publishers
- Saravanakumar.AR (2014) Enhancing Achievement in Science through Metacognition KVS Printers Karaikudi
- Saravanakumar. AR (2010) *Essential of Educational Psychology*, M.A. Education Course Material , DDE, Alagappa University Karaikudi
- Sprinthall, C, Richard and Sprinthall, A Norman(1990). *Educational Psychology: A development approach*. Newyork: Mc Graw Hill.
- Tromburgy D.Hershel.(1984) *Introduction of Educational Psychology*. Newyork: West Publishing Company.
- Venugopal, G.N Nithyasri &Prof K.Nagarajan (2013) Teaching of biology Sriram Publishers Chennai

---

# UNIT – V MICRO-TEACHING/ UNIT PLANNING / LESSON PLANNING

---

*Learning Resource in  
Science - II*

## **Structure**

5.1 Introduction

5.2 Objectives

5.3 Microteaching

5.3.1 Definition of Microteaching

5.4 Scope of Microteaching

5.5 Microteaching Cycle

5.6 Relevant skills in Microteaching

5.7 Unit plan

5.7.1 Definition of unit plan

5.8 Developing unit plan and Steps in unit planning

5.9 Characteristics of a good unit plan

5.10 Lesson planning

5.10.1 Definition of Lesson plan

5.11 Essential features and Importance of Lesson planning

5.12 Steps in Lesson planning

5.13 Preparing Lesson plan

5.14 Distinguishing Lesson plan and unit plan

5.15 Let Us Sum Up

5.16 Unit End Exercises

5.17 Answers to Check Your Progress

5.18 Suggested Readings

**NOTES**

**NOTES**

---

## **5.1 INTRODUCTION**

---

It is very well known that the quality of a nation is judged by the quality of its citizens. The quality of the citizens is mostly determined by the educational system in the nation, which in turn is decided by the quality of teachers. The quality of the teachers depends upon the soundness of the teacher education programs. The Indian Education Commission (1964 – 1966) have stressed, investment in teacher education can yield very rich dividends because the financial resources required are small when measured against the resulting improvement in the education of millions. First –rate teacher training institutions can thus play a crucial role in the development of education of a country. Regarding the present situations in student teaching programmers the Education Commission. (1964-1966) have observed: “At present student teachers are commonly required to give a specified number of isolated lessons many of which are often unsupervised or ill-supervised. The practice of continuous block teaching, the duration of which varies from two to six weeks, is adopted only in a few institutions and its organization still leaves much to be desired”.

---

## **5.2 OBJECTIVES**

---

- Learn the meaning and scope of microteaching
- Describe skills in micro teaching
- Apply relevant skills in micro teaching
- Understand the steps in unit plan and it characteristic.
- Explain the meaning, importance and steps in lesson plan.
- Distinguish the lesson plan and unit plan.

---

## **5.3 MICRO TEACHING**

---

### **5.3.1 Definitions of Micro Teaching**

- Microteaching has been defined in several ways. Allen, D.W. and Eve, A.W. (1968) defined microteaching as “a system of controlled practice that makes it possible to concrete on specific teaching behavior and to practice teaching under controlled conditions”.
- Allen, D.W. (1966) defined microteaching as “a scaled down teaching encounter in class size and class time”.



- Buch, M.B. (1968) has given a comprehensive definition of micro-teaching as a “teacher education technique which allows teachers to apply clearly defined teaching skills to carefully prepared lessons in planned series of 5 to 10 minutes. It encounters with a small group of real students, often with an opportunity to observe the results on videotape”.
- McAleese, W.R. and Unwin, D. (1971) defined microteaching as a scaled down teaching encounter in terms of time, class, size, lesson, length and teaching complexity.
- Passi, B.K. (1976) wrote that “the most important point in microteaching is that teaching is practiced in terms of definable, observable, measurable and controllable teaching skills”.
- Singh L.C. (1977) defined microteaching as “a scaled down teaching encounter in which a teacher teaches a small unit to a group of 5 pupils for a small period of 5 to 20 minutes. Such a situation offers a helpful setting for an experienced or inexperienced teacher to acquire new teaching skills and refine old ones”.
- A composite definition of micro teaching would thus be: Microteaching is a teacher training technique involving a specific teaching behavior/ skill of short duration – 5 to 6 minutes for a small class comprising 5 or 6 fellow teacher trainees/peer group on a single concept of subject matter.

---

#### **5.4 SCOPE OF MICROTEACHING**

---

- The teacher in the classroom uses several techniques and procedures to bring about effective learning in her students. These activities include introducing, demonstrating, explaining or questioning; the teacher could make use of nonverbal behaviors such as smiling, gesturing and nodding. These group of activities are called teaching skills. Acquiring a number of skills an experienced teacher can use these appropriately in her teaching, in order to achieve her lesson objectives.
- The teacher trainee is introduced to a wide range of teaching skills. Microteaching allows the teacher trainee to practice any one skill on her own, and then combine it with others when it has been mastered.
- A teaching skill has been defined in various ways, a few definitions will clarify the meaning of the term: McIntyre et al.

#### **NOTES**

**NOTES**

(1977) defined teaching skill as “a set of related teaching behaviors which in specified types of classroom interaction situations tend to facilitate the achievement of specified types of educational objectives”.

- Passi (1976) defined teaching skill as “a group of teaching acts or behaviors intended to facilitate pupil’s learning directly or indirectly”.

---

## **5.5 MICROTEACHING CYCLE**

---

Microteaching may be considered as a miniaturized classroom teaching. It may be described as a “scaled down” teaching encounter. A micro lesson at the practicing stage, like the rehearsal of a drama will not be a pleasant one. But it will be a good lesson for getting training in that specific skill. The following are the steps generally followed when this technique is employed for teacher training.

- Planning
- Teaching
- Feedback
- Replanning
- Reteaching
- Refeedback
- Thus the six steps generally involved in a microteaching cycle i.e. plan – teach – feedback – replan – reteach and refeedback are depicted in the following figure.

### **Steps in Micro – Teaching**

#### **Planning**

After deciding the skill to be practiced, the first thing to do is the presentation of a model of that specific teaching skill. A model can take the form of Videotape recordings of the requisite teaching behaviors, a film demonstrating the use of the skill, role-playing or written or spoken descriptions of a micro lesson exposing the skill. A teacher may also present a model lesson. Then the trainees criticize the model and learn to discriminate and identify the component behaviors of the skill. Keeping the model in view each trainee plans a micro

lesson based on the components of the skill. The lesson may be prepared for 5 or 10 minutes on the skill on a single concept.

### **Teaching**

After planning is over, the trainees teach the micro lesson in a micro class of 5 or 10 students. The students may be real student or peers, acting as students. The content of the lesson is generally a single concept. The whole lesson is built around a single teaching skill so as to maximize the use of behavioral components, involved in that skill during teaching. The lesson can be observed by either a supervisor or peer supervisor using a specially developed evaluation proforma for the skill. It can also be recorded in a tape recorder or on a videotape for later evaluation. Mostly a videotape recorder is used, if available. This session is called teach session.

### **NOTES**

### **Feedback**

After the teach session, the trainee is given the feedback. If a videotape recorder is being used, he can go to a viewing room with or without the supervisor and assess his attempt at using that particular teaching skill. He may compare his performance with the model. If there is no videotape recorder the supervisor may go out to a different room along with the trainee. They discuss the extent to which the trainee could demonstrate the skill in the light of the previously decided model. The sources of feedback may be many. They can be student peers, supervisor, self, video recording, the observation perform a filled by these observers. The feedback can be prescriptive or descriptive. This session may be termed as view/assess/ feedback/ critique session. Time devoted may be 5 to 10 minutes.

### **Replanning**

After getting feedback, the trainee goes to another room where he re-plans or restructures his lesson. In this light of the feedback received during the earlier session. This session is known as replan / restructure session, which may last for 5 or 10 minutes.

### **Reteaching**

After replanning the lesson, the trainee reteaches the same unit, which is restructured to the same or different, set of students. Similar supervisor of the lesson will go on as in teach session.

## **Refeedback**

After reteach sessions there will be refeedback regarding the lesson whatever may be the source of feedback. This session is, termed as review/ refeedback/ recritique session. All the sessions may be together called as one microteaching cycle.

## **NOTES**

---

### **5.6 RELEVANT SKILLS IN MICRO TEACHING**

---

The major premise underlying the concept of microteaching is that the complex teaching act can be split into component skills; each simple, well-defined and limited. These skills can be identified, practiced, evaluated, controlled and acquired through training.

A large number of skills have been identified. The first effort made by Allen and Ryan resulted in identifying fourteen skills, Singh L.C. (1979) makes references to twenty two general teaching skills, Menon et al. (1983) have suggested a list of seventy four skills.

These skills have been chosen as they foster teacher-pupil interaction, particularly as they belong to the four areas of motivation, presentation, recapitulation and questioning. These are the skills of

- Set Induction / Introduction
- Explaining
- Stimulus variation
- Reinforcement
- Questioning
- Blackboard writing
- Demonstration
- Closure

These skills are discussed giving the major components, the objectives and a simple appraisal guide.

#### **Skill of Introduction / Induction**

This is a pre-instructional technique. Training in set helps the teacher prepare students for the lesson in order to induce the maximum pay – off in learning. **Set is more than a brief introduction.** Its purpose is

to get the students in the mood, clarify the goals of instruction, using students' present knowledge and skills to involve them in the lesson. Instructional set can vary in length and in elaborateness. It can take many forms: on analogy, a demonstration, posing an intriguing problem.

The major components of the skills of introduction are: gaining attention, arousing motivation, structuring and making links.

## NOTES

### **Skill of Explaining**

A teacher is said to be explaining when s/he is describing 'how', 'why' and 'what' of a concept, phenomenon, event, action or condition. Explaining can be defined as an activity to bring about a concept, principle etc. It is an activity to fill up a gap in someone understands. The skill of explaining aims at making sure that the explanation is understood. All teachers should strive to perfect the skill of explaining accurately and effectively.

- To enable his/her pupils to describe processes, structures and procedures.
- To enable his/her pupils to state reasons why events occur and predict possible consequences of events.

### **Skill of Stimulus Variation**

Training in the skills of stimulus variation is aimed at helping teacher trainees to avoid-teaching styles likely to induce monotony in the classrooms. A stimulus situation that changes in different ways is one of the most powerful influences in maintaining interests in the students in the class. Some of the things the teacher can do are use of movements, avoidance of teaching standing in one spot, use of gestures, and development of verbal and nonverbal methods to hold the students' attention.

The skill of stimulus variation covers the activities the teacher can introduce to every the presentation methods used in a lesson. This skill is concerned with three main areas of teaching. They are:

- The manner, voice and teaching style of the teacher.
- The media and materials used during teaching.
- The teacher/pupil relationship during the class.

**NOTES**

**Skill of Reinforcement**

Reinforcement skill can increase students' involvement in their lessons in a number of positive ways. The skill is being used when the teacher reinforces good behavior with a smile, when the teacher praises a good answer, or encourages a slow learner. Such positive reinforcement strengthens desirable behavior, increase student participation. Negative reinforcement, on the other hand, weakness are undesirable behavior.

**Skill of Questioning**

A good teaching technique employs different questioning levels, techniques and direction.

**Questioning levels**

- Low level questions: It is the lowest or preliminary knowledge level questions, which requires the students to recall information that he has stored. Therefore a low level response requires memorization on the part of the student and requires no processing of information.

Examples: Who discovered nitrogen?

What are rare gases?

The simplest key to follow is that a question whereby a student has to just recall information, such as terms, facts, names and events, is a low level question.

- High level questions: This requires a degree of intellectual processing on the part of the student – comprehension, application, analogy, synthesis and evaluation.
- Examples:

Questions beginning with

“Why do you suppose...?”

“Give me an example from your life...”

- Description questions: Such questions are easy to ask, quite easy to answer and excellent for promoting student involvement.

Examples: Observe and describe the illustration or demonstration.

“What do you notice here?”

“Describe the precipitate”

- Comparison questions: Such questions require the learner to look at two or more objects, statements, illustrations or demonstrations and identify similarities or difference between them.

Examples:

1. How does fluorine differ in its reaction with metals from the other halogens?
2. Compare the working of a force pump and a lift pump.

### **Skill of Blackboard Writing**

The importance of effective blackboard writing cannot be stressed enough, especially in a country like India. “Operation Blackboard” aspired to equip every single school in the country with blackboards which implies that every potential teacher should be proficient in the use of the blackboard. Good blackboard writing leads to the following:

- Clarity in understanding concepts
- Reinforcement of the matter which is being conveyed verbally by the teacher.
- Presentation of a holistic picture of content.
- Variety and draws attention of the pupils to the relevant points.

### **Skill of Demonstration**

This skill is highly needed in the subjects of practical relevance in science, as the teacher has to demonstrate the working of an apparatus, functioning of an instrument, preparation of a gas etc. This helps the students in acquiring the essential knowledge, understanding, skills and applications regarding the concerned facts, principles, concepts and activities. The teacher has to take care of several components behavior for acquisitions. of this skill. The components include handling of equipment and materials, relevant subject matter,

### **NOTES**

## NOTES

pupil's participation, visibility of the demonstration work, drawing relevant inferences, emphasizing cause and effect relationship etc.

The skill of demonstration helps the students to understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

The first step in using this micro-skill is to carefully define what we would like the students to be able to do. Demonstration in science skills is categorized into three separate groups: Science Process Skills, Reasoning Skills, and Critical Thinking Skills.

### **Skill of Closure**

This skill is complementary to set induction. It involves training in different methods of concluding a lesson with the student taking steps to ensure that the pupils have understood and are able to see the connections with other phenomena. It is more than a quick summary of the portions taught and the pupils are able to relate new knowledge with the previous one.

The skill of closure assist students to establish links between new and past knowledge by reviewing and applying material to familiar and new examples, cases, and situations.

Generally closure can be achieved by following steps:

- Making a review. Both making a spoken summary and making a written summary have to be done in this section.
- Giving psychological/social encouragement to the class
- Examining how well the objectives of the lesson have been achieved
- Giving feedback
- Reflection



**Check your Progress**

**Note** a) Write your answer in the space given below

b) Compare your answer with the one given at the end of the unit

1. What are the steps in microteaching cycle?

.....  
.....

2. List some skills of teaching

.....  
.....

**NOTES**

---

**5.7 UNIT PLAN**

---

The lesson plan is a plan for a single period. Teachers can prepare the lesson plans for every period. They can also prepare the plan for the entire unit in the book instead of preparing it for every period. The preparation of the plan for entire unit or group of related topics in the textbook is called as “unit plan”. This unit plan may be used for four or five periods depending on the quantity of content in the unit. This simplifies the work of the teacher since he need not prepare the lesson plan for every period.

Planning is a pre-requisite for effective teaching. A student teacher or a novice in the profession finds that it is most rewarding to plan for teaching . Planning is a decision making process where a biology teacher fathers decision about various aspects of teaching and learning; such as expected learning outcomes, selection and organization of content, learning activities and evaluation procedures. Thus a plan includes all the instructional activities that the teacher will use in teaching. The teacher is at liberty to prepare a plan for a period or for a unit or topic. If he prepares a plan for the period it is called “period lesson plan” and if he plans for a unit it is called “unit plan”.

**5.7.1 Definition of unit plan**

The term unit signifies the ‘unity’ or ‘wholeness’ for the learning activities related to some problem of them. Planning involves the selection of proper, suitable techniques or procedures from the alternative ones. Therefore unit planning is an organizations of

**NOTES**

activities and resources with its focus on the expected outcomes to meet the needs of students.

According to Preston: “A unit is as large a block of related subject matter as can be overviewed by the learner”.

According to Bossing: “A unit consists of a comprehensive series of related and meaningful activities so as to achieve students’ purpose, provide significant educational experience and result in appropriate behavioral changes”.

---

### **5.8 STEPS IN UNIT PLANNING**

---

A unit should always be viewed as an integrated whole. While planning a unit, the following factors should be kept in mind:

- Content analysis (the what of the unit)
- Objectives with specifications (the why of the unit) ]
- Learning activities (the how of the unit)
- Testing procedures (evidence of achievement)

---

### **5.9 CHARACTERISTICS OF A GOOD UNIT PLAN**

---

- The aims should be clear and well defined.
- It should cater to the needs, capabilities and interests of the students.
- A good unit should provide suitable activities for students.
- A good unit should be flexible enough to provide for individual differences.
- A unit should have meaningful segments of well-organized subject matter.
- It should provide for project work, excursions, film viewing and the like.
- A unit should not be too lengthy or too short.
- The length of the unit should be such as to retain the interest of the students.

- A good unit should be such as to retain the interests of the students till the end.
- It should be part of a sequence that permits growth from year to year.

---

## 5.10 LESSON PLANNING

---

## NOTES

Good lesson planning is the key to successful teaching. Lesson planning in advance has a futuristic implication which permits a teacher to anticipate pupils' reactions, any by using these reactions to prepare adequately in order to avoid foreseeable difficult. It helps a teacher manage her time effectively.

### 5.10.1 Definitions of Lesson plan

A lesson plan is a teacher's detailed description of the course of instruction for an individual's lesson – Wikipedia, the free encyclopedia

Good defined a lesson plan as an “outline of the important points of a lesson arranged in the order in which they are to be presented to students by the teacher”.

---

## 5.1 1ESSENTIAL FEATURES AND IMPORTANCE OF LESSON PLANNING

---

Lesson plan is actually a plan of action. A teacher without lesson plan ends his day tired from his efforts to keep proper discipline in the class and discouraged with his failures. A teacher with good plans is also tired, but his tiredness is tempered with the joy of satisfaction. The advantage of lesson plan can be listed as follows:

- It makes the teacher's work regular, well organized and systematic.
- It prompts confidence and self –reliance in the teacher.
- It helps the teacher to proceed with particular aims in view and thus makes him conscious of interests and attitudes to be developed in the students.
- It renders a saving in time, for the students have a better understanding of the subject and develop some desirable attitudes in a specified time, while in the absence of a

## NOTES

plan it might have taken more time for the similar understanding.

- Lesson plans establish proper connections between different lessons of study. Therefore, they provide continuity in the teaching process.
- It stimulates the teacher to introduce striking questions and illustrations.
- It provides greater freedom in teaching, for a teacher who has properly planned his lesson, enters the classroom with confidence; without any anxiety, ready to attack the problem and prepared to carry it out like a skilled workman.
- It helps the teacher to plan the teaching aids to be used in the class, well in advance and also ensure their workability.
- It avoids wastage of time.

---

### **5.12 STEPS IN LESSON PLANNING**

---

There were various forms of written lessons plans used by practicing teachers. A teacher needs some information about the class, students and their background before he/she attempts to plan a lesson. Usually a lesson is divided into many stages or steps. When a detailed lesson plan is being developed, all these steps are used in some form or the other. In the above section, we have given you an idea about some of the approaches of lessons planning. In this section we will help you to write your plans based on different approaches.

#### **Herbartian approach**

The steps of the Herbartian approach are given below:

- General information regarding the subject, topic, class, age level of children estimated time.
- Instructional Objectives
  - General Objectives
  - Specific Objectives

## NOTES

You are aware that different subjects at different grade levels have some general objectives whereas specific objectives are written in behavioural terms as they focus on the expected outcomes of our teaching the topic over a given period of time. These specific objectives, also known as instructional objectives must be measurable and observable. You are required to identify your behavioural objectives and state them in a clear and unambiguous language.

- **Instructional aids**

Select teaching aids which you think proper for clarifying the concepts to be

taught: List all such teaching aids used in the form of charts, static or dynamic

model, real specimens, etc.

- **Testing of previous knowledge**

Development of the lesson is based on the previous knowledge of your students. We have to assume the previous knowledge of students related to the content to be taught and test it through a single direct question.

- **Introduction**

This step mainly concerns with introducing a topic through introductory questions or by creating the appropriate situation. The focus is on preparing our students to receive new knowledge by linking it with their previous knowledge.

- **Presentation**

Presentation comprises of the ways in which relevant content is presented. Most of the teachers develop their lesson with the help of developing questions and using student's responses for further presentation of the content. This presentation or development stage is interactive in the real classroom situation; it depends on teachers' communication skills and teaching skills like questioning, explaining, giving demonstration and providing reinforcement on desirable student behaviour.

- **Recapitulation**

Recapitulation of the lesson helps the teacher to find out the extent of learning that occurs during the period of instruction. It can be done by

**NOTES**

asking several questions. This stage provides feedback to the teacher about his/her teaching process.

- **Black Board Summary**

Teacher writes the summary of his teaching points and explanations. It is to be developed simultaneously when lesson is being developed.

- **Home Assignment**

At the end of the session, suitably and thought provoking questions or activities must be planned and given to the students. It gives a change of reception or practice to the students. It also gives an opportunity to them to assimilate, whatever they have learned.

### **Evaluation approach**

The design of lesson plan according to this approach consists of three aspects: (i) Input, (ii) Process and (iii) Output.

- **Input**

It includes the identification of objectives in behavioural terms. They are known as Expected Behavioural Outcomes (EBOs). The entering behavioural of the learners is also identified. The sequence of instructional procedure is determined with the help of these instructional objectives. These objectives are broadly classified into four categories: knowledge, understanding, application and creativity. You have to write objectives in behavioural terms.

- **Process**

This is an interactive stage when you are actually in the classroom and communicating with your students. You have to select different teaching strategies, audio-visual support materials for effective presentation of the content.

- **Output**

This aspect of instructional procedure refers to real learning outcomes (RLOs). This is equivalent to terminal behaviour which is usually measured by using oral and written questions. Output aspect is concerned with evaluation of the desirable behavioural change among students.

---

## 5.13 PREPARING LESSON PLAN

---

Effective teaching needs proper planning, transaction in the classroom and feedback. Practically there are three stages of a planned lesson: pre-active, interactive and post-active. Pre-active stage is a stage of planning before going to the classroom. The interactive is a stage of interaction between teacher and his/her students in the real classroom situation. Post active stage is a stage of self-evaluation of our teaching work.

There cannot be a single format for writing a lesson plan because it varies from teacher to teacher and subject to subject, the only thing which can be suggested is that it should be a well-ordered structure which follows some basic fundamental parts of a lesson. Some of the formats based on different approaches to lesson planning discussed in section are suggested below for your guidance. You are free to make changes according to the objectives you plan to achieve and the nature of the subject etc.

### Herbartian Lesson Plan Format

Subject : Date :  
Unit : School :  
Topic : Class :  
Duration : Period :

- General Objectives :
- Specific Objectives :
- Teaching Aids :
- Method :
- Previous Knowledge :
- Introduction :
- Statement of the Topic/Aim :
- Presentation or Development of the Lesson :

Teaching Points      Teacher's Activity      Students' Activity

OR

**NOTES**

**NOTES**

Content	Objective	Teaching-Learning
	Evaluation	Activities
<ul style="list-style-type: none"> <li>• Recapitulation :</li> <li>• Black Board Summary :</li> <li>• Home Assignment :</li> <li>• References :</li> </ul>		

**5.14 DISTINGUISHING LESSON PLAN AND UNIT PLAN**

S. No	Lesson Plan	Unit Plan
1.	A daily action plan	Extends over more than 8 or 10 periods, depending on the subject matter, the objectives to be achieved and the learning activities
2.	Content presented in the form of teaching points, in logical and psychological order	Content is grouped in terms of facts, principles, generalizations etc.
3.	Learning activities in detail	Learning activities just mentioned
4.	Actual test items given	Evaluation tools and techniques just mentioned
5.	Part of the whole	Made up of several lesson plans



**Check Your Progress**

**Notes :**

- a) Write your answer in the space given below.
- b) Compare your answer with the one given at the end of the unit.

3. Define unit plan

.....  
.....

4. List out the four categories of educational objectives.

.....  
.....

5. What is pre-active stage?

.....  
.....

**NOTES**

---

**5.15 LET US SUM UP**

---

In this unit, you have learnt about micro teaching, unit planning and lesson planning. Microteaching is laboratory training approach. It is a scaled down method of teaching in which time number of student's skills to be practiced are reduced. Teaching take places only for 5-7 minutes for only 5-6 students. Immediate feedback is obtained and the student teacher replan and teaching again till the particular skills is mastered until they learnt the need, advantage and the strategies of planning. A good planning is useful for various purposes. Long term, short term planning are the two kinds of strategies of planning. The unit plan is written for teaching a topic or concept which may consists of many lessons. Lesson plan is written for teaching a particular lesson to be taught within 45 minutes. Usually Herbart approach is used for writing lesson plan. Introduction, presentation, comparison, principle, detection and application are the five steps involved in Herbartian approach. Then, you have learnt how to write a unit plan and lesson plan. The proforma for each one has also been discussed.

---

**5.16 UNIT END EXERCISES**

---

1. How to arrange Micro –teaching cycle?
2. How can you prepare a good lesson plan?
3. Discuss the skills in micro –teaching.
4. Prepare a Herbartian lesson plan.

**NOTES**

5. Differentiate the lesson plan and unit plan

---

### **5.17 ANSWERS TO CHECK YOUR PROGRESS**

---

1. plan – teach – feedback – replan – reteach and refeedback.
2. Set Induction / Introduction, Explaining, Stimulus variation, Reinforcement, Questioning, Blackboard writing, Demonstration and Closure
3. According to Preston: “A unit is as large a block of related subject matter as can be overviewed by the learner”.

According to Bossing: “A unit consists of a comprehensive series of related and meaningful activities so as to achieve students’ purpose, provide significant educational experience and result in appropriate behavioral changes”.

4. knowledge, understanding, application and creativity.
5. Pre-active stage is a stage of planning before going to the classroom.

---

### **5.18 SUGGESTED READINGS**

---

1. Venugopal, G.N Nithyasri & Prof K.Nagarajan (2013) Teaching of biology Sriram Publishers Chennai
2. Radhamohan (2010) Innovative Science teaching for Physical science teachers PHI Learning Private Ltd, New Delhi
3. Mathew.T.K &T.M Mollykutty (2006) teaching of Science TNOU B.Ed Study Material , Chennai .
4. Saravanakumar .AR(2014) Enhancing Achievement in Science through Metacognition KVS Printers Karaikudi

---

## **UNIT VI LEARNING RESOURCE IN SCIENCE – I**

---

### **Structure**

- 6.1 Introduction
- 6.2 Objectives

## 6.3 Science Laboratory

### 6.3.1 Structure and Design

## 6.4 Organization and Maintenance of Science Laboratory

### 6.4.1 Organization of Laboratory

### 6.4.2 Laboratory Equipments

### 6.4.3 Maintenance

## 6.5 Maintenance of Registers

### 6.5.1 Types of Registers

### 6.5.2 Use of Stock Registers

## 6.6 Storage of Chemicals

## 6.7 Organization of Practical work

## 6.8 Let Us Sum Up

## 6.9 Unit –End – Exercises

## 6.10 Answers to Check Your Progress

## 6.11 Suggested Readings

## NOTES

---

## 6.1 INTRODUCTION

---

“To learn science is to do science. There is no other way of Learning science”.

**- Dr. D.S. Kothari**

Science Laboratory plays an important role in teaching science. It is hard for a genuine science teacher to teach science or provide opportunities and great learning situations without advocating laboratory. Laboratories are wonderful setting for teaching and learning science. Students can discover & learn the scientific concepts by doing experiments in the lab. While constructing the science lab one must plan the required space. Various connections adopted to make the efficient lab.

---

## 6.2 OBJECTIVES

---

1. Develop the scientific concept and principles.

2. Explain the structure and design of Science laboratory.
3. Understand the organization and maintenance of Science laboratory.
4. Describe the storage of chemicals organization of practical work.

---

## **6.3 SCIENCE LABORATORY**

---

### **NOTES**

Laboratory is a place where students and teachers do experiments in order to prove the theories in the textbooks. When the students do the experiments, some accidents may occur. These accidents may not occur in well-organized and maintained laboratories. Whatever may be the nature of organization and maintenance the students are the people who perform the experiments. Because of their inexperience, they may come across accidents. We cannot give guarantee that accidents may not occur in a laboratory. But, the occurrence of the accidents can be avoided or prevented. When some accident happen in a laboratory, the first questions asked is whether all necessary to take precautions have been taken or not, so the teacher is expected to take necessary safety precautions for each and every experiment. In addition, the science teacher, who is in charge of laboratory, takes the general precaution with regard to the entire laboratory.

### **6.3.1 Structure and Design**

#### **Practical Work by Individuals or Small Groups**

Students may opt for one of the following possible options:

- All pupils working on the same experiment;
- All pupils moving from one experiment to another in a cyclic manner
- All pupils working on different experiments and reporting to the class during the discussion;
  - Individual work based on an individualized approach;
- Long-term practical work projects which may extend over a term.

**Design criteria:** To carry out each of these activities efficiently, the usual range of services near fixed or movable benches and availability of resources is required.

### **Lecture/ Demonstration:**

The experiment may be demonstrated:

- From work benches at suitable points in the laboratory; or
- From a trolley placed at a suitable point.

**Design criteria:** All students should get a clear view of the demonstration an arrangement of furniture and pupils for individual practical work/written assignments and one plan for watching a demonstration. Thus, in the all-purpose laboratory (8m x 11m), furniture is arranged for individual practical work. The same laboratory can be used for lecture demonstration by shifting the furniture suitable. The tables with sinks cannot be moved.

### **Discussion**

The discussion related to the demonstration among the students is

- In small groups.
- In a compact group helping with the design of an experiments;
- At the work benches, discussing on a class basis the implications of some observations.

**Design criteria:** Pupils at their work benches should be able to see the teacher and vice versa. This is also essential from the safety point of view in laboratories. Movable tables, which can create space for a class discussions are an advantage.

### **Audio – Visual Activities**

The teacher and the students are jointly involved in the following audio-visual activities.

- Using an overhead projector;
- Screening a film, with a 16 mm projector;
- Observing slides (under a microscope or on a projector);
- Watching's a TV/CCTV programme
- Displaying a chart.

**Design criteria:** Most of these visuals aids can be used under normal daylight. The factors to be considered during design are:

**NOTES**

## NOTES

- The position of the screen;
- The number of pupils viewing;
- The relative positions of screen and window;
- The seating arrangements in the laboratory;
- The availability of the projector stand and trolley;
- The proximity of suitable electric sockets;
- Curtains/ venetian blinds.

### **Display Exhibition Area**

In the display area of the laboratory, there should be provisions for

- Charts, diagrams, reports;
- Apparatus, models, projects;
- Light objects hung from the ceiling.

**Design criteria:** Provision of pin-board in all display areas is essential. The use of movable screens covered with colored cloth is convenient. Gazed top exhibition cupboards and low tables are suitable for exhibition of books, apparatus and specimens.

### **Services**

For a science laboratory, adequate and appropriate provision of services is of the utmost importance and basic to the organization of practical activities. The requirements vary and are dependent on the age group of the pupils and the specific demands of the subject. For instance, chemistry laboratories make special demands on water but a generous supply of electrical main outlets.

The teachers should have easy access to mains, gas, electricity and water controls in the laboratory. The provision of services at different locations and for different functions needs to be considered at the design stage itself. Particular attention should be given to the following areas:

- Demonstration positions
- Pupil's working points, taking subject-specific requirements into considerations

- Dark rooms
- Workshops
- Preparation areas
- Fittings like fume cupboards, centrifuges etc.
- Services such as television, projectors etc.

## NOTES

### **Environmental services and controls**

The provision of a pleasant and comfortable working environment should be the main consideration at the planning stage. The points to be kept in mind are:

- Adequate provision of heating and proper ventilation system
- Proper lighting
- Noise-free or minimum noise premises.

---

## **6.4 ORGANIZATION AND MAINTAINENCE OF SCIENCE LABORATORY**

---

The management takes faced by the head of school are manifold. In pursuing the objectives for the school, the head has to make the best use of available human and material resources, and delegate authority for the various subject areas to the appropriate heads of departments while retaining final responsibility. The head of a science department has similar management functions as the head of the school, though on a different scale, evidently, the major responsibility is the implementation of policy decisions affecting science curriculum, in the school. The overall aim of the head of a science department should be the development of a stimulating and interesting environment in which pupils, science staff and ancillary staff can work with initiative towards appropriate goals.

### **6.4.1 Organization of the Laboratory**

The tasks of organization and administration within a science department are likely to be more effectively carried out if we consider the following points in mind.

## NOTES

- **Time –Tables**

The copies of the complete school time table, the laboratory time tables and time tables of all science teachers, should be displayed on large pin boards for easy-reference.

- **Notice board**

A Notice board should be fixed outside the science laboratory with up-to-date information. This should contain science laboratories time tables, lists of experiments in each cycle, a list of laboratory rules, public examination timetables etc.

- **Storage System**

A well-organized storage system enables easy collection of apparatus from the store and its transfer. According to the facilities available in the school one must plan the location and design of preparation and storage facilities.

### **6.4.2 Laboratory Equipments**

Physics laboratory should have the following equipment:

- (i) Working tables (ordinary) with teak wood top.
- (ii) At least one table having gas point fitted to it. This may be used for experience on heat.
- (iii) Projected platforms for balances.
- (iv) Almirahs
- (v) Demonstration table having draws, water and gas points.
- (vi) Wall board or black board.
- (vii) Two large sinks at the corners of the laboratory.
- (viii) Stools (in two sizes)
- (ix) Physics laboratory should have an attached dark room.

### **6.4.3 Maintenance**

- Apparatus should be purchased in sufficient quantity which can be stored in the laboratory; otherwise it will be destroyed or soiled.



- Every item should be designed a fixed place.
- Registers (consumer, breakage, stock, order) should be updated regularly.
- Remaining items should be kept on racks, ready for use.
- Heavy items like cans of distilled water, iron stands should be kept in the lower part of shelves.
- Reagents and chemicals in frequent use should be kept on working table racks.
- Poisonous and other corrosive chemicals should be kept under lock and key.
- All chemicals should be clearly labeled.
- All the apparatus should be cleaned after use.
- Chemicals like silver nitrate, which decompose on exposure to light, should be kept in coloured bottles and hygroscopic chemicals stored in air-tight jars/containers.
- Minimum use of chemicals should be encouraged for experiment.

## NOTES

### Check Your Progress

#### Notes :

- a) Write your answer in the space given below.
- b) Compare your answer with the one given at the end of the unit.

1. How was the experiment demonstrated?

.....  
.....

2. What are the points keep in mind in the environment services?

.....  
.....

---

## 6.5 MAINTENANCE OF REGISTERS

---

### 6.5.1 Types of Registers

After the receipt of the apparatus, the articles should be properly checked and entire in the stock registers. A proper record of the science apparatus is very important to check any article at any time and it also facilitates in giving concrete answers to management during auditing.

#### NOTES

The types of registers which a science department can maintain are;

- Permanent stock register
- Breakable stock register
- Consumable stock register
- Order register
- Requirement register

#### Permanent stock register

The permanent stock register contains details of items which are not liable to be consumed or broken like troughs, test-tube racks, magnets, wooden stands etc. some articles like lenses, thermometer, ammeters are also entered in this register, as they are considered non-consumable. Also in this register, one could enter the working and non-working models, the laboratory has, viz. Charts, cameras microscopes, telescopes and spectrometers.

#### Specimen of Permanent Stock Register Item

Month and Date	Particulars	Details of Company Rate	No. of Breakage Items	No. on Hand	Teacher's Signature

#### Breakable stock register

The breakable stock register will include articles of glassware like flasks, test-tubes, beakers, funnels, pipettes, burettes etc.

<b>Specimen of Breakable Stock Register</b>	<b>Date</b>	<b>Details of Broken Items</b>	<b>Signature of the Student</b>	<b>How the Breakage Took Place</b>	<b>Signature of the Science Teacher</b>	<b>Head of the Dept.</b>
<b>Consumable stock register</b>						

Chemicals and other fluids to be consumed like

distilled water, copper sulphate, magnesium wire, sulphuric acid are entered in this register.

### **Order register**

The order register includes a record of the requisitions sent for the purchase of new apparatus. The entries should include serial number and date of order, name of the company, the articles ordered, articles received, cost of each item, total cost of each item etc. It is a good practice to staple the copy of the order on hand, page of the register and voucher (or Photostat of voucher) on the right hand page of each order.

### **Requirement register**

The most suitable way of collecting suggestions for new resources for the science staff, including the head of the departments, is to note the ideas in a requirement register. These suggestions should be dated, contain a clear specification, name the supplier and give an indication of the price. It may be helpful to categorize these suggestions as essential, highly desirable or luxury, so that priorities can be drawn when placing orders.

### **Use of Stock Registers**

- All the pages of every stock register should be numbered.
- On the outer cover of each register, the following particulars should be written.
  - Name of the school
  - Name of the register

## NOTES

- Number of the volume of the register
  - Total number of pages
  - Dates on which it was opened and closed.
- 
- The stock register should be divided into a number of portions under various headings like Mechanics, Heat, Light etc.
  - Entries in each portion should be made alphabetically.
  - The first few pages of the register should be left blank for index, which will help in tracing any article without waste of time.
  - Sufficient space must be left between the entries to facilitate additions in their proper places.
  - Breakage and items consumed should be entered in the column provided in the stock register.
  - The stock register should be initialed by the teacher in-charge and the head of the institution at the end of the academic year.

---

### **6.6 The Storage of Chemicals**

---

The chemicals on the shelves in the cupboards should be grouped in a systematic manner. The commoner chemicals should be arranged in such a manner that all the compounds of one element are placed together. The elements are often arranged in alphabetical order. An alternative method is to arrange the elements and their compounds in the order in which they occur in the groups of the periodic table. A third method is to group all the elements, oxides, sulphates, citrates and other similar compounds together.

Whichever method is used, it is an advantage to number each bottle or jar and to have an under book so that any substance can be located at a moment's notice. The bottles must be replenished periodically. All labels should be brushed over with melted paraffin wax in order to avoid fading and prevent deterioration and to ensure permanent adhesion.

---

### **6.7 Organization of Practical work**

---

The science teacher will have to plan her lesson such that the theory and practical work complement each other. This will help maintain close relationship between the laboratory experiments and demonstrations with the concepts dealt with and developed in the theory class.

Practical work can be classified into three types:

- demonstrations
- laboratory work by students
- project work.

Demonstrations are generally done by the teacher, either in the classroom or in the laboratory. Students can help in the arrangement of the apparatus and in the doing of the experiment.

Laboratory experiments are done by the students – either individually or in groups.

Project work could be done either in the school laboratory or out of the classroom, depending on the nature of the project.

**NOTES**

### **6.8 LET US SUM UP**

In this unit, we have discussed the planning, management of Science Laboratory in which we have touched upon the broad

aspect such as laboratory objectives, different types of laboratories (i.e) for high schools and for higher secondary schools. Maintenance and storing of equipments and other science materials can be handled in a safe way.

#### **Check Your Progress**

Notes : a) write your answer in the space given below

b) Compare your answer with the one given at the end of the unit

3. What are the types of register maintain in Science lab?

.....

4. List out the three types of practical work.

.....

### **6.9 UNIT END EXERCISES**

- Draw a layout of your school science laboratory and suggest improvements.

**NOTES**

- Describe some of the accidents that generally occur in the laboratories & state the procedure you adopt in each case for relief.
- How far can the development of laboratory skills in the children help in effective science learning?

---

### **6.10 ANSWER TO CHECK YOUR PROGRESS**

---

1. The experiment may be demonstrated:

- From work benches at suitable points in the laboratory; or
- From a trolley placed at a suitable point.

2.

- ❖ Adequate provision of heating and proper ventilation system
- ❖ Proper lighting
- ❖ Noise-free or minimum noise premises.

3.

- ✓ Permanent stock register
- ✓ Breakable stock register
- ✓ Consumable stock register
- ✓ Order register
- ✓ Requirement register

4.

- demonstrations
- laboratory work by students
- project work.

---

### **6.11 SUGGESTED READINGS**

---

- Ahmed, Shakhty. R.(1983). Management of laboratory Science Program me. New Delhi: Report of orientation Programmed in Educational Planning and administration, NIEPA (MIMEO).
- Aretha, P. (2004). I-Edition, Methods of Teaching Biological Science. Hyderabad: Neelkamal Publications Pvt. Ltd.
- Das, R.C., Gupta. S,K. (1985). Science Teaching in schools. New Delhi: Sterling Publications Pvt.Ltd.
- Mathew.T.K &T.M Mollykutty (2006) teaching of Science TNOU B.Ed Study Material , Chennai .
- Radhamohan (2010)Innovative Science teaching for Physical science teachers Phi Learning Private Ltd, New Delhi
- Saravanakumar .AR(2014) Enhancing Achievement in Science through Metacognition KVS Printers Karaikudi
- Sharma, R.C., Shula, C.S., (2002). IV-Edition, Modern Science Teaching. New Delhi : Dhanpat Ray Publishing Company (P) Ltd. Email : dhanapatrai @ vsnl.com
- Stood, J.K., (1987). Teaching of life science. Chandigarh : Kohl Publishers
- Thurber, W.A., & Collette, A.T., (1964). Teaching Science in Today's Secondary Schools. New Delhi : Prentice Hall of India Pvt.Ltd.
- Vanaja, M. (2005). I-Edition. Methods of Teaching Physical Science. Hyderabad : Neelkamal Publications Pvt. Ltd, www.neelkamalpub.co.
- Venugopal, G.N Nithyasri &Prof K.Nagarajan (2013) Teaching of biology Sriram Publishers Chennai

## **NOTES**

---

## UNIT VII - LEARNING RESOURCE IN SCIENCE – II

---

### NOTES

#### Structure

7.1 Introduction

7.2 Objectives

7.3 Accidents and First Aids

7.3.1 First – Aid kit

7.3.2 Safety Equipment

7.4 Improvisation of Apparatus

7.5 Qualities of a Good Science Text book

7.5.1 Author

7.5.2 Physical setup and Organization

7.5.3 Subject Matter

7.5.4 Language Style and Vocabulary

7.5.5 Illustrations

7.5.6 Binding and Appearance

7.6 Criteria for Evaluation of Science Textbooks

7.7 Let Us Sum Up

7.8 Unit –End – Exercises

7.9 Answers to Check Your Progress

7.10 Suggested Readings

---

### 7.1 INTRODUCTION

---

“To learn science is to do science There is no other way of Learning science”.

- **Dr. D.S. Kothari**



Students can discover & learn the scientific concepts by doing experiments in the lab. During the experiments in science lab, one must aware of first aid kit, registers and accidents. Science textbooks and its physical setup, organization, subject matter plays a significant role for studying science. Usage of textbooks inside and outside the classroom is helpful for the learners to learn the concept with proper understanding.

## NOTES

---

### 7.2 OBJECTIVES

---

1. Understand the accident and first aid.
2. Recognizes the improvisation of apparatus.
3. Develop the qualities of a good science textbook.
4. Importance to the criteria for educational of science textbook.

---

### 7.3 ACCIDENTS AND FIRST AIDS

---

Laboratory safety is the most important task that a science teacher should know. With the increasing scientific progress, the corresponding hazards are also increasing. A laboratory is a dangerous place, if not managed properly as it contains chemicals, glass wares, reagents etc. Good laboratory practices are prerequisite for the management of safety in any laboratory. For this purpose, certain safety rules should be adopted & strictly followed. General information regarding the safety and proper usage of chemicals must be instructed before conducting experiments in the lab. Pupils must be made aware of the hazards involved in any experiment they do be taught to work systematically.

- Students must be made to understand the laboratory rules and ask them to follow the rules, strictly.

#### 7.3.1 First-Aid-kit

Though utmost care and precaution are taken in the maintenance and systematic organization of the practical work, unforeseen accidents may occur in the laboratory. In such a situation, the teacher should not panic, but maintain clam and compose. If unexpected accidents may happen, she should call for immediate attention. But before the arrival of medical aid the teacher should provide first aid to the injured person. Keeping a first aid kit it an essential component of any science lab.

**NOTES**

### **7.3.2 Safety Equipment**

A long with the first aid box, every laboratory should be equipped with the following safety equipment also,

- Fire extinguishers
- Rubber Gloves
- Asbestos safety screens
- Dust Bins
- Thick Blankets
- Sand Buckets etc.

---

### **7.4 IMPROVISATION OF APPARATUS**

---

One of the objectives of teaching science is the inculcation of the scientific attitudes and the training in the scientific method. This is possible through instruction, demonstration and experimentation. So far, we have mainly concerned on instructions. It is through demonstration and experimentation that most of the desired attitudes are developed.

The plea of most of the science teachers against effective demonstration and experimentation is the lack of adequate apparatus which is yet a great problem for a developing country like India. If all the school-going children are to be trained in the scientific method as they should be, large amount of money will have to be set apart for building up well-equipped laboratories. It is very doubtful that such provision can be made in India for decades to come. In these circumstances we cannot wait for that day when government will provide all facilities for teaching science. We are living in a progressive scientific world and we have to march ahead with other advanced countries even in the face of so many problems.

One way out of this economic problem is the improvisation of apparatus. We can very easily prepare ordinary laboratory apparatus from simple articles found in homes and other places. The only things required are the ingenuity and resourcefulness of the teacher and his willingness to do work. At least we should learn a lesson from the great scientists like Edison, Priestley, Madame Curie, Dalton and others who had no big funds to provide themselves with expensive apparatus and elaborate laboratories. They carried out their experiments most

### Check Your Progress

Notes : a) write your answer in the space given below

b) Compare your answer with the one given at the end of the unit

1. List out any 5 items kept in the first aid box.

-----  
-----

2. List some of the common accidents in the laboratory.

-----  
-----

successfully in the humblest of conditions, with home-made and crude apparatus.

---

## 7.5 QUALITIES OF A GOOD SCIENCE TEXT BOOK

---

The primary aim of the textbooks is to enable the students to get the subject matter of a specific subject very easily and also in an understandable manner. The textbook is the storehouse, which gives the subject matter in a well-organized manner.

The textbook helps the students to revise the lessons taught in the classroom in an orderly pattern, the textbook should also contain diagrams, pictures, photographs and line diagrams. It is also useful to give practical work, assignments and homework to the students. So it becomes inevitably necessary to concentrate on the quality of textbook, which is more important for effective teaching.

When a textbook is selected importance should be given to the quality and qualification of the author and publisher in addition to the subject matter.

### 7.5.1 Author

- Author should possess a complete knowledge in the subject and should be able to express and explain the subject matter in an easily understandable simple language.
- He should necessarily be an experienced teacher.
- Some educationalists suggest that the author should be given special training in writing textbooks.

**NOTES**

**NOTES**

- He should possess required educational qualification and very rich experience in teaching.

**7.5.2 Physical Setup and Organization**

- The external features of a textbook like the quality of paper, method of printing size quality of wrapper and setup should be attractive.
- Printing letters should be according to the age of the students.
- The color and design in the wrapper of the book should be too big or too small. But should be medium.
- The pictures in the textbook should be completely labeled. Pictures may be exhibited in required places in the form of color pictures and photographs.

**7.5.3 Subject Matter**

- Subject matter should satisfy the aims and objectives of teaching biology
- Description of the subject matter should be based on the development of mind and interest of the students.
- Should be based on three and experience of the students.
- Recent inventions and new principles to be added in the subject matter.
- Should contain hints regarding experiments, procedures and points to be observed.

**7.5.4 Language Style and Vocabulary**

- It should be based on the experience and ability of the students.
- The words and terms used by the biologists and language experts should only be used.
- Biological terms should be used according to the nature of mother tongue.
- Sentences which explain the meaning directly should be used.

### 7.5.5 Illustration

- Illustration should be relevant to content.
- Photographic reproductions should be large and clear.
- Figures should be adequately labeled.

### 7.5.6 Binding and Appearance

- Book should be attractive and well-binded.
- Book should be printed in a neat and clear manner.
- Size of the book should be normal.
- Price of the book should be moderate.

## NOTES

---

## 7.6 CRITERIA FOR EVALUATION OF SCIENCE TEXTBOOK

---

Score cards and checklists are used to evaluate and select a subject text book for a course, George Hunter has suggested the following score card to evaluate book.

HUNTER SCORE CARD	POINTS
1.Educational rank of the author	50
2. Mechanical makeup and cost	100
3.Psychological soundness	300
4.Subject matter	250
5.Literary style	110
6.Learning exercises	140
7.Teachers help	50
Total	1000

Scores must be given to each book by evaluating them on the basis of the above aspects. The book which secures maximum score will be selected as a textbook.

**NOTES**

---

## 7.7 LET US SUM UP

---

In this unit, we have discussed about the safety measures and the materials kept in the first aid kit, some common laboratory accidents and their remedies. In the last section of this unit, we have discussed about the qualities of a good science textbook.

---

## 7.8 UNIT END EXERCISES

---

### Check Your Progress

Notes : a) write your answer in the space given below

b) Compare your answer with the one given at the end of the unit

3. List out any 2 criterions in binding and appearance of science textbook.

-----  
-----

4. How many points are given to subject matter and learning experiences in Hunter Score card of evaluating science textbook?

-----  
-----

- Describe some of the accidents that generally occur in the laboratories & state the procedure you adopt in each case for relief.
- How far can the development of laboratory skills in the children help in effective science learning?

---

## 7.9 ANSWER TO CHECK YOUR PROGRESS

---

1.
  - Acetic Acid-
  - Ammonium hydroxide-
  - Adhesive tape –roll
  - Aspirin
  - Bandages-various sizes

- Dittol
- Dressing
- Tincture Iodine
- Boric Acid
- Universal Antidote
- Potassium Permanganate
- Methylated spirit etc.

2.

- (i) Fire
- (ii) Burns
- (iii) Eye injuries
- (iv) Poisoning and
- (v) Cuts.

3.

- Book should be attractive and well-binded.
- Book should be printed in a neat and clear manner.
- Size of the book should be normal.
- Price of the book should be moderate.

4. 250, 140

---

## 7.10 SUGGESTED READINGS

---

- Ahmed, Shakhty. R (1983). Management of laboratory Science Program me. New Delhi: Report of orientation Programmed in Educational Planning and administration, NIEPA (MIMEO).
- Aretha, P. (2004). I-Edition, Methods of Teaching Biological Science. Hyderabad: Neelkamal Publications Pvt. Ltd.
- Das, R.C., Gupta. S. K. (1985). Science Teaching in schools. New Delhi: Sterling Publications Pvt. Ltd.
- Mathew.T.K &T.M Mollykutty (2006). Teaching of Science TNOU B.Ed Study Material, Chennai.

**NOTES**

**NOTES**

- Radhamohan (2010). Innovative Science teaching for Physical Science teachers. New Delhi: PHI Learning Private Ltd.
- Saravanakumar.AR. (2014). Enhancing Achievement in Science through Metacognition. Karaikudi: KVS Printers
- Sharma, R.C., Shula, C.S., (2002). IV-Edition, Modern Science Teaching. New Delhi : Dhanpat Ray Publishing Company (P) Ltd. Email : dhanapatrai @ vsnl.com
- Stood, J.K., (1987). Teaching of life science. Chandigarh : Kohl Publishers
- Thurber, W.A., & Collette, A.T., (1964). Teaching Science in Today's Secondary Schools. New Delhi : Prentice Hall of India Pvt.Ltd.
- Vanaja, M. (2005). I-Edition. Methods of Teaching Physical Science. Hyderabad : Neelkamal Publications Pvt. Ltd, [www.neelkamalpub.co](http://www.neelkamalpub.co).
- Venugopal, G.N Nithyasri & Prof K.Nagarajan (2013) Teaching of biology Sriram Publishers Chennai



---

# UNIT VIII INFORMATION AND COMMUNICATION TECHNOLOGY IN SCIENCE EDUCATION

---

*Science Teacher and  
Teacher Perspectives - I*

## NOTES

### Structure

8.1 Introduction

8.2 Objectives

8.3 Audio – Visual Aids

8.3.1 Definition of Audio Visual Aids

8.3.2 Classification of Audio Visual Aids

8.3.3 Importance of Audio Visual Aids

8.4 Hardware

8.4.1 Principles and uses of Hardware

8.4.2 Film strip cum slide projector

8.4.3 Overhead projector

8.4.4 Motion picture projector

8.4.5 Radio

8.4.6 TV

8.4.7 CCTV

8.4.8 Tape Recorder

8.5 Software

8.5.1 Principles of software

8.5.2 Objects

8.5.3 Specimens

8.5.4 Slides

8.5.5 Transparencies

8.5.6 CDs

**NOTES**

- 8.5.7 Audio and Video Tapes
- 8.6 Educational Broadcasts
  - 8.6.1 Radio and TV Lessons
  - 8.6.2 Programmed Learning
  - 8.6.3 PowerPoint
- 8.7 Internet
  - 8.7.1 Use of Internet in teaching science
  - 8.7.2 e- learning
- 8.8 Let Us Sum Up
- 8.9 Unit End Exercises
- 8.10 Answer to check your progress
- 8.11 Suggested Readings

---

## **8.1 INTRODUCTION**

---

The Information and Communication Technology in education is in a nascent stage. The general notion of technology in education is reflected in the design, preparation and production of textbooks and other instructional materials for schools. The National Council of Educational Research and Training (NCERT), New Delhi has taken up a major role in this gigantic task.

The major important representation of Information and Communication Technology in science education is the presentation and use of teaching aids. The quality of teaching aids in recent times has improved. The variety of teaching aids ranges from a two dimensional chart to a three –dimensional model. Further, the introduction of electronic media has brought a third dimension and movement teaching aids in education. Information and Communication Technology helps to develop simulated programmers in education, which are designed to depict the real world happenings without the danger, expense or time needed to experience the actual event.

---

## 8.2 OBJECTIVES

---

- Know about hardware and software
- Describe the classification of Audio Visual aids.
- Know about low-cost educational material
- List the potential and limitation of Radio and TV in education
- State the merits of CCTV in education
- Know about the projected aids and their working nature. Advantages of using projected aids as teaching aids.
- Identify the use of computer in science teaching

## NOTES

---

## 8.3 AUDIO – VISUAL AIDS

---

“The supply of teaching aids to every school is essential for the improvement of the quality of teaching. It would indeed bring about an educational revolution in the country.” – Kothari Commission (1964-66).

Long ago, the Greeks and the Romans used to convey thought and information through words, pictures, symbols etc. It was not till seventeenth century that stress was given to illustrative books and models.

**Rousseau**, a great educator, discouraged the use of more words in education. He advocated that nature of body and mind of child and his surroundings should be taken into account. As a result of this, shift took place from teacher to child –centered education.

Froebel was another exponent who pleaded that children should learn from things around them. His kindergarten with gifts and songs’ provides activity for the students. Montessori’s didactic apparatus provides even more opportunity for the pupils to learn by doing.

### 8.3.1 Definition of Audio Visual Aids

“Audio-visual aids are those devices by the use of which communication of ideas between persons and groups in various teaching and training situations is helped. These are also termed as multi-sensory materials”.

- **Edgar Dale**

NOTES

“Audio –visual aids are those sensory objects or images which initiate or stimulate and reinforce learning”

- **Burton**

“Audio –visual aids anything by means of which learning process may be encouraged or carried through the sense of hearing or sense of sight”.

- **Good’s Dictionary of Education**

### 8.3.2 Classification of Audio Visual Aids

1. **Simple Hardware:** Magic Lantern, epidiascope, slide projector, film strip projector, opaque projector & overhead projector etc.

2. **Hardware:** Radio, TV, CCTV, record player, tape recorder, motion pictures, teaching machine, computer.

3. **Software:** Film –strips, printed materials like PLM, maps, diagrams, charts, graphs & posters, 3D objects like models, specimens etc.

The success of the teacher is largely determined by his ability to communicate ideas to the students. These ideas are expected to bring about change in the behavior of the students. The student learners are learnt by seeing, listening and doing things by themselves. The audio visual aids offer teachers opportunities to increase the effectiveness of the ideas which they intend to communicate. It is proved by researchers that AV-aids help in learning more, learning faster, remembering longer and learning more thoroughly.

Now let us discuss the various simple aids and software that would be useful in the teaching-learning process.

### 8.3.3 Importance of Audio Visual Aids

“I hear, I Forget.

I see, I remember.

I do, I understand”

Audio –visual aids are instructional devices which can be heard as well as seen (Audio means to hear, and Visual means to see). These aids are intended to impart knowledge to the pupils through sense to ensure quick and effective learning. No wise teacher can ignore the use of aids in order to make his lesson more interesting and real. It is an admitted fact that we learn through the senses and the sense of sight

and hearing have a greater share in this process. We might recall that man depended upon the sight long before he felt the need of speech, and that the alphabet was derived from the picture sign language. But, it should always be borne in mind that these aids should be used as aids to teaching and should not replace the teacher but revolutionize methods of teaching.

## **NOTES**

1. The audio-visual aids are best attention compellers. They arouse interest and motivate the pupils to action and stimulate physical and mental activity.
2. It saves time and the learning is more solid and durable. The pupil learns about 35% more in given time and the knowledge learnt is retained for 55% longer time.
3. It reduces verbalism or the meaningless use of words and phrases and contributes towards the clearness of perception and accuracy in learning.
4. It extends first-hand experience when the students see a demonstration, handle the apparatus, perform the experiment themselves and prepare charts, sketches and models etc.
5. By reviewing and rehearsing the aids used, pupils get opportunity to correct misconceptions and secure additional ideas. A film after having been shown to the students can be reviewed by the active discussion among students and with the teacher. By showing the film again the pupils correct their mistakes and get a chance to revise what they have learnt and at the same time gather some additional information which they had unconsciously overlooked.
6. It helps in bringing vivid reality into the classroom. Mere chalking and talking do not help much and it is important to make use of the aids.
7. It is the most natural and the easiest way of learning. Image is the greatest instrument of instruction. When a child sees and objects, he forms an image of that object.
8. Though first-hand experience is the most educative type of experience but always it is neither desirable nor possible for the pupils. For various reasons it may be necessary to provide various experience. In many cases the actual materials inaccessible, very expensive or physically so constituted that they cannot be easily studied. So at such occasions it becomes essential to provide a representation of the real resource. If it is readily available and less expensive, it may be even more desirable. For example, it is not desirable that the students should have the direct experience of recognizing the characteristics, actions, affects and remedies of any fatal disease, say plague, typhoid etc. It is always useful to give them

**NOTES**

vicarious experience. Similarly it is not possible for everybody to climb up the Everest but the children have vicarious experience of climbing even by seeing a film. So, in such situations reproduction is better for the original may be too complex, too large, too small, too slow, to be successfully experienced first-hand.

9. It breaks monotony and gives variety to the class-room technique which is always attractive to the children.
10. Longing for mastery and ownership is, to some extent, satisfied. The pupils get chance to touch, feel handle and manipulate things.
11. Some type of freedom prevails in the classroom. Pupils can laugh, talk, ask questions, comment and discuss. The students are motivated to do work and they work of their own accord and not out of the fear of the teacher.
12. The large number of pupils and shortness of teachers require some aids that can simplify teacher's work.
13. New curricula have broadened and extended the field of education which can be satisfactorily covered only with the help of teaching aids.
14. It provides opportunity to inculcate scientific attitudes and give training in the scientific method.

**Check your progress**

**Notes:** a) Write your answer in the space given below

b) Compare your answer with the one given at the end of the unit.

1. Write down the classification of audio-visual aids?

.....  
.....

2. Write any three importance of audio visual aids?

.....  
.....

---

**8.4 HARDWARE**

---

**8.4.1 Principles and use of Hardware**

Educationists categorized the concept of educational technology into two approaches viz. the hardware approach and the software approach.

The hardware approach is based on the application of engineering principles for developing electro-mechanical equipment for instructional purpose. Film projectors, television, tape recorders, teaching machines, computers etc. are called educational hardware. This approach is the result of the impact of scientific and technological development during the present century. Hardware approach mechanizes the process of teaching so that teachers would be able deal with more students with less expenditure and time in educating them.

## NOTES

### 8.4.2 Film strip cum slide projector

Film strip-cum-slide projectors are available from number of firms in India. Indian models may cost up to Rs. 1,000/- . The projectors can be operated by a teacher and students. Film strips are otherwise called ‘still films, strip films or slide-film’. It is a related sequence of transparent still pictures or images on a strip of 35 mm film. The pictures may be in color or black& white and it may be in single or double frame. Most of the film-strips have single frames.

Normally, a film-strip contains 20 to50 frames in about 2 to5 feet in length.

This projector can also project pictures from 2” x 2” slides i.e. made from 35 mm photographs.

#### Advantages of film-strip

- It is easy & convenient to use
- It takes up little space and can be stored easily in a container.
- It is inexpensive.
- A wide range of film-strips are available in colour black & white.
- It can be used at any desired place while teaching.
- The pictures in film-strips are sequential in order.
- It can be used effectively even in semi-darkened room.

The steps to be followed for using film-strips effectively are

- Selection
- Preview
- Class preparation
- Presentation &
- The follow –up activity

**NOTES**

### **8.4.3 Overhead projector**

From the name of the equipment itself, it would be evident that in overhead projector, the projected image is obtained behind and over the head of the instructor. The OHP reflects images coming from a powerful light that shines through a transparency on a screen by means of a tilted, highly polished mirror and lens assembly.

The screen image is brilliant enough to be seen even in a lighted room. The projector area ranges from 3" x 3" to 10" x 10"

Normally OHP's are composed of a projection lamp to act a source of light, condensing lenses to concentrate all the light into usable beam, a polished mirror and lens assembly and a blower for cooling the system.

The lamp in OHP should not be kept burning continuously for long periods. To use it as chalk board is a very costly affair.

#### **Advantages of OHP**

- A large image in a minimum projection distance is obtainable.
- Permits the instructor to face the class as he/she writes or indicates points of importance on the transparency.
- Projector image obtained could be seen even in a lighted room.
- Simple and convenient to operate the equipment.
- How cost, homemade materials could be used in minimum time.

### **8.4.4 Motion picture projector**

Motion pictures present an abstract version of the real event, with consequent losses as well gains. The motion pictures can dramatise events effectively and make the experience as close to reality as possible. In comparison with field trips, motion pictures present experiences that are compressed in time and space. A motion picture omits unnecessary details and presents only necessary aspects. Slides, Filmstrips and Micro-Projections are classified as one-dimensional. They can be either projected on a screen by means of projection machines and accessory equipment or given for individual study. They provide only visual experience whereas radio and recordings provide auditory experience only. Television or motion pictures are presented in a proper sequence whereas these materials are individual items. The experience of seeing is less ordered and formalized.



### 8.4.5 Radio

By definition, a radio is the transmission, and reception of signals by means of electromagnetic waves. Radio listening contributes immensely to the students fund of information. It exerts an influence on his attitudes and appreciation, social behavior and power tom develop critical thinking.

#### Advantages of radio listening

- It is highly and can provide a strong motivation stimulus.
- It improvised an outlet for student ability and talent.
- It develops better speech habits.
- It develops good listening habits in students.
- It stimulates a spirit of cooperation and responsibility.

#### Radio an educationally invaluable tool

The following characteristics make radio as on educationally valuable tool.

- **Inexpensiveness:** Compared to the other audiovisual (projected) aids, this is relatively inexpensive, when used in combination with other media, it can be a very effective aid
- **Updated and Immediacy:** Radio can bring latest new information to the student. Immediacy implies listening into the event as it is taking place. i.e. line broadcast e.g. the words of the astronauts as they talk earth station.
- **Leaping barriers of time and space:** News broadcast make us well aware that within a few minutes we can get on-the spot information from abroad.
- **Authenticity and realism:** Radio can bring the voice of an authority into the classroom. One can listen to the interview and record the ideas of scientists, doctors etc.
- **Listening fosters imagination:** While listening to the radio, as in reading, one can imagine the surroundings, and the background of the story or whatever.

### 8.4.6 TV

Television (TV) is a widely used telecommunication medium for transmitting and receiving images, either monochromatic (“black and white”) or color, usually accompanied by sound.

The importance of television in the communication of information is based on ideas, skills and attitudes in a country like India cannot be undermined.

### NOTES

**NOTES**

**Major educational values of TV**

- Communication using the television can be effective because it can transmit a wide range of audiovisual materials like film, objects, pictures etc.
- Television gives the student access to excellence. One can see and hear the gifted artist, the great scientists: the science programs on television provide rich content, to students and excellent instructional practice to the classroom teachers.
- Television is a great equalizer of educational opportunity.
- It can bring the world of reality to the classroom.
- Television can save the time of both teacher and taught.
- It can heighten the interest in the topic, as by using zoom shots, magnification and split screen. The students get a good view of whatever is being demonstrated or shown on TV.

**8.4.7. CCTV (Closed Circuit Television)**

CCTV can be used in a number of rather different ways in education.

**(i) As a visual Aid**

The main use here is to demonstrate to a class, something which could otherwise only be seen clearly by a small proportion of the class. This is achieved by magnifying the object of the demonstration and showing it to the whole class by means of a television set usually positioned fairly high up in the room so that everyone in the class can see it comfortably.

For eg. a biology class could see a microscope slide at the same time, a dissection or an operation could be demonstrated to a large number of medical students and other small pieces of equipment could be shown to engineering students and so on.

**(ii) As an aid in the training of teachers**

In many Teacher Training Institutions (TTI), CCTV is used. During Micro-Teaching sessions, when a teacher trainee teacher, that can be videotaped using the video camera. Later on during the feel-back session, the trainee can watch this video-tape to observe both the visual & verbal aspects of his teaching. He can see what activities he performed and simultaneously he can hear the words he spoke. The

other trainee peers and the teacher educator also observe this video play back for analyzing the teaching behavior of the trainee.

### (iii) Educational Networks

In many western countries, several large CCTV educational networks have been established linking a number of schools together. Research is now being carried out onto different aspects of the use of CCTV in education.

### 8.4.8 Tape Recorder

This is an extremely versatile aid which can be used effectively for introducing a lesson. For instance, the talk by a renowned scientist can be recorded and used when needed. The teachers can use this auditory aid for teaching several topics in chemistry (e.g. bonding) as well as for a commentary for slide shows.

The main criteria to be looked into when choosing a cassette recorder are

- **Portability** : Recording equipment should be light weight and easy to carry if it is to be moved from one room to another.
- **Versatility** : Does the school need only a tape recorder or would two-in-one with a stereo system be a good buy?
- **Performance**: It should record and reproduce good sound, and operate at constant speeds.
- **Simplicity**: It should be easy to operate so that any layman can operate it.
- **Construction**: The construction and design should be such as to stand the wear and tear of daily life.
- **Price**: Select equipment on the merits of performance relative to its price level and how well it meets the needs of the school.
- **Company and dealer**: it is wiser to choose equipment from a well-known authentic firm. A dealer in the same locality would be convenient, both for regular serving and for any repairs which may arise from time to time.

## NOTES

**NOTES**

**Check your progress**

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

3. What are the advantages of Radio Listening?

.....  
.....

4. List out the advantages and disadvantages of radio and TV in education

.....  
.....

---

**8.5 SOFTWARE**

---

**8.5.1 Principles and use & software**

Software approach uses the principles of psychology for building in the learner a complex repertory of knowledge or modifying his behavior. It originates from the pioneering works of Skinner and other behaviorists. The programmes which such a technology produces are often called 'software' Newspapers, books, magazines, educational games, flash card may also form part of software. Software approach is characterized by task analysis, writing precise objectives selection of appropriate strategies, immediate reinforcement of responses and constant evolution.

**8.5.2 Objects**

Objects which have been removed as units from the natural settings and shown during the course of teaching prove to be good teaching aids. Making of their replicas or models is not advisable. For example if the teacher wants to make the students aware about micrometer, thermometer, vernier caliper, hacksaw, handsaws and other laboratory and workshop equipment making of their models will be a mere waste of time, as their models can never be accurate. The models made of these will not be operative. Whereas if these things in actual shape will be visualized by the teacher before the students in working conditions, the students will know how do these function? They will learn a lot.

### 8.5.3 Specimens

There are many things which are very small in size like mustard seed, wheat seed, bajra etc. These cannot be shown individually being very small in size. So it is desirable that their specimens in small packs. Rapeseed or mustard seed or also seed should be packed in empty match boxes and be shown to the students. At the most we can fix, a tracing paper lid on match box's inner box. Such samples should be stored for future showing.

### 8.5.4 Slides

Many years ago, the 'magic lantern' was a force in family entertainment. The slides which years ago were cumbersome, are now small, and their projector can be carried easily in a case. Although the large slides (31/4 x 31/4) are still found, but new standard size is 2'x2' Usually these slides and transparencies are held between two sheets of plastic or glass, which protect the slides from heat and dust. Sometimes frames also made of cardboard for holding slides.

### 8.5.5 Transparencies

Transparencies are very useful in teaching. Transparencies can be made on transparent plastic sheets, easily available. Some illustration can be drawn on transparent pieces of transparent plastic sheets by special pens available for making transparencies. Such transparencies can be projected and used on overhead projector displayed or taken on screen. Sometimes, the teacher has to teach many sections of one class. Repeating same black board work, diagrams and illustrations in each and every class again and again looks odd and boring to the teacher. Moreover, this cannot be done same in each class. Doing the black board work drawing same drawings, diagrams and illustrations is also time consuming. It is therefore, desirable that presenting same visual material transparencies be prepared and used on overhead projector.

### 8.5.6 Compact Disc (CDs)

One of the methods of disseminating information to students which is both educationally and financially efficient is by use of compact discs. Many schools have a collection of compact discs which students can use for their assignments, drill and practice sessions as well as preparing for the board examinations.

Compact disc technology offers one method of supplying courseware that is economical to produce, easily packaged and posted, with the ability to update material with relative ease. The target

## NOTES

audience may vary considerably, dependent on the course being offered and the geographic and demographic range of the students. A science teacher should therefore be very careful before letting students use the compact discs to ensure that the curriculum requirements, benchmarks and objectives of the course the students are enrolled in matches that of the compact discs.

## **NOTES**

Compact disk technology, through its ease of production, relative economy and the ability to disseminate text, audio and visual materials in one easy to use package will be a major force in information transmission in the short to medium term. Developments in removable hard drive technology, possibly the Internet and the development of a high capacity reusable medium will be the telling factor in its lifespan.

### **8.5.7 Audio and Video Tapes**

Tape recorder and audio CDs are the audio players. Tape recorder is used to record sounds on magnetic tape which can be reproduced at will as many times as required. When a new recording is made the recording already contained in the tape is automatically erased. Sounds can also be recorder in CD by using special instrument called audio writer which can be reproduced at will as many times as required. The sounds produce from the CD will be of more quality than the sounds produced from tape recorder. Educational audio CDs are available in the market on different topics and subjects. They can be bought and used in the classes with the help of Audio CD player which is available in the market separately as well as with tape recorder as two in one or five in one.

The uses of the tape recorder in education are as follows

1. It can be used to record educational broadcasts and for replay at suitable and convent times.
2. It can be used to record music and sound effects for use during staging of drama in schools and cultural programmes.
3. It can be used to record the talk of important visitor to the school and this can be effectively used later.
4. It can be used very largely in language laboratories for giving speech-training and for correction of pronunciation defects.
5. Recordings of model talks by teachers or experts in the languages can be frequently used.
6. Instructions for experiments or any activity can be recorded on cassette and the individual can listen to it by earphone and do the necessary operation without disturbing others.

7. Commentary to filmstrips or sliders can be suitably recorder on a tape-recorder and the tape may be played back while the students view the filmstrip or slide pictures projected on the screen.
8. In teacher training institutions a tape –recorder can be very effectively used during the “Micro-teaching” sessions. They will provide necessary feedback for discussions to improve the lesson.

Tape recorders are of two types, table model and portable type. Table model works in 230-240 volts of A.C. Portable models can be operated with dry cells. Magnetic tapes are used in these to record and replay the sounds.

## NOTES

### Check your progress

**Notes:** a) Write your answer in the space given below

b) Compare your answer with the one given at the end of the unit

5. Define Transparencies

.....  
.....

6. What are the uses of Tape Recorder?

.....  
.....

---

## 8.6 EDUCATIONAL BROADCASTS

---

Are specifically prepared broadcasts for serving the cause of education and lessons, lectures.

Educational Broadcasts are carefully planned audio-learning experiences which represent resources ordinarily beyond those available to local classrooms. Lessons are prepared under the supervision of excellent teachers, radio programmed specialists and subject authorities who work directly with professional radio writers. Such a co-operation results in a learning resource which effectively anticipates the needs of the pupils.

Educational broadcasts often are planned to engage the active participation of local pupils. Radio lesson handbooks describe the program me content, outline local classroom pupil responsibilities, and list the materials that should be on hand when the broadcast begins. Such materials are usually prepared and distributed to participating teachers well before the broadcast.

## NOTES

Preliminary study and discussion by the class are encouraged, and suggestions for these activities are also included in the manuals, wherever possible. The programmers include audio instructions or cues relating to experiments or activities which necessitate pupil's participation during the broadcast or immediately after it. The class is also encouraged to carry on a follow-up discussion projects or create activities.

### **8.6.1 Radio and TV Lessons**

Radio has been playing a vital role in the field of communication since its origin. After the growth of printed word as an instrument for the dissemination of ideas, messages, information and knowledge, the spoken word appeared with fresh educational values as the vehicle of communication. Even though, Radio works with sound only. It has the power to stimulate values and to stir imagination and to increase knowledge and understanding.

Radio is regarded as an extension of personal communication and effective communication medium with the individual as well as the groups. At one given time, radio can simultaneously arrest the attention of thousands of people irrespective of its clientele of various educational attainments. Teaching and learning involves communication between the teacher and the learner through a medium and radio acts as one such medium. Radio is one of the mass communication media, which has got a great advantage over the other media.

Taking into consideration the potentiality of educational technology in which radio is a part, the National Policy of Education enunciated that, Educational Technology will be employed in the spread of useful information, the training and values etc. both in the formal and non-formal sectors. Maximum use will be made of the available infrastructure. In villages without electricity, batteries or solar packs will be used to run the programs.

### **Educational Implications of the Radio**

Radio has a distinctive role to play due to following reasons.

- Radio extends the area of acquaintance
- It brings people of rare contributions to the learners
- It helps in inculcating values
- It helps slow learners and pupils having poor sight
- It can be used as a medium to teach all subjects
- It refreshes knowledge of teachers



- Wide Coverage
- Cheap Medium
- Easy repair and low maintenance

### **Educational Television**

Educational Television is a system that present learning content in various subjects produce by an agency. It is a means of providing direct instruction (formal) as well as continuing education (non-formal). It has the capacity to bring the world into a classroom and a classroom into a home. India is a large country with varied climatic conditions, a large and ever growing population and vast tracts of inaccessible remote locations. T.V. as a mass medium has the potential to play a major role in the educational setup our country.

### **Role of ETV**

- Improvement of Quality
- Television as a catalyst
- Television as a means extending children's experience
- Television as a means of introducing affective education
- Television as a means of equalizing educational opportunity
- Television as a means of improving efficiency and productivity
- Television – based Instructional systems

### **8.6.2 Programmed Learning**

A variety of personalized instructional techniques and technologies were developed in the 1950's viz. programmed learning, teaching machines, cybernetics, personalized system of instruction etc. Programmed learning represents an effective strategy in the teaching learning process. It is a highly individualized strategy, which has been found to be quite useful for classroom instruction as well as self-learning or auto instruction. Programmed Learning / Instruction emerged out of experimental research on operant conditioning which was formulated by B.F Skinner and law of effect which was proposed by E.L Thorndike.

### **Definitions of Programmed Learning/ Instruction**

Generally speaking the instructions provided by a teaching machine or programmed textbook is referred to as programmed instruction or programmed learning. Programmed learning involves instruction with carefully specified goals and skillfully arranged learning experiences, which are self-instructional and self-corrective.

### **NOTES**

## NOTES

Thus programmed instruction is a new path towards automation and individual learning/ instruction

Smith and Moore (1962) “Programmed instruction is the process of arranging the material to be learned into a series of sequential steps, usually it moves the student from a familiar background into a complex and new set of concepts, principles and understanding”.

Leith (1966) “A programme is a sequence of smaller steps of instructional material (called frames), most of which requires a response to be made by completing a blank space on a sentence. To ensure that require responses are given a system of cueing is applied and each response is verified by the provision of immediate knowledge of results. Such a sequence is intended to be worked at the learners own pace as individualized self-instruction.

Skinner (1954) Programmed learning is the first application of laboratory technique utilized in the study of the learning process to the practical problems of education.

Gulati and Gulati (1976) “programmed learning as popularly understood is a method of giving individual instruction in which the student is active and proceeds at his own pace and is provided with immediate knowledge of results. The teacher is not physically present. The programmer while behavior and validate his strategy in terms of students learning.

### **Characteristics of programmed learning**

- i. The content is broken into small easy steps and each step is presented in several sentences each called a ‘Frame’
- ii. The frames are arranged sequentially
- iii. Most of the frames require that the learner makes some kind of response an answer to a question an activity to demonstrate the understanding of the material i.e. frequent response is elicited from the students
- iv. The student is provided immediate confirmation of the right answer in the learner is provided immediate reinforcement. In case he is correct his response is reinforced and if he is wrong he may correct himself by receiving the correct answer.

- v. Units are arranged in a careful sequence such that it shapes the behaviour of a learner
- vi. It is the interaction between the learner and learning material which is emphasized in programmed learning. Here the learner is active and is motivated to learn and respond
- vii. Programmed learning provides self-pacing and thus learning may occur at an individual rate rather than general depending upon nature of the learner, learning material and learning situation
- viii. It calls for the overt responses of the learner which can be readily observed, measured and effectively controlled
- ix. It has provision for continuous evaluation which helps in improving the students' performance and quality of programmed learning material
- x. The content and sequence of the frames are subject to actual tryout with the pupils and are revised on the data gathered based on the response of the learner
- xi. Goals to be achieved are also evaluated and stated specifically
- xii. In programmed learning the suitability and the appropriateness of the materials depends on the learner. If the learner makes mistakes the programmed material should be rejected.

## NOTES

### **Principles of programmed learning**

A good programmed learning material incorporates good principles of learning. The basic idea of programmed learning is that most efficient, pleasant and permanent learning must take place. The following are the principles on which programmed learning is based.

#### **Principle of small steps**

A programme is made up of a large number of small, easy-to-take steps. A student can proceed from knowing very little about a topic to mastery of the subject by going through a programme.

#### **Principle of active responding**

This principle rests on the assumption that a learner learns better by being active. Programming provides opportunity for the learner to respond frequently. It not only presents material to the learner but also induces sustained activity.

## NOTES

### **Principle of immediate confirmation**

The psychology phenomenon of reinforcement is the basis of this principle. Necessity of providing immediate confirmation is important from two points of view i) the learner will not wildly guess ii) when the learners is not sure of the responses he/she needs to be confirmed of the correctness of the responses or provided with the right response.

### **Principle of self-pacing**

Programmed learning is a technique of individualized learning. It is based on another basic assumption that learning can take place better if an individual is allowed to learn at his own pace. The pupil is not forced to move with other members of the class. Some students naturally learn more rapidly or more slowly than others. In a normal classroom some students may be left behind as they are not able to keep pace with the teacher but here the learner is able to learn at his own pace. This principle controls individual difference in the process of learning.

### **Principles of students testing**

Continuous evaluation of the learning process helps in maximizing learning is another assumption on which programmed learning is based. The students leave behind a record of his responses because he is required to write a response for each frame on a response sheet. This detailed record helps in revising the programme and also provides a feedback to the teacher about the students' progress.

### **8.6.3 PowerPoint**

A PowerPoint presentation is learning resource instructional design goals must be clear to the teacher at the start.

- Be clear about the objectives of your presentation
- Provide a framework for the learning Remember that the outline of almost every lecture is exactly the same Present on overview so that the class is clear on what is going on
- Allow active engagement in the learning If possible keep some lights on so that students can take notes. Have a copy of the printout available in the library for reference
- Stay within the limitations of short term memory Keep the number of points on each slide to five or less.
- Keep it simple avoid gimmicky
- Retain eye contact with the students Do not read from the slides blindly

- Select a clear fairly large font size so that all students can read the slide easily. Avoid flowery and designer fonts
- Keep in touch with the pulse of your class. Pose questions frequently so that the class does not get in to a stupor
- Remove as many distractions as possible Do not fiddle around with knobs and other gadgetry This can be very irritating for the students
- Allow slides to support your talk not to be your talk. Do not hide behind your slides Remembers that slides are only teaching aids not the teacher
- Set and keep the right tone Too many slides can clutter and confuse the students
- Check that the objectives have been met. A few questions every now and then can break the monotony of a power point presentation.
- Every teacher needs to keep in mind on teaching aid no matter how sophisticated it can replace a teacher. A teacher with subject mastery excellent communication skills and the ability to develop rapport with the class is undoubtedly an irreplaceable asset to any school.

## NOTES

### Check your progress

Notes: a) Write your answer in the space given below

b) Compare your answer with the one given at the end of the unit

7. Write note on educational television

.....  
.....

8. Write the principles of programmed learning

.....  
.....

---

## 8.7 INTERNET

---

The internet and the ease of information viewing and retrieval that are possible through the web mean that students are no longer limited to information provided by textbooks and printed materials in libraries. Students may search on the World Wide Web for preprints and reprints of articles for discussion, bulletin boards on specialized topics for conference abstracts and proceedings or for topical compilations of materials for research or teaching. Most web navigation software system includes search engines that allow the user to locate information or sites by topic area. With more than a thousand

new website added everyday browsing for information on the web needs to be done even more carefully than a literature search for library references. Bear in mind that while the web holds enormous potential in providing access to information much of the information available has not been reviewed for quality or reliability.

## NOTES

### 8.7.1 Use of internet in teaching science

Your students are motivated to learn today students love is comfortable with and receptive to computers.

Global awareness and understanding your students can communicate easily with people from different corners of the world and this can increase global awareness and understanding.

**Environmental friendly** Use of internet can decrease the amount of paper used in the classroom as much of the writing can be done on the computer and some printed materials can be kept on the website.

### 8.7.2 e-learning

The term electronic learning has come to light in recent past when the buzz word 'E-business' first came into general use. Another term that expresses a similar concept is web-based training. The concept of E-learning is very old even before the emergence of internet Computer Aided Instruction (CAI) and Computer Based Training (CBT) were used for the same purpose. Today's e learning is not only CAI or CBT but also it encompasses the use of CDROM, mobile phone and personal digital assistants.

#### Definition

E-learning is that form of learning which uses a network for delivery interaction or facilitation It is also known as '**distributed learning**', '**distance learning**', '**technology enabled learning**' and '**online learning**'

E learning can be classified in synchronous or asynchronous mode. In a synchronous mode classes are real time which is instructional and the students are connected through a chat room. On the other hand asynchronous e learning is that where students can have access to prepackaged training based on his requirement and convenience.

#### Components of E-learning

E learning is comprised of the following elements

#### Content delivery method

Contents of traditional learning system are mostly based on text. But as in the case of e learning content audio or video may accompany

texts e learning allows content to be adjusted and supplied according to the level or progress of the individual learner. There are three methods of E learning process.

1. **Live broadcasting:** It is like to live television broadcasting Unlike television broadcasting e learning can be two way system that allows participations to take tests ask questions or respond to questionnaires This capability is frequently used for seminars and other events
2. **Video on Demand (VOD):** This technology is being introduced via cable television (CATV) systems. Large numbers of learners can access video content whenever they like As with live broadcasting it can function as a two way system.
3. **Interactive communication:** Interactive learning systems take advantage of the two way capabilities of the technology

## NOTES

### Motivational factors of e learning

1. Due to globalization of business it is essential to bring employees together at the same time. It is possible through E-learning
2. Corporate sector wants enhancement in their competitiveness by training to manpower.
3. Employees want to enhance their learning opportunities.
4. Widespread proliferation of information technology has enabled the teacher trainees to have access to internet.

### Advantages of E-learning

1. **Lower cost:** since learning takes place online it eliminates many of the expenses of face to face training
2. **Time is saved:** with E-learning sales forces stay in the field Sales representatives can access the material they need
3. **Flexibility:** E-learning is an extremely adapted technology that can be used to cover everything from sales fundamentals to specific product launches
4. **Faster Response:** E learning makes new knowledge and skills available immediately and reduced the learning time required to master even the most complicated topics.
5. **Greater effectiveness:** Advanced E-learning technology provides a high degree of interactivity that ensures good results

**NOTES**

E-learning is an effective way of training a wide range of individuals since it can be tailored to meet the needs of the individual learners.

6. **Better moral:** Through live virtual classroom chats and collaborative exercises E-learning helps organization to keep morale and efficiently
7. **Greater competitiveness:** In an era when knowledge is power. E-learning helps sales forces achieve an advantage over competitors.
8. **Ability to provide instruction in real time:** Even with conventional classroom instruction or correspondence courses a learners' progress performance are assessed.
9. **Ability to give training to large numbers of people simultaneously:** Through learning great improvements are needed to create systems that support the fine-tuned instruction. So large number of people can be trained simultaneously. E-module: The University Grant Commission (UGC) has developed an E-module through which students can watch and listen to lectures on various subjects and appear or web based tests from the comforts of their home.

**Check your progress**

**Notes:** a) Write your answer in the space given below

b) Compare your answer with the one given at the end of the unit

9. Write the use of internet?

.....  
.....

10. Describe the E learning

.....  
.....

---

**8.8 LET US SUM UP**

Hardware and software are the two components of educational technology hardware are used for the channels of message transmission. Charts graphs games displays boards etc. are some activity aids. CAI power point presentation learning are the latest innovation in education In the last section of this we have discussed about principles and use of internet in teaching science.



---

## 8.9 UNIT END EXERCISE

---

- Develop the hardware and software
- Describe the classification of Audio-Visual aids
- List out the potential and limitation of radio and TV in education.
- State the merits of CCTV in education
- Know about the projected aids their working nature, advantages of using projected aids as teaching aids.

---

## 8.10 ANSWER TO CHECK YOUR PROGRESS

---

1. Simple hardware  
Software
2. Best attention compellers  
Save time and learning is more solid and durable.  
Reduce verbalism.
3. Provide strong motivation stimulus  
Develop better speech habits  
Develop good listening habits
4. Great equalizer of educational opportunity  
Bring the world of reality  
Save the time of both teacher and taught
5. Transparencies are useful in teaching. Transparencies can be made on transparent plastic sheets, easily available.
6. Used to record educational broad casts  
To record music and sounds  
To record the talk of important visitors

### NOTES

**NOTES**

7. Educational Television is a system that present learning content in various subjects produce by an agency.
8. Small steps  
Active responding  
Immediate confirmation  
Self-pacing  
Students testing
9. Global awareness and understanding  
Environmental friendly
10. E-Learning is that form of learning which uses a network for delivery interaction or facilitation.

---

**8.11 SUGGESTED READINGS**

---

- Kulshreshtha S.P & Harpal Pasricha (2005) *Teaching of Science* Meerut R.Lall Book Dept
- NCERT *Instructional Objectives of School subjects*
- Panneer Selvam A & Rajendran K (2005) *Teaching of Physical science* Chennai: Shantha Publishers
- Rajasekar S (2005) *Methods of teaching Physical science* New Delhi Neelkamal Publications Pvt.Ltd
- Sharma R.C (1999) *Modern Science Teaching* New Delhi Dhanpat Raj Publishing Company Pvt.Ltd

---

# UNIT IX - CURRICULUM REFORMS IN SCHOOL SCIENCE

---

*Science Teacher and  
Teacher Perspectives - I*

## **Structure**

9.1 Introduction

9.2 Objectives

9.3 Curriculum

9.3.1 Meaning of Curriculum

9.3.2 Definition of Curriculum

9.3.3. Principles of Curriculum Construction

9.4 Organization of Content Matter

9.5 Critical Evaluation

9.5.1 Tamilnadu Higher Secondary School Science Curriculum

9.6. Curriculum Improvement Projects in India and Abroad

9.6.1 NCERT

9.6.2 CHEM study

9.6.3 PSSC

9.6.4 Biological Science curriculum study

9.6.5 Nuffield

9.7 Recent trends in Science Curriculum

9.8 Let Us Sum Up

9.9 Unit End Exercises

9.10 Answer to check your progress

9.11 Suggested Readings

**NOTES**

**NOTES**

---

## **9.1 INTRODUCTION**

---

A university should answer the needs of its belonging society. That affirmative seems an expense common place, for the fact of it being emptied along the practice of the planning of the education in Brazil. In spite of the profits he/she has to be repeated for the truth level that contains. In the measure in that we thought about a reform curricular, this relationship between teaching and society should be protected. Actually a proposal of curricular change stays besides the restricted extent of a course, because it doesn't quit being a change proposal also, for the society

A curriculum that assures the commitment and the necessary credit for the transformation of the current reality of the binomial inseparable teaching and research plus extension, so that the success of the medical course of the Federal University of Alagoas. UFAL can contribute, in a more appropriate way with the improvement of health conditions and life styles of community. In turns the curricular development a complex process because it needs the involvement of all (academy, service and society).

---

## **9.2 OBJECTIVES**

---

- Define curriculum
- Explain the principles of curriculum
- Describe how to construct and organize the content matter.
- Critically evaluate the school science curriculum. Describe the curriculum improvement project in India and abroad.
- Identify modern trends in science curriculum.

---

## **9.3 CURRICULUM**

---

Curriculum is an important element of education. Aims of education are reflected in the curriculum. In other words, the curriculum determined by the aims of life and society. Aims of life and society are subject to constant change.

Hence, the aims of education are also subject to change and dynamic. The aims of education are attained by the school programmes, concerning knowledge, experiences activities skills and

values. The different school programmes are jointly known as curriculum.

### 9.3.1 Meaning of Curriculum

The term curriculum has been derived from a Latin word *Currere* which means a race course or a runway on which one runs to reach goals. Accordingly a curriculum is the instructional and the educative programmes by following which the pupils achieve their goals, deals and aspirations of life. It is curriculum through which the general aims of a school education receive concrete expression.

Traditional concept the Traditional curriculum was subject centered while the modern curriculum is child and life centered.

### 9.3.2 Definition of Curriculum

The term curriculum has been defined by different writers in different ways

1. Cunnigham –Curriculum is a tool in the hands of the artist (teacher) to mould his material (pupils) according to his ideas (aims and objectives) in his studio school.
2. Morroe - Curriculum includes all those activities which are utilized by the school to attain the aims of education.
3. Froebel – Curriculum should be conceived as an epitome of the rounded whole of the knowledge and experience of the human race.
4. Crow and Crow - The curriculum includes all the learners experience in or outside school that are included in a programme which has been devised to help him developmentally, emotionally, socially, spiritually and morally.
5. T .P Nunn - The curriculum should be viewed as various forms of activities that are grand expressions of human spirit and that are of the greatest and most permanent significance to the wide world.
6. John Dewey - Curriculum is a continuous reconstruction moving from the child's present experience out in to that represented by the organized bodies of truth that we call studies the various studies are themselves experience they are that of the race

## NOTES

**NOTES**

7. Franklin Bobbit - Curriculum is the entire range of experiences both directed and undirected concerned is the unfolding the abilities of the individual.
8. Harold O Rugg - The curriculum is a succession of experiences and enterprises having a maximum lifelikeness for the learner giving the learner that development most helpful in meeting and controlling life situation.
9. Hollis Caswell in Caswell & Campbell - The curriculum is composed of all the experiences children have under the guidance of teachers Thus curriculum considered as a field of study represents no strictly limited body of content but rather a process or procedure.
10. Ralph Tyler - The curriculum is all the learning experiences planned and directed by the school to attain its educational goals.
11. Robert Gagne - Curriculum is a sequence of content units arranged in such a way that the learning of each unit may be accomplished as a single act provided the capabilities described by specified prior units (in the sequence) have already been mastered by the learner.
12. James Popham & Evabker - Curriculum is all planned learning outcomes for which the school is responsible curriculum refers to the desired consequences of instruction.
13. JL McBrien & R.Brandt - Curriculum refers to a written plan outlining what students will be taught (a course of study). Curriculum may refer to all the course offered at a given school or all the courses offered in a particular areas of study.
14. Indiana Department of Education - Curriculum means the planned interaction of pupils with instructional content materials resources and processes for evaluating the attainment of educational objectives.

**9.3.3 Principles of curriculum construction**

There are some principles forming the basics of curriculum construction. They are given below

### **1. Principles of child centeredness**

The curriculum should be according to the needs of the children at a particular age. The physical, mental, emotional and psychomotor needs should be taken care of. The content and activities should be selected according to the growth, age and development of the child.

### **2. Principles of community centeredness**

It should determine the purpose of a society. Every society has its own aspiration. There is growth and development in every society. The needs and aspiration of the society should be fulfilled. The core philosophy of the society the human resource needs etc. should be considered while formulating the curriculum.

### **3. Principles of integration of the needs of the child society and discipline**

It should integrate the child's activities his needs and the needs of the discipline. These three should be integrated in a synchronized way.

### **4. Principles of conservation**

It should help in preserving and transmitting the traditions standards of conduct on which culture and civilization depend.

### **5. Creativity principle**

It should place the pupil in the place of discover and provision should be made for creative type of activities. Children by nature are very curious and creative. There should be a conscious efforts in the curriculum to nurture and enhance creativity.

### **6. Principle of Integration of science**

The scientific knowledge is increasing day by day. Every aspect of life integrated with science. Science consists of different branches viz. Physics, Chemistry, Biology etc. The curriculum should try to integrate these branches of science and integrate science with others subjects as well.

### **7. Forward looking principle**

It should the child in adjustment and prepares him for full and effective adult life. The child is at the school for 12 years. After that it enters into a different world i.e. vocational or higher studies. The curriculum should enable the child to cope up with the situation it faces.

## **NOTES**

**NOTES**

**8. Principles of elasticity and variety**

It should not be rigid but should be changed to suit the changing needs of the pupils and society. It should be flexible broad based. There are different types and nature of people. The curriculum should contain variety so that majority needs of different pupil should be entertained.

**9. Principles of totality of experience**

It should be well balanced properly graded, fairly broad based and approximately designed for meeting the needs of the society and the individual. The different experiences given by the curriculum should make the pupil feel the totality of experiences.

**10. Principle of activity centeredness**

There should be emphasis on learning by doing. More provision should be made for individualized laboratory work and other field experience. There should be more provision in the curriculum for making the child engaging in project work and field activities.

**Check your progress:**  
**Notes:** a) Write your answer in the space given below  
b) Compare your answer with the one given at the end of the unit

1. Define curriculum  
.....  
.....
2. Write various steps involved in the curriculum process  
.....  
.....
3. What are the principles of curriculum construction?  
.....  
.....

---

**9.4 ORGANIZATION OF CONTENT MATTER**

---

The next step in curriculum development is the selection of content. There are some parameters to be borne in mind while choosing the content.

- Content should be recent and relevant



- Content should be accurate
- Content should be adequate

The National Curriculum Framework (2005) has prescribed the following points while selecting the content.

The most important consideration while developing a science curriculum is to ensure a reduced emphasis on mere information and provide greater exposure to what it means to practice science. The content should not be content dominated and it should give sufficient time for discussion and reflection. The concepts introduced at any stage of the curriculum must be within the cognitive reach of the learner at that stage. While deciding contents across grades introduction of some concepts at a very early stage (pipe line approach) should be avoided. It hinders any meaningful understanding. They may be introduced at later stage. A difficult concept is not simplified merely by presenting it briefly and removing its rigor. Rather the prerequisites in terms of ideas experiences and activities should be provided at the appropriate levels. We should avoid also steep gradients as currently existing between the secondary and higher secondary stages. Pedagogy cannot be decoupled from content the two must be developed together.

Much greater emphasis on creative expressions of students in non formal ways both in and out of schools activities on practical work on developing elementary technological modules on surveys of bio diversity health and other aspects of environment etc. should be exploratory investigative activities outside the text book Parts of these activities should be imaginatively incorporate in textbooks.

### **Text books**

In an ideal education system a text book is only one of the diverse tools for curriculum transactions. It is the only accessible and affordable curriculum resource. We must use the text book as one of the primary instruments for universalisation of good science education. Text book must help realize the basic curricular objectives of different stages. They should raise meaningful and interesting questions and emphasize applications and problem solving. They should systematically establish linkages of many kinds with everyday experiences within and between topics between different curriculum areas and across the years of schooling. Such linkages would form powerful reinforces of learning. Curricular choices and text book writing should be characterized by diversity and alternative approaches.

### **NOTES**

**NOTES**

Different states may choose different contents according to their needs. If possible even each district may choose different contents.

---

## **9.5 CRITICAL EVALUATION**

---

### **9.5.1 Tamilnadu Higher Secondary School science curriculum**

- Content should be organized in to large areas or units each of which represents some major problem of living area of daily application or some aspect of environment
- The content of any single area or unit should be broken do in to smaller learning problems which have interest significance and usefulness to the learner
- The learning experiences in any single problem should be organized to promote functional understanding growth in the processes of problem solving and the development of attitude appreciation on and interest.
- Abundant opportunities should be given for building principles and concepts
- Provision should be made for effective evaluation including self-evaluation
- The sequence of unit should be planned to give recurrent contacts with facts concepts and principles of science and to provide a spiraling and enlarging pattern of growth in concepts and principles.
- Problem situations should provide definite training in one or more of the elements of scientific method
- The course in science should be organized to provide frequent opportunity for pupils to participate in planning and to engage in individual and group projects.

---

## **9.6 CURRICULUM IMPROVEMENT PROJECTS IN INDIA AND ABROAD**

---

Curriculum construction is a dynamic process. Some efforts to improve science curriculum in India and abroad area follows:

1. NCERT

2. CHEM Study
3. PSSC
4. BSCS
5. Nuffield

## NOTES

### 9.6.1 NCERT Curriculum

In 1961, the National Council for Educational Research and Training (NCERT) was established. The council has contributed a lot to the development of school education. It was only the NCERT which established panels of textbooks writers at the national level for the preparation of text books. One of the groups developed biology textbooks reflecting the BSCS spirit. It brought a substantial change in biology textbooks all over the country. The summer institute in science conducted in collaboration with UGC and USA ID urged the biology teachers to use new textbooks and discovery approach. The programme was initiated in 1963. The NCERT has published BSCS materials for use in this institute. In 1968, National Education Policy was announced. In 1975, the curriculum for the ten year school, a framework was published. In 1985, National Curriculum for Primary and Secondary Education, a frame work was published which accepted the rationale of Science for all.

Some of the significance features of the biology course developed by the NCERT are follows

1. Students will be able to proceed for higher education in ecology, botany, physiology, microbiology, agriculture, anthropology and medicine
2. They will also be prepared for vocations such as controlling pests vegetative propagation in horticulture sericulture and poultry farming.
3. A number of skills are to be developed students will be able to undertake small individual projects and open ended experiments and prepare charts and models.
4. Students will be able to understand the various biological aspects of social problems such as those of environment population and individual community health resources.

The beginning of the 10 +2 patterns of education has given much impetus to science education in general and biology education in

## NOTES

particular. The biology courses at both the secondary and higher secondary stages are rich in content and include environment aspects molecular aspect, health nutrition and agriculture aspect. The biology teacher is prepared both in the content and teaching methodology. Still much remains to be done. In the light of new emerging perspectives in biology education in the developed countries we need changes in objectives approaches and evaluation techniques.

At the elementary stage, the teaching is confined to the study of nature and common objects and phenomena in the form of general science.

For classes VI to VIII, NCERT has recommended integrated science curriculum. It is a combinations of relevant topics from important branches of science which are integrated with the environment of students rather than presenting an artificial integration of discipline.

At classes IX and X, science is developing as a discipline of mind. The newer concepts and the experimental approach to the learning of science are stressed. These are the recommendations of NCERT regarding curriculum.

### **9.6.2 Chemical Education Material Study (CHEM study)**

The CHEM study materials are highly integrated around the development of concepts theories and ideas in chemistry

- The experimental nature of science is the basis of students investigation of chemical reactions
- It was originated in 1960 by JA Compel
- It uses inductive approach i.e. from particular to general

#### **Content of CHEM study**

1. Emphasis on the structure of chemical systems including electron structure the geometrical arrangement of the atoms their relative size and shapes the packing together of atoms and molecules the forces between them and how these affect their chemistry is expected to guide the student in his understanding and interpretation of the complex chemical formula
2. The text material begins with an overview of the field of chemistry

3. The student introduced to major generalization including energy and chemical reactions rates of chemical reaction's equilibrium and chemical reactions, stoichiometry atoms and their structure periodicity of chemical properties and electron structure
4. After the generalization have been developed through experimentation the students are expected to continue using what they learned in interpreting and understanding more complex ideas.
5. It has 25 chapters

## **NOTES**

### **Materials developed under CHEM study**

1. Text book
2. Laboratory manual
3. Teacher's guide
4. Supplementary materials
5. 16mm colour movie films
6. Series of chemistry monographs

#### **iv. Chemical Bond Approach (CBA)**

- The chemical bond approach is organized around the central themselves theme that is stated in its title that of chemical bonds.
- Originated by George C Primental University of California (1960-69)

### **Objectives**

- To diminish the separation between scientist and teachers in the learning of science
- To stimulate and prepare those high schools students who plant to continue the study of chemistry in college as a professional career
- To encourage teachers to undertake further study of chemistry

## NOTES

### **It has 5 parts in 18 chapters**

- Part I Nature of chemical change
- Part II Electrical Nature of Chemical systems
- Part III Models aids to the Interpretation of Systems
- Part IV Bonds in Chemical System
- Part V Order Disorder and Change

### **It is used as deductive approach**

i.e. from general to particular

### **Materials developed in CBA**

1. Laboratory Manual
2. Teacher's Guide
3. Evaluate instrument in cooperation with educational testing service

### **9.6.3 The Physical Science Study Committee (PSSC)**

#### **Founder Uri Haber Sehaim (1959-1968) MIT Cambridge**

#### **Aim**

1. To present a view of modern physics to the students
2. In order to achieve this aim the committee has devoted its efforts to develop a course involving scientific inquiry on the part of the students equally important that the student see physics as an unfinished and continuing activity
3. Stresses on understanding of facts how to use them for interpreting more complex physical phenomena

#### **Features of PSSC**

PSSC course contains four closely interconnected parts distributed in 34 chapters

#### **34 chapters**

Part I Time space and Functions

Part II Geometrical Optics and Wave

Part III Dynamic aspects of Motion

Part IV Electricity and Magnetism

### **Materials developed for the PSSC Course**

1. Text book
2. Laboratory Guide
3. Film series (53 titles)
4. Achievement test
5. Science study series of paper bound books
6. Teacher's guides
7. Low cost apparatus

### **9.6.4 Biological Science Curriculum Study (BSCS)**

This is introduced at the intermediate stage (Between ages 7 to 9)

Founder William V. Mayer University of Colorado USA (1958 -1969)

The BSCS was established for the improvement of biological education on at all levels.

The reorganization of biology curriculum is an imaginative investigative and inquiry oriented fashion resulted in the BSCS. The BSCS has played an important role in the spectacular improvement in biology education. It was organized to improve biological education at all levels of instruction.

The initial goal of the BSCS was the production of classroom materials for average students in a first course in biology at the secondary level. The materials were structural around a series of major themes.

The first experimental edition of BSCS books were completed in 1960s and were tested. From this experience the three experimental versions were revised in 1961 and subjected to trials 500 schools in 1961 -62 school year and in 950 schools in the following year. After three years of extensive trial and revision the three experimental versions were reorganized to become the commercially published editions in 1963.

### **NOTES**

## NOTES

The aim was to include the recent scientific knowledge into biology text and to select the most appropriate materials to develop attitudes skills and knowledge keeping in view for many students then high school is terminal. The materials were to be something broader and larger than were facts and elementary generalization. It is to be a reflection of the principles and emphasis of science as a whole.

### **Three separate versions were developed**

Biological Science: Molecules man

Biological Science: High school biology (green version)

Biological Science: an inquiry with life (yellow version)

All the versions have been developed on nine unifying themes which is presented throughout the text. These nine themes were selected on the basis of two major determining factors.

1. The procedures and conceptions that best characterize modern biological science
2. The needs and problems of the students

### **Themes**

1. Sciences as investigation and inquiry
2. The history of biological concepts
3. Complementarity of structure and function
4. Diversity of type and unity of pattern
5. Change of organisms through time as evolution
6. Genetic continuity
7. The complementarity of organism and its environment
8. Regulation and homeostasis
9. Biological basis of behavior

Though about 70% of the content on these versions in common they emphasize different approaches

**The Blue versions:** Biological Science: Molecules to man



This version approaches the study of biology with emphasis upon recent advances in physiology and biochemical evolution. The next presents unifying approach of teaching the levels of biological organisations as we assume that they have evolved from the simplest to the most complex that is, from molecules to man. The content is

1. Interaction
2. Evolution of life process
3. New life
4. Genetic continuum

**The green version:** High School Biology

This version approaches the study of biological for ecological and behavioural aspects. A major emphasis is placed up at the biological community and world home. The content of the text is

1. The world of life; The biosphere
2. Diversity among living things
3. Patterns in the biosphere
4. Within the individual organism
5. Continuity of the biosphere
6. Man and the biosphere

**Yellow Version:** An Inquiry with life

This is concerned within cellular level of organization and the content is organized around the concepts of biological unity, diversity and continuity

- Unity
- Diversity
- Interaction
- Continuity

**Special Course for Slow learners**

In addition to the three texts BSCS has developed a fourth version for slow learners It is known as Biological Sciences.

**NOTES**

## NOTES

Patterns and processes The content is presented in simple language, and simple methods of learning have been included. Laboratory work and practical work also included. Programmed learning has been used as one of the approaches to simplify the content.

A major ancillary programme of the BSCS was the development of a handbook for teachers of biology This is intended to be an everyday referenced for teachers for biology. It has the section which consists of all together 18 chapters.

### 9.6.5 Nuffield Science Teaching Project

The Nuffield foundation is one of the UK's best known as charitable trusts was established in 1943 by William Morris (Lord Nuffield) the founder of Morris Motors.

The Nuffield science teaching projects were initiated in England. The Nuffield foundation took the task of improving science education and launched the project in 1961- 62.

The Nuffield programme do not provide a highly structured, readymade curriculum with clearly defined behavioural objectives and an elaborate text books. The main purpose was to develop materials that will help teachers to present science in a lively, exciting and intelligible way. The students are expected to learn by inquiry. The teachers has greater freedom to translate and adapt the program me to meet student s needs and systems requirements. The teachers' guide rather, than the students' text represent the real heart of then programme. The course content is treated as molecules cellular tissue level and population level. The main feature of the subject matter it that is focuses the pupil attention on living organisms and not just biological principles. An attempt has been made to link various biological themes. For e.g. Population, genetics and ecology can be considered together.

#### Course is based on four themes

- The living community
- The maintenance of the individual organism
- The organism in relation to the environment
- The developing organism

The projects lay emphasis experimentation and critical evaluation of evidence Learning is based on laboratory work. Use of

variety of teaching of teaching methods was also provided in the course. Films and other materials are also used for experimentation and discussion.

Examination system is also noteworthy. The long questions in the traditional questions various types replaced by short questions. Various types of question are included to replace simple knowledge based questions.

## NOTES

**The six categories of questions include are:**

1. Simple recall type
2. Association recall type
3. Experimental recall type
4. Experimental design type
5. Deductive type
6. Continuous prose.

---

## 9.7 RECENT TRENDS IN SCIENCE CURRICULUM

---

The curriculum is a dynamic process and it has to include the latest developments happening from time to time. In this regard, there is a lot of development in biological sciences. Some of them are discussed below.

**Biochemistry:** It is the study of the chemical processes and transformations in living organism. Biochemistry dealt with the function of cellular components such as proteins, carbohydrate, lipids, nucleic acids and other bio molecules. It studies the chemical properties of important biological molecules like proteins, in particular the chemistry of enzyme catalyzed reactions. Cell metabolism endocrine systems genetic code DNA, RNA protein synthesis, cell membrane transport and signal transduction in some areas of biochemistry.

**Biophysics:** It is an interdisciplinary science that applies the theories and methods of physics to questions of biology. In the past, it deals with creating mechanical limbs Nano machines to regulate biological functions. Today it deals with sequence analysis to neural networks. Biophysics addresses biological questions that are at a molecular level. PCR amplification, gel blotting, fluorescence labeling and vivo staining

## NOTES

are some techniques use in Biophysics. Protein structures, Kinetics of interaction are some topics of biophysics.

**Environment Toxicology:** It is a branch of toxicology concerned with the study of toxic effects caused by natural or synthetic pollutants to the constituents of ecosystems, animals, and vegetables and microbial in an integrated context. It aims to predict the effects upon natural population communities or ecosystems the ecosystems of stressors are the anthropogenic in origin or otherwise. It incorporates aspects of ecology, toxicology, physiology, molecular biology, analytical chemistry and other disciplines to study the effects of xenobiotic on the environment. The ultimate goals of this approach are to predict the effects of pollution and the necessary actions to restore eco services and functions efficiently.

**Genetics:** it is the science of heredity and variation in living organisms. The modern genetics seeks to understand the mechanisms of inheritance. DNA and chromosomes Reproduction Genetic recombination and linkage, Genetic code regulation Natural selection and evolution and genomics are some of the topics covered in Genetics.

**Genetic Engineering:** It is the study of manipulation of genes generally outside the organism's natural reproductive process. The isolation manipulation and reintroduction of DNA into cells are some techniques used in this field. The aims is to introduce new characteristic physiologically or physically such as making a crop resistant to a herbicide introducing a novel trait enhancing the existing ones producing a new protein or enzyme, manufacture of human insulin enthroprotein new type of experimental mice, (onco mouse) etc.

**Ecology:** it is the scientific study of the distribution and abundance of living organisms and how the distribution and abundance are affected by interactions between the organism and their environment. The environment of an organism includes both physical properties which can be described as the sum of local a biotic factors such as sunlight climate and geology and biotic factors which are other organisms that share the habitat. The populations, communities, ecosystem and biosphere are the primary subjects of ecological inquiry. It draws heavily on other branches of sciences such as geology geography, meteorology, pedology genetics chemistry and physics. Ecological knowledge such as biodiversity and population dynamics has provided the basis for environmentalism.

**Conservation and preservation of Natural Resources:** In order to conserve and protect our various precious resources such as forest,

energy, wildlife, fisheries agriculture etc. We may follow some of the following measures

- i. No commercial exploitation of natural resources
- ii. Generation of three types of forests (tall trees, smaller trees and herbs)
- iii. Intensive plantation
- iv. Checking of trade in animal products
- v. Wild life protection
- vi. Judicial use of available land and resources
- vii. Introduction of high yielding diseases resistant of crops and mixed cropping
- viii. Periodic soil health monitoring etc.

The above described new trends should be include in the curriculum at various levels from time to time. That will enrich the curriculum, and help producing the necessary manpower required for the future.

---

## 9.8 LET US SUM UP

---

In this unit, you had learnt about science curriculum. First of all you have studied the curriculum its meaning and principles and the curriculum construction process selection of learning experiences content organization of content and the evaluation are the major processes of curriculum development. You have learnt the curriculum content. The content should be recent, relevant accurate and adequate. There are various approaches for curriculum development. Conceptual/factual, flexible/structured, process/content pupil centered, Teacher centered and integrated/Disciplinary are some of the approaches. Each approach has its own pros and cons. Then you learnt different trends in science curriculum development. Individualized inter-disciplinary and social issues oriented are some recent trends. Then you studied curriculum evaluation at the last we discussed various new trends in science projects in India and abroad.

---

## 9.9 UNIT END EXERCISES

---

1. Define curriculum
2. What are the various processes of curriculum development?

## NOTES

## NOTES

3. Discuss the principles of curriculum development elaborately.
4. Explain how can you select the contents of a curriculum
5. Different approaches for curriculum development explain them
6. Describe recent trends in curriculum development
7. Briefly discuss various trends in science

---

### 9.10 ANSWERS TO CHECK YOUR PROCESS

---

1. Curriculum is a set of activities related to aims of education, content, learning experiences, transition in the classroom etc.
2. Objectives, selection of learning experiences, selection of content, organization and integration of learning experiences & evaluation
3. Principles of child centeredness, community centeredness, integration of the needs of the child, society and discipline, conservation creativity Integration of science. Forward looking, elasticity and variety totality of experiences and activity centeredness.

---

### 9.11 SUGGESTED READINGS

---

- Anju Soni. Teaching of Science. Ludhiana: Tendon Publication.
- Mathew.T.K &T.M Mollykutty (2006). Teaching of Science TNOU B.Ed Study Material , Chennai .
- NCERT. (1975). The curriculum of the 10 year school.
- NCERT. (1987). Science Education for the first Ten Years of Schooling. Syllabus for Upper primary Stage.
- Radhamohan (2010)Innovative Science teaching for Physical science teachers Phi Learning Private Ltd, New Delhi
- Saravanakumar .AR(2014) Enhancing Achievement in Science through Metacognition KVS Printers Karaikudi
- Venugopal, G.N Nithyasri &Prof K.Nagarajan (2013) Teaching of biology Sriram Publishers Chennai

---

# UNIT X ASSESSMENT IN SCIENCE LEARNING

---

*Science Teacher and  
Teacher Perspectives - I*

- 10.1 Introduction
- 10.2 Objectives
- 10.3 Concept of Evaluation and Assessment
- 10.4 Test and its types
- 10.5 Achievement Test
  - 10.5.1 Nature of achievement test
  - 10.5.2 Function of achievement test
  - 10.5.3 Types of achievement test
  - 10.5.4 Teacher-Made test
- 10.6 Qualities of a Good Test
- 10.7 Evaluating Outcomes of Science Teaching
  - 10.7.1 Formative Evaluation
  - 10.7.2 Summative Evaluation
  - 10.7.3 Diagnostic Evaluation
  - 10.7.4 Norm -referenced Evaluation
  - 10.7.5 Criterion –referenced Evaluation
- 10.8 Principles of Test Construction
  - 10.8.1 Blue Print
  - 10.8.2 Question Paper
- 10.9 Item Analysis
- 10.10 Standardizing a test
  - 10.10.1 Definition
  - 10.10.2 Construction of standardization

**NOTES**

**NOTES**

10.11 Diagnostic Test

10.11.1 Meaning

10.11.2 Testing

10.11.3 Characteristics

10.11.4 Steps in construction

10.12 Remedial Teaching

10.12.1 Role of remedial teaching

10.12.2 Remedial Drill

10.12.3 Steps in Remediation

10.13 Let Us Sum Up

10.14 Unit End Exercises

10.15 Answers to check your progress

10.16 Suggested Readings

---

**10.1 INTRODUCTION**

---

In this unit, you will be learning about the evaluation of student's attainment in science i.e. the written examination, evaluation of practical work in science, construction of tests, marking and interpretation of results. After teaching a topic or a number of topics the teacher should test whether the students have learnt the concepts of the topics by means of tests. The tests may be oral tests, or written tests and it is left to the teacher to decide the type of test. Science also contains practical and experiments. Students should also be tested in these practical and experiments and these are called practical tests. These practical tests are entirely different from written tests. It is the duty of the teacher to evaluate the achievement of students as a result of teacher's teaching and student's learning. Only when the teacher knows whether the students have learnt the content of a topic, then only he will be able to teach further content in the topic. You will be learning about tests, which are useful for this purpose.

---

**10.2 OBJECTIVES**

---

After completing this unit, you will be able to:



- distinguish between evaluation and assessment,
- identify the importance of evaluation and assessment,
- clarify the concepts of evaluation and assessment,
- identify the purpose of evaluation and assessment in science,
- identify and use the techniques of assessment in science in both theory and practical,
- identify and use the prescribed steps in test construction,
- identify and use the criteria of a good test,
- set a science question paper with the help of objectives, design and the blueprint,
- monitor the learner's progress, and
- identify the weakness of the slow learners or the slow average students by diagnostic tests in science, and provide the necessary remedial measures.

## NOTES

---

### 10.3 CONCEPT OF EVALUATION AND ASSESSMENT

---

Practically, all our school evaluation activities are limited to the area of scholastic attainment rather than the total growth of the child. This is just a part of the evaluation process, which is called 'assessment'.

#### Assessment

Assessment is an attempt to measure not the pupil as a whole, nor his 'worth' but some particular abilities like knowledge of some science content/skill of handling the apparatus, setting up the experiments, performing the experiments, collecting and analyzing the data (observations) and concluding etc. Assessment declares the students merely as pass, fail or categories them into 1<sup>st</sup>, 2<sup>nd</sup> or 3<sup>rd</sup> divisions. It is very important and also very useful if done objectively. Divisions and percentage of marks help students to get admission in higher classes, if there are no admission tests and to get jobs if there can be no recruitment test or interviews.

#### Evaluation

Evaluation on the other hand, carries a very wide meaning compared to assessment. The term 'Evaluation' stands for assessment in all the educational outcomes and outputs that are brought about as a result of the teaching learning process. Evaluation is used to assess the change in the total behavior of the child related with all the three domains (cognitive, affective and psychomotor). Evaluation also assesses the child's progress in science curriculum as well as co-

**NOTES**

curricular activities like science projects, innovative experiments, science excursion and science fairs etc.). Evaluation has its own importance as compared to assessment. Evaluation may be considered as a comprehensive and continuous system of assessment that may help in knowing whether the extent to which the identified objectives have been achieved and the expected behavioral changes have taken place in the learners in order to set them on the right path of learning. This evaluation may help place in the learners in order to set them on the right path of learning. This evaluation may help science teachers to assess their methods of teaching, and the school principals in bringing desirable reforms in the overall educational and administrative set up.

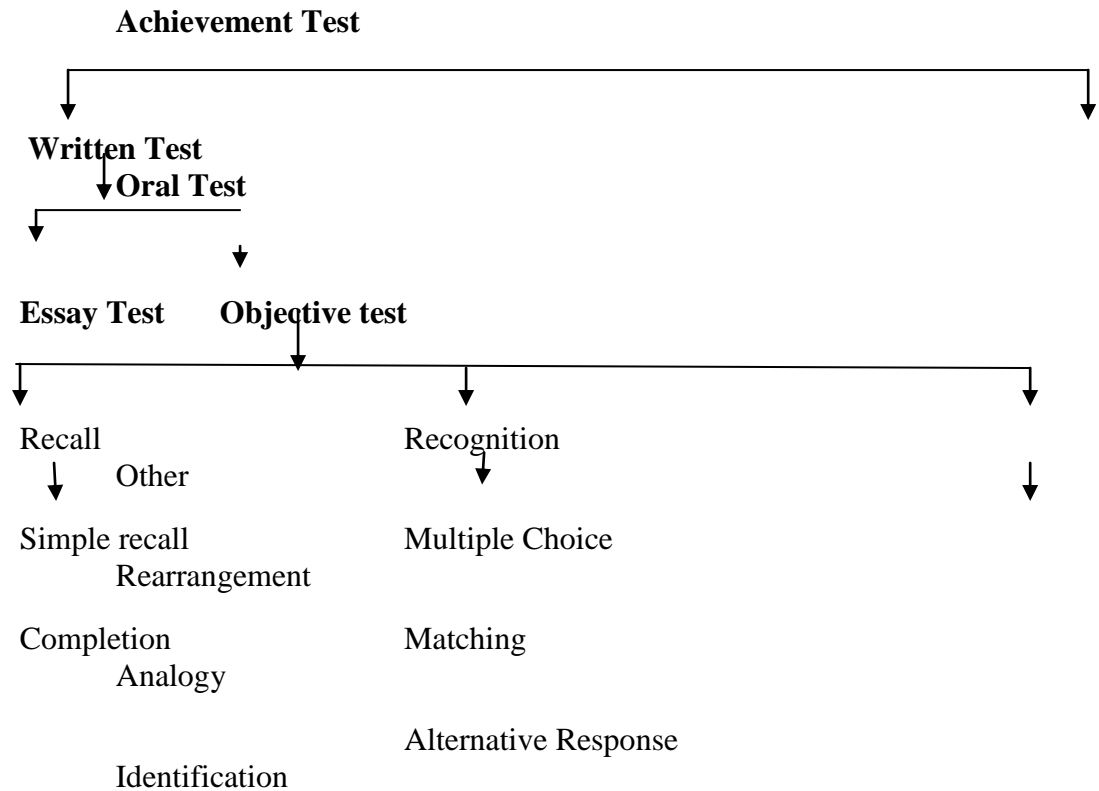
---

**10.4 TEST AND ITS TYPES**

---

Tests are meant only for the checking the knowledge of the students. A test is a device to obtain measurement in education. A test usually presents a uniform set of tasks to all members of a given group at a schedule time with a due prior notice.

**Schematic Representation of Achievement Test**



---

## 10.5 ACHIEVEMENT TEST

---

Achievement may be defined as a change in behavior in a desired direction. Learning results in changed responses to certain types of stimuli. Achievement can occur in a variety of ways and at a variety of levels. Some illustrations are:

- improving skills in handling apparatus
- increasing knowledge, such as learning the different parts of an optical instrument
- increasing understanding, such as the prediction of outcomes under a given set of conditions.

Obviously, some types of learning outcomes are fairly easy to measure, while others (such as appreciation of scientific phenomena) are considerably more difficult to measure.

### 10.5.1 Nature of Achievement Test

Achievement test comprise a very important test in the school evaluation program. According to **Downie**, any test that measures the attainments or accomplishments of an individual after a period of training or learning is called an achievement test. **Good's** Dictionary defines an achievement test as a test designed to measure a person's knowledge, skills, understandings, etc., in a given field taught in school. The International Dictionary of Education defines achievement as a test designed to measure the effects of specific teaching or training in an area of the curriculum.

**Super, D.E.** defines an achievement test as a proficiency test used to ascertain what and how much has been learnt and how well a task can be performed, the focus being on evaluation of the part without reference to the future. Achievement tests differ from aptitude tests in that the former measures quality and quantity of learning attained in a subject of study or group of subjects after a certain period of instruction, whereas the latter measures the pupil's innate capacity for attainment or accomplishment independent of any learning. A satisfactory achievement test in science would be one which gave reliable evidence of the extent to which the students had achieved the objectives of instruction.

### 10.5.2 Function of Achievement Test

The major functions of achievement tests are that they act as a

- basis for promotion to the next class;

## NOTES

## NOTES

- guide for the teacher to assess the entry level of each student at the beginning of the year;
- means of motivating students before the start of a new assignment;
- mode of assessing how effectively a teacher has been able to attain her objectives;
- tool in identifying areas of strengths and weaknesses in a student understanding of a subject.

### 10.5.3 Types of Achievement Test

There are two types of achievement test:

- Teacher-made tests
- Standardized tests

Teacher made tests can further be categorized into the following three types:

- Oral tests
- Written tests
- Practical tests

Written tests can be further classified as:

- Essay type                      short answer type                      Objective type

### 10.5.4 Teacher Made Test

#### Oral Tests

Oral tests are used extensively in the lower classes as well as in the high school. Most science examinations have provision for viva voice, conducted either at the end of a project or during the practical examination instead of writing the response. The student gives the needed information verbally in a fact manner.

#### Advantages

- Questioning over a wide coverage of subject area is possible.
- Any misconceptions can be clarified both by the student and the teacher.

#### Disadvantages

- It can be time-consuming.
- The probability of bias exists

## Written tests

Written tests can be further classified into essay-type; short answer type and objective – type.

### Essay –Type Test

This allows relative freedom of response to a given problem. Generally the essay-type paper carries a few questions from which the student is expected to either answer all or choose a selected number.

The familiar essay questions require answers which may involve;

- an exposition of theories
- an explanation of processes
- the solution of problems
- description of apparatus, instruments etc.
- historical surveys
- the interpretation of practical and numerical data.

Such questions may test factual knowledge, ingenuity and the students' power to express coherently a long train of logical reasoning.

### Advantages of Essay-type tests

- They are easy to construct.
- They can be used to test the student's language mastery, expression and organizational ability of a student.
- Chances of copying are minimal.

### Suggestions for construction of Essay-type tests

- The test should neither be too general nor too specific.
- The direction and scope of the response should be well defined.
- The time factor should be given due consideration.
- An effort to construct a uniform essay-type test for all the students should be made.

### Suggestions for scoring in Essay-type tests

- Inform the students about the method of scoring before giving the test.
- The examinee's identity should be kept anonymous by allotting roll numbers.
- One should be clear about minimum essentials of an acceptable answer.

## NOTES

## NOTES

- Score all responses to each item before going on.

### **Disadvantages**

- Subjective bias
- Rote memory
- Sampling limited
- Bluffing
- Difficult to score

### **Short Answer-type Test**

This type of test is a combination of short answers and objective –type.

### **Advantages of short answer-type**

- Questions of this form can be made stimulating.
- Students can be trained to select relevant information and present it in a few short, crisp sentences.
- Short answers are easy to score.
- Reliability of scoring is high

### **General principles for constructing Short –answer items**

- Use of simple, short and grammatically correct sentences.
- Avoid double negatives.
- Avoid qualitative terms.
- Avoid absolute terms.
- Avoid abstract statement deviating from the main context.
- Keep each item independent and unified – that is, it must deal with a single item of information.
- Give due consideration to time allotted for the test.
- Give clear, specific and complete directions.
- Keep the system of responses as simple as possible.

### **Objective type tests**

In this type the answer to the question is generally provided in the question paper itself. The student has to choose the correct answer. Objective type of tests is of two types. They are **recognition type** and **recall type** of tests. In recognition type of tests consists of True/False, multiple choices, and matching. In recall type of test the student's power of recall is tested. It consists of simple recall type and completion type of questions.

**Check Your Progress**

**Notes:** a) write your answers in the space give below

b) compare your answers given at the end of the unit

1. Generally examination is treated as being equivalent to evaluation. Is this justified?

.....  
.....

2. What is the difference between assessment and evaluation?

.....  
.....

**NOTES**

---

**10.6. QUALITIES OF A GOOD TEST**

---

Educationists and researches agree that a good test should possess the following qualities.

**10.6.1. Validity**

When a test measures what it is supposed or purported to measure, then it is said to possess validity. When the teacher wants to measure or test the knowledge of facts an principles, scientific thinking, understanding ability and application related to biology, then he should frame questions to test each of these and include in the test. For example a test in science meant for measuring the acquisition of science knowledge should measure only science knowledge and not the linguistic or handwriting or arithmetic ability of the student. The validity of a test is the achievement of the purpose for which the test is constructed.

**10.6.2 Reliability**

When student is tested by different types of tests, different examiners and during different periods the student should obtain the same score or nearly the same score or the differences in scores should be negligible. Then, the test is said to possess reliability or the test is reliable. **A test is said to be reliable if it measure consistently in the same way, whatever, it measures.**

**NOTES**

### **10.6.3. Objectivity**

The result of the test should not change according to the individuals who score it. When the answer paper of a student is valued by different examiners and the result obtained is more or less the same then the test is objective. The test, which does not give room for the likes and dislikes of the examiners is said to possess objectivity. There is no room for personal influences. The attitude of the examiner also does not affect the result.

### **10.6.4. Practicability**

Practicability is related to practical aspects of the test in respect of administration, scoring and economy. It refers to the degree to which the test can be successfully employed by classroom teachers and school administrators without an unnecessary expenditure of time and energy. Practicability depends on the following factors.

- i. Easy for administration
- ii. Easy for scoring
- iii. Easy for interpretation
- iv. Economy of cost, time and energy

---

## **10.7 EVALUATING OUTCOMES OF SCIENCE**

---

### **Evaluation in Science**

Evaluation in science assess all the teaching learning in terms of overall behavioral changes related to science content (facts, concepts, laws, principles, theories, formulae etc.) and science processes (observing classifying using number, measuring using space time relationship communicating predicting, inferring, defining operationally formulating hypotheses interpreting data, controlling variables and experimenting). Not only does evaluation assess the desired science knowledge but it also assess the desired science knowledge, but it also assess its comprehension, application, analysis synthesis and evaluation. Evaluation not just assess the cognitive domain objectives, but it also assesses affective domain objectives receiving (attending), responding, valuing organization and characterization by a value or value complex. Evaluation not just a assess the curricular abilities in science but it also assessed science based co-curricular abilities in the child. Evaluation thus has made the process of testing and assessment as continuous and comprehensive. The purpose of evaluation is therefore, to assess the overall development of the child.



## **Assessment in Science**

Assessment usually measures how much science content (concepts and skills) has been achieved by a child out of the identified content he/she was supposed to achieve in a particular class. This content is generally knowledge but state education boards in class X and XII examination and the progressive schools also in other classes have also started including comprehension (understanding) and application oriented as well. The assessment will be more objective and useful if emphasis is given the following purposes to be achieved.

- Providing feedback to each pupil about his/her progress in science
- Giving feedback to the teacher about the effectiveness of his/her science teaching
- Providing information to prepare individuals for further science education and employment opportunities
- Motivating children to develop interest in science

Tests and other evaluation techniques can also be in terms of their functional role in classroom instruction. These categories of evaluation procedure are divided into the following heads.

1. Formative Evaluation
2. Summative Evaluation
3. Diagnostic Evaluation
4. Norm-referenced Evaluation
5. Criterion-referenced Evaluation

### **10.7.1 Formative Evaluation**

The primary function of formative evaluation is to provide continuous feedback to both students and teachers regarding learning process and failures. Formative evaluation rests on specially prepared tests for each aspect of instructional process. These tests provide direct evaluation of the learning outcomes of the students. Teacher made tests and commercialized tests are utilized in the formative evaluation procedure.

The term formative denotes the ongoing or systematic assessment of student achievement while the term course or instructional programme is in progress. Feedback to the students and not the assignment of a grade should be the purpose of making a formative evaluation. The gathering of the data during the time of

## **NOTES**

## NOTES

programme for the purpose of guiding the developmental process is formative evaluation. A person who is continually being evaluated during the course will find many things that can be changed for the better during the operation of the programme. Thus formative evaluation is most useful for the immediate decision making that students face. The daily interaction between the teachers and students provides the students with the necessary feedback for immediate decision-making. The feedback depends upon (i) determining what a student needs to know to facilitate further improvement (ii) gathering accurate data using a variety of appropriate devices (tools) and (iii) presenting these data to the student in a fashion he will comprehend. Thus it is a continuous and integral part of instruction where 'one uses a variety of techniques such as attitude and aptitude inventories, checklists, rating scales etc. other than the tests. It is an end in itself and its main function is the appraisal of value of evidences collected by the data gathering devices.

### **10.7.2 Summative Evaluation**

It is a very typical evaluation procedure that takes place at the end of a course content of teaching. This evaluation procedure is prepared to ascertain the degree to which the instructional objectives have been obtained. The primary function of summative evaluation provides grades or certificates of student's progress. It also judges the appropriateness of well formulated instructional objectives and the effectiveness of teaching process in the good social setting of the institution.

The term summative refers to assigning a grade for students' achievement at the end of a term, course or instructional programme. Therefore, making an overall assessment or decision with the instructional programme is summative evaluation. It may focus only on a single aspect of subject matter achievement or skills. It means to an end and its main function is collection of evidences to determine the present status or position of a pupil in a particular area. It may be done off on and it need not be an essential part of instruction. The interaction between the teacher and the pupil is very limited and the feedback that the pupil gets is much less when compared with the formative evaluation.

Although formative evaluation is perhaps most helpful to the student, summative (or terminal) evaluation of the kind provided at periodic intervals also can assist him in decision making, particularly in the formation of long range plan. Pupils often cannot easily combine all the daily feedback provided and obtain an overall picture of their

progress. They need the insight provided by the teachers. Thus an overall summary is of value. For example, the student would like to know whether he did 'well' or 'poorly' in mathematics, or what his 'grade' in mathematics is. This knowledge would help him to decide whether mathematics is a field in which further inputs of his resources are likely to be productive for him.

### **10.7.3 Diagnostic Evaluation**

It deals with the continuous or recurring learning problems. These learning problems are cured by the standard corrective prescriptions of this type of evaluation of procedure. The main function of diagnostic evaluation is to ascertain the serious causes of persistent learning problems and find out the proper solution for remedial action.

Test results provide a basis for drawing conclusion about learning and teaching. A useful test not only provides information about students' achievement but also reveals the instructional effectiveness as well. If you examine individual performance, you should be able to determine each student's degree of proficiency on each objective. Where proficiency is sufficient, progress can continue to new learning areas. Where proficiency has not been demonstrated, remedial instruction aimed directly at those objectives can be instituted. In this way a test can have diagnostic value. Test performance not only serves to certify success but also provides the kind of information that will make it possible to overcome failure.

Where instruction is of a group nature, test results must be applicable to judgments of group progress. If group success has largely been attained then instruction on new material can begin. If group gains been minimal remedial instruction should be provided before instruction can progress to new areas. Finally the interpretable test gives the teacher information on the adequacy of instruction. If proficiency on a particular objective has not been demonstrated by many students, it is probably because instruction in this area has been less than successful. Probably the learning experiences, we are insufficient for achievement of this objective. Changes in lesson plans or learning materials for attaining this objective should be seriously considered for subsequent instruction or replace those currently in use. Thus, evaluation serves many important diagnostic purposes too.

### **10.7.4 Norm-referenced Evaluation**

Test from which information about the relative performance of a specific group of people is available are called norm referenced tests. In norms referencing, the interpretation of the test scores is done

## **NOTES**

## **NOTES**

by comparing them to the scores already obtained by other students who constitute the norming group. We determine whether a score is high or low by comparing it with scores obtained by students of the same grade level in the norming group. Place the total scores on the test of all your students who have taken the test in rank order going from the highest score to the lowest and then assign each score a percentile rank or simply separate scores into the top fifth second, fifth middle fifth, fourth fifth and lowest fifth approximately one fifth of the scores in each category. Comparative look at test scores does represent a way to provide them with some meaning at least in relative terms. The norm referenced test is therefore sometimes called the test of relative achievement. Its purpose is to place students as accurately as possible somewhere along the range of possible achievement for the test from the very lowest to the very highest scores.

### **Advantages**

The advantages of norm referenced tests can be listed as under

- Norm referenced test related students score with that of the norming group
- Norm referenced scores help to interpret individual scores by comparing them with group data.
- It helps teachers to make conclusion based on the test scores relatively independent of the failings or weaknesses of the test.
- Norm referenced interpretations of test score permits teachers to make meaningful comparisons among students in terms of their achievement.
- Norm referencing gives summative results gives information regarding the relative position of the individual student or group. Thus a norm referenced interpretation of the test score permits the e teachers to make meaningful comparisons among students in terms of their achievement.

### **Norms**

Norms are sets of score based on the results of an external reference or standardization group that take the test solely for the purpose of providing comparative data for interpretation Norms therefore represents a set of test results obtained in order to help interpret the results of scores from future testing.

## Representation of Norms

Norms can be represented in the following ways as

- Standard scores corresponding to test scores reflect the deviation of test from the mean score of the norm group.
- Percentile ranks, corresponding to test scores tell us what percent of the norming group scored at or below a particular score on the test grade equivalent tell us the school grade at which the given score is typical or average for members of the norming group.

## NOTES

### 10.7.5 Criterion -referenced Evaluation

It is possible to interpret scores some tests in terms of how many items students get right regardless of how this number compares to group performance. In such cases we say that the test represents a performance criterion and that students who gets every item right or some pre-determined number of items right are capable of the total performance demanded by the test. We call such an approach criterion referencing.

It is important to note that a test cannot be automatically called criterion referenced simply because it is not norm referenced. Criterion referenced means that the test performance is linked or related to behavioral reference and that the test has been designed and constructed on such a basis. In other words the test by design must furnish information about students' ability to carry out certain performance in absolute terms. We must have some basis for saying that a student knows how to add and subtract fractions if he or she can complete all the items on the test. If no students can pass the test and if it truly has a behavioural or performance criterion, then we must conclude that no student has met the proficiency criterion for the skill being tested. Put in other way the test results can be interpreted as a n indication of the acquisition of knowledge and skills which the training aimed at achieving.

### Steps in constricting of criterion referenced tests

The construction of a criterion referenced test takes the following steps

- Prepare a content outline listing the skills and knowledge that the test attempts to measure
- Identify the performance (i.e. measurable objectives)

**NOTES**

- Write times according to the specification at least two per objective to make up the test
- Validate the fact that the skills and knowledge measured by the test are in fact pre requisite to the performance objectives identified in step 2
- Decide upon a criterion or cut off score showing test performance a student must obtain to indicate sufficient proficiency in the skills and knowledge to be able to perform the criterion behaviours.

**Features of criterion referenced test**

The important features of criterion referenced test are:

- They are based on a set of behavioral or performance objectives
- They are designed to have a high degrees of appropriateness by virtue of being based on objectives
- They represent samples of actual behavior or performance
- Performance on them can be interpreted in terms of predetermined cut off scores.

**Check Your Progress**

- Notes:** a) write your answers in the space give below  
b) compare your answers given at the end of the unit

3. Write the criteria of a good test

.....  
.....

4. What is the use of Evaluation?

.....  
.....

---

**10.8 PRINCIPLES OF TEST CONSTRUCTION**

---

According to evolution approach, the construction of a test should be should be structured according to a pattern which includes the following steps. The test may be constructed in a lesson or a period

lesson. The duration of the test may be for 40 or 45 minutes and for a maximum of 25 marks.

### The Objectives

The teacher frames certain objectives to achieve when he prepares the lesson plan. After teaching the lesson he has to find out whether the objectives have been achieved or not. For that he has to conduct a test. He should decide about the objectives that he is going to test in that test and the marks to be allotted to the objectives in the test. That means the teacher should decide the marks for various objectives that he is going to test in the test. That is known as distribution of weightage to objectives. The marks allotted to knowledge and understanding should not be more than 60% and for application and skill should not be less than 40%.

### NOTES

### Weightage to objectives

Example for this is given below:

S.No.	Objectives	Marks	Percentage
1	Knowledge	11	44
2	Understanding	4	16
3	Application	8	32
4	Skill	2	8
<b>Total</b>		<b>25</b>	<b>100</b>

This means the lesson or topic on which the test is constructed. This test is constructed on “structure of plan and animal cell” since you have already prepared a lesson plan on this lesson. In this lesson you have to decide the content aspects on which you are going to ask questions and the total marks for which questions under each content aspect are to be set up. There may be a number of subheadings out of which you will be interested in asking questions only on a few headings. The subheadings and the marks for which questions are asked in this should also be mentioned in the distribution of marks to content.

### Weightage to Content

S.No	Objectives	Marks	Percentage
1	Plant cell	1	4
2	Animal cell	11	44
3	Differences	2	8

4	Nucleus	3	12
5	Cell	4	16
6	Protoplasm	1	4
<b>Total</b>		<b>25</b>	<b>100</b>

## NOTES

### Number and types of Test Items

After dividing and distributing marks to different aspects of content, you have to decide about the total number of questions to be asked. The total number of questions in the test should be finalized in accordance with

- a) The duration of the test
- b) The form of the questions
- c) The age level of the students
- d) The difficulty level of the subject matter, and
- e) The range of the subject matter.

When the total number of questions is decided then the types of questions to be framed are to be decided. Three or four types for a period and four or five types for two hours test can be used. Since this is a period test only three types can be used. They are essay type, short answer type and objective type tests. Under objective type tests it is always better to frame multiple – choice items for period tests. Then the number of questions under each type should be decided. Since the maximum duration is one period one-essay type question, four short answer questions and ten multiple – choice items can be asked. It should be found out whether it is possible for the students to answer all these within the prescribed time.

The marks to be given to each question should also be decided. The multiple choice items can be given one mark each while the short answer questions can be given two marks each. So the total mark allotted for these two type tests is eighteen and the remaining seven marks can be allotted for the essay type questions. Then it is necessary to fix the time required for the student to write answer for each type of questions. This should be mentioned against each type. All these distributions are shown below.



## Weightage to Number and types of test items

S.No	Type of questions	No. of questions	Marks	Time
1.	Multiple choice items	10	10	10 mts.
2.	Short answer type	4	8	12 mts.
3.	Essay type	1	7	18 mts
<b>Total</b>		<b>15</b>	<b>25</b>	<b>40 mts</b>

## NOTES

### 10.8.1 Blue print for the unit test

The first three items discussed in the beginning of this lesson are given a concrete shape in the form of a blue print. The first three are two dimensional in nature whereas the blue print is three- dimensional chart covering the following:

- Objectives to be tested
- Subject matter or content to be covered
- The type of questions and the marks given to each type of questions

In blue print the marks are distributed according to objectives, content and the type of questions. In this content represents the area in which questions are asked. Objectives include four.

S. No	Objectives	Knowledge			Understanding			Application			Skill			Total
		E	S	O	E	S	O	E	S	O	E	S	O	
	Content													
1	Plant cell			2 (2)					2(1)					4
2	Animal cell	1(1)		1(2)	4(1)				2(1)	2(1)				11
3	Difference								2(1)					2
4	Nucleus			1(1)					2(1)					3
5	Cell			4(4)										4
6	Protoplasm			1(1)										1
	<b>Total</b>	<b>11</b>			<b>4</b>			<b>8</b>						<b>25</b>

## NOTES

### **Blue print for the unit test**

Instructional Objectives are knowledge, understanding, application and skill. Under each objective, three types of questions can be asked and they are essay type questions, short answer type and objective types represented by the letters E, S, O respectively in the blue print. The numbers within brackets indicate the number of questions asked and the numbers without brackets indicate the marks allotted to the questions. The questions represent knowledge, understanding, and application and skill objectives.

### **Scheme of Option**

It is to be decided whether to give overall choice or limited internal choice. Since this is a test for a period and that too on a lesson or topic three is no 'need for any choice in the questions paper. So there is no option for the students. Scheme of option – NIL.

### **Sections**

Then it is to be decided whether to have different sections. In the questions paper since you are using different types of questions. Three sections in this questions paper can be used. Section – A contains ten multiple –choice items, Section – B contains four short answer questions and Section – C contains only one essay type questions. Thus the questions paper contains three section namely section. A, B and C.

### **10.8.2 Questions paper for the unit test**

After designing the blue print the questions are to be set. The questions should be framed on the basis of the blue print. The type of the questions, the mark allotted to the questions and the content selected for framing the questions should be based on the blue print. At the beginning of each type of questions clear instructions should be given along with suitable example. Marks allotted for each questions should also be noted against each questions or at the beginning of each type of questions.

---

## **10.9 ITEM ANALYSIS**

---

In order to know whether the test item has the difficulty value or not, the item should be analyzed. This can be found out by arranging the scores of students highest to lowest. Then take the papers of 1/3<sup>rd</sup> of students who got the highest scores and 1/3<sup>rd</sup> who got the lowest scores and find out whether the item discriminates the poor student from the

good student or not. Usually the test item should have 50% difficulty i.e. it must be solved by 50% students.

In order to find out whether the item has the good discriminating value and is worth retaining, find out the number of students who attempted the item correctly in the 27% high group and 27% low group. The items in which the number of correct responses of the high group exceeds that of the low group are the best items and should be retained. This can be found out by the following formula:

$$W_L - W_H = + V_e$$

Where,  $W_L$  is number of wrong response in the low group.

$W_H$  is the number of wrong responses in the high group.

If the difference between the  $W_L$  and  $W_H$  is positive, the item is the best item and should be retained. The items which show the zero or no discriminating value should be discarded.

The difficulty of each choice is simply the percentage of students responding to that choice. It is calculated by taking the total number of students responding to each choice (high group + low group) and dividing by the total number of students responding to that item. In equation form, this would be

$$\text{Difficulty} = \frac{\text{number correct in High Group} + \text{number correct in Low Group}}{\text{Total number of Students}}$$

Total number of Students

Consider the following data from a class of 30 students:

The discrimination for choice “a” would be  $\frac{16+6}{30}$ , or 73.3 percent.

The difficulty for choice “b” would be  $\frac{0+4}{30}$ , or 13.3 percent.

The difficulty for choice “c” would be  $\frac{0+2}{30}$ , or 6.7 percent.

The difficulty for choice “d” would be  $\frac{1+1}{30}$ , or 6.7 percent.

## NOTES

## Evolution in Science Teaching

### Discrimination Index of each Choice in each item

#### NOTES

The discrimination index refers to the degree to which the item discriminates between students in the high group and students in the low group. The discrimination index is calculated by subtracting the number of students in the low group responding to a given choice from the number of students in the high group responding to that choice, and dividing by one-half of the total number of students. In equation form, this would be

Discrimination Index =

$$\frac{\text{Number correct in High Group} - \text{Number correct in Low Group}}{\frac{1}{2} \text{ Total number of Students}}$$

Using the previous data,

The discrimination index for choice “a” would be  $\frac{16-6}{15}$ , or .67.

$$\frac{16-6}{15}$$

The discrimination index for choice “b” would be  $\frac{0-4}{15}$ , or -.27.

$$\frac{0-4}{15}$$

The discrimination index for choice “c” would be  $\frac{0-2}{15}$ , or -.13.

$$\frac{0-2}{15}$$

The discrimination index for choice “d” would be  $\frac{1-1}{15}$ , or 0.0.

$$\frac{1-1}{15}$$

A positive discrimination index indicates that more students who scored high on the test are responding correctly to that item than students who scored low on the test. A negative index means just the opposite – more students who scored low on the test are responding to that item than students who scored high on the test.

---

### 10.10 STANDARDIZING A TEST

---

Standardization of test requires a more critical analysis of the content, a more detailed statement of specific objectives, and a more

careful choice of test items besides consistent statistical analysis then that required by teachers made achievement tests.

### **10.10.1 Definition**

A standardized test is a test administered and scored in a consistent manner. The tests are designed in such a way that the “questions, conditions for administering, scoring procedures, and interpretations are consistent” and are administered and scored in a predetermined standard manner.

A standardized test score is the result of translating the number of correct answers in a test the raw score into more user friendly score on a completely different scale. That enable account to be taken of students’ age and that allows scores from more than one test to be meaningfully added together. This process of converting raw scores to standardized scores may be referred to as standardizing a test or simply standardization.

### **10.10.2 Construction of Standardization**

The major steps involved in the construction and standardization of any test are.

- Planning the test.
- Writing the test items.
- Trying out the test in the preliminary form (Pilot Study).
- Item analysis.
- Assemble the test in the final form.
- Administering the test and scoring out.
- Establishing the Reliability and Validity of the test.
- Establishing the test norms

## **NOTES**

---

## **10.11 DIAGNOSTIC TEST**

---

**English and English** (1958) have defend a diagnostic test in these words, “one designed to locate the particular source of a person’s difficulties in learning especially in school subjects, thus providing clues to what further measures of instruction, guidance, or study are needed.”

**NOTES**

**10.11.1 Meaning**

A diagnostic test is a test designed to locate specific learning deficiencies in case of specific individual's at a specific stage of learning. It helps the teacher in identifying the status of the learner at the end of a particular lesson, unit or course of learning as to what 'specific teaching or learning points' have been properly grasped by the learner. If such a deficiency is located in several students, it becomes obvious to the teacher to reflect upon whether something went wrong with his method of teaching. After administering a diagnostic test or a battery of diagnostic tests to students, a teacher takes remedial measures to overcome the deficiencies thus discovered.

**10.11.2 Diagnostic Testing**

While everyone concedes the desirability of diagnostic, of a few teachers have realized its full value. It is not a procedure followed mechanically. It is a part of an attempt to learn as much as possible about the students who are to be taught. Every test, a teacher conducts in the class is largely a diagnostic test. A test is diagnostic to the extent that its results are used as a basis for further teaching. Some tests lend themselves more readily and effectively to the accomplishment of this purpose than to others. The tests useful for the science teacher may out be the same as those which designed to diagnose study skills, knowledge of special vocabulary and reading difficulties. Every test designed to measure achievement also makes foible to diagnose the student's abilities, interest and difficulties.

For diagnostic purpose every test item has its particular value in addition to its contribution to the test as a whole. The purpose of an achievement test however, is to yield a total score which can serve as an index of performance, understanding or growth. The teacher should not overlook the opportunity of using the result of every written test for diagnostic purpose wherever it may be related to interest, aptitude, skill, knowledge etc. He may tally the responses to particular selected items or he may analyze the papers of particular students. The most revealing errors sometimes appear on unexpected items or unexpected papers. So it is often advisable to make a tally sheet containing the responses of all the students to all the items. Thus with the help of diagnostic testing every teacher can classify his students in a proper order according to their capabilities and responsibilities.

### 10.11.3 Characteristic

**Cook, Walter W.** (1958) has stated the following characteristics of an effective diagnostic test.

1. It should be an integral part of the curriculum, emphasizing and classifying the important objectives.
2. Its test items should require responses to be made to situations approximating as closely as possible to be functional.
3. It should reveal the mental process of the learner sufficiently to detect points of error.
4. It should point out the learning difficulties of the students.
5. It should be designed to detect faulty learning problems associated with retention of difficult elements etc.
6. It should suggest or provide specific remedial procedures for each error detected.
7. It should be designed to cover a long sequence of learning systematically.
8. It should reveal pupil progress in objective terms.

### NOTES

### 10.11.4 Steps in the construction

The following steps are involved in the construction of a diagnostic step.

1. Identifying learning deficiencies
2. Analyzing errors
3. Analyzing content
4. Identifying learning points to be covered emerging from above.
5. Developing test formats and their try – out
6. Selecting items for inclosing in the test.
7. Assembling the test.

### Check Your Progress

**Notes:** a) write your answers in the space give below

b) compare your answers given at the end of the unit

5. Write five steps in test construction

.....

.....

6. What is the use of multiple choice questions in science examination?

.....

.....

**NOTES**

---

## **10.12 REMEDIAL TEACHING**

---

Some teachers attempt to handle remedial teaching regularly by working with one, two or three needy students. This involves extra individual coaching for a few pupils. This procedure may work very well in those classes where there is a great homogeneity of ability with the exception of one or two isolated cases. Some schools also feel that weak pupils need more help than the help that can be given in the regular classes. They arrange a specially planned programmer tailored to the needs of these students. Remedial groups containing four to six children, as formed for personalized instruction. The larger the group the more difficult is to maintain the individualized and personalized relationship which is necessary for recovery of the student.

Remedial teaching should be based on a careful diagnosis of defects and their causes. It aims to correct weakness. It may be concerned with two type of deficiencies.

- 1. Presence of misconceptions**
- 2. Absence of correct concepts.**

The misconceptions are to be removed and correct concepts, skills, and attitudes are to be taught which had not been learned but should have been learned. Due to individual difference it is not possible to plan a remedial programmer in advance which may be effective in all circumstances.

### **10.12. 1 Role of Remedial Teaching**

In order to improve science teaching learning, effective remedial teaching is a must. Remedial teaching as the name suggest, is the teaching that is undertaken for providing remedial education to those who are in need of such education for overcoming their deficiencies, weakness and difficulties related to the learning activities pertaining to some areas or aspects of a particular subject. Remedial teaching can take various forms like:

- ❖ Class teaching
- ❖ Group tutorial teaching
- ❖ Individual tutorial teaching
- ❖ Supervised tutorial teaching
- ❖ Auto – instructional teaching



❖ Informal teaching

### **10.12.2 Remedial Drill**

There are in general two ways of maintaining a high level of pupil achievement in any subject after direct instruction has been discontinued. These are (1) broad, general drill with no integral units of testing to discover breakdowns in pupil mastery, and (2) systematic remedial drill devices to fight forgetting, plus diagnostic testing to discover breakdowns in pupil mastery, and (2) systematic remedial drill devices to fight forgetting, plus diagnostic testing to discover the exact causes of weakness when such weakness begin to cause poor work on review drills. The first method involves the systematic use of properly distributed general practice over the complete function. The second involves the periodic location of the specific defect of each pupil by means of diagnostic tests and the immediate correction of these defects by the use of a properly constructed remedial drill.

### **NOTES**

Unquestionably, the latter is the more economical method of maintaining mastery of desired skills on the part of pupils. It is obvious that general review is valuable at times, but just to review with no specific idea of what the review is to accomplish is too naïve and hopeful to be effective.

### **10.12.3 Steps in Remediation**

The program that coincides most closely with the experience of successful teachers and with a sound psychology of learning calls for the following steps in the order indicated: (1) teach, (2) review, (3) test for weaknesses whenever they appear, and (4) follow with remedial drill units on the specific weaknesses revealed by the tests.

It may be worthwhile to note that material so constructed as to be effective for remedial purposes is also sound enough to be used for initial instruction; in fact. The chief distinction between good content for initial teaching purposes and remedial drill purposes is evident when they are to be used. The most effective remedial drill for the pupil who does not have an adequate sight – meaning vocabulary for silent reading purposes is a drill on the vocabulary he/she should have learned in the first place.

**NOTES**

**Check Your Progress**

**Notes:** a) write your answers in the space give below

b) compare your answers given at the end of the unit

7. What are Diagnostic test and remedial measures in science?

.....  
.....

8. Mention the different types of tests used by teachers to evaluate the students.

.....  
.....

---

**10.13 LET US SUM UP**

---

The ultimate aim of education is the wholesome development of the students. The teacher teaches the student knowledge, skill, attitudes and character and contributes much for his development. Process evolution and product evolution are the two types of evolution. As a good science teacher you should also know and practice monitoring of learners progress as well as diagnostic tests and remedial measures in science. As a good science teacher you should be a good science evaluator. A good assessment programmed depends upon the appropriate and accurate evidence that we get about pupils growth.

---

**10.14 UNIT END EXERCISES**

---

1. How will you classify the observation and mention the merits and demerits of the same?
2. How the researchers use the checklist?
3. What are all the way the progress cards will be beneficial to the parents? Suggest whether it is necessary or not?

---

**10.15 ANSWERS TO CHECK YOUR PROGRESS**

---

1. No, evaluation is a very wide term compared to examination
2. Assessment is only part of evaluation process. It is an attempt to measure some particular abilities whereas evaluation measures total behavioural change across all 3 domains of the child.
3.
  - o Validity

- Reliability
  - Objectivity
  - Predictability
4. To motivate the students, to select students for admission
  5. Designing blue printing, framing question, assembling question and preparing instructions
  6. MCQ are objective can test higher order abilities easier in checking and coding
  7. When we teach science in a class we ask some questions before we introduce the topics. These questions test previous knowledge for the lesson. In order to find out that previous knowledge of the subject some test is given to the child. With the help of responses of the children on the test, the teacher knows where the children are lacking for that he/she takes necessary measures.
  8. Intelligence test, achievement test, aptitude test and standardized test.

## NOTES

---

### 10.16 SUGGESTED READINGS

---

- ❖ Dr.Gadd Bhuvaneswara Lakshmi Dr.Digumarti Bhaskara Rao (2004) *Methods of etching life science* New Delhi Discovery Publishing house
- ❖ JC Aggarwal (2004) *Essential of Examinations System Evaluation Test & Measurement* Vikas Publishing House Pvt.Ltd
- ❖ Prod B .C Roi (2002) *Method teaching of Science* Lucknow Prakasham Kendra
- ❖ Dr. Vanaja M. (2005) *Methods of teaching Physical science* Hyderabad Neelkamal Publicatin Pvt ltd
- ❖ Dr.G.Venugopal Mrs N.Nithyasri (2005) *Teaching of Biology* Chennai Ram publishers
- ❖ Mathew TK & TM Mellykuthy (2006) *Science Education* Rainbow Publishers Kereal

**NOTES**

---

## **UNIT XI - SCIENCE TEACHER AND TEACHER PERSPECTIVES – I**

---

- 11.1 Introduction
- 11.2 Objectives
- 11.3 Science Teacher
- 11.4 Qualifications of a Science Teacher
  - 11.4.1 Academic Qualifications
  - 11.4.2 Professional Qualifications
- 11.5 Special Qualities of Science Teacher
- 11.6 Personal Qualities of Science Teacher
- 11.7 In service Training
- 11.8 Classroom Climate
  - 11.8.1 Meaning of the Term Classroom Climate
  - 11.8.2 Factors Affecting Classroom Climate
- 11.9 Teaching Behaviour Patterns
  - 11.9.1 Autocratic Pattern
  - 11.9.2 Democratic Pattern
  - 11.9.3 Laissez Faire Pattern
- 11.10 Let Us Sum Up
- 11.11 Unit End Exercises
- 11.12 Answers to check your progress
- 11.13 Suggested Readings

---

### **11.1 INTRODUCTION**

---

In this unit you are going to know qualifications and qualities of a science teacher and also discuss the meaning of classroom climate, teaching behavior patterns with reference to the classroom climate

assessing or analysis. Teaching can be considered as interactive communication. Teacher in the classroom undertakes the task of influencing the minds of pupils so as to modify their behavior. This act of influence is essentially a two-way process. The teacher impresses upon the pupils both verbally and non-verbally.

---

## 11.2 OBJECTIVES

---

## NOTES

After completing this unit, you will be able to:

- Know the qualities of science teacher
- Understand the special qualities of science teacher
- Distinguish the qualities and special qualities of science teacher
- Attitude of science teachers towards classroom climate
- Differentiate between different behavior pattern

---

## 11.3 SCIENCE TEACHER

---

In the present set up, the teacher is the pilot, in every scheme of work. The success or failure of a science course depends on the teacher. He may be provided with an excellent laboratory best equipment well-stocked library, an ideal curriculum and very suitable timetable, but unless he himself put his heart in his work, loves his profession, knows his subject and understands the technique of teaching he is not likely to become a successful teacher. A devoted teacher, who is wedded to his profession, is sure to shine in spite of numerous obstacles and handicaps.

In the words of **Kothari Commission**- “Among all the different factors which influence the quality of education and its contribution to national development, the quality, competence and character of teachers are undoubtedly the most significant”.

In the words of **Dr. S. Radhakrishnan**, “The teacher’s place in society is of vital importance. He acts as the pivot for the transmission of intellectual traditions and technical skills from generation to generation and helps to keep the lamp of civilization burning”.

---

## 11.4 QUALIFICATIONS OF A SCIENCE TEACHER

---

It is considered under two heads:

- Academic Qualifications and
- Professional Training or Education.

**NOTES**

### **11.4.1 Academic Qualifications**

Before learning “how to teach” science, the teacher must be familiar with what to teach. Therefore, the basic academic qualification of the teacher is very important. The minimum basic qualification laid down by the education departments of different states is B.Sc., for middle and high schools and M.Sc., to teach electives in higher secondary schools. The science teacher should possess adequate knowledge in both Botany and Zoology. At the degree level, one subject has been studied as main subject and the other as ancillary subject along with Physics or Chemistry.

### **11.4.2 Professional Qualifications**

Along with basic academic qualifications, every biology teacher must have undergone teacher training course, that is, B.T., or B.Ed. It is all the more necessary when new techniques of teaching, methods of evaluation, improvisation of science apparatus, equipment, science kit and activities are being introduced. It is, therefore, most essential that science teacher must equip himself with this useful training. This will help the teachers to get knowledge about psychology, which is most essential for teachers. This will enable the teachers to know about the interests, physical and mental abilities of the students and give work according to them. The laws of learning will also help the teacher to use them in the teaching of science. This training helps the teacher to prepare his lesson in advance and treat the student as the centre of education.

---

## **11.5 SPECIAL QUALITIES OF SCIENCE TEACHER**

---

Science teacher should possess some special qualities in addition to the requisite qualities of teachers in general. He should plan his lesson and teach. He should know the syllabus of each and every class and teach integrating the subjects of other classes. He should know different methods of teaching and use the appropriate method for each topic. He should plan and organize science laboratory and practical work. He should demonstrate the experiments in an attractive manner. By using mobile laboratory he could eliminate the insufficiency of laboratory. He should be able to repair and improvise apparatus. He should be able to organize field trip, excursion and exhibition. He should develop keen observation and critical thinking in the students. He should know the method of preparing slides, using microscope, photography, printing and enlarging. He should be able to operate tape records, filmstrip projectors, overhead projectors, LCD projectors etc. He should be able to organize museum and maintain it.

He should know the method of preserving various types of plants and animals and the chemicals used for them. He should be able to construct and maintain aquarium, vivarium, terrarium, aviary and school garden. He should be able to organize science exhibition and library and maintain them.

---

## **11.6 PERSONAL QUALITIES OF SCIENCE TEACHER**

---

**NOTES**

The science teacher should have a good appearance. He should wear neat and clean dress. He should be alert and active at all times. He should be kind and sympathetic towards students. He should allow the students to ask questions and raise doubts boldly and clear them then and there. He should allow the students to interact with him. He should be punctual and regular to the classes and in all other classroom and school related works. He should arrange the practical classes neatly with help of students. Practical classes should be regular. He should talk loudly and with proper modulation. His voice should be clear and audible and with correct pronunciation and stress.

---

## **11.7 IN SERVICE TRAINING**

---

A science teacher in order to keep himself informed about the latest methods of teaching should refresh his knowledge of science, and should go through some of the latest books on biology and be familiar with apparatus concerning science teaching, obtain practical training in the organization of science clubs and participate in district and state level science fairs etc. He must be ever willing to attend and participate in such seminars and refresher courses organized by the Extension Service Departments. He must be willing to attend in-service training programmes, summer institutes, refresher courses, seminars, conferences and workshops. These are organized by National Council of Educational Research and Training, Regional Colleges of Education, State Institute of Science Education, State Council of Educational Research and Training and Professional Organizations. The NCERT has also established centers of continuing Education all over the country, which provide facilities for in-service education. The science teacher should also become a member of good science association like All India Teachers Association and also subscribe and contribute to good science journals.

---

## **11.8 CLASSROOM CLIMATE**

---

The behavior of the teacher and students set a typical atmosphere in the classroom which motivates the teacher to teach and

**NOTES**

the students to learn. This atmosphere is called Climate and since this climate is created inside the classroom it is called “Classroom Climate”.

**11.8.1 Meaning of the Term Classroom Climate**

The term classroom climate may be defined as the generalized attitudes towards the teacher and the class that the students share in common in spite of individual differences. The development of these attitudes is an outgrowth of classroom social interactions. As a result of participation in classroom activities, students develop expectations about how the teacher will act, teach, reply to their questions, draw diagrams on the blackboard, conduct experiments/demonstrations, reprimand students etc. They form an idea about what kind of a person their teacher is. They also form general attitude towards the class as a whole. These expectations and attitudes colour all aspects of classroom behavior creating a social atmosphere or climate that appear to be fairly stable, once established.

Thus the term ‘Classroom Climate’ is merely a shortened reference to those qualities that consistently predominate in most teacher-student contacts and contacts between students in the presence or absence of the teacher. Climate of a class can be referred to as a way of life. When a group of people meet for an hour or more in a day in the same place and for some general purposes, they will come to know what to expect from each other, what statements will be appreciated or disregarded, what sort of norm will be respected, and what sort of ideas will be rejected. The habitual mode of behavior exhibited in the classroom by a set of students and their teacher, lending it individualistic atmosphere is called ‘Classroom Climate’.

**11.8.2 Factors Affecting Classroom Climate**

The social climate that prevails in a classroom mainly centres on the teacher and students. The behavior of the teacher is not the same in all classes and in all periods. The behavior of different teachers is also not the same. Teachers differ in their behaviours inside the classroom. In the same way the behavior of students is not the same in different subject periods and for different teachers. So we can conclude that though classroom climate is largely determined by the teacher, he is not the sole factor. No teacher is an island; he works in the midst of his students and with the subject. Therefore the factors affecting classroom climate could be listed as: (1) Teacher (2) Students (3) Subject that is taught in the class.



---

## 11.9 TEACHING BEHAVIOUR PATTERNS

---

### 11.9.1 Autocratic Pattern

In this pattern the teacher uses a particular method to solve the problem or to teach the concepts. The students are accustomed to that particular method and if a substitute teacher solves the problem in a different pattern, the students do not accept it though it may be an easy method. What we can say is that they have become set in their ways of solving problems. They are being forced to follow one routine, which is presented to them readymade. Instead of thinking through each new situation, they expect every problem to be like the last standard example. This is “stimulus-response” psychology. By demanding the practice of his routine, the teacher is reducing readiness to think, reducing readiness to reason. His students are discouraged, even prohibited from attempting to scale concepts through creative problem-solving.

The tragedy here is that this kind of teacher thinks that they are “doing their job” but they never try to analyze what “their job is”. They have the knowledge, the intelligence and the inherent abilities to bring children to self-controlled learning, but this never seems important to them. This kind of teacher operates on schedules and does not care for the slow nor hurry for the fast learners. He gives one example and asks the students to solve other problems in the same manner.

### 11.9.2 Democratic Pattern

This is in between a pattern of dominance and one of *laissez-faire*. The latter does not give room for the kind of responsible guidance a teacher should give his students; the former does not encourage personal responsibility and growth in goal forming and concept seeking which should be a part of every person’s education. The teacher in this pattern asks the students what they like to learn. Based on the aims, students select the topics to be learnt, later each topic will be discussed by the entire class. Its advantages and disadvantages will be weighted in the light of the amount of class time available, its priority in helping to improve the quality of living, its usefulness in helping to pass the examination, its special interest to a few students.

In this pattern the teacher is a guide and friend, he is firm and demanding, but not coercive, he is permissive. There is an absence of threat in his class; there is freedom to proceed with the business of learning but no freedom to disrupt learning. In this pattern the poorer students and the science-shy students have much better opportunity to exert leadership. So far three different types of classroom climate have

## NOTES

## NOTES

been discussed. Among them, which is the most suitable climate? What activities should be followed by the teacher in order to promote learning in students? It is important to find answer for these questions. Generally, when a teacher exercised domination at certain times and integration in appropriate times then it is the best climate suitable for learning. This may appear opposite to the research findings superficially. When we carefully analyse the data gathered from researches, we can find instances of domination of teachers in the classroom.

### **11.9.3 Laissez Faire Pattern**

Laissez -Faire means an idea of certain person that one should not make too many laws but allow things to go on in their own ways. This is a classroom-teaching pattern in which coordination and planning are absent in the teaching approach. In this the teacher gives undue importance to the students and asks them “what do you want to do this period”? By this the teacher impresses them that they could do what they want; he is there only to help them; they could work in groups, individually or as a class; the examinations are to be made up by the students with his guidance.

The students select some topics. Every day the groups meet to work in allotted corners and other spaces of the room. The teacher is ready there to help.

#### Advantages and Disadvantages

- The students will learn to work together.
- The best students will learn a great deal. But immature and slow learners idle away their time without any purposeful learning.
- The students will learn to arrive at hypothesis.
- They will learn to experiment.
- They will learn to report and take keen interest in the subject.
- Amount of student-learning in the classroom may not be substantial.

### Check Your Progress

**Notes:** a) write your answers in the space give below

b) compare your answers given at the end of the unit

1. List out few qualities of a science teacher?

.....  
.....

2. What are the two heads of the qualifications of science teachers?

.....  
.....

3. Write three patterns of teaching behavior?

.....  
.....

### NOTES

---

## 11.10 LET US SUM UP

---

A teacher who teaches courses in science has to be specialized in a field of science subjects. Having strong knowledge of subjects areas in science combined with a broad subject background enabling contributions to teaching programme, excellent interpersonal oral and written communications skills. Maintaining students' attendance records grades and other required records. Prepared and delivered lectures to undergraduate and graduate students on topics such as physics chemistry and biology and great ability to perform research in science.

---

## 11.11 UNIT END EXERCISES

---

- Discuss the qualities of a science teacher
- Explain about the in-service training
- How will you assess the classroom climate?

---

## 11.12 ANSWERS TO CHECK YOUR PROGRESS

---

1.
  - Good appearance
  - Wear neat and clean dress
  - Alert and active

**NOTES**

- Sympathetic towards students
- Punctual and regular to the classroom
- 2.
  - Academic qualification
  - Professional training
- 3.
  - Autocratic
  - Democratic
  - Laissez faire

---

**11.13 SUGGESTED READINGS**

---

- Mathew.T.K &T.M Mollykutty (2006) *Teaching of Science* TNOU B.Ed Study Material , Chennai .
- Radhamohan (2010)*Innovative Science Teaching for Physical Science Teachers* PHI Learning Private Ltd, New Delhi
- Saravanakumar .AR (2014) *Enhancing Achievement in Science through Metacognition* KVS Printers Karaikudi
- Venugopal, G.N Nithyasri &Prof K.Nagarajan (2013) *Teaching of Biology* Sriram Publishers Chennai.

---

# UNIT XII - SCIENCE TEACHER AND TEACHER PERSPECTIVES – II

---

*Science Teacher and  
Teacher Perspectives - I*

12.1 Introduction

12.2 Objectives

12.3 Assessing the Classroom Climate

12.3.1 Flander's Classroom Interaction Analysis

12.3.2 Ground Rules for Recording Interaction Categories

12.3.3 Uses of Flander's Interaction Analysis for Effective Teaching

12.3.4 Advantages of Flander's Interaction Analysis

12.3.5 Limitations of Flander's Interaction Analysis

12.4 Individualized Instruction

12.4.1 Approaches to Individualized Instruction

12.4.2 Methods for Preparing Individualized Instruction Material

12.5 Gifted Children

12.5.1 Definition

12.5.2 Identification of Gifted

12.5.3 Methods of Educating the Gifted

12.5.4 Enrichment Programs for Gifted

12.6 Let Us Sum Up

12.7 Unit End Exercises

12.8 Answers to check your progress

12.9 Suggested Readings

---

## 12.1 INTRODUCTION

---

Pupils interpret these acts of the teacher, understand them and react. Based on the reactions of the pupils, the teacher either continuous

**NOTES**

## NOTES

his activities further or modify suitably so as to make them more meaningful to pupils. Thus formal system of teaching in the classroom could be considered as a process of natural interactions taking place between the teacher and the pupils. These interactions are largely (about 80%) verbal in character. Educationists feel that an analysis of verbal interactions that take place between the teacher and pupils in the classroom will lead to a better understanding of the nature of instruction and will also reveal the teaching behavior or teaching style of the teacher. This lesson deals with the analysis of classroom interactions, its pattern and significance in teaching and learning apart from discussing the essential qualities and qualifications required of a good science teacher.

---

### 12.2 OBJECTIVES

---

After completing this unit, you will be able to:

- Know about Flanders' Interaction Analysis
- Analyse the different approaches to Individualized Instruction
- Understand the identification of gifted child
- Develops skills in handling gifted child and their enrichment programmes

---

### 12.3 ASSESSING THE CLASSROOM CLIMATE

---

The classroom climate can be assessed by measuring the interaction between the teacher and the students and the attitudes of the students. Ned A. Flanders has developed an interaction analysis (FIAS) to measure the interaction between the teacher and students. There are ten categories in this system. Out of the ten categories in the system evolved by Ned A. Flanders, seven categories are assigned to teacher talk and two to student talk and the tenth category to pauses (Short periods of silence) and talk that is confusing or noisy. The seven categories assigned to teacher talk are again divided into indirect and direct influence. Categories 1 to 4 represent indirect influence and categories 5 to 7 represent direct influence. Indirect influence encourages student participation and freedom of action. Direct influence increases the active control of the teacher and often aims at conformity and compliance. That is direct influence of the teacher could be felt in the teaching activities like lecturing, restraining students' responses and behavior, and giving advice to students.

The observer sits in the classroom in the best position to hear and see the participants. The observer allows 5 to 10 minutes to get

acclimatized to the class situation and then begins to record at every 3 seconds or every 5 seconds, the type of interaction that takes place by writing the number of the category to which it belongs. For example when the teacher asks a question to a student it is noted down as '4', while appreciating a student's response as '2', lecturing as '5' etc. when there is no activity in the 3 second period or more than one student talks simultaneously, it is marked as '10'. The observer should decide carefully the nature of the interaction category. Live video recording facilities objective reporting.

## NOTES

### 12.3.1 Flander's Classroom Interaction Analysis

- Accepts feelings of pupils (in an unthreatening manner)
- Praises or Encourages (jokes to release tension but not at someone else's expense, nods head, says go on etc.)
- Accepts or used ideas of pupils (clarifies, builds, or develops student's ideas)
- Asks questions (with the intent that the student answers)
- Lectures (gives facts, opinions about content or procedure, express his own ideas, asks rhetorical questions etc.)
- Gives directions (directs, commands, orders and expects students to comply)
- Criticizes or justifies authority shouting at, extreme self-reference etc.)
- Student talk-response (pupil replies to teacher's questions and queries)
- Student talk-initiation (Pupil himself initiates the talk)
- Silence of confusion (pauses, short periods of silence, noisy behavior, cannot understand what the teacher is doing etc.)

### 12.3.2 Ground Rules for Recording Interaction Categories

Because of the complexity of the problems involved in categorization, several ground rules have been established. These rules of observation help in developing consistency in trying to categorize teacher behavior. They have been useful in working classroom with all subject areas and all grade levels.

**NOTES**

### **12.3.3 Uses of Flander's Interaction Analysis for Effective Teaching**

- A teacher who frequently uses the categories 1, 2, 3 and 4 is said to be democratic teacher because he encourages more students' participation. Learning proficiency is high in such type of classes.
- A teacher who frequently uses the categories 5, 6 and 7 is said to be an authoritative teacher because he gives more directions and curtails students' participation. This results in increased students' dependence. Such teachers are advised to change their teaching style.
- A teacher who gives room for frequent occurrence of category 10 is ineffective in verbal communication and classroom management.

### **12.3.4 Advantages of Flander's Interaction Analysis**

- It enables the observer to describe in considerable detail and in sequence, the on-going pattern of classroom events.
- It is a well tried and reliable technique to analyse the classroom climate. It has simple rules to codify the classroom events that could be easily mastered and applied.
- When properly used, it can serve as a means to develop self-insight on the part of the teacher with objective feedback about his teaching. Thus it enables him to make changes when and where he himself sees fit.
- This is used as an effective technique to analyse the patterns of interaction in service and pre-service education.
- This supplements the technique of micro-teaching and team-teaching in teacher education.

### **12.3.5 Limitations of Flander's Interaction Analysis**

- This system gives importance to only verbal communication that takes place in the class i.e. this system is not adequate to describe the totality of classroom activities. For example the demonstrations conducted in science class, drill and practice given in solving numerical problems in the mathematical class, map drawing skill practiced in social studies class, silent reading undertaken by pupils in language class, blackboard



writing of teachers etc. cannot be codified in this system; all these activities will be marked as 10, meaning silence or confusion which is absurd.

- This system heavily depends on the skills of the observer and his likes and dislikes.
- Non-verbal communications like gestures, facial expressions, physical movements etc. are over-looked in this system.
- This system permits no room for pupil discussion.
- Forming the interaction matrix and undertaking the analysis to infer about the different aspects of teaching behavior are cumbersome, laborious and time-consuming.
- FIAS could be attempted only by expert teachers who have been specially trained in this.
- The quality of the subject matter or content cannot be judged; only social skills involved in classroom management are taken care of.
- FIAs is not suitable to study the classroom climate where more formal teaching, that too giving more emphasis for content-coverage is in progress.
- Utility of FIAS is very much limited for educational researchers who have to study many kinds of problems encountered in education.
- Both silence and confusion are placed in the same category in FIAS. But silence and confusion are not of same nature. Further no distinction is made between meaningful silence and silence without any reason.
- Category number 4, does not clarify what type of questions (simple or probing questions) being asked.
- FIAS does not give much importance for pupil related activities as it shows more concern for analyzing the teaching-behaviour.

## **NOTES**

---

### **12.4 INDIVIDUALIZED INSTRUCTION**

---

In recent years there has been a trend towards individualized instruction. The main goal of individualized instruction is that each child's learning is self-initiated and self-directed. The child should

## NOTES

learn to learn independently at his own pace and according to his interests and abilities. The programmed learning, instructional modules and teaching machines are some of the techniques used in individualized instruction. As we know that no two individuals are the same in their physical and intellectual make up, cognitive experiences or past learning, psychomotor skills, past successes and failure in learning, perception of the self-etc. since children differ in their prior experiences, they differ in what they need to learn and in what they already know. Brandwein points out:

“Children do different things as they learn. Some children may understand a simple circuit after reading about it without writing up a circuit. Some may understand a point perfectly after hearing it explained; some need to see pictures, some need to read about it; many need to do it. Thus, the only sole procedure in working with children is to give them opportunities to approach the learning through a variety of activities. All children may not need to do all things. Judicious guidance by the teacher plus ample planning with the children, is the key to the organization of learning situations where children do what they need to do to learn best”.

### 12.4.1 Approaches to Individualized Instruction

Various approaches to individualized instruction are used. Some of them are:

- **Individually diagnosed and prescribed programmes:** These programmes have clearly specified behavioural objectives, with materials and methods of presentation matched to the objectives.
- **Self-directed materials:** In this type of programme students and teachers cooperate in establishing the outcomes of learning. The students are free to select the materials and methods to achieve the goals. This approach is generally useful with above-average learner.
- **Personalized programmes:** In this type of programmes, the students' select own objectives and then follow a direct programme with specialized materials. This approach is more useful with high school students.
- **Independent study:** In this approach the child selects his own objectives as well as the topic. He also decides the method of

achieving the objectives. This approach is usually useful with above average students.

### **12.4.2 Methods for Preparing Individualized Instruction Material**

A variety of methods are used to prepare individualized instructional materials. The materials can be in the form of printed material, films, machines, laboratory sets etc. the materials are generally developed in the form of small learning units called as modules. In some respects the module is self-contained, partly self-instructional, and includes multi-media. It can be completed in a short time. The following procedure can be used to develop a module:

### **NOTES**

- Select a topic and break it down to small manageable units (which can be finished in a week or two).
- Select or prepare performance objectives for the learning unit or module.
- Identify the activities for the student to meet the objectives. These activities should be arranged in a logical sequence and may be plotted on a chart to see the progress for the child.
- Determine the level of mastery or competency needed by the student to begin the activities. For this purpose a pre-test may be given to find out what knowledge and skills the child already has.
- Prepare an outline of a study guide for the use of the child. The guide should include the title of the module, the performance objectives, the sequence of activities, some definitions and references, some basic instructions to help the child begin, some exercises for self-evaluation and indicators which tell the student when to get his work checked by the teacher.
- Prepare instructions for helping the student proceed through the module.
- Try out the module with a few students and observe whether or not the sequence of instructions and available materials are adequate.
- Refine the module from your observation and comments of students and your colleagues.

## NOTES

### Merits

The following are some merits of individualized instruction:

- It provides for a learning environment that encourages the child to be motivated intrinsically.
- It permits each child to progress at his own pace.
- It helps each child to learn according to his interests, abilities, and mode of learning.
- It increases experiences for investigating by each child.

### Demerits

- Individualized instruction requires a small class.
- It needs increased time for the teacher to prepare and collect materials.
- Materials for individualized instruction are not available.
- Individualized instruction requires well-equipped science laboratory as well as other physical facilities.

---

## 12.5 GIFTED CHILDREN

---

School children with superior learning aptitudes are frequently referred to as gifted children. The gifted child is both an asset and a responsibility. There is a limited pool of ability and special talent in every country. This must be identified and developed to save it from total loss.

### 12.5.1 Definition

In words of **Sumption** and **Lueckins** (1960) the gifted are defined as ‘those who possess a superior nervous system characterized by the potential to perform tasks requiring a comparatively high degree of intellectual abstraction or creative imagination’. Witty (1951) defined a gifted person as “one whose performance is consistently remarkable in any potentially valuable area”.

However, it is sufficient to say that the gifted, generally speaking are individuals who deviate from the norm by having superior abilities which are typically viewed as intellectual in nature. The genius in one field is generally poor in several others and in our examination

system, a genius is more likely to fail or put up only a mediocre ‘total’ of marks than to come out at the top. Ramanujam and Tagore could not even pass the routine examinations. We should, therefore, search separately for each special talent, whether in mathematics, science, fine arts or technology.

### 12.5.2 Identification of Gifted

The search for talent must be a continuous process and has to be taken up at all stages. The secondary stage, however, is the most crucial. The identification process should involve the entire range of school personnel. The science teacher should have an integral part in identification of all kinds of exceptionalities.

**Laycock** suggested the following 20 items which may be used to identify a gifted child.

- Posses superior power of reasoning, of dealing with abstractions in order to generalize from specific facts, of understanding meanings, and of perceiving relationships.
- Has great intellectual curiosity.
- Learns easily and readily.
- Has a wide range of interests.
- Has a broad attention span that enables him to concentrate on an to preserve in solving problems and pursuing interests.
- Is superior in quantity and quality of vocabulary as compared with other children of his own age.
- Has ability to do effective work independently.
- Has learned to read early, often well before school.
- Shows initiative and originality in intellectual work.
- Shows alertness and quick response to new ideas.
- Is able to memorize quickly.
- Has great interest in nature of man and the universe, problems of origin and density, and the like.
- Possesses an unusual imagination.

### NOTES

## NOTES

- Follows complex directions easily.
- Is a rapid reader.
- Has several hobbies.
- Has reading interests which cover a wide range of subjects.
- Makes frequent and effective use of the library.
- Is superior in arithmetic, particularly in problem solving.

No one method of identifying gifted children is in itself sufficient. Therefore, a combination of methods and personnel must be employed. The process of identification includes teacher observation, individual intelligence tests, group intelligence tests, achievement test batteries and creativity tests.

### **12.5.3 Methods of Educating the Gifted**

#### **1. Rapid Promotion or Double promotion**

By this we mean more than one promotion during the course of the year. If a child shows an extra ordinary achievement in one class he may be given a double promotion.

#### **2. Homogeneous Grouping**

According to this scheme students with more or less similar or same level of potentials are grouped together according to the intellectual physical and social interests of the students.

#### **3. Enrichment of the curriculum**

This implies that the gifted students be encouraged to study a variety of books and reference material. On the co curricular side also provision for a sufficient variety of activities should exist in a school so that the students may develop various social and moral qualities of a high order.

#### **4. Special schools**

In some of the advanced countries of the world separate schools have been provided for such students.

#### **5. Summer schools**

These schools may be planned during summer vacations. These schools are being successfully tried in the USA Academically talented students

are selected from different parts of the country on the basis of the psychological tests interview and previous school record and are brought together for a special educational programme.

### **12.5.4 Enrichment programmes for gifted**

The National Talent Search Scheme has been started by NCERT, New Delhi in 1963. It is meant to locate scientific talent of the gifted children up in the ladder. Through this scheme, a promising students now is able to pursue his studies up to Ph.D in Engineering, Medicine and Social Sciences including commerce without any financial liability not only this even the employment is ensured after completing the studies.

#### **Objectives of the scheme**

This scheme is carried out for fulfilling the following

- To stimulate scientific talent by a process involving competition and by recognition of merit
- To help talented students to continue their studies upto Ph.D level
- To provide programme is science to such scholars with a view to nurturing their talent
- To encourage schools to take more active interest in conducting a search for scientific ability
- To help in building up a body of future scientists to contribute to scientific advancement both in pure and applied fields
- To create consciousness among educationists for improving the curriculum in science subjects
- To improve methods of teaching and evaluation techniques in schools
- To fix up the students in contract basis in higher institutions and help them to pursuing higher education up to Ph.D level.

#### **Details about the scheme**

For the National talent search schemes state level tests (first stage) are to be conducted and on the basis of merit in the state level written test prescribed number of candidates are to be admitted for the National

**NOTES**

**NOTES**

Test	Duration	Max Marks	Qualifying marks
Mental ability Test (MAA)	1 ½ hrs	100	40*
Scholastic Aptitude	1 ½ hrs	100	40*

level examination (second stage) that will be conducted by the NCERT New Delhi

**State level examination**

To select candidates for all India examination (2<sup>nd</sup> stage testing) a state level written test (1<sup>st</sup> stage testing) is to be conducted every year by the state. Social science put together in the aggregate total (i.e. 180/300) in the IX standard Annual Examination and now studying in the standard X in their school are alone eligible to appear for the examination.

All students with the above aggregate marks appearing in X standard in all type of recognized schools including Kendriya Vidyalaya will be eligible to appear at the state level test from the state in which the institution is located The states may if deem necessary prescribe other eligibility condition and or examination fee.

**Scheme of Examination at state level**

Each state /Union territory shall hold a written examination consisting of the following

In case of SC/ST candidates qualifying marks shall be 32.

The general mental ability test will be compulsory for all candidates. In the scholastic aptitude test candidates will have to answer items on any four subjects of the eight subjects given below

- Physics
- Chemistry
- Mathematics
- Biology
- History
- Geography



- Civics and Economics

The two tests shall be administered separately. Therefore the booklets for both the tests and the answer sheets shall be printed and distributed separately. The medium of examination shall be English or regional language as provided in the constitution of India.

Each State/Union Territory shall recommend a given number of candidates for the second level test to be conducted by NCERT. The candidates shall be recommended on the basis of merit in the written examinations held at the state level. No correspondence from the unselected candidates shall be attended to. The examination will be conducted in all the revenue district headquarters. The venue of the examination will be notified by the respective Chief Educational Officers and put upon their Notice Board sufficiently in advance.

## NOTES

### Check Your Progress

**Notes:** a) write your answers in the space give below

b) compare your answers given at the end of the unit

1. List some uses of Flander's Interaction Analysis for effective teaching.

.....  
.....

2. What are the approaches to individualized instruction?

.....  
.....

3. List some identification of gifted child suggested by Laycock.

.....  
.....

---

### 12.6 LET US SUM UP

---

A teacher who teaches courses in science has to be specialized in a field of science subjects. Having strong knowledge of subjects areas in science combined with a broad subject background enabling contributions to teaching programme, excellent interpersonal oral and written communications skills. Maintaining students' attendance records grades and other required records. Prepared and delivered

**NOTES**

lectures to undergraduate and graduate students on topics such as physics chemistry and biology and great ability to perform research in science.

---

**12.7 UNIT END EXERCISES**

---

- How will you assess the classroom climate?
- What are the enrichment programmes for gifted children?
- Explain the methods for preparing Individualized Instruction Material

---

**12.8 ANSWERS TO CHECK YOUR PROGRESS**

---

1.

- A teacher who frequently uses the categories 1, 2, 3 and 4 is said to be democratic teacher because he encourages more students' participation. Learning proficiency is high in such type of classes.
- A teacher who frequently uses the categories 5, 6 and 7 is said to be an authoritative teacher because he gives more directions and curtails students' participation. This results in increased students' dependence. Such teachers are advised to change their teaching style.
- A teacher who gives room for frequent occurrence of category 10 is ineffective in verbal communication and classroom management.

2.

- ❖ Individually diagnosed and prescribed programmes
- ❖ Self-directed materials
- ❖ Personalized programmes
- ❖ Independent study

3.

- Has great intellectual curiosity.
- Learns easily and readily.
- Has a wide range of interests.
- Has a broad attention span that enables him to concentrate on an to preserve in solving problems and pursuing interests.

- Is superior in quality and quality of vocabulary as compared with other children of his own age.
- Has ability to do effective work independently.
- Has learned to read early, often well before school.
- Shows initiative and originality in intellectual work.
- Shows alertness and quick response to new ideas.
- Is able to memorize quickly.

## **NOTES**

---

### **12.9 SUGGESTED READINGS**

---

- Mathew.T.K &T.M Mollykutty (2006) *Teaching of Science* TNOU B.Ed Study Material , Chennai .
- Radhamohan (2010)*Innovative Science Teaching for Physical Science Teachers* PHI Learning Private Ltd, New Delhi
- Saravanakumar .AR (2014) *Enhancing Achievement in Science through Metacognition* KVS Printers Karaikudi
- Venugopal, G.N Nithyasri &Prof K.Nagarajan (2013) *Teaching of Biology* Sriram Publishers Chennai.

---

## **UNIT XIII - RECENT TRENDS IN SCIENCE EDUCATION – I**

---

### **NOTES**

- 13.1 Introduction
- 13.2 Objectives
- 13.3 Nano Science
  - 13.3.1 Definition
  - 13.3.2 Advantages of a Nano technology
  - 13.3.3 Disadvantages of Nano technology
- 13.4 Biotechnology
  - 13.4.1 Definition
  - 13.4.2 Branches of Biotechnology
  - 13.4.3 Applications of Biotechnology
- 13.5 Biosensor
  - 13.5.1 Definition
  - 13.5.2 Parts of a Biosensor
  - 13.5.3 Applications of Biosensor
- 13.6 Microbiology
  - 13.6.1 Definition
  - 13.6.2 Branches of Microbiology
- 13.7 Micro electronics
  - 13.7.1 Definition
  - 13.7.2 Parts for a micro electronic device
- 13.8 Environmental Engineering
  - 13.8.1 Definition
  - 13.8.2 Scope of environmental engineering
- 13.9 Equitable education in Tamil Nadu
  - 13.9.1 Meaning
  - 13.9.2 Advantages of Equitable education system
  - 13.9.3 Disadvantages of equitable education system
- 13.10 Let us Sum Up
- 13.11 Unit- End- Exercises
- 13.12 Answer to Check Your Progress
- 13.13 Suggested Readings

---

## **13.1 INTRODUCTION**

---

Reforms in Education are determined by the request of the socio-economic development reported to existing possibilities, referring to the economic conditions as well as the development of science, educational policy and managerial capacities in learning. The explanation is simple any kind of development implies people who are prepared to realize it (professionals of all categories) and school is the one to prepare them for this aim.

### **NOTES**

---

## **13.2 OBJECTIVES**

---

After completing this unit, you will be able to:

- Identify with recent trends in science education
- Define Bio- technology, Nano- science and Bio- sensor

---

## **13.3 NANOSCIENCE**

---

Nano science ("nanotech") is the manipulation of matter on an atomic, molecular, and supra molecular scale. The earliest, widespread description of nanotechnology referred to the particular technological goal of precisely manipulating atoms and molecules for fabrication of macro scale products, also now referred to as molecular nanotechnology. A more generalized description of nanotechnology was subsequently established by the National Nanotechnology Initiative, which defines nanotechnology as the manipulation of matter with at least one dimension sized from 1 to 100 nanometers. This definition reflects the fact that quantum mechanical effects are important at this quantum-realm scale, and so the definition shifted from a particular technological goal to a research category inclusive of all types of research and technologies that deal with the special properties of matter that occur below the given size threshold. It is therefore common to see the plural form "nanotechnologies" as well as "nanoscale technologies" to refer to the broad range of research and applications whose common trait is size.

Scientists currently debate the future implications of nanotechnology. Nanotechnology may be able to create many new materials and devices with a vast range of applications, such as in medicine, electronics, biomaterials energy production, and consumer products. On the other hand, nanotechnology raises many of the same issues as any new technology, including concerns about the toxicity and environmental impact of nanomaterials, and their potential effects on

**NOTES**

global economics, as well as speculation about various doomsdays. These concerns have led to a debate among advocacy groups and governments on whether special regulation of nanotechnology is warranted.

**13.3.1 Definition**

Nanotechnology as defined by size is naturally very broad, including fields of science as diverse as surface science, organic chemistry, molecular biology, semiconductor physics, micro fabrication, etc. The associated research and applications are equally diverse, ranging from extensions of conventional device physics to completely new approaches based upon molecular self-assembly, from developing new materials with dimensions on the nano scale to direct control of matter on the atomic scale.

**13.3.2 Advantages of Nanotechnology**

To enumerate the advantages and disadvantages of nanotechnology, let us first run through the good things this technology brings:

- Nanotechnology can actually revolutionize a lot of electronic products, procedures, and applications. The areas that benefit from the continued development of nanotechnology when it comes to electronic products include nano transistors, nano diodes, OLED, plasma displays, quantum computers, and many more.
- Nanotechnology can also benefit the energy sector. The development of more effective energy-producing, energy-absorbing, and energy storage products in smaller and more efficient devices is possible with this technology. Such items like batteries, fuel cells, and solar cells can be built smaller but can be made to be more effective with this technology.
- Another industry that can benefit from nanotechnology is the manufacturing sector that will need materials like nanotubes, aerogels, nano particles, and other similar items to produce their products with. These materials are often stronger, more durable, and lighter than those that are not produced with the help of nanotechnology.
- In the medical world, nanotechnology is also seen as a boon since these can help with creating what is called smart drugs. These help cure people faster and without the side effects that other traditional drugs have. You will also find that the research of nanotechnology in medicine is now focusing on areas like tissue regeneration, bone

repair, immunity and even cures for such ailments like cancer, diabetes, and other life threatening diseases.

### **13.3.2 Disadvantages of Nanotechnology**

When tackling the advantages and disadvantages of nanotechnology, you will also need to point out what can be seen as the negative side of this technology:

- Included in the list of disadvantages of this science and its development is the possible loss of jobs in the traditional farming and manufacturing industry.
- You will also find that the development of nanotechnology can also bring about the crash of certain markets due to the lowering of the value of oil and diamonds due to the possibility of developing alternative sources of energy that are more efficient and won't require the use of fossil fuels. This can also mean that since people can now develop products at the molecular level, diamonds will also lose its value since it can now be mass produced.
- Atomic weapons can now be more accessible and made to be more powerful and more destructive. These can also become more accessible with nanotechnology.
- Since these particles are very small, problems can actually arise from the inhalation of these minute particles, much like the problems a person gets from inhaling minute asbestos particles.
- Presently, nanotechnology is very expensive and developing it can cost you a lot of money. It is also pretty difficult to manufacture, which is probably why products made with nanotechnology are more expensive.

## **NOTES**

---

## **13.4 BIO-TECHNOLOGY**

---

### **13.4.1. Definition**

Biotechnology is a branch of Science, the use of biological processes, organisms, or systems to manufacture products intended to improve the quality of human life. The uses of microorganisms, such as bacteria or yeasts, or biological substances, such as enzymes are used to perform specific industrial or manufacturing processes. Applications include the production of certain drugs, synthetic hormones, and bulk foodstuffs as well as the bioconversion of organic

waste and the use of genetically altered bacteria in the cleanup of oil spills.

### 13.4.2 Branches of Biotechnology

Several branches of Biotechnology are following as:

#### NOTES

**Bioinformatics** is an interdisciplinary field which addresses biological problems using computational techniques, and makes the rapid organization as well as analysis of biological data possible. The field may also be referred to as *computational biology*, and can be defined as, "conceptualizing biology in terms of molecules and then applying informatics techniques to understand and organize the information associated with these molecules, on a large scale." Bioinformatics plays a key role in various areas, such as functional genomics, structural genomics, and proteomics, and forms a key component in the biotechnology and pharmaceutical sector.

**Blue Biotechnology** is a term that has been used to describe the marine and aquatic applications of biotechnology, but its use is relatively rare.

**Green Biotechnology** is biotechnology applied to agricultural processes. An example would be the selection and domestication of plants via micro propagation. Another example is the designing of transgenic plants to grow under specific environments in the presence (or absence) of chemicals. One hope is that green biotechnology might produce more environmentally friendly solutions than traditional industrial. An example of this is the engineering of a plant to express a pesticide, thereby ending the need of external application of pesticides. An example of this would be Bt corn. Whether or not green biotechnology products such as this are ultimately more environmentally friendly is a topic of considerable debate.

**Red Biotechnology** is applied to medical processes. Some examples are the designing of organisms to produce antibiotics, and the engineering of genetic cures through genetic.

**White Biotechnology**, also known as industrial biotechnology, is biotechnology applied to industrial processes. An example is the designing of an organism to produce a useful chemical. Another example is the using of enzymes as industrial catalysts to either produce valuable chemicals or destroy hazardous/polluting chemicals. White biotechnology tends to consume less in resources than traditional processes used to produce industrial goods.



### 13.4.3 Applications of Biotechnology

The applications of bio- technology are categorized in the following ways

#### (a) Genetic Engineering:

Through genetic engineering the alterations in the genetic makeup of an organism can be done successfully, Genetic engineering can be employed in increasing food production from plants and animals; it is applied in the diagnosis of diseases and improvements in the medical treatment.

#### (b) Plant Tissue Culture:

The technique of growing plant tissues on artificial nutrient medium under laboratory conditions, so as to produce new plants, is called as plant tissue culture. These may be the Meristem Culture, Embryo Culture and Anther Culture and so on.

#### (c) Monoclonal Antibody:

The specialized types of protein molecules produced in the laboratory are called as monoclonal antibodies. These are produced naturally in our bodies when any bacteria or virus invades it. Monoclonal antibodies are produced in our blood and protect us from different types of diseases. These bodies are used in identifying different types of cells. These are also employed in many diagnostic tests for bacteria and viruses. The experiments are on using monoclonal antibodies for fighting against cancer.

#### (d) Synthesis of Enzymes:

Specific enzymes can be synthesized through the application of bio-technology. These enzymes are used in various processes like removal of stains, softening of fabrics, preparation of digestible foods, processing of meat and, even the treatment of cancer.

#### (e) Synthesis of Biodegradable Plastics:

Bio-technology is currently employed in the synthesis of plastic which is biodegradable i.e. unlike other plastics; this plastic can be broken down into simpler substances by microorganisms.

#### (f) Blood Substitute:

Today the number of people needing blood transfusion is increasing due to frequent accidents and diseases. In view of these facts,

### NOTES

**NOTES**

biotechnologists are trying to synthesize artificial blood through biotechnology.

**(g) Bio- Mining:**

Different types of bacteria are being currently employed in the extraction of different metals like copper, zinc, lead and other metals. These bacteria act on the metallic compounds available inside the earth and help in the isolation of respective, metals.

**(h) Bio- Protein:**

Bio- technology has many types of dramatic applications in the field of medicine. It has produced Factor- VIII (1986), which is a blood clotting protein and which is not produced in haemophilic persons. Under these conditions the haemophilic people are always at the risk of bleeding to death. In the process of synthesis of Factor VIII, the human genes having codes of production of blood clotting protein are transplanted into the **haemophili person.**

**(i) Cloning:**

The bio- technology of production of cells or organisms that are originally derived from a single original cell or organism by asexual method under laboratory conditions is called as cloning. The copies of organisms produced during cloning have identical genetic makeup and are known as clones. We can define a clone as an individual cell or organism which has been grown by a single body cell and which is genetically identical to its parent cell.

**(j) Applications in food and beverage industry:**

A number of food products are produced on industrial scale through the fermentation technology. Some of those products are wine, idlis, yoghurt, cheese, mycoproteins, quorn, bread etc. Besides this biotechnology helps in the production of different vitamins, amino acids and vinegar etc.

**(k) Application of Bio- technology in Pharmaceuticals**

Bio-technology is used in Production of human insulin from non-human sources, production of hormones like Interferon, Cytokinins, Steroids and human growth hormones, Gene-therapy for prevention and control of diseases and development of vaccines and antibodies.

### **(l) Application of Bio- technology in Agriculture:**

The application of bio- technology in agriculture can make it more sustainable. The introduction of bio-fertilizers in soil can improve its composition besides making it fertile in a natural way. Similarly, the introduction of bio-pesticides can control pests through natural ways without contaminating the natural environment. The development of disease resistant and pest resistant crop varieties through bio-technological methods has further supported the agriculture and hybridization technology has supported animal husbandry to produce more milk and meat.

**(m) Application of Bio- technology in Pollution Control:** The natural tendency of microorganisms can be exploited through bio- technology for solving the problem of wastes in the environment. In nature, green plants control atmospheric carbon dioxide by utilizing it in photosynthesis. Hence, plantation of more and more fast growing trees may be an important bio- technological method of controlling carbon dioxide level of atmosphere.

### **(n) Application of Bio- technology in Waste Water Treatment:**

The treatment of waste water comprises three major steps- the Primary Treatment, the Secondary Treatment and the Tertiary Treatment. The primary treatment comprises many sub- steps like sedimentation, chemical coagulation and precipitation. These sub- steps remove most of the physical impurities or pollutants. The secondary treatment comprises biological process involving bio- technology of employing bacteria, fungi, algae etc. for the breaking down of complex pollutants. In this process, the effluent is passed through a microbial slime layer. The microbes present in this layer break down the organic and nitrogenous waste liberating carbon dioxide and nitrogen dioxide.

**(o) Application of Bio- technology in the degradation of pesticides:** Different species of bacteria and fungi tend to degrade pesticides. These microorganisms can be genetically manipulated to degrade more and more of them. Some species of bacteria like *Pseudomonas* sp., *Flavobacterium*, *Azotobacter*, *E.coli* and *Acromobacter* tend to degrade different pesticides. It has been reported that a mixture of *Phenerocheate* (a fungus) and enzyme peroxidase in suitable proportion can degrade DDT.

### **(p) Bioremediation:**

The application of biotic agents like microorganisms in the correction and recovery of environmental damage is called as bioremediation. The

## NOTES

## NOTES

removal of oil spilled on sea water by the help of bacteria is one example of bioremediation.

**(q) Industrial Applications of Bio- technology:** Bio- technology is currently being applied in many areas of industry like the production of stain remover, detergents, bread, biotech-polyester, vitamins; stone washed jeans, bleached paper etc. Here are some examples-

(i) Detergents containing protease enzyme can remove stains of proteinaceous nature both on fabrics and lenses,

(ii) Detergents containing lipase enzyme can remove stains of oil and grease, and those containing amylase can remove starch grains stuck with fabrics. Now a day, polyesters are being synthesized from corn starch feed stock through the application of bio- technology. The enzyme cellulose is used for fading of jeans.

---

## 13.5 BIO-SENSOR

---

### 13.5.1 Definition

A **Biosensor** is an analytical device, used for the detection of an analyte that combines a biological component with a physicochemical detector. Biosensor reader device with the associated electronics or signal processors are primarily responsible for the display of the results in a user-friendly way. This sometimes accounts for the most expensive part of the sensor devices, however it is possible to generate a user friendly display that includes transducer and sensitive element. The readers are usually custom-designed and manufactured to suit the different working principles of biosensors.

### 13.5.2 Parts of a Biosensor

A biosensor typically consists of a bio-recognition component, bio transducer component, and electronic system which include a signal amplifier, processor, and display. Transducers and electronics can be combined, e.g., in CMOS-based micro sensor systems. The recognition component, often called a bio receptor, uses biomolecules from organisms or receptors modeled after biological systems to interact with the analyte of interest. This interaction is measured by the bio transducer which outputs a measurable signal proportional to the presence of the target analyte in the sample. The general aim of the design of a biosensor is to enable quick, convenient testing at the point of concern or care where the sample was procured.

### **13.5.3 Applications of Biosensor**

There are many potential applications of biosensors of various types. The main requirements for a biosensor approach to be valuable in terms of research and commercial applications are the identification of a target molecule, availability of a suitable biological recognition element, and the potential for disposable portable detection systems to be preferred to sensitive laboratory-based techniques in some situations. Some examples are given below:

- Glucose monitoring in diabetes patients
- Other medical health related targets
- Environmental applications e.g. the detection of pesticides and river water contaminants such as heavy metal ions
- Remote sensing of airborne bacteria e.g. in counter-bioterrorist activities
- Detection of pathogens
- Determining levels of toxic substances before and after bioremediation
- Detection and determining of organophosphate
- Routine analytical measurement of folic acid, biotin, vitamin B12 and pantothenic acid as an alternative to microbiological assay
- Determination of drug residues in food, such as antibiotics and growth promoters, particularly meat and honey.
- Drug discovery and evaluation of biological activity of new compounds.
- Protein engineering in biosensors
- Detection of toxic metabolites such as mycotoxins.

### **NOTES**

**NOTES**

**Check Your Progress**

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

b) Compare your answer with the one given at the end of the unit.

1. Write any four branches of biotechnology

.....  
.....

2. Define Bio sensor

.....  
.....

---

**13.6 MICROBIOLOGY**

---

**13.6.1 Definition:**

Microbiology is a branch of biology that studies micro-organisms. They are very small organisms; we cannot see with the naked eye, we can see it only under microscope so it is also called as microscopic organisms. Example: bacteria, fungi, parasites, protozoan etc.

**13.6.2 Branches of Microbiology**

- **Bacteriology:** The study of bacteria.
- **Mycology:** The study of fungi.
- **Protozoology:** The study of protozoa.
- **Phycology/algology:** The study of algae.
- **Parasitology:** The study of parasites.
- **Immunology:** The study of the immune system.
- **Virology:** The study of viruses.
- **Nematology:** The study of nematodes.
- **Microbial Ecology:** The relationship between microorganisms and their environment.

- **Microbial Genetics:** The study of how genes are organized and regulated in microbes in relation to their cellular functions.
- **Cellular Microbiology:** A discipline bridging microbiology and cell biology.
- **Evolutionary Microbiology:** The study of the evolution of microbes.
  - **Microbial Taxonomy:** The naming and classification of microorganisms.
  - **Molecular Microbiology:** The study of the molecular principles of the physiological processes in microorganisms.
- **Medical Microbiology:** The study of the pathogenic microbes and the role of microbes in human illness..
- **Pharmaceutical Microbiology:** The study of microorganisms that are related to the production of antibiotics, enzymes, vitamins, vaccines, and other pharmaceutical products.
- **Industrial Microbiology:** The exploitation of microbes for use in industrial processes.
- **Microbial Biotechnology:** The manipulation of microorganisms at the genetic and molecular level to generate useful products.
- **Food Microbiology:** The study of microorganisms causing food spoilage and food borne illness. Using microorganisms to produce foods, for example by fermentation.
- **Agricultural Microbiology:** The study of agriculturally relevant microorganisms. This field can be further classified into the following:
  - **Plant Microbiology:** The study of the interactions between microorganisms and plants and plant pathogens.
  - **Soil Microbiology:** The study of those microorganisms that are found in soil.
- **Veterinary Microbiology:** The study of the role of microbes in veterinary medicine.

## NOTES

- **Environmental Microbiology:** The study of the function and diversity of microbes in their natural environments.

- **Aquatic Microbiology:** The study of those microorganisms that are found in water.

## NOTES

---

### 13.7 MICROELECTRONICS

---

#### 13.7.1 Definition

Microelectronics is a subfield of electronics. As the name suggests, microelectronics relates to the study and manufacture (or micro fabrication) of very small electronic designs and components. Usually, but not always, this means micrometer-scale or smaller. These devices are typically made from semiconductor materials. Many components of normal electronic design are available in a microelectronic equivalent.

#### 13.7.2 Parts of Microelectronics

Microelectronics include transistors, capacitors, inductors, resistors, diodes and (naturally) insulators and conductors can all be found in microelectronic devices. Unique wiring techniques such as wire bonding are also often used in microelectronics because of the unusually small size of the components, leads and pads. This technique requires specialized equipment and is expensive.

---

### 13.8 ENVIRONMENTAL ENGINEERING

---

#### 13.8.1 Definition

Environmental Engineering is the integration of Sciences and Engineering principles to improve the natural environment, to provide healthy water, air, and land for human habitation and for other organisms, and to clean up pollution sites. Environmental engineering can also be described as a branch of applied science and technology that addresses the issue of energy preservation, production asset and control of waste from human and animal activities. Furthermore, it is concerned with finding plausible solutions in the field of public health, such as waterborne diseases, implementing laws which promote adequate sanitation in urban, rural and recreational areas. It involves waste water management and air pollution control, recycling, waste disposal, radiation protection, industrial hygiene,



environmental sustainability, and public health issues as well as knowledge of environmental engineering law. It also includes studies on the environmental impact of proposed construction projects.

Environmental engineers study the effect of technological advances on the environment. To do so, they conduct studies on hazardous-waste management to evaluate the significance of such hazards, advice on treatment and containment, and develop regulations to prevent mishaps. Environmental engineers also design supply and industrial wastewater treatment systems as well as address local and worldwide environmental issues such as the effects of acid rain, global warming, ozone depletion, water pollution and air pollution from automobile exhausts and industrial sources

## **NOTES**

### **13.8.2 Scope of Environmental Engineering**

#### **Solid waste management**

Solid waste management is the collection, transport, processing or disposal, managing, and monitoring of solid waste materials. The term usually relates to materials produced by direct or indirect human activity, and the process is generally undertaken to reduce their effect on health, the environment, or aesthetics. Waste management is a distinct practice from resource recovery, which focuses on delaying the rate of consumption of natural resources. The management of wastes treats all materials as a single class, whether solid, liquid, gaseous, or radioactive substances and the objective is to reduce the harmful environmental impacts of each through different methods.

#### **Environmental impact assessment and mitigation**

Scientists have air pollution dispersion models to evaluate the concentration of a pollutant at a receptor or the impact on overall air quality from vehicle exhausts and industrial flue gas stack emissions. To some extent, this field overlaps the desire to decrease carbon dioxide and other greenhouse gas emissions from combustion processes. They apply scientific and engineering principles to evaluate if there are likely to be any adverse impacts to water quality, air quality, habitat quality, flora and fauna, agricultural capacity, traffic impacts, social impacts, ecological impacts, noise impacts, visual (landscape) impacts, etc. If impacts are expected, they then develop mitigation measures to limit or prevent such impacts. An example of a mitigation measure would be the creation of wetlands in a nearby location to mitigate the filling in of wetlands necessary for a road development if it is not possible to reroute the road.

**NOTES**

**Water supply and treatment**

Engineers and scientists work to secure water supplies for potable and agricultural to evaluate the water balance within a watershed and determine the available water supply, the water needed for various needs in that watershed, the seasonal cycles of water movement through the watershed and they develop systems to store, treat, and convey water for various uses. Water is treated to achieve water quality objectives for the end uses. In the case of a potable water supply, water is treated to minimize the risk of infectious disease transmission, the risk of non-infectious illness, and to create a palatable water flavor. Water distribution systems are designed and built to provide adequate water pressure and flow rates to meet various end-user needs such as domestic use, fire suppression, and irrigation.

**Wastewater treatment**

There are numerous wastewater treatment technologies. A wastewater treatment train can consist of a primary clarifier system to remove solid and floating materials, a secondary treatment system consisting of an aeration basin followed by flocculation and sedimentation or an activated sludge system and a secondary clarifier, a tertiary biological nitrogen removal system, and a final disinfection process. The aeration basin/activated sludge system removes organic material by growing bacteria (activated sludge). The secondary clarifier removes the activated sludge from the water. The tertiary system, although not always included due to costs, is becoming more prevalent to remove nitrogen and phosphorus and to disinfect the water before discharge to a surface water stream or ocean outfall.

**Air pollution management**

Scientists have developed air pollution dispersion models to evaluate the concentration of a pollutant at a receptor or the impact on overall air quality from vehicle exhausts and industrial flue gas stack emissions. To some extent, this field overlaps the desire to decrease carbon dioxide and other greenhouse gas emissions from combustion processes.

**Environmental Protection Agency**

The U.S. Environmental Protection Agency (EPA) is one of the many agencies that work with environmental engineers to solve key issues. An important component of EPA's mission is to protect and improve air, water, and overall environmental quality in order to avoid or mitigate the consequences of harmful effects.

### Check Your Progress

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

b) Compare your answer with the one given at the end of the unit.

3. What is Microbiology?

.....  
.....

4. Write any four Branches of Micro Biology?

.....  
.....

5. What are the parts of microelectronics?

.....  
.....

### NOTES

---

## 13.9 EQUITABLE EDUCATION IN TAMIL NADU

---

### 13.9.1 Meaning

Equitable education system or Tamil Nadu Uniform System of School Education is a School Education Department of Government of Tamilnadu, India programme to integrate the various school educational systems within the state. There are over 1.2 crore students in four streams of school education comprising about 45,000 state board schools, 11,000 matriculation schools, 25 oriental schools and 50 Anglo-Indian schools, with different syllabus, textbooks and schemes of examinations. Uniform System of School Education was implemented by Tamil Nadu Uniform System of School Education Act 2010 which paves way for quality education to all children without any discrimination based on their economic, social or cultural background. The new system of education was introduced for classes I and VI in the 2010 academic year. The main need for this system to be proclaimed as the syllabus in Tamilnadu, was that all the school students must have uniform study, diminishing the variations between the Matriculation or CBSE Students and the Government school Students. The motivation for a uniform syllabus.

**NOTES**

### **13.9.2 Advantages of Equitable Education System**

1. Uniform Equitable Education System for Matriculation, State Board and Anglo Indian Schools
2. Overcome the advantages of Metric students like Coaching
3. Option to download required books from Internet
4. Improves Communication and Presentation skills of rural students

### **13.9.3 Disadvantages of Equitable Education System**

1. New system is inadequate to raise the standard of education
2. Current Text Books printed is like Election Propaganda
3. Current syllabus doesn't have good quality
4. No competent professional body for prescribing the common books and syllabus
5. No scope for creative learning and extra Textual learning's

---

### **13.10 LET US SUM UP**

---

In this unit, you had learnt about the recent trends in science education, branches of science and its applications. Discussed the scope of Environmental Engineering, as a teacher it is very much important to improve the natural environment. You have experienced the innovative methods of teaching science. You Knew about the Equitable Education System in TamilNadu.

---

### **13.11 UNIT END EXERCISES**

---

1. Discuss the role of Nano technology to enhance the human welfare.
2. Write the application of Biosensor.
3. Explain the branches of Microbiology.
4. Discuss the present scenario of Equitable education system in TamilNadu.

---

## 13.12 ANSWER TO CHECK YOUR PROGRESS

---

1.

- Blue bio technology
- Green bio technology
- Red bio technology
- White bio technology

2. Bio Sensor is an analytical devices used for the detection of an analyze that combines a biological component with a physiochemical detector.

3. Micro biology is a brand of biology that studies micro organisms

4.

- Bacteriology
- Mycology
- Protozoology
- Phycology

5. Translators capacitors, inductors, resistors, diodes insulators and conductors.

## NOTES

---

## 13.13 SUGGESTED READINGS

---

- Venugopal, G.N Nithyasri & Prof K.Nagarajan (2013) *Teaching of Biology*. Chennai: Sriram Publishers
- Radhamohan (2010). *Innovative Science Teaching for Physical Science Teachers*. NewDelhi: PHI Learning Private Ltd, New Delhi
- Mathew.T.K & T.M Mollykutty (2006). *Teaching of Science*. Chennai: TNOU B.Ed Study Material.
- Saravanakumar.AR (2014). *Enhancing Achievement in Science through Metacognition* Karaikudi: KVS Printers

---

## **UNIT XIV - RECENT TRENDS IN SCIENCE EDUCATION – II**

---

### **NOTES**

14.1 Introduction

14.2 Objectives

14.3 Activity Based Learning (ABL)

14.3.1 Meaning

14.3.2 History of Activity Based learning

14.3.3 Advantages of Activity Based learning

14.4 Advanced Learning Methodology (ALM)

14.5 Continuous Comprehensive Evaluation (CCE)

14.5.1 Meaning

14.5.2 Advantages of Continuous Comprehensive Evaluation

14.5.3 Disadvantages of Continuous Comprehensive Evaluation

14.6 Trimester system in TamilNadu School Education

14.6.1 Meaning

14.6.2 Origin of the system

14.6.3 Advantages of the system

14.7 Let us Sum Up

14.8 Unit- End- Exercises

14.9 Answer to Check Your Progress

14.10 Suggested Readings

---

### **14.1 INTRODUCTION**

---

In traditional school, information stood on the first place, all attention was directed towards it being the very important center of teaching process. In this concept information stood at the basis of science teaching and it was thought that the person who had the information could automatically operate with it at a satisfactory level.

This concept has sometimes generated high performance but at the students mass level it has generated failure which forced the opened learning systems to resort to important reforms. In this unit we will discuss about the recent trends in Science Education and learn branches of science.

---

## **14.2 OBJECTIVES**

---

- Discuss the innovative methods of teaching science
- Differentiate Activity Based Learning and Active Learning Methodology
- Understand the concept of Continuous and Comprehensive Evaluation
- Know about the trimester system in Tamil Nadu school education

---

## **14.3 ACTIVITY BASED LEARNING**

---

### **14.3.1 Meaning**

Activity-based learning or ABL describes a range of pedagogical approaches to teaching. Its core premises include the requirement that learning should be based on doing some hands-on experiments and activities. The idea of activity-based learning is rooted in the common notion that children are active learners rather than passive recipients of information. If child is provided the opportunity to explore by them and provided an optimum learning environment then the learning becomes joyful and long-lasting.

### **14.3.2 History of Activity-Based Learning**

The ABL method seeks to address some major problems of the traditional lecture method of teaching. In doing so, it has brought about a paradigm shift in some key classroom processes such as the role of the teacher and instructional materials and methods. It was started in Chennai in 2003, first in 13 corporation schools, then in all 264 corporation schools and in 2007 it was upscale to nearly 37,000 schools across the state of Tamil Nadu. Its implementation has been made possible with a lot of effort and resources. Key effectiveness studies, comparing the method with the traditional method should have been taken up before up scaling but unfortunately, were not done (V. Vasanthakumari, Dr. S. S. Rajagopalan and Dr. R. Jayakumar, 2008). Further, any instructional methodology always presents challenges

## **NOTES**

## NOTES

once set out into the field and needs a lot of research that can provide good evidence of its effectiveness and /or provide ways to improve its effectiveness. The SSA has been undertaking studies assessing its impact on various aspects of schooling recently. However, it again seems to use the „one-size fits all“ thought. It is important to address this issue, as any innovation that does not take care of individual student needs cannot be truly child-centered. Further, it has been noted that the anti-detention policy, where students are promoted to the next class whether or not they have progressed cognitively, is adversely affecting the quality of education (EdWatch, 2008). In addition, previous studies and the nation-wide Annual Survey of Education Report (ASER 2010) have shown low levels of achievement among government school students. This has been reported even in the state of Tamil Nadu where the educational innovation of Activity Based Learning (ABL) has been up scaled by the SSA throughout the state. The results of ASER-2010 contradict the reports of the evaluations of ABL done by the SSA (Nehru and Raghupati, 2011). Many reasons could underlie these discrepancies in assessed outcomes. These findings underscore the need for independent research to investigate the quality of learning in our schools. Such research is of extreme importance as it can generate specific evidence that can form the basis of effective educational reforms.

### **14.3.3 Advantages of Activity Based Learning**

- ABL comprehensively addresses the context of multi-grade reality and frequent student absence
- It is a robust and holistic methodology, developed by practicing teachers
- Successful learning by all children leads to acquisition of confidence, pride and high self-esteem
- Incorporates assessment and remedial teaching without branding children as failures
- Curriculum adapted from existing textbooks by teachers, so easier to accept by key stakeholders
- Working models were developed that managers and teachers could visit to experience the changed practice first-hand
- Well-structured move from pilot in Chennai (2003 to 2007) to pilots in blocks (2005 to 2007) to state wide scale-up (2007) in 37,486 schools, 6.5 million children and 120,000 teachers



- Effective media strategy and support
- Complementary graded reading programme, books produced by teachers
- On-site support to teachers provided through 6,000 BRTE – quality of this support high
- Managers of education have prioritised the reform
- Adequately resourced through SSA
- Effectively led by Minister and Departmental Head of Education, political will – logistics excellent; TLM and infrastructure
- Learners have welcomed the change
- Success is breeding success
- Parents are excited and stimulated by the results

The State trusted its teachers, trusted its children, had confidence in its diagnosis, believed in the strength of the new teaching and learning methodology and knew exactly how to take the reform to scale.

---

#### **14.4 ADVANCED LEARNING METHODOLOGY (ALM)**

---

There is a silent revolution going on the field of school education after the implementation of Sarva Shiksha Abhiyan in some of the states of India. Sarva Shiksha Abhiyan (SSA) was initiated in Tamilnadu during 2001-2002. SSA in TamilNadu has reached a stage of introspection and evaluation. Reviews of Progress made in the Education for all scheme showed appreciable improvement in almost all the key dimensions such as opening and upgrading of schools for providing better access to children. The other dimensions of SSA such as providing better infrastructure facilities, supplying free textbooks, utilization of school grant, teacher appointment and their continuous updating of skills and content knowledge through rigorous in service training. Teaching learning materials alternative education schemes education of girls, Strengthening school community partnership through Village Education Committee and midday meal programme have seen phenomenal improvement. The gender disparity has almost been removed in terms of student enrolment, retention attendance, and achievement and transition rates. A rigorous evaluation and continuous

#### **NOTES**

**NOTES**

monitoring have helped in identifying the bottlenecks in realizing the objectives of SSA.

**14.4.1 Need for ALM**

Classroom techniques that involve promoting activities for students in doing things and thinking about what they are doing may be called as Active Learning Method (ALM). It seems to involve an inward looking simultaneous with the outward looking. It has two basic assumptions: a. Learning is by nature an active one not a passive listening and b. Different people learn in different way. Active learning methodologies require that the students must find opportunities to meaningfully talk, listen, write read and reflect on the content, ideas, issues and concerns of an academic subject. ALM shifts the focus from the teacher to the students and from delivery of subject content by the teacher to active engagement of the student with the material. Through appropriate inputs from the teacher students learn to practice apprehend knowledge and use them meaningfully. In this competitive era of globalization quality is the watch word it is the fittest alone that survives in the struggle for life. Hence in order to enhance and sustain quality in the teaching learning process, revolutionary steps in the form of Activity Learning methods (ALM) have been introduced up to high school level.

**14.4.2 Importance of ALM**

ALM methodology is an ideal teaching methodology that aims at bringing out the innate talents and creative skills of every child. It is a radical approach which has brought sea changes in the classroom transaction process. This methodology has taken education away from the conventional lecture method and laid stronger foundation for student centered approach. It has changed and shaped the classrooms as a centre for a hub of activities. Each and every steps of the methodology prepares him/her to face the outer world efficiently children imbibe the necessary skills in every aspect of ALM and it makes them to face future competitions in any task with courage. The presentation, group discussion, preparing to face large number of details of mind mapping will help to come up with flying colours in all the assignments in their future.

Some cognitive research in the field of education has shown that a large number of individuals have learning styles that are best approached using pedagogical techniques other than lecturing. Strategies promoting activities that involve students in doing things and thinking about what they are doing may be called Active learning.

## **NOTES**

ALM has been implemented in the middle and high schools of TamilNadu in teaching the Upper primary students. During ALM class the student looks the pictures the tables the main and subheadings and at anything else that catches his eyes. In the brain, quick overview of the content and style of presentation and an emergence of feelings interest or disinterest are by the first responses. The process of reading checking meaning of words rereading and then articulation of one's own questions expands the network of associations in the brain. While asking questions the reader gains meaning and his access to empowerment gets emphasized. The role of teachers is to encourage questioning guide the process and ensure that essential questions are not left out. Mind Map an alternative to note taking is a salient feature of this technique. Drawing the visual allows the student an opportunity of an interesting activity all the while chewing on the content. Discussions help the student to listen to accept and to appreciate different viewpoints. It also helps the students to clearly communicate and to clarify widen and depend learning consolidate and reinforce the subject learnt. Discussions also improve the skills of decision making. The purpose of summarizing is for revisiting the text without having to go through the cumbersome process of rereading the text without having to go through the cumbersome process of rereading the original text. The purpose could also help in memorizing where there are number of facts to be remembered. It is also helpful to crystallize one's views and knowledge and to take it forward. Subject wise assessment by the student has its own value.

It helps build a perspective on both the process and content of learning. It promotes also a self-reflection on why learning has or has not happened. For the teacher, it gives a clear picture of individual responses to the classroom processes and a sense of what worked for each individual. Writing is graded complex skill and levels can vary from being able to write words to writing sentences to writing to paragraphs and essays. ALM may be seen as the bridge that signs the processes of school education to this basic requirement. They exposure to the ALM methodologies in a regular and sustained way holds the potential for the student to discover that h is a part of one works and one's future. ALM seeks to build a link between knowledge and empowerment and seeks to equip each student with the ability to think, to apply and to discover. Started on an experimental basis this methodology is being extended now to all the middle and high schools in TamilNadu. Based on the continuous feedback, the limitations initially faced in implementation have been gradually overcomes.

---

## 14.5 CONTINUOUS COMPREHENSIVE EVALUATION

---

### NOTES

#### 14.5.1 Meaning

Continuous and Comprehensive Evaluation is an education system newly introduced by Central Board of Secondary Education in India, for students of sixth to tenth grades. The main aim of CCE is to evaluate every aspect of the child during their presence at the school. This is believed to help reduce the pressure on the child during/before examinations as the student will have to sit for multiple tests throughout the year, of which no test or the syllabus covered will be repeated at the end of the year, whatsoever. The CCE method is claimed to bring enormous changes from the traditional chalk and talk method of teaching provided it is implemented accurately.

#### 14.5.2 Advantages of Continuous Comprehensive Evaluation

- One of the upsides of the CCE system is that it aims to help reduce stress in students because they work alongside the students individually and guide them depending on their specific strengths and ability. In addition, they refrain from using negative language if a student can't complete a project or understand something. They also pride themselves on encouraging students to excel in areas that they are stronger in.
- The CCE system also focuses on holistic education which aims to develop various aspects of a student's personality which ultimately helps them identify what they are better at and stronger at in terms of academics.
- There is no pressure for students to become highly academic because they aim to encourage individuals to choose subjects based on their interests while retaining the importance of academia. They aim to make the students feel more relaxed so they improve on their academic ability without feeling under pressure.

#### 14.5.3 Disadvantages of Continuous and Comprehensive Evaluation

- ❖ A downside of the CCE system is the grading system. This is because the bracket is very wide, for example students that score between 90 and 100 will get an A\* grade. You may see this as a positive scheme because it gives the

chance for more students to receive a higher grade, however, a student that scores 8 more points than someone else but doesn't receive a better grade may seem unfair.

- ❖ Despite the system aiming to lessen stress, the grading system may in fact cause more stress for the students. For example, a student may feel more pressure to get a higher grade because the grade margin is substantially larger than you would expect.

---

## **14.6 TRIMESTER SYSTEM IN TAMIL NADU SCHOOL EDUCATION**

---

### **14.6.1 Meaning**

In a bid to bring relief to school children from carrying an overload of books, Tamil Nadu government will introduce trimester system in schools for classes I-VIII from the next academic year, 2012-13. "As per the existing system, students are forced to carry books which have portions meant for the whole year. Children are literally burdened with books. The enrichment of knowledge along with syllabus revision has resulted in increased volume and size of the books and the physical strain the children undergo", a School Education department released.

### **14.6.2 Origin of the System**

In a Government Order dated December 9, the department said a solution for the problem was to introduce trimester pattern, as announced by Chief Minister J. Jayalalithaa in August in the Tamil Nadu Assembly. According to the proposed system, the academic year would be divided into three terms between June and April and existing books suitably divided into three parts. "The rationale for introducing the trimester system is to create a school where teaching and learning is valued with an emphasis on learning outcomes demonstrated in students' performance. A well-designed curriculum through thinner books along with creative instructional practices will form the key to success", the GO said. A trimester pattern would allow for more interactive and collaborative experiences and included provisions for immediate feedback and helping those students that lagged catch up with others, it said.

"Large time and the smallness of the term books motivate students to work together in a sportive and friendly manner avoiding cut-throat sense of unhealthy competition among peers. Balancing the core classes over three terms allows for less stress on students", it said.

**NOTES**

The teachers, for their part, need not rush to cover lessons, the GO said, adding the “trimester system coupled with comprehensive and continuous evaluation method will certainly mark a qualitative leap as far as the education of children is concerned”.

Ms. Jayalalithaa had announced that the trimester pattern would reduce the “physical strain” on students.

**14.6.3 Advantages of the System**

- Physical and Mental load of the child will be substantially reduced
- Learning in stress free environment
- No Fear of examination
- Help to explore the inherent potential of the child
- Unhealthy marks driven competition would be minimized

**Check Your Progress**

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

b) Compare your answer with the one given at the end of the unit.

1. What do you mean by ABL?

.....  
.....

2. Write any two advantage of Activity Based learning?

.....  
.....

3. Write any two advantages of trines tic system?

.....  
.....

---

**14.7 LET US SUM UP**

---

In this unit, you had known about the ABL method, ALM and Continuous Comprehensive Evaluation. Finally, we have discussed Trimester System in Tamil Nadu.

---

## 14.8 UNIT END EXERCISES

---

- ❖ What is the need of Advanced Learning Methodology in Science teaching?
- ❖ Discuss the advantages and disadvantages of Continuous Comprehensive Education.
- ❖ How is Trimester system implemented in TamilNadu School Education?

## NOTES

---

## 14.9 ANSWER TO CHECK YOUR PROGRESS

---

1. Activity based learning describes a range of pedagogical approaches to teaching. It emphasized that learning should be based on doing some hands on experiments and activities.
2.
  - ❖ It is a robust and holistic methodology developed by practicing teachers
  - ❖ Effective media strategy and support
3.
  - Physical and mental load of the child will be substantially reduced
  - No fear of examination

---

## 14.10 SUGGESTED READINGS

---

- Venugopal, G.N Nithyasri & Prof K.Nagarajan (2013). *Teaching of Biology*. Chennai: Sriram Publishers.
- Radhamohan (2010). *Innovative Science Teaching for Physical Science Teachers*. NewDelhi: PHI Learning Private Ltd.
- Mathew.T.K & T.M Mollykutty (2006). *Teaching of Science*. Chennai: TNOU B.Ed Study Material.
- Saravanakumar.AR (2014). *Enhancing Achievement in Science through Metacognition*. Karaikudi: KVS Printers.

**MODEL QUESTION PAPER**  
**B.Ed.,**  
**TEACHING OF SCIENCE**

**NOTES**

**Write all the questions**

**10x2=20**

1. Write the comprehensive definition of Science.
2. What are the goals of science teaching framed by NSF?
3. What is lecture cum Demonstration method?
4. Define Micro teaching
5. List some of the common accidents in science laboratory.
6. Write any three importance of Audio-visual aids
7. What do you mean curriculum?
8. Differentiate : Assessment and Evaluation
9. Mention any two special qualities of a science teacher
10. What is Bio-technology?

**Part-II**

**II. Write any five questions out of Eight**

**5x5=25**

11. Explain in detail about the term "Science as a Body of knowledge
12. Describe the criteria for selecting a method of teaching science
13. Briefly discuss about the microteaching cycle".
14. How is advancement of science helpful in science teaching ?
15. What are the recent trends in Science curriculum? Explain
16. Describe the qualities of a good test?



17. Explain about the behavior patterns of Teaching
18. Discuss about the present scenario of equitable education in Tamil Nadu.

### **Part-III**

#### **III. Write any two in the following internal choice**

19. a) Describe the nature , objectives and strategies for teaching science
- (or)
- b) Discuss the role of ICT in Teaching Science.
- 
20. (a) Describe in detail about the curriculum and Assessment in teaching science.
- (or)
- (b) “Quality of science depends upon the quality of science teachers” –justify in detail.

#### **NOTES**