TEACHING OF PHYSICAL SCIENCE

B.Ed. I YEAR

UNIT 1: NATURE OF PHYSICAL SCIENCE

And

UNIT 2: AIMS OF LEARNING PHYSICAL SCIENCE

And

UNIT 3: LEARNING OBJECTIVES OF PHYSICAL SCIENCE

1.1 INTRODUCTION

Science has been derived from the Latin word “Scientia” which means knowledge. It is a systematized body of knowledge which may pertain to any subject or field of life ‘Science is organized common sense', ‘Science is an interpretation of the natural phenomenon'. Science and technology are playing an important role in our lives. They have become an integral part of our social and cultural life. Various activities are controlled and governed by science. It has helped man to acquire supremacy over nature. Because, the modern civilization is a scientific civilization. This is an age where the modern society is completely drawn into the scientific environment; and science has become an integral part of our life and living. Now, we cannot think of a world without science. Because, science is both the body of knowledge and the process of acquiring it. To open with, science is a cumulative and endless series of empirical observations which result in the formation of concepts and theories with both concepts and theories being subject to modifications in the light of further empirical observations.

1.2 OBJECTIVES

On completion of this unit, one should be able to,

1. Acquire knowledge about science and its nature.
2. Understand the relationship between the process and product.
3. Understand the importance of teaching science based on the nature of science.
4. Analyse the impact of science and technology on modern living.
5. Acquire knowledge about the inter-disciplinary approach and its advantages.
6. Acquire knowledge about aims, objectives of Blooms Taxonomy.

7. Classify objectives in cognitive, affective and psychomotor domains.
8. Write down the objectives in behavioural terms.
9. Understand the objectives of teaching science at primary level.
10. Understand the objectives of teaching science at secondary level.
11. Understand the objectives of teaching science at higher secondary level.

1.3 WHAT IS SCIENCE?

"Science is universal and so can be its benefits. Its material benefits are immense and far-reaching industrialization of agriculture and release of nuclear energy, to mention two examples-but even more profound is its contribution to culture" - Kothari Commission.

In simple words, science is the investigation and interpretation of natural phenomena which occur in our daily life. Some of the definitions of science are as follows.

1. "Science is an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation and are fruitful of further experimentation and observation" - James B. Conant.
2. Science is nothing but perception.
3. Science is organized and systematized knowledge relating to our physical world.
4. Science is classified knowledge gained from a systematic study of behaviour of nature.
5. Science is nothing but gaining of knowledge on the basis of experience.
6. Science is cumulative and endless series of empirical observation which results in the formation of concepts and theories with both concepts and theories being subject to modification in the light of further empirical observation.
7. Genius persons by their persistent efforts, careful experimentation and exact reasoning have collected mass of tested information which we call science.

8. Science is a process of thinking, a means of acquiring knowledge and means of understanding the natural world.
9. Science is a quest for an understanding of certain aspects of human experience. It is a process of experiencing.
10. Science is both a body of knowledge and the process of acquiring the refined knowledge.

There are some of the definitions that give us an idea about what is meant by science. Science is a multidimensional activity and it is very difficult to search a universal acceptable definition of science.

Thus Science is simultaneously a body of knowledge and continuous, self evaluative process of enquiry.

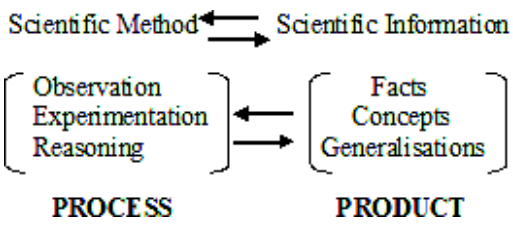
Science thus has two important approaches.

(a) Science as a Product.

(b) Science as a Process.

Various laws, theories, principles etc., are included in the category of science as a product where as scientific attitude, scientific method etc., form part of science as a process through both aspects are important in their own way but to attain the aims of science education in schools more emphasis will be places on process approach.

The process of searching scientific knowledge can be explained as follows:



The diagram shows that products (concepts, facts etc.,) are derived from process (observation and experimentation) and that these products lead to further process. Thus,

science is a continuous search for new knowledge through continuous inquiry. Thus we can summerise the above relationships by saying that ‘Science is both a body of knowledge (Product) and method of inquiry (Process)'. It is one of the specialized characteristics of science.

1.4 THE NATURE OF SCIENCE

In the last three decades some attempts have been made to understand the nature of science. Joseph J. Schwab (1964) and Bruner (1962) have explained the nature of science in technical terms, which is based on the idea of the structure of knowledge or structure of disciplines. According to this idea, the nature of science comprises.

(a) Substantive structure of science and

(b) Syntactical structure of science.

The Substantiate structure of science represents the major conceptual schemes which constitute the basic knowledge used in science. The substantive structure of science contains different classes of statements, such as definitions, knowledge statements, etc., we may call them ‘key concepts' or ‘major ideas'. Examples of such major concepts have been given in all major science curricular projects developed in the USA, namely, Physical Science Study Committee (PSSC), CHEM Study etc.,

The syntactical structure of science is concerned with the so called processes of scientific inquiry, means by which scientific knowledge is acquired and verified. These processes can be further divided into simple skills so that pupils can practice them without any difficulty. Some of the processes of science are as follows.

Observation, measurement, classification, formulating hypothesis, experimenting etc., At this stage it is easy to infer that the nature of science has two aspects, that is, concepts of science which build the substantiate structure of science and the processes of science which build the syntactical structure. Both are equally important.

Recently a third dimension to the nature of science has been added which has been recognized by workers. This is known as the social aspect of science.

Science has been taken as a human activity which influences society and is being influenced by society. The applications of science to society and its impact on human lives are first as important as learning content and skills. In fact some science educators have strongly recommended a new emphasis on science teaching that includes social, moral ethical aspects of science. In other words, many of the science technology are based on social issues that have moral, ethical and social relevance, such examples are as follows.

Pollution, acid rain, nuclear energy, bio-engineering, etc.

Thus, the nature of science has clearly indicated that science is different from other disciplines, because each discipline has its own conceptual structure, its own methodologies and skills and its own social bearing.

1.5 SCOPE OF SCIENCE

When we try to assess the importance of a subject in school curriculum, we look at it from three angles.

1. The characteristics of science.
2. The utility of the subject.
3. The cultural values of the subject.

1.5.1 Characteristics of Science

Besides the nature of science, explained in the pervious paragraphs, it has specialized characteristics which we do not find in other disciplines Showalter and others have described the characteristics of science in the following words.

1. Science is empirical. Scientific knowledge is derived by observations or experimentation which is further extended on the continuity of observations.

   Observations → Processes → Concepts

2. Science grows through processes of science. Scientific knowledge grows through processes of science or inquiry approach or methodologies of science. These

processes of science are from simple to complex. Similarly, inquiry approaches are also from simple i.e., stable inquiry to difficult, that is fluid inquiry.

3. Scientific knowledge is replicable. It has been observed that science is based on evidence which can be investigated or researched in a different place and at a different time given similar conditions.
4. Scientific knowledge is holistic because the knowledge produced by different branches of science contributes to an overall conceptual scheme which is internally consistent.
5. Scientific knowledge is tentative in nature. It is subject to change. In other words, science is uncertain and its knowledge is consistently changing in the light of new evidence. We can say that "if science is knowledge, it is dynamic knowledge".
6. Scientific knowledge is unique as it differs from other area of knowledge. It is distinguished from other realms by virtue of the nature of knowledge and its procedure in generating new knowledge.
7. Scientific knowledge is humanistic because it is a product of human effort to find out the unknown things of nature. All this knowledge is related to the human beings and the scientific concepts are the products of culture.
8. Science has its own values of objectivity, rationality, neutrality and humanity. Science is one of the approaches truly based on philosophical, sociological, psychological and moral dimensions. It depends on those values which are common to all human kind-freedom, liberation, happiness, speculation and imagination.

1.5.2 The Utility of the Subject

(a) The "Intellectual Value" (Knowledge Value) of science is necessary for almost every individual in the scientific world of today. Study of this subject develops not only high regard for truth but also for search of truth. Science fosters intellectual ways of thinking and reasoning.

(b) Science has great "Vocational Value", Agriculture, Engineering etc., are science

based. Fully realizing the vocational value of science, in the +2 stage, certain applied sciences are offered in the vocational stream.

(c) Scientific discoveries to solve the mysteries of nature are concerned with "aesthetic value" in the sense that science is concerned with truth of all existence and it provides a chance for application.

(d) The moral integrity caused by the pursuit of science is mainly due to the nature of science. The "Moral Values" of scientists could be maintained only when they express the truths without any fear or bias.

(e) The "Utilitarian Value" of science is quite obvious. Right from the cradle to the grave, all our activities are controlled and fashioned by science.

(f) Science provides "Scientific Method" of solving problems. The various steps in scientific method can be listed as sensing the problems, collection of data, forming hypothesis, verifying the hypothesis and then drawing conclusions. Science created self-confidence in life.

1.5.3 The Cultural Values of the Subject

Science has a cultural value also. By the study of lives of great scientists we not only know about their great works but also draw inspiration for the study of science. The methods of science inspire the students to do things in reasonable and logical manner. Science is studied through observation and practical training. All these things help the development of the power of reasoning. In short, we may say that science is an essential part of education which helps the students to prepare themselves for future life.

Keeping in view the points mentioned above, it is quite clear that science occupies an important place in our life, and must also be given an important place in the school curriculum.

1.6 INTERDISCIPLINARY APPROACH

All the branches of science are interdependent. There are many areas in science

which are common to all science subjects. Because of the reciprocal relationship between various subjects, the inter-disciplinary approach or correlation is being emphasized. In physical science teaching, we cannot confine ourselves with physics and chemistry alone, we are to combine and correlate physics and chemistry with other subjects, and with learner environment to avoid rote memory and artificial learning. This is what is known as interdisciplinary approach in science teaching.

Inter disciplinary approach can be discussed under three headings.

1. Correlation of science subjects with one another.
2. Correlation of science with other school subjects.
3. Correlation of science with life and environment.

1.6.1 Relationship of Science Subjects with one another

Chemistry and biology are interdependent. A biology teacher while teaching digestion needs to use the knowledge of chemistry. Further photosynthesis in Botany is taught by interdisciplinary approach- Botany and chemistry.

Similarly, the atomic structure and the electronic configuration of atoms, of elements, radioactive isotopes are areas common to physics and chemistry. Hence interdisciplinary approach is essential for better understanding.

1.6.2 Relationship of Science with other School Subjects

1. Science and Literature

There are excellent writers in Biography and Natural History and on discoveries and inventions. These can be recommended for class and home reading as literature.

2. Science and Languages

Elementary books used in foreign countries for science teaching might occasionally be read. More advanced foreign text books on special subjects should be placed in the library. Children can't express themselves until they develop a good language (both written and spoken) skill.

3. Science and History

The life of a nation is greatly influenced by the application of scientific discovery to national trade, industry, diet and standards of living and by the imparting of current scientific thought on the general idea of the age.

4. Science and Geography

Simple problems connected with the composition, pressure, temperature and moisture of the air are usually dealt with in science courses; so also conventional currents in air and in the sea and variation of the density of water with temperature. It will mutually benefit both subjects if the science and geography masters work in cooperation, so that the use of thermometers, barometers, rain gauge and hygrometer can be really understood.

5. Science and Social Studies

Science has changed our way of thinking and the standard of living. Many superstitious beliefs are vividly explained on the basis of scientific principles. Modern dress materials, Jewelleries, Transportation facilities, mass media, films, cinema theatres, magic shows etc., are all scientific inventions that make our lives a different one. Everyday, science has its play from dawn to night.

6. Science and Fine Arts

The topic of sound can be easily and interestingly taught, when the topic is compared with musical instruments. Pitch and length of the string, vibration of air columns and flutes etc., can be demonstrated easily. In the preparation of record note books or charts children need skill of drawing without proper diagrams we cannot teach some complex concepts such as structure of atoms etc., Science drawing, improvisation, musical groups can be included as activities in science club.

7. Science and Mathematics

Many problems of proportion, inverse ratio, equations and graphs are constantly in

use in science courses. The early introduction of the ratio of trigonometry is a great help in the science course and their use in mechanics, magnetism and light give reality to their meaning.

8. Science with Painting and Drawing

Drawing is of immense importance for all branches of science, may be physics or chemistry or biology. Preparations of charts, models, diagrams etc., require skill in drawing. Diagram in science have important place. Without diagrams, we cannot grapple with theoretical descriptions.

9. Science and Craft

Correlation between science and craft is possible to a great extent. Now-a-days improvisation has proved its utility. Besides making school self-sufficient it also cultivates in the students the habit of manual work. They learn more when they do it with their own hands and knowledge of basic principles underlying the apparatus improvised by them is understood by them.

10. Science and Economics

Science has a profound effect on the economy of a particular country. India has been able to achieve self sufficiency of food due to artificial manure and good insecticides. Similarly health of nation is, dependent upon the knowledge of science in terms of balanced diet food preservation, canning, medicine etc., Similarly the industrial economy is also dependent upon the chemical know-how of metals, their ores etc.,

1.6.3 Relationship of Science with Life and Environment

For basic needs of life such as food, clothing, shelter, we have to depend upon science. Science has gone deep in the veins of modern society. All our daily routine is controlled by science and its products. In food production, insecticides, pesticides, preservation of food industry and ingredients of balanced diet are the basis on which science can be correlated. Science helps otherwise in cooking, transportation,

communication, metallic industry etc. It is therefore essential on the part of science teacher that he should make sure that applications of that topic in daily life affects the thought and actions of students, so that students begin to understand the implications of the subject.

Advantages of Inter Disciplinary Approaches.

(a) Correlation gives a sort of unity to the curriculum.

(b) It encourages all-round development and growth of the child.

(c) It assists in bringing closer the school and society.

(d) It establishes a close relationship between experience and knowledge.

(e) It prevents narrow specialization.

(f) It makes education natural.

(g) It makes the lesson interesting by bringing in the other subjects and experience.

(h) Learning by doing is fostered while organizing projects to correlate different subjects.

(i) It broadens the teachers' outlook.

(j) It helps teachers to learn more from books and keep their knowledge up-to-date.

1.7 AIMS AND OBJECTIVES OF TEACHING SCIENCE

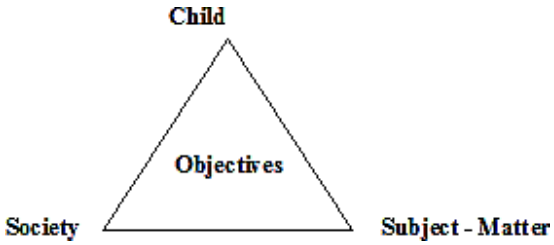
Education is imparted for achieving certain ends and goals. Various subjects of the school curriculum are different means to achieve these goals. The term aims of teaching science stands for the goals, targets or broader purposes that may be fulfilled by the teaching of science in the general scheme of education. Aims are like ideals. Their attainment needs a long-term planning. Their realization is not an easy task. Therefore, they are divided into some definite, functional and workable units named as objectives. The objectives are those short-term, immediate goals or purposes that may be achieved within the specified classroom situation. They help in bringing about behavioural changes in the learners for the ultimate realization of the aims of teaching science. The aims are broken into specified objectives to provide definite learning experiences for bringing about desirable behavioural changes.

1.8 TAXONOMY OF EDUCATIONAL OBJECTIVES

Based on the above clarification, objectives related to education as a whole, are known as ‘educational objectives'. In the words of B.S.Bloom “By educational objectives, we mean explicit formulations of the ways in which students are expected to be changed by the educative process, that is , the ways in which they will change in their actions”. In order to save time and effort, it is very important that the objectives of a subject be clearly identified and defined.

The formulation of educational objectives is a matter of careful choice on the part of the teachers and administrators. The following factors are involved:

1. The needs and capabilities of the pupils.
2. The specific demands of his social environment.
3. The nature of the subject matter.



The criteria of a good educational objective is that it is,

1. In accordance with general aims of education
2. Unambiguous
3. Useful
4. Specific
5. Feasible

1.9 CLASSIFICATION OF EDUCATIONAL OBJECTIVES

Educational objectives indicate the nature of the education system and show the direction in which education will act. Educational objectives serve as guides for teaching

and learning. These also develop awareness among the teachers about the importance of their work and provide guidelines in selecting teaching-learning activities. For teaching which aims at worthwhile behaviour changes, a clear understanding of educational objectives is essential.

Some educators have attempted classification of educational objectives. Classification is a valuable system to group similar things under one heading based on common characteristics or common relationship that exists between groups and individuals.

The main functions of classifying educational objectives are as follows.

1. It is helpful in planning curriculum.
2. It is helpful in planning, teaching and learning activities.
3. It is helpful in identifying desired behavioural outcomes among the learners.
4. It is helpful in preparing evaluation or testing materials.
5. It is helpful in comparing curricular goals with wider educational objectives.
6. It is helpful in the search for the relationships that exist among groups and individuals.
7. It is helpful in defining, translating and exchanging educational thoughts in a uniform way.

1.10 BLOOM'S TAXONOMY

A number of attempts have been made by experts in the field of classification of educational objectives. Perhaps the most widely used system of classification of objectives is the one prepared by a group of college and university teachers and later reported in "Taxonomy of Educational Objectives" (1956) edited by Benjamin S. Bloom. 'Taxonomy' is a term derived from two Greek words 'taxis' meaning 'arrangement' and 'nomos' meaning 'law'. In this derivative sense, taxonomy means 'orderly arrangement'. They classified the educational objectives into three broad categories or domains.

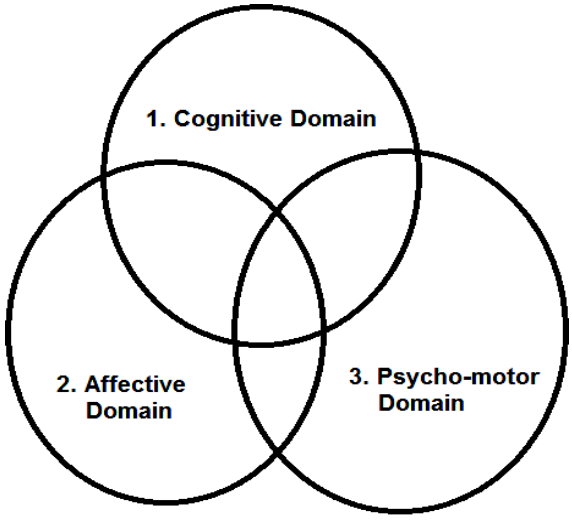
The Domains are:

1. Cognitive Domain (knowing)
2. Affective Domain (feeling)
3. Psycho-Motor Domain (doing)

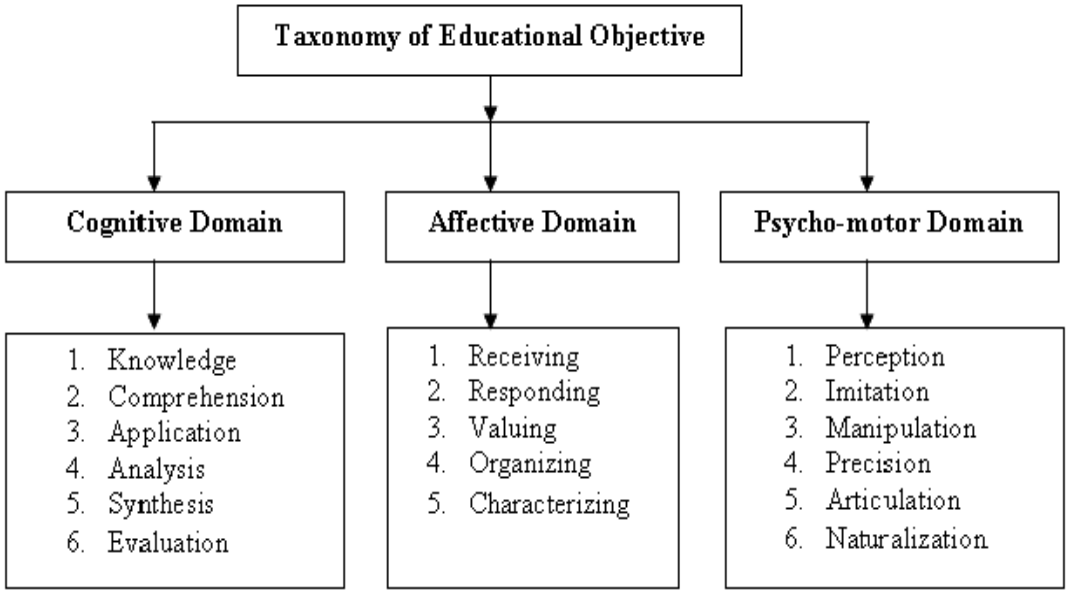
These domains are hierarchical because when learning takes place, the first activity is a mental process of trying to understand, analyze, synthesize and associate the information with something already known. This thought process comes under cognitive domain.

In the second stage, the knowledge acquired begins to produce changes in the interest, attitude and feelings of the individual. These types of behavioural changes are grouped under affective domain. In the third stage, the feeling acquired gives way to exhibit muscular skills and manipulative skills. These changes are grouped under psycho-motor domain.

Besides, the above classification, each domain can be further split up into major categories which are also hierarchical. The major categories are as follows.



Bloom's Taxonomy



1.11 CATEGORIES IN THE COGNITIVE DOMAIN

The arrangement in this category can be observed as follows.

1.11.1 Knowledge

This is the first and the lowest level of cognitive domain. It includes recall of information such as specifications, facts, methods, processes, generalizations, patterns etc., and thus the knowledge objective emphasizes what can be described as memory.

1.11.2 Comprehension

This second category includes Translation, Interpretation and Extrapolation. This is also related to the use of ideas. It refers to a type of understanding of the materials or literal message contained in a communication.

1.11.3 Application

The third level includes the ability to apply abstract ideas to a concrete situation. The abstractions may be in the form of general ideas, rules or procedures or generalized methods.

1.11.4 Analysis

It means the "break down of the materials into its constituent parts and detection of the relationships of the parts and of the way they are organized. "Analysis includes analysis of elements, analysis of relationships and analysis of organizational principles.

1.11.5 Synthesis

This category is just the opposite of analysis. Synthesis is the "Putting together of elements and parts so as to form a whole. This involves the process of working with pieces, parts, elements and arranging and combining them in such a way as to constitute a pattern or structure not clearly there before".

1.11.6 Evaluation

It is the assignment of symbols to phenomenon, in order to characterize the worth or value of a phenomenon, usually with reference to some social, cultural or scientific standards. Evaluation involves judgments in terms of internal evidence as well as external criteria.

To conclude, it may be pointed out that the above six major categories in the cognitive domain do not always appear in the isolation from one another.

1.12 CATEGORIES IN THE AFFECTIVE DOMAIN

The arrangement in this category can be observed as follows.

1.12.1 Receiving

This is at the lowest point on the affective domain. Receiving may be defined as "Sensitivity to the existence of certain phenomena and stimuli, that is, the willingness to receive or attend to them".

1.12.2 Responding

Responding refers to a behaviour which goes beyond merely attending to the phenomena; it implies active attending, doing something with or about the phenomena, and not merely perceiving them.

1.12.3 Valuing

Valuing implies “Perceiving them as having worth or value. The three sub-categories of this objective are acceptance of value, preference for a value commitment.

1.12.4 Organising

This involves building up of organized system of values. The individual organizes a set of values such as truth, goodness and helping others in determining their relationships and deciding their need and priority.

1.12.5 Characterising

In this category, the individual displays the integration of values and it becomes a lifestyle with him. He gets these values organized into some kind of internally consistent system, which has controlled the behaviour of the individual for a sufficient time. This category is concerned with one's view of the universe and one is philosophy of life.

1.13 CATEGORIES IN THE PSYCHO-MOTOR DOMAIN

The arrangement in this category can be observed as follows.

1.13.1 Perception

Skill of keen observation, skill of sensing a problem and skill of developing self-motivation are the specific objectives under this category.

1.13.2 Imitation

Skill of repeating the actions and skill of reflective thinking are the specific objectives under this category.

1.13.3 Manipulation

Skill of operating upon the intelligence and manage cleverly by using unfair method are the specific activities that fall in the category.

1.13.4 Precision

Skill of experimentation, skill of précised movements and neat execution of skills are the activities that fall under this objective.

1.12.5 Articulation

Skill of global thinking, reflective thinking, skill of mind and body and the development of mathematical skills are specific objectives of this step.

1.13.6 Naturalization

As we practice a skill, in due course it becomes our natural habit. Skill of attaining success and skill of multiple actions are the specific activities under this objective.

Since science is a study usually involving direct experimentation, the psycho-motor domain has got great relevance.

Although there are various educational objectives classified under the three domains, the objectives of the teaching of science are different for different levels of education.

The table showing the cognitive, affective and psycho-motor development among children of various levels is given below.

1.14 OBJECTIVES OF SCIENCE EDUCATION AT VARIOUS LEVELS

Levels	Cognitive	Affective	Psycho-Motor
K.G.	----------	Receiving and Responding	Observation
Primary (I, II, III and IV)	Knowledge and comprehension	Receiving and Responding	Observation
Higher Primary (V, VI & VII)	Knowledge, comprehension and application	Receiving and Responding	Observation and induction
Secondary (VII, IX & X)	Knowledge, comprehension,	Receiving, responding and valuing	Observation, induction and

	application and analysis		deduction
Higher Secondary (XI & XII)	Knowledge, comprehension, application, analysis, synthesis and evaluation.	Receiving, responding, valuing, organizing and value orientation.	Observation, induction and deduction.

The objectives at primary level are further given in detail as shown below.

Class I & II : a) Development of healthy habits.

b) Development of power of observation.

Class III & IV: At this stage the other objectives in addition to (a) and (b) above are,

c) Personal hygiene and sanitation.

d) To expose the child to the formal areas such as plants and animals, to study about his surroundings such as air, water, weather, the earth and the simple machines that affect his daily life.

1.15 AIMS OF TEACHING SCIENCE AT DIFFERENT LEVELS

The whole process of the teaching of the science directs the students towards these objectives. These objectives are guided by the content materials of the curriculum, lessons and topics. Various standards and stages of education of science for the primary classes shall be different from the objectives of the teaching of science at the secondary stage of education. Principles of education are applied in the field of education up to secondary stage only. Teachers who teach up to secondary classes have to acquire a degree in teaching or education. Teachers in the field of higher education are not required to possess any such degree. We shall, therefore confine our stage up to secondary stage

of education. Up to the secondary stage of education, we have three stages,

1. Primary stage.

2. Junior High School or Lower Secondary stage of education consist of classes VI toVIII.

3. Secondary stage of education consists of classes IX to XII.

1.15.1 Primary Stage of Education and the Objectives of the Teaching of Science

The objectives of the teaching of science are different for different stages of education. While laying down the objectives for the teaching of science for primary classes, we have to keep in mind the psychological requirements of the students of this age group. It is also necessary to keep in mind the capacity of these boys of the tender age to adapt themselves to their environment.

Following are generally accepted as the objectives of the teaching of science.

(a) **Development and training of the power of observation**

Generally, children of the age group of five to ten years come under the primary stage of education. Normally, children of this age group are very active. They are curious to know about all the things they come in contact with. They are keen observers. It is, therefore, necessary to develop and train their power of observation. The teacher should therefore try to achieve this objective. He should train and encourage them to collect plants, different kinds of flowers etc. He should also train them to know about various things about these collected objects.

(b) **Knowledge of the relationship between physical and social environment**

Children of their group come in contact with the natural as well as social environment. They should, therefore, be trained to know about the relationship that exists between the community and the nature. They should be taught about the various gains that community or the society derives from nature.

(c) **Objectives with regard to character and behaviour**

It is also necessary to develop certain qualities of character in the young

boys and girls of this age group and also to bring about changes in their behavioural pattern. They may be taught the lesson of conservation of national wealth. They may also be taught to have respect for the agencies of nature. These two qualities may be, later on, transferred to other fields of life.

(d) **To develop the habits of personal, family and community cleanliness**

Children may be taught about the habits of personal and social hygiene. They should be taught to keep themselves and their environment clean.

(e) **Importance of science in life**

Students should be trained to know about the utility of science in life and several contributions made by science for the betterment of human life.

(f) **Knowledge of casual relationship**

Normally young boys are inquisitive by nature. Sometimes their curiosity is explained away and it dies down. The teaching of science must develop in the students the consciousness of the relationship of cause and effect. They should be encouraged to know about the causes of the several events that they observe around them. This will ultimately help them in the development of the scientific outlook.

(g) **Development of practical outlook**

Mere giving of knowledge of facts is not sufficient. We have seen that the students of this stage of education are pretty active. This activity may be so channelised to develop practical outlook. This practical outlook would help them to make proper use of their theoretical knowledge.

1.15.2 Objectives of the Teaching of Science for Junior High School Classes

Here we find students of the age group of II. We have already seen that the students of classes VI, VII and VIII comprise this stage of education. Children of this stage of education are more developed. They are more balanced. They are less impulsive

and are not pleasures and pains are not the sole guides of their actions. They are no more

children only. The objectives of teaching of science for this stage of education may, therefore, be laid down on the following lines.

(a) **Development of knowledge and skill for social life**

Developing knowledge, skills, outlook and interests in the students may help in them the building of the background for vocational and social lives that may come later on.

(b) **Development of the power of reasoning**

At this stage of education, we find that students have developed a power of reasoning. They may be given opportunities for the development of the power of reasoning while teaching science.

(c) **Practical use**

At this stage, we find that the students have developed a sense of practical use. They are able to apply the knowledge acquired. They should be given opportunity for practical use.

(d) **Development of the quantitative sense and the capacity to solve problems**

The students of this stage have the quantitative sense developed in them. They should be given opportunity to solve problems for further development of this sense and they may also acquire ability to solve the actual problems.

(e) **Numerical Sense**

The students at this stage should be given numerical problems to solve. This would give them an opportunity to solve numerical problems and also to develop a sense of application of theoretical knowledge to numerical aspect of things.

(f) **Economic efficiency and knowledge about society and natural environment**

Economic conditions of the country are such that many students have to give up education after this stage. It is, therefore, necessary to make then efficient to earn their livelihood. In other words, economic efficiency should be developed in them. This can

be acquired properly when they have proper knowledge about their social and natural environment.

1.15.3 Objectives of Teaching of Science at Higher Secondary Stage of Education

The students of this stage of education are more developed than the students of the Junior High School Classes. They have certain interests and aptitudes developed in them. These students have to be prepared for future life as well as higher education. The students of this stage of education should be taught science with a view to achieve the following three things.

(a) Development of the psychological aptitude and interests

(b) To prepare and equip for higher education

(c) Economic efficiency and capacity to earn livelihood

In order to achieve the above mentioned things, certain objectives must be kept in view. It is these objectives that have to govern the teaching of science in the higher secondary stage for education. The following are the objectives.

(a) Knowledge

This perhaps, is the major aim of teaching science. The pupils studying science should acquire the knowledge of:

1. Scientific Terminology.
2. Scientific facts to understand scientific literature.
3. Ways and means of dealing with specifications.
4. Conventions.
5. Trends and sequences.
6. Natural phenomenon.
7. Correlation and interdependence of different branches of science.
8. Methodology.
9. Theories and structure.

10. General rules of health and human machine.

The students should be able to apply this knowledge in their daily life.

(b) Understanding

This is the second objective in the cognitive domain and includes translation from one form to another and interpretation. It has been found that up to 70% to 80% of the scientific facts learned in science course are forgotten within one year after the completion of the course. For understanding, the students must be trained to generalize the facts and events which are having common characteristics, constantly seeking generalizations that make things more understandable. These generalizations are frequently referred to as concepts, principles and laws-which are very essential to understand science in every day life and forms a strong base for higher education.

(c) Application

The third aim of teaching physical science in higher secondary schools is to make the students into more alert citizen and better equipped to improve the community life. In order to achieve this, the student should be able to apply the generalizations to their daily life. This will serve as a bridge to fill the gap between classroom work and real life activities. Moreover, the application of principle will help in verifying the principle itself.

(d) Skills

Knowledge of content alone is not enough for enriching a student. Therefore, stress is not on the memory of the content but on development, improvement and refinement of tools with the passage of time. The various skills which can be developed through science teaching are, Observational Skill, Experimental Skill, Constructional Skill, Problem Solving Skill and Drawing Skill.

Possession of these skills is very essential in solving practical problems.

(e) Attitude

By definition "Attitude is a condition of readiness for a certain type of activity" Finding answers to problems through direct observation, experimentation, verification and testing of knowledge are some of the initial manifestations of scientific attitude. Science teacher, on the other hand, should make special efforts to develop them by employing democratic procedures in the classroom activities.

(f) Interest

The teaching of science should also aim at developing some interest in reading scientific literature, in scientific hobbies, in activities of science club and so on. Interest should not be super imposed; on the other hand, everybody should be free to select the activity according to one's own inner appeal.

(g) Appreciation

The students of science should be able to appreciate the contributions of science in the progress of civilizations. The basic idea of this aim is to develop a real feel of science. Application cannot be taught as such. It develops from understanding and attitudes.

(h) Personality Traits

The teaching of science aims to develop personality traits also. The pupil should report his results and observations faithfully. Science teaching should provide suitable opportunities for every individual to unfold environment, must be provided to draw out the best in the child-body, mind and soul.

1.14 CONCLUSION

Science has acquired new meaning and scope in recent years. The reasons for introducing science as a compulsory subject in the school curriculum are mandatory. The

inter-disciplinary approach in science teaching is being emphasized in this lesson.

The need formulating objectives of science teaching has been emphasized in this lesson. The Bloom's Taxonomy of educational objectives under the three domains-cognitive, affective and psychomotor has been discussed. You have also studied the objectives that are relevant to teaching of science at different levels.

1.15 LET US SUM UP

In this unit we have learnt about science-nature of science and how children learn science. Science is both process and product. Because of the scientific nature of our society and the individual needs of its members, every person in order to function effectively, must be scientifically literate. Science is a branch of human knowledge, because science is both process and product of his inherent knowledge. In this unit, the relationship between the process and product of science was elaborately discussed. The importance of teaching science based on the nature of science was discussed in general and the impact of science and technology on modern living in particular. It is very obvious that most of the changes in this century have been due to the contribution of science. Science affects every aspect of our lives. It has controlled health, transportation and power. Quick means of communication makes man to feel that he has almost conquered time and space. The inter-disciplinary approach of teaching science and its advantages were also highlighted elaborately. Then the taxonomy of educational objectives as given by Bloom was also discussed. Bloom classified the objectives under three major domains viz., cognitive, affective and psychomotor. There are six objectives under cognitive domain, which are knowledge, comprehension, application, analysis, synthesis and evaluation. Five objectives under affective domain deals with the abilities like receiving, responding, valuing, organization and characterization. The psychomotor domain comprises of the abilities related to the action or manual work like imitation, manipulation, precision, articulation and naturalization.

On the basis of this classification, the general instructional objectives are

designed. They are structured as knowledge, understanding, application, skills, interest and attitude.

1.17 UNIT - END EXERCISES

Answer the following questions:

1. Briefly discuss the scope of science.
2. Explain how the relationship between the process and product is substantiated by the concept of science.
3. Briefly discuss the impact of science and technology on industrialization.
4. Bring out the advantages of inter-disciplinary approach.
5. Briefly discuss the importance of teaching of science based on the nature of science.
6. Write an essay on the impact of science and technology on modern living.
7. Write short notes on the correlation of science with other school subjects.
8. Define an ‘Educational Objective'. How is it different from ‘Aim'?
9. What are the purposes of classification of educational objectives?
10. Briefly discuss the classification of cognitive domain.
11. Briefly discuss the classification of affective domain.
12. Discuss in brief the classification of psycho-motor domain.

1.18 ANSWER TO CHECK YOUR PROGRESS

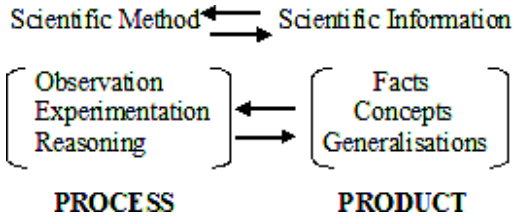
1. Briefly explain the nature of science.

Science is the investigation and interpretation of natural phenomena which occur in our daily life. Naturally science is a quest for an understanding of certain human experience.

2. Briefly explain the characteristics of science.

Science is empirical. Scientific knowledge is derived by observations or experimentation which is further extended on the continuity of observations.

3. Bring out the interrelationship between the process and product in a few words.



The diagram shows that products (concepts, facts etc.,) are derived from process (observation and experimentation) and that these products lead to further process.

4. Write short notes on inter-disciplinary approach.

All the branches of science are interdependent upon each other. There are many areas in science common to all science subjects. Because of the reciprocal relationship between various subjects, the inter-disciplinary approach or correlation is being emphasized.

5. Bring out the relationship of science with mathematics in a few words.

Many problems of proportion, inverse ratio, equations and graphs are constantly in use in science courses. The early introduction of the ratio of trigonometry is a great help in the science course and their use in mechanics, magnetism and light give reality to their meaning.

6. Bring out the relationship of science with life and environment in a few words.

For basic needs of life such as food, clothing, shelter, we have to depend upon science. All our daily routine is controlled by science and its products. In food production, insecticides, pesticides, preservation of food industry and ingredients of balanced diet are the basis on which science can be correlated.

7. What are the factors involved in the formulation of educational objectives?

The following factors are involved in the formulation of educational objectives.

1. The needs and capabilities of the pupils.
2. The specific demands of his social environment.

3. The nature of the subject matter.

8. What are the three domains of Bloom's Taxonomy?

The three domains are: 1. Cognitive Domain (knowing)

2. Affective Domain (feeling)

3. Psycho-Motor Domain (doing)

9. State the categories in the Cognitive Domain.

The categories in the cognitive domain are knowledge, comprehension, application, analysis, synthesis and evaluation.

10. List out the categories in the Affective Domain.

The categories in the affective domain are receiving, responding, valuing, organizing and characterizing.

11. List out the categories in the Psycho-Motor Domain.

The categories in the psycho-motor domain are perception, imitation, manipulation, precision, articulation and naturalization.

UNIT 4: LESSON PLANNING

4.1 INTRODUCTION

Planning is important in every walk of life. The success of a piece of work is ensured if the work is properly planned. Without planning we shall be aimlessly loitering about, applying means without aiming at the achievement of ends. Just as planning is important in our daily life, planning is of unique importance in the teaching-learning process. For a successful and effective teaching, planning is the first and the most important step. The teacher should know before hand 'what' to teach and 'how' to teach. Planning leads to systematic work and helps to avoid wastage. The plan for each unit is known as unit plan. A unit is a group of lesson plans that covers a particular topic. The planning for a particular period of 20 or 25 minutes is known as a lesson plan. The lesson plan helps the teacher to realize the instructional objectives. A teacher can bring about direction by specifying objectives and providing suitable learning experiences.

4.2 INSTRUCTIONAL OBJECTIVES

An objective represents the desired change in the pupil who undergoes education. It is what the pupil is expected to do after studying a course. These objectives are of two types

They are,

4.2.1 Non-behavioural (or) General objectives

4.2.2 Behavioural (or) Specific objectives.

The general objectives are educational objectives. The general objectives are broad and cannot be achieved in one science lesson. Although they are important, they are not useful for practical purposes. They do not help the teacher in every day class room teaching.

Unless the teacher specifies for a particular lesson, he can neither plan his instruction for the lesson efficiently nor test its effect. i.e., specific objectives. In the coming paragraphs, details about the objectives are given with examples.

4.3 GENERAL INSTRUCTIONAL OBJECTIVES

If the objectives are stated as general objectives, they contain non-behavioural verb i.e., they contain 'non-action' verb.

For example,

(i) The pupil understands the three laws of reflection.

(ii) The pupil develops skill in drawing the experimental set up for the preparation of chlorine gas.

(iii) The pupil develops skill in drawing the different parts of a flower.

The formulation of these objectives helps the teacher to have a comprehensive view of the related ideas included this study unit.

4.4 CRITERIA FOR WRITING GENERAL INSTRUCTIONAL OBJECTIVES (G.I.Os)

4.4.1 The general instructional objective should contain a non-action verb.

For Example: The pupil requires knowledge about the properties of chlorine gas.

4.4.2 The pupil understands the principles of magnetic lines of force. (iii)The pupil develops skill in drawing the floral diagram of a flower.

Here the verb 'acquires', 'understands' and 'develops skill' are non-action verbs. They are in the form of inner development or passive aspect of mental activity which we cannot measure or observe directly.

4.4.3 It should also mention the subject matter area (content). The statement of objectives helps the teacher to evaluate the student level. Unless the subject matter area is known to the teacher, he will not be able to organize learning activities and hence realize the objectives.

Do not write,

To provide knowledge about magnetic field.

To develop favorable attitude among the pupils.

Better Write,

(i) The pupil acquires knowledge about magnetic filed.

(ii) The pupil develops favourable attitude.

It should be written in the form of the achievement of every single student and not in the form of the achievement of a group of students or class.

For example:

Do not write,

The class acquires knowledge about magnetic filed.

The class develops skill in drawing and labelling.

Better write,

(i) The pupil acquires knowledge about magnetic filed.

The pupil develops skill in drawing and labelling.It should contain only one ability to be developed or achieved or modified. For example:

Do not write,

The pupil acquires knowledge and understands the properties of chlorine.

The pupil acquires knowledge and understands the significance of reproduction.

Better Write,

(i) The pupil acquires knowledge about the properties of chlorine.

(ii) The pupil understands the properties of chlorine.

(iii) The pupil acquires knowledge about the significance of reproduction.

(iv) The pupil understands different parts of a flower.

4.4.4 To conclude, the general instructional objectives should be related to the level of the students.

4.5 SPECIFIC INSTRUCTIONAL OBJECTIVES (S.I.Os)

If the objectives are stated in specific terms, then they are called specific instructional objectives. They contain behavioural verb ie., they contain 'action' verb. It

means that the objective should reflect the terminal behaviour of the learner in specific terms. Therefore, such objectives are called as 'behavioural objectives' or Expected Learning outcomes, (E.L.Os), Behavioural objectives and 'specifications' are one and the same. Montague and Built have defined behavioural objectives as follows

"A behavioural objective is a goal for, or a desired outcome of, learning which is expressed in terms of observable behaviour (or performance) of the learner".

We can also say that the outcome of learning, as a result of instruction, is called behavioural objective.

The achievement of such objectives in every day instruction will finally lead to the achievement of educational objectives (i.e., general objectives) which are general. Hence before planning his lesson, a teacher should specify such objectives which could be achieved at the end of the lesson. By going through this, you will train yourself in writing the specific Objectives.

4.6 SPECIFIC INSTRUCTIONAL OBJECTIVES (S.I.Os) OR SPECIFICATIONS

As mentioned earlier Specific Instructional Objectives must be stated in specific behavioural terms so that they can be observed and measured. When an objective is written in full or detailed form it has three parts.

The action or behaviour that the learner is to perform.

The conditions under which the action or behaviour is to be performed for observation.

The criteria by which the action or behaviour is to be judged.

A few examples are given below satisfying the characteristics. Example,

(i) From the list of planets, the learner will be able to locate the five, nearest to the sun. Specific Instructional Objective, for the above

1. A list of planets - Condition (under which learner performance occurs)
2. Locate - Action (in observable behavioural terms)

3. Five nearest to the sun - Criterion (minimum expected level of performance of the learner)

(ii) The pupils will the able to interpret the three chemical properties of chlorine correctly in their own works without any reference material.

1. With out any reference material - Condition
2. Interpret - Action
3. The three chemical properties of chlorine correctly in their own works - Criterion

4.7 FUNCTIONS OF S.I.Os

Specific Instructional objectives

4.7.1 Are useful in identifying those students behaviour which correspond to a given set of content or lesson.

4.7.2 Provide criteria for the selection of learning activities.

4.7.3 Provide accurate means to evaluate the progress of the learner.

4.7.4 Are helpful in organizing content in a proper sequence and selecting instructional methods.

4.7.5 Are useful in performance assessment.

4.8 CRITERIA FOR WRITING SPECIFIC INSTRUCTIONAL OBJECTIVES (S.I.Os) OR SPECIFICATIONS

The specific instructional objectives should contain an action verb i.e., behavioural term. Example,

The pupil defines Boyel's Law.

The pupil explains the meaning of the term refraction.

In the above example 'define' and 'explain' are action verbs. Here defining and explaining are related to behaviour. The specific instructional objective should be written in the form of a completed activity or a behavioural outcome which is

'observable' and 'measurable'.

The statement of specification should contain two parts. They are,

(a) The modification part i.e., pupils expected behaviour and

(b) The content part by which the student's behaviour is to be changed or modified

Do not write,

(i) The student explains

(ii) The student compares

Better write,

(i) The student explains the experiment to verify the laws of refraction.

(ii) The student compares the properties of an acid with base.

(iii) The pupil compares the characteristic features of the root system of monocot plants with that of the dicot plants.

It should be in the form of the student's achievement and not in the form of the teacher's interaction.

Do not write,

To explain the term refraction with example.

To describe the method of preparation of Hydrogen sulphide in a Kipp's apparatus.

Better write,

(i) The student explains the terms refraction with example

(ii) The student describes the method of preparation of Hydrogen sulphide in a Kipp's apparatus.

(iii) The student describes the process of photosynthesis that takes place in green plants

It should be written in the form of the achievement of every single student and not in the form of whole class or group of students.

Do not write,

The students define Boyle's Law

The class identifies the uses of Ammonia

The class understands the economic importance of insects in cross pollination

Better write,

(i) The student defines Boyle's Law

(ii) The student identifies the uses of Ammonia

(iii) The pupil understands the economic importance of insects in cross pollination.

4.8.1 It should contain only one behaviour to be developed, achieved or modified.

Do not write,

4.8.1.1 The student defines the term refraction and verifies the law of refraction.

Better write,

(i) The student defines the term refraction.

(ii) The student verifies the law of refraction.

4.8.2 The specification should be related to the level of the students.

Let us study each of the objectives in terms of behavioural patterns or specifications.

Objective: 1

Knowledge: The pupil acquires knowledge of terms, facts, concepts, definitions, fundamental laws, principles and processes in the field of Physics.

Specifications: The pupil,

1. Recalls terms, facts, concepts etc., in Physics.
2. Recognizes facts, concepts etc., in Physics.

Objectives: 2

Understanding: The pupil develops understanding of terms, facts, concepts, definitions, fundamental laws, principles and processes in the field of Physics.

Specifications: The pupil,

1. Gives illustration of a principle.
2. Scrutinizes statements of facts.
3. Locates errors in given statements, arrangements etc., and rectifies the same.
4. Sees relationship between cause and effect.

5. Classifies as per criteria.
6. Translates verbal statements into symbols and vice-versa.
7. Verifies facts, principles etc.,
8. Selects appropriate apparatus tools etc.,
9. Distinguishes between related concepts.
10. Gives explanation of familiar phenomena in physical processes
11. Uses appropriate unit for various physical processes.
12. Finds out the adequacy, superfluity, or relevancy of the given data.
13. Identifies the significance and limitations of physical principles.
14. Reads graphical relations of physical quantities.

Objecitve: 3

Application: The pupil applies his knowledge and understanding.

Specifications: The pupil,

1. Analyses
2. Locates the principles relevant to a phenomenon.
3. Interprets observations.
4. Makes certain predictions.
5. Establishes relationship between cause and effect, the known and the unknown.
6. Verifies predictions.
7. Relates basic principles in solving physical problems.
8. Realizes the limitations of the validity of a theory.
9. Devises new experiments.
10. Represents the relation between physical quantities, graphically.

Objective: 4

Skill: The pupil, acquires skill in (A) the practical aspects of handling apparatus, recording observations etc., and (B) drawing diagrams, graphs etc.,

(A) Manipulative Skill

Specifications: The pupil,

1. Checks apparatus and equipments regarding their working condition
2. rectifies, if possible, (under laboratory conditions)
3. Sketches the arrangement of apparatus (if necessary) at the outset.
4. Sets up the apparatus in a planned manner.
5. Uses equipment within their limitation.
6. Records relevant readings accurately and systematically.
7. Performs experiments with reasonable speed and neatness.
8. Carries out simple projects.

(B) Drawing Skill

Specifications: The pupil,

1. Draws neat sketches and diagrams to scale.
2. Draws diagram according to the actual arrangement of the apparatus.
3. Selects proper scales for graphs.
4. Draws neat free-hand graphs.
5. Records and presents data in tables, charts, graphs etc.,
6. Labels the parts of a diagram accurately.

Objective: 5

Interest: The pupil develops scientific interest through the study of physical sciences.

Specifications: The Pupil,

1. Puts questions in scientific discussion
2. Reads scientific literature and biographies of prominent scientists
3. Takes to scientific hobbies
4. Takes parts in science talks and debates.
5. Visits places of scientific interest.
6. Organizes or actively participates in science club activities.
7. Contributes articles on topics of scientific interest

8. Observes and studies natural and man made surroundings.

Objective: 6

Attitude: The pupil develops scientific attitude through the study of physical sciences.

Specifications: The pupil,

1. Respects the teacher of Physics
2. Records and interprets his observations honestly.
3. Is clear and precise in his statements and activities
4. Bases his judgments on verified facts and not on opinion.
5. Is willing to consider new ideas and discoveries
6. Locates sequential development and growth of Physics
7. Is prepared to reconsider his judgement
8. develops independent thinking
9. Pursues his activities with precision and consistency undaunted by failures.
10. Shows spirit of team-work, self-help and self-reliance.
11. Realizes the danger in the misuse of scientific knowledge

Objective: 7

Appreciation: The pupil appreciates the contribution of Physics to human happiness.

Specifications: The pupil,

1. Follows and adjusts to the impact of Physics on society and individual.
2. Derives pleasure in understanding the scientific advance in inter-planetary travels, radio, astronomy, electronics etc.,
3. Feels that more invention and discoveries are possible.
4. Shows respect and admiration for great scientists.
5. Manifests a spirit of scientific enquiry.

Objecitve: 8

Personality Traits: The pupil develops good personality traits through the study of Physics.

Specifications: The Pupil,

1. Develops punctuality.
2. Reports his observation faithfully.
3. Avoids wastage of materials.
4. Develops self-confidence.

4.9 UNIT PLAN

When the subject matter in the text book is not adequately grouped and presented, the teacher has to reorganize the subject matter into suitable units. According to Preston, "A unit is as large a block of related subject-matter as can be over-viewed by the learner". It represents a theme around which some lessons can be developed.

A unit plan is a detailed outline for a series of interrelated lessons on a selected topic of study which lasts two to four weeks. Availability of the period (time) is very important aspect for the preparation of unit plan.

Advantages of Unit Planning

i. It clears the aims - general as well as specific, of teaching. Teacher can cater to the need, aptitude and attitude of different students.

ii. It works in and develops democratic atmosphere i.e., the students as well as the teacher work in a co-operative way.

iii. It saves time and develops among students interest in learning as they actually know the value of content learnt by them.

iv. It develops certain skills among the students and sharpens their insight. The students can apply the knowledge gained in other life situations also.

v. As students learn independently it gives confidence develops resourcefulness and reliance.

Steps involved in developing a Unit Plan

The teacher should have thorough idea about the subject matter of the unit before

he makes an attempt to write the unit plan. While planning a unit, the following steps are to be followed.

Steps involved in a Unit Planning

1. Preparation: This is to motivate children for learning. Since it is a new topic, a correlation can be made to life situation.
2. Previous knowledge tested: The background knowledge of the students are to be tested. The basic step to start with should be fixed in this step.
3. Presentation: The subject matter is presented with teaching aids, extra activities and exercises.
4. Summarisation: The whole unit is summarized under systematized sub-headings.
5. Drill or Recapitulation: The whole unit is revised by putting small questions.
6. Evaluation: The fulfillments of objectives are tested and remedial measures can be planned after evaluating it.

Writing a Unit Plan

There are many types of formats that can be used. Generally, a unit plan format includes the following components.

7. Unit Title.
8. Major Objectives of the Unit.
9. Concepts (Topics).
10. Scope of the content.
11. Method of Teaching.
12. Time required.
13. Teaching Aids and materials required.
14. Pupil's Assignment.
15. Evaluation (effectiveness of teaching).

The format of a Unit Plan

Proforma 'A'

Subject …….. Class …….

Name of the Unit ……..

Major objectives of the Unit …….

Sl. No	Concepts (Topics)	Number of Lesson required	Time required (periods)	Scope of subject content	Procedure to be adopted (indicate the method of teaching)	Teaching Aids
1.						
2.						
3.						
4.						

After completing the Proforma 'A', detailed unit plan should be prepared according to the Proforma 'B'

Proforma 'B'

Concept: (Proforma 'A') ……..

Lesson No …….

Sl. No	Sub Concepts	Behavioural Objectives	Procedure (Teacher pupil activity)	Pupil's Assignments	Evaluation
1.					
2.					
3.					
4.					

4.10 LESSON PLAN

After planning for the unit, we are to concentrate on lesson plan. Lesson plan is teacher's mental and emotional visualization of class room activities. Carter V. Good defines a lesson plan as, "a teaching outline of the important points of a lesson arranged in order in which they are to be presented. It may include objectives, points to be asked,

references to materials, assignments etc."

In the words of Lester B. Stands, "A lesson plan is actually a plan of action. It therefore,

i. Includes the working philosophy of the teacher,
ii. His knowledge of philosophy,
iii. His information about and understanding of his pupils,
iv. His comprehension of the objectives of education,
v. His knowledge of the material to be taught and
vi. His ability to utilize effective methods".

Advantages of Lesson Plan

4.10.1 It helps the teacher to be systematic and orderly in his teaching process.

4.10.2 It helps to face challenging questions in the class.

4.10.3 It builds up definite aim for each day's work.

4.10.4 It gives confidence and self reliance.

4.10.5 It helps in finishing the lesson in the allotted time.

4.10.6 It gives good idea to use the teaching aids effectively.

4.10.7 It helps the teacher to select appropriate method to teach a particular unit.

4.10.8 It gives chances for good correlation with other subjects and life situation.

4.10.9 It gives an idea of how questions can be framed involving reflective thinking.

4.10.10 It helps to get thorough knowledge when they prepare the lesson plan in advance.

Criteria of a Good Lesson Plan

Every teacher should know the essential elements of a good lesson plan.

1. A good lesson plan should be preferably written.
2. It should give information regarding the subject, topic, strength, date and time allotment for the particular class.
3. It should contain the general objectives.
4. It should also include the specific objectives which are going to be achieved after the completion of the lesson.

5. It should list out all the instructional aids that are to be used for particular period, Maps, charts, diagrams on black board, films, film strips and other audiovisual aids.
6. The materials of instruction or subject matter should be well selected and organized in an orderly manner.
7. It should be built up on the previous knowledge of the class.
8. It should explain the learning activities provided to the students.
9. It should indicate the teaching techniques to be used by the teacher how the lesson is to be presented, what methods are to be followed, what questions are to be asked and what illustrations are to be used.
10. It should give place for evaluation by which the teacher is able to know whether he has achieved his aims.
11. It should contain review or recapitulation (i.e.) an outline or summary of whole lesson taught in the particular period.
12. It should include one or two assignments for pupils to strengthen learning.

Herbartian Steps or Steps Involved in a Lesson Plan

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

13. **Preparation**

The teacher should first of all prepare the students to get new knowledge. He should excite the students in such a way that they feel the need of learning new things. It can be done by

1. Testing the previous knowledge.
2. Story telling.
3. The novelty of experimentation or activity.

This is the most important step, for well-began is half-done.

2. **Presentation**

Immediately after the first step of preparation the aim of the lesson should be

clearly stated. The subject matter should be presented in simple and familiar way. It should be done with the active participation of students. Students should not be passive listeners. Question asked should be relevant, according to the mental level of students and evenly distributed. Aids should be used and "Black Board summary" should be developed side by side.

3. **Comparison**

Whatever students learn, they compare it with similar set of examples. It is felt that knowledge is not like piling up bricks, it is like a tree that grows. This step is the most important when we are establishing principles or generalizing definitions.

4. **Generalisation**

It should be done with the participation of students. In most of the science lesson we have to arrive at certain generalizations, formulae, principles or laws are to be established.

5. **Application**

Whatever the students learn should be applied to new situations and so that the transfer of training and knowledge gained becomes permanent. Here knowledge becomes clear and meaningful.

6. **Recapitulation**

This is the last but not in any way the least important step. Here the teacher knows what the students have learnt, where they stand and whether the teacher himself is successful in his aims or not.

It should be noted that these Herbartian steps need not be followed strictly in teaching all types of lessons. The type of lesson plan will depend upon the nature of the topic to be taught and the method of teaching. In some cases one step of the Herbartian scheme may be stressed than the other while in other cases some steps

may be deleted completely.

Writing a Lesson Plan

Every teacher must write his lesson plan well in advance. The method of writing the lesson must reflect the modern trends of science teaching. There is no one money order form like Proforma for writing up the lesson plans.

The lesson plan is written in four columns.

14. Specifications - Deciding 'Why to teach?'
    (Stating G.I.Os & S.I.Os)
15. Content - 'Analyzing 'What to teach?'
    (Analysis of content area)
16. Learning Experience - Deciding 'How to teach?'
    (Methods and learning activities)
17. Evaluation - Measuring 'How far it is taught?'
    (Evidence of achievements)

Learning experiences depend on specifications. Content is given through appropriate learning experiences to realize the specification. Evaluation is directed towards assessing the extent to which the specification has been realized.

The teacher should have thorough idea about the content area of the lesson before he makes an attempt to write the lesson plan.

Usually the following is commonly used, with little modifications, in a majority of the teacher training institutions.

The Format of a Lesson Plan

Preliminary information: (such as class, subject, topic, etc.,)

I. **General Instructional objectives:** The pupil,

1. Acquires knowledge ……..
2. Understands ……...

3. ……...

II. **Specifications:** The pupil,

1. Recalls ……

2. Recognizes …….

3. Explains …….

4. …….

III. **Teaching Aids:**

List of apparatus / chemicals / charts

IV. **Introduction:**

(Motivation)

V. **Presentation:**

…….. …… ……..

…….. …… ……..

Specification	Content	Learning Experience	Evaluation

VI. **Recapitulation:** (2 or 5 Short answer type questions)

VII. **Assignment:** (1or 2 Essay type questions)

Signature of the Guide Teacher **Signature of the TraineeLesson Plan (Model)**

1. Name of the Trainee :

2. Name of the school :

3. Class :

4. Strength :

a) Roll :

b) Present :

5. Date :

6. Period :

7. Duration : 25 minutes

8. Subject : Science

9. Unit : 7 Magnetism

10. Topic : Magnetic field - Mapping

I. General Instructional Objectives : The pupil,

1. Acquires knowledge about
    a) Magnetic field,
    b) Magnetic lines of force.
2. Understands the magnetic lines of forces around a magnet.
3. Applies his knowledge in identifying earth's magnetic lines.
4. Develops skills in a) observation and b) drawing and labelling.
5. Appreciates the nature of Earth's magnetic field.

II. Specific Instructional Objectives: The pupil,

1. Recalls the definition of "magnetic - field".
2. Recognizes the magnetic lines of force.
3. Recognizes the magnetic lines around bar magnet.
4. Interprets the earth's magnetic lines.
5. Interprets the observed phenomena.
6. Compares earth's magnetic lines with the magnetic lines of a bar magnet.
7. Reason for the appearance of earth's magnetic lines.
8. Draws the magnetic lines of
    a) a bar magnet,
    b) the earth.
9. Enjoys the activities related to magnetism.

III.

IV. Teaching Aids:

1. Bar magnet
2. Iron fillings
3. Glass plate
4. White papers
5. Pencil
6. Compass needle
7. Chart-magnetic lines of a bar magnet

V. Introduction:

1. This lesson may be introduced just by testing the previous knowledge of the pupils.

   Tr. : What is the name of the substance that attracts iron fillings?

   Pupil : Magnet

   Tr. : What are the two poles in a magnet?

   Pupil : North pole and south pole.

2. The Teacher brings the north pole of a Bar Magnet near the north pole of a compass needle.

   Tr. : What do you observe?

   Pupil : Like poles repel each other.

VI. Presentation: So, well students, today we shall discuss the properties of a magnet.

VII. Recapitulation:

1. Define magnetic field.
2. What is the experiment to know the magnetic forces around a magnet?
3. Define magnetic lines of forces.
4. State the properties of earth's magnetic lines.

V. Presentation: So, well students, today we shall discuss the properties of a magnet.

Specifications	Content	Learning Experience	Evaluation
Recalls	Magnetic energy	Teacher states magnetic energy with reference to light energy. Tr. Demonstrates the following activities: Activity (1): Placing a glass plate over a bar magnet keeps white-paper on it. Sprinkle iron filings & taps the glass plate.	Define magnetic energy.
Observes	Iron fillings arrange themselves and present a pattern of lines.	1. What do you observe?	
Recalls Interprets	Magnetic field	Tr. Defines the magnetic field.	Define magnetic field.
Interprets	The lines around the magnet indicates the magnetic lines of forces	Tr. States the magnetic lines of forces.	
Recognises	The lines around the magnet indicates the magnetic lines of forces	Tr. States the magnetic lines of forces	How do they know that magnetic forces exist around the magnet?
Observes	Magnetic lines of forces	Activity (2): Keep a bar magnet on a white paper and draws the magnetic lines using compass needle.	
Draws Infers	Diagram	Tr. Allows the pupil to draw the same.	
Infers	Lines of force start from the north pole of a magnet and ends at the south pole.	Tr. Explains the direction of the lines using a chart.	What is the direction of the lines of force of a bar magnet?
Observes	Earth's magnetic lines	Activity (3): Tr. Draws the earth's magnetic lines using compass needle and the following observations are made.	
Interprels	Earth's magnetic lines are parallel to each other	2. Examine these lines, how are they?	
Draws	Drawing the magnetic lines of earth	Tr. Allows the pupil to draw earth's magnetic lines.	

Compares	North pole of the magnetic poles of earth is found at geographical south.	Tr. Explains the magnetic poles of earth with reference to Geographical poles.	Which magnetic pole is found at the geographical north of earth?
Infers	For small distance the field is uniform.	Tr. Explains the property of the earth's magnetic lines.	
Reasons	For long distance the field is uniform	Tr. Gives the reason for its appearance in terms of magnitude and direction.	Why the magnetic lines of force of earth are straight and parallel?

VIII. Assignment:

1. Describe the process of drawing the magnetic lines of a bar magnet.
2. Explain (with a diagram) the process of drawing the magnetic lines of force due to earth's magnetic field.

Signature of the Guide Teacher **Signature of the Trainee**

With the knowledge that we have gained so far, let us attempt to prepare the objectives in terms of behavioural terms for a topic in Physics.

Preparing G.I.Os and Specifications for the lesson 'Floatation' (VIII standard):

General Instructional Objectives: The pupil,	**Specific Instructional Objectives: The pupil,**
1. Acquires the knowledge of the principle of floatation.	1. Recalls the names of floating bodies. 2. Recalls the depravities of familiar solids and liquids. 3. Recognizes the cause of floatation 4. Recognizes the first and second laws of flotation.

2. Understands

a) The laws of floatation

b) The method of working hydrometer.

5. Sees relationship between the densities of floating bodies and the liquids in which they float.

6. Interprets the first and second laws of flotation.

7. Explains the method of working of hydrometer.

3. Applies the laws of flotation in hydrometer.

8. Reasons for various bodies floating in various liquids.

9. Verifies the first and second laws of flotation.

4. Develops skill in observation and interpretation in scientific experiments.

10. Use hydrometer to find out the density of a given liquid.

11. Records relevant readings accurately.

5. Develops interest in floating bodies in their study.

12. Enjoys in reading books on flotation.

Preparing G.I.Os and Specifications for the lesson 'Ammonia' (IX standard):

General Instructional Objectives: The pupil	**Specific Instructional Objectives: The pupil**
1. Acquires knowledge of ammonia	1. Recalls the names of ammonium salts. 2. Recognizes a few names of fertilizers.
2. Understands, a). The methods of preparation of Ammonia.	3. Explains the laboratory preparation of Ammonia 4. Explains the Haber process of preparing Ammonia.
b). Properties of Ammonia.	5. Identifies the physical and chemical properties of Ammonia.

3. Applies the knowledge of Ammonia in identifying the Uses.	6. Verifies the use of Ammonia in daily life.
4. Develops skill in observation, experimentation and drawing.	7. Observes the laboratory preparation of Ammonia. 8. Performs the experiment related to physical & chemical properties of Ammonia. 9. Draws the experimental set up for the preparation of Ammonia.
5. Appreciates the use of Ammonia.	10. Visits local industries where Ammonia is prepared.

4.11 LET US SUM UP

In this unit we have discussed the need for planning our curricular work for a class and subject on yearly and daily basis. For an efficient and effective teaching planning is essential, for it gives confidence to the teacher and the teaching becomes systematic and organized. The proceeds on well-thought of lines and not follow haphazard and thoughtless teaching. Good planning helps us in smooth transaction of curricular materials to the learners in an effective way. We have also highlighted the various approaches to planning the lesson. A detailed attempt has been made to help you to design your own lesson plan by presenting different formats. In the last section of this unit we have discussed the management of science laboratory in which we have touched upon the broad aspects such as laboratory objectives and problems of procurement, maintenance and storing of equipments and other science materials in a safe way.

4.12 UNIT - END EXERCISES

4.12.1 What is meant by lesson planning? Describe the features of a Lesson Plan.

4.12.2 Describe the Herbartian steps of Lesson Planning.

4.12.3 Write a Lesson Plan on a topic of Chemistry of class X.

4.12.4 What are the advantages of a lesson planning?

4.12.5 Write a Lesson Plan for the seventh class on the subject of reflection of light.

4.12.6 Define a Unit Plan. What are the advantages of a Unit Plan?

4.12.7 What are the relationships between specifications and learning experiences?

4.13 ANSWERS TO CHECK YOUR PROGRESS

1. List out the criteria for framing out the general instructional objectives.

1. The general instructional objective should contain a non-action verb.
2. It should also mention the subject matter area (content). The statement of objectives helps the teacher to evaluate the student level. Unless the subject matter area is known to the teacher, he is not able to organize learning activities and finally realize the objectives.

3. It should be written in the form of the achievement of every single student and not in the form of the achievement of a group of students or class.
4. It should contain only one ability to be developed or achieved or modified.
5. To conclude, the general instructional objectives should be related to the level of the students.

2. List out the criteria for framing out the Specific Instructional Objectives.

If the objectives are stated in specific terms, then they are called specific instructional objectives. They contain behavioural verb i.e., they contain 'action' verb. It means that the objective should reflect the terminal behaviour of the learner in specific terms. Therefore, such objectives are called as 'behavioural objectives' or Expected Learning outcomes, (E.L.Os), Behavioural objectives and 'specifications' are one and the same. Montague and Built have defined behavioural objectives as follows

"A behavioural objective is a goal for, or a desired outcome of learning which is expressed in terms of observable behaviour (or performance) of the learner".

3. Briefly explain the purpose of designing a Unit Plan.

According to Preston, "A unit is as large a block of related subject – matter as can be over-viewed by the learner". It represents a theme around which some lessons can be developed.

A unit plan is a detailed outline for a series of interrelated lessons on a selected topic of study which lasts two to four weeks. Availability of the period (time) is very important aspect for the preparation of unit plan.

4. Briefly explain the purpose of writing a Lesson Plan.

Lesson plan is teacher's mental and emotional visualization of class room activities.

Carter V. Good defines a lesson plan as, "a teaching outline of the important points of a lesson arranged in order in which they are to be presented. It may include objectives,

points to be asked, references to materials, assignments etc."

5. Briefly state the steps involved in writing a lesson plan suggested by Herbartian.

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

1. Preparation

The teacher should first of all prepare the students to get new knowledge. He should excite the students in such a way that they feel the need of learning new things. It can be done by

1. Testing the previous knowledge.
2. Story telling.
3. The novelty of experimentation or activity.

This is the most important step, for well - begun is half - done.

2. Presentation

Immediately after the first step of preparation the aim of the lesson should be clearly stated. The subject matter should be presented in simple and familiar way. It should be done with the active participation of students. Students should not be passive listeners. Question asked should be relevant, according to the mental level of students and evenly distributed. Aids should be used and "Black Board summary" should be developed side by side.

3. Comparison

Whatever students learn, they compare it with similar set of examples. It is felt that knowledge is not like piling up bricks, it is like a tree that grows. This step is the most important when we are establishing principles or generalizing definitions.

4. Generalisation

It should be done with the participation of students. In most of the science lessons we have to arrive at certain generalizations. Formulae, principles or laws are to be established.

5. Application

Whatever the students learn should be applied to new situations and unfamiliar facts so that there is transfer of training and knowledge gained become permanent. Here knowledge becomes clear and meaningful.

6. Recapitulation

This is the last but not in any way the least important step. Here the teacher knows what the students have learnt, where they stand and whether the teacher himself is successful in his aims or not.

It should be noted that these Herbartian steps need not be followed strictly in teaching all types of lessons. The type of lesson plan will depend upon the nature of the topic to be taught and the method of teaching. In some cases one step of the Herbartian scheme may be stressed than the other while in other cases some step may be deleted completely.

UNIT 5: METHODS AND TECHNIQUES OF TEACHING PHYSICAL SCIENCE

5.1 INTRODUCTION

The main aim of teaching science is to create a scientific awareness among the pupils and this can only be achieved if the teaching is effective and based on the principles of teaching .How the pupil will learn effectively, depends on the teaching methods that the teacher adopts. There are many effective and efficient methods of science teaching which could be made use of, to bring out the expected outcome from the pupils .Let us discus some of the methods in this study unit.

5.2 OBJECTIVES

On completion of this unit, one should be able to,

5.2.1 Acquire knowledge about methods.

5.2.2 Understand the methods of lecturing.

5.2.3 Understand the criteria for a good demonstration.

5.2.4 Apply Assignment Method, Discussion Method and Project Method in Science Teaching.

4. Analyse the advantage and limitations of Heuristic Method.

6. Understand the Computer Assisted Instruction.

7. Analyse the merits and demerits of CAI.

5.3 GENERAL METHODS OF TEACHING SCIENCE

Methods of teaching science can be classified broadly into two types

(i) Teacher - Centered

(ii) Pupil - Centered

Teacher - Centered teaching is teacher concerned methods of teaching. Here teacher's convenience is considered mainly, where the students are just passive recipients of knowledge. The teaching environment is very much formalized and teacher occupies a central position in the classroom.

The main concern in pupil centred teaching is the pupil himself .The purpose is to

develop in the learner skills and abilities in independent learning and problem solving. The classroom climate is flexible here and the teacher acts as a facilitator to the students.

I Teacher Centred Methods

Lecture

Demonstration

Lecture cum Demonstration

II Pupil Centred Methods

Heuristic

Assignment

Laboratory

Discussion

Project

5.4 Teacher Centered Methods

5.4.1 Lecture Methods

Lecture methods involve one-way communication procedure. The teacher is the only active participant here and all the pupils are just passive listeners. The teacher delivers the lecture for a fixed length of time on a topic. Meanwhile the pupils are expected to listen to it and take down notes.

It is essential that a lecture should be properly organized under the heading of

Introduction.

Body of the lecture with examples.

Conclusion.

Lecture methods become effective in the following occasions:

1. Introducing a new topic.
2. Summarising the lesson.
3. Providing additional information or the topic concerted.
4. Explaining abstract concepts.

The lecture should be prepared carefully so that, it is neither too long nor too short, Also care should be taken to avoid overload of information in the lecture delivered.

Merits

1. It is economical both in terms of money and time
2. It can be applied at any environment by the teacher to educate the pupils.
3. A teacher can handle many students at a time
4. Simplifies the work of a teacher.

Demerits

1. The student is a passive listener. The principle of child centered education hence is not served.
2. No provision is given to the student's participation. Therefore it is against the principle of learning by doing.
3. Training in scientific methods and practical skills will not be developed.
4. It is not concerned about the individual differences among the pupils.

5.4.2 Lecture cum Demonstration Methods

Demonstration can very easily act as complimentary to lecture methods .This combines the merits of the lecture methods and demonstration .It is difficult to talk about things which the pupil have to imagine. Hence under these circumstances the lecture methods combined with the demonstration might be a better way of teaching such topics. The pupils will learn the abstract things through the lecture and demonstration. It helps them to visualize the related concepts. The students observe the demonstration critically and try to draw inferences. Thus their power of observation and reasoning are also exercised.

This method is especially useful where,

i. the apparatus is costly.
ii. the apparatus is very delicate.
iii. the experiment involves danger.

iv. the apparatus requires some special techniques of handling.

v. there is a shortage of apparatus as well as time.

Criteria of a Good Demonstration

1. The demonstration should be planned and rehearsed well in advance.
2. The teacher should be clear of the purpose of demonstration.
3. Demonstration should be the result of the active participation of the pupils and the teacher.
4. The apparatus for demonstration should be arranged in order.
5. The demonstration should be visible to all the pupils in the class.
6. Demonstration should be simple and specific.
7. The apparatus used should be simple and with in the compression of the student.
8. Demonstration should be chosen such that it is performable in the time, available.
9. Demonstration should be supplemented with other teaching aids to make it more interesting.
10. Demonstration should make the student think and also should provide opportunities for them to find an answer for it through their own efforts.
11. The teacher should maintain the interest of the students during demonstration
12. The teacher should stress the students to write what they observe.

Requisites for a Good Demonstration

Here are some tips about the requisites which would help a teacher for a good demonstration.

1. The demonstration table should be visible to all and ought to be carried out in a properly illuminated room.
2. The apparatus used should be large in size, correct and clear.
3. Always teacher should have apparatus in spare for emergency purpose.
4. A black board behind the demonstration table would be better, in order to summarise and to draw necessary sketches and diagrams.

4. The Teacher's expertise in handling the apparatus plays an important role here.

6. Time should be provided for pupils to record the data.

7. Reflective type of questions should be asked to stimulate the power of reasoning and interest in the students.

Steps in Demonstration

Steps for effective demonstration are given here under.

1. Planning the demonstration.

2. Introduction of the content on which the demonstration is to be formed.

3. Experimentation and teaching, step consists of actual demonstration and explanation of the related concept.

4. Tabulation of the results obtained during demonstration and summarization are done through eliciting the points from the students.

4. Conclusion

Advantages

1. It is less expensive and time saving.

2. Avoids false imagination among students and provides concrete ideas about the topic.

3. It provides chances for critical thinking and reasoning through observation.

Limitations

1. It doesn't provide place for “learning by doing”

2. Visibility is always a problem.

3. Lab skills can't be developed among students.

5.4.3 Pupil Centred Method

Laboratory Method

It is also known as individual practical method or experimental method. In this method the students are given an opportunity to carry out experiments independently. They may be provided with manual containing detailed instructions of procedure regarding the experiments to be performed .The teacher observes their activities .The teacher offers only guidance wherever necessary.

It provides opportunities for training in scientific methods .It also kindles the problem solving mentality among pupils. A simple problem like what happens when a magnet is suspended freely, involves only a few steps like

1. Statement of the problem
2. A single trial
3. Conclusion

In some cases repetition of experiment becomes essential till we obtain concurrent results.

Experiment or Exercise

A true experiment is one in which the result is not known in advance. But in some cases the students are asked to verify the result already established beyond doubt. They can't be considered as true experiment .From the part of the student there is no thrill or excitement in doing these verifications.

Controlled Experiments

Experimental type of investigation is often channelised by what is called “controlled experiments” In the controlled experiments every effort is made to control the factors involved all variables expect two are kept as nearly constant as possible the relationship of the two is studied by varying one and studying the effect on the other. One of the two experiments is often called the ‘control' or ‘check' and the other is called ‘natural' group. The effect of the dependent variable on the independent variable which is manipulated is studied and logical conclusions are drawn.

Organisation of laboratory works

The following suggestions if adopted would make the laboratory work fruitful.

1. Co-ordination should be there between the theoretical and practical work.
2. The experiments to be performed are to be chosen, having in mind, the level of the pupil.
3. The purpose of doing the experiment and its aim should be made very clear to the pupil.
4. The faithful record of the experiments should be maintained by each pupil.

4. Note books must be checked, and signed by the teacher during the end of each lab period.

6. The apparatus have to be arranged properly, so that it is easy to be distributed to the pupils.
7. In case of shortage of experiments students shouldn't be denied from doing the experiments. Alternative arrangement can be made.

Grouping of the Pupils

There are two ways in which laboratory work can be organized.

1. Even front system
2. Group rotation system.

Even Front System

In this system all the pupils in the class do the same identical experiments during a particular time. In the system, supervision is also easy as the difficulties met by the pupils would almost be the same.

Group Rotation System

In this method, students are divided into convenient batches. About six to eight different experiments in science can be planned for a single cycle. Students will be asked to perform the experiments in groups or single, each of the experiments in the cycle for rotation. When all the experiments in the cycle have been completed by all the students the

next cycle of experiments will be planned.

Laboratory Manuals

Laboratory manuals are no doubt time savers. But they make little or no provision for independent thinking among the students. The laboratory manual might help a beginning teacher who had little training in the subject. Besides it is also useful to pupils who want to work under self-direction. However the laboratory manuals must not be allowed to dominate the science programme.

Instruction Cards

These are the cards prepared by the teacher, containing suitable instruction, taking into consideration the needs of his pupils and the apparatus available in the school. These cards would contain minimum needed instructions. It should contain information covering the following points.

1. The purpose of the experiments
2. The method to be adopted for collecting data.
3. Precautions to be observed, if any.
4. Method of tabulating the collected data.

3. Questions that may help in reaching the desired conclusions.

Assignment Method

Assignment method is the embodiment of both lecture demonstration method and the individual laboratory work by the students. So, it includes the merits of both methods and is best suited for high and higher secondary classes. The whole of the prescribed course is divided into a number of well-connected portions to be covered in the week or so, and are called as assignments.

Two types of assignments can be used are

i. Home assignments

ii. School assignments

Home Assignments

These include writing of answers to questions assigned by the teacher. The teacher gives references from different sources concerning the topic. Grasping the ideas given by the teacher, the pupils write down the answers to the questions set by the teacher and hand them over to the teacher. The teacher goes through the answer and finds out discrepancy if there is any. He may ask the pupils to refer the text book if their answers are not up to the mark.

School Assignments

This includes the performance of experiments in the laboratory and answering of a few questions put by the teacher. Some of the experiments that are difficult or those which involve danger are performed by the teacher himself and questions relating to that will be but to the students. The experiments which the students can perform and which are simple are assigned to them.

They are given a sheet of instructions before they start their practical work. They go through these instructions and answer the questions asked in their note books. The

teacher also keeps a ‘progress record' with him in which he enters the progress of every student. This helps the teacher to know where each student stands.

Objectives of Assignments

An assignment should help the students to imbibe the scientific attitudes and should provide the training in scientific method. The students should develop interest in further study of science by introducing new and wider avenues of study. It should help a student to discover facts of science so that he may weave them into appropriate concepts and principles.

Criteria of a Good Assignment

1. An assignment should be in relation to the topic under discussion.
2. It should be brief and to the point so that students may easily comprehend its implications.

3. It should be clear in its aims and objectives and ought to be simple.

4. The assignment given should be in such a way that it kindles the enthusiasm and interests of the students.

5. It should be presented in a way that it stimulates reflective thinking and gives freedom to students to discover things for them selves.

6. The given assignments should be sufficiently thought-provoking and challenging.

Merits

1. This method is based upon the principle of 'learning by doing' and provides full opportunity to the students to work in the laboratory.
2. The students form the habit of extra study. They learn how to consult references and gather the desired data.
3. This method is economical because the same type of apparatus is not required at a time as all the pupils in the class are given different assignments depending upon their progress and interest.
4. It helps in developing the scientific attitudes and training in the scientific method.
5. The teacher can give individual attention to the pupils.
6. The 'progress chart' gives an idea of the weaker and the brighter students just at a glance. The teacher thus, can check the weaker students from time to time and give instructions accordingly.

Demerits

1. The success of this method depends upon a well-drawn up assignment.
2. The text books written with regard to these are not available.
3. It requires a well equipped library and laboratory which is yet a problem for a developing country like India.
4. It is a slower process and the heavy curriculum may not be finished in the limited time.
5. There is a danger that the weaker students may copy the results from the brighter students.

Discussion Method

This method should also find its due place in the teaching of science. It can be followed in an institution depending upon the time and resources available. There can be two different approaches in which any one can be chosen depending upon the available time.

i. The teacher gives a brief introduction of the topic for discussion. The students are allowed to prepare individually for an hour or so. However teacher would guide them if necessary. After the scheduled time, the teacher initiates the discussion by probing the students by some questions or problems. By putting some key questions in logical sequence the topic is covered through discussion. The main points are written on the black-board.

ii. The first approach is time consuming. This method could be used only when block 2 or 3 periods are available continuously. In other cases the second approach may be useful. Hence the teacher gives the introduction to the discussion earlier, say a couple of days before he has planned to have the discussion. The students are divided into groups depending upon the strength of the class. So in the next days the students would collect data with regard to the topic of the discussion and get their materials and points prepared for discussion.

On the day of the discussion the teacher initiates the discussion by recollecting some of the points which he gave as introduction the other day and also he poses some questions. Thus the students are motivated to take part in the discussion actively. As they are all already prepared, even a single period is enough to carry out the discussion. In this way this second approach saves time.

Whenever this method is followed the teacher should keep in view the following points.

i. The topic for discussion should commonly be of general nature - neither very simple nor too technical.

ii. Extra reading and beyond the text reading should be emphasized to the students. The

best group among the students could be appreciated so as to motivate them.

iii. The discussion should stick on to the theme and time shouldn't be wasted in irrelevant discussions.

iv. Maximum number of students are to be encouraged to take part in the discussion actively. At the same time class discipline should not be disturbed.

5.4.3.1 Heuristic Method

Science is not a thing to be talked about but a practical subject and the best way to learn it is by doing. This method involves the true spirit of science ie, discovery, original investigation and inductive approach. The method is formative rather than informative.

Definition

In the words of Prof. Armstrong, 'Heuristic method is a method of teaching which involves our placing the students as far as possible in the attitude of a discoverer. 'Heurisco' which means to find out so, any method which excites children to work and think for themselves can be called 'Heuristic method'.

In this method a problem is assigned to the class and each child is responsible for solving the problem. He is free to move about and discuss the problem with the class-mates. Each student is given a 'sheet of instruction' regarding the problem. The teacher acts only as a consultant. The pupils are expected to work and think for themselves. They learn how to tackle a problem, gather relevant data, formulate the tentative solutions and then derive at desired conclusions.

The success of this method depends on more than one factor. But the most important factor is the teacher. The teacher should be informative and ought to be a scholarly person. He should possess in full, the spirit of inquiry. He himself should initially have the attitude of a discoverer. He should plan problems according to the age, ability and interests of the pupils.

Advantages

1. This method is pupil-centered and involves learning by doing.

2. It develops a liking for self-activity and develops self-confidence in pupils.

3. There is every possibility for individual attention.

4. Patience and perseverance are developed among students.

4. It inculcates the habit of hard work in students.

Limitations

1. The method is costly.

2. It is a time consuming method.

3. Textbooks written on this line are not available.

4. It is not suitable for lower classes.

4. It needs more resources to execute.

6. Trained teachers on the lines of this method are not available.

Project Method

Based on the philosophy of pragmatism and to lessen the gap between school life and the life in society, project method is employed. According to Dr. Kilpatrick, "A project is a unit of whole hearted purposeful activity carried on preferably, in its natural setting'. According to Stevenson, 'A project is a problematic act carried to its completion in its natural setting'.

Principles of Project Method

Project method is based on the following principles.

i. Learning by doing.

ii. Learning by living.

iii. Children learn better through association, cooperation and activity.

Steps involved in the Project Method

i. Providing a situation

The teacher should provide such situations to the students which may create interest

among them. For this the teacher may seek the help of library, laboratories and journals.

ii. Choosing and proposing

The students should be allowed to choose the project. The teacher should retrain from proposing any project; otherwise the whole purpose of the method would be defeated. The teacher must exercise guidance in selection of the projects and if the students make an unwise choice, the teacher should tactfully guide them for a better project.

iii. Planning

For the success of the project, proper planning is a must. In the process of planning the teacher has to act only as a guide and he should give suggestions at times but actual planning is to be left to the students.

iv. Execution

Once the project has been chosen and the details of the project have been planned, the teacher ought to help the students to execute the project according to the plan. This step is the longest step in the project method, hence claims lot of patience from the part of the students and teacher as well. Students are likely to face some practical difficulties only during the time of execution. Hence the teacher should guide and support them.

v. Evaluation

The outcome of every project has to be studied. The evaluation should be done both by the pupils and the teacher. During evaluation let the students have self criticism and look through their own failings and findings. The evaluation of the project has to be done in the light of plans, difficulties in the execution and achieved results.

vi. Record

A complete faithful record of the project should be kept by the student. The record prepared must contain every detail from proposal to the execution. It should also hold information of duties allotted to different students and how far they were carried out by them. It should also include the details of the places visited and surveyed, map etc drawn, guidance for future and all other relevant details.

Role of the Teacher

1. The teacher has to be well informed. He should initially keep his enthusiasm and interest alive.
2. He should help students in selecting projects according to their ability, interest and age.
3. He should be encouraging and inspiring.
4. He should be alert enough to check whether the project is running along right lines.
5. He should suggest books for references, places to visit, people to contact and so on.
6. He should be accessible to the students.
7. He should provide a democratic atmosphere in the class.

Merits

1. It is based on psychological laws of learning. The education is related to child's life and he acquires it through meaningful activity.
2. It imbibes the spirit of cooperation as it is a cooperative venture.
3. It provides opportunities for pupils of different tastes and aptitudes within the frame work of the same scheme.
4. It introduces democracy in education.
5. It is problem solving method and places very less emphasis on cramming or memorizing.
6. It puts a challenge to the student and thus stimulates constructive and creative thinking.
7. This method provides an opportunity for mutual exchange of ideas.
8. It develops self-confidence and self-discipline.
9. A project tends to illustrate the real nature of the subject.
10. This method helps the children to organize their knowledge.

Drawbacks of Project Method

1. Project method is time consuming and can be used as a part of science work only.

2. Though it provides superficial knowledge of so many things it provides insufficient knowledge of some fundamental principles.
3. The teacher has been assumed as the master of all subjects which is practically not possible,
4. This method can't be put under a regular framework, thus the regular time table of work will be upset.
5. This method is not economical as it requires tours, purchase of apparatus and equipments etc.

Scientific Method

The method or the procedure which the scientists use in the pursuit of science may be termed as scientific method. Basically, the scientific method is a problem-solving method, in other words it is a method of solving a problem scientifically. The students once trained in this method will approach all the problems in the same way, even if they are put in a situation which they are quite ignorant of.

In the words of Lundberg, "Scientific method consists of systematic observation, classification and interpretation of data".

Importance of Scientific Method

(a) Scientific method is a well sequenced and structured method for finding the results through experiments.
(b) Scientific method of teaching helps to develop the power of reasoning, application of scientific knowledge, critical thinking and positive attitude in the learner.
(c) Scientific method offers ample opportunities to the students to solve a problem by an experimental design making use of his previous knowledge. Hence understanding a concept becomes still deeper.
(d) In present day's situation a pupil needs a continuous training and the outgrowth of day-to-day work in an atmosphere of careful and persistent investigation.
(e) Scientific method helps the students to become real scientists as they learn to

identify and formulate scientific problems. It also provides training in techniques of information processing.

(f) It develops a habit of logical thinking in the students as they are required to interpret data and observation.

(g) Through scientific method students learn science on their own and teacher works only as a guide. It provides a help to the students to learn to see relationships and pattern among things and variables.

Steps Involved in Scientific Method

i. Sensing the problem

A situation should be provided to the students in which they feel the need of asking and enquiring the teacher .The teacher can also raise a problem which stimulate reflective thinking and help in of arriving at a rational solution .The time and availability of resource must be taken into account.

ii. Defining the problem

The student define their problem in scientific language and proceed towards the solution .The teacher should help them in framing the statement of the problem, as students may find it difficult to define the problem by themselves.

iii. Analysis of the problem

The students now find the key words and phrases in the problem which provide clue to the further study of the problem. At the same time, the students must have knowledge of every key word and the understanding of the whole problem.

iv. Collection of data

After the analysis of the problem, the teacher suggests on the problem. Based on the guide lines of the teacher, the students start the work of collection of relevant data. This might include collection of models, picture specimens as audio-visual aids. Apart from these, some problems may require some field trips for collection of data. While collecting data as for as possible mechanical and personal errors should be avoided.

v. Interpreting the data

This step involves reflective thinking .This phase of problem solving demands much guidance from the teacher .The data is organized on the basis of similarities and difference. They can construct tables and graphs.

vi. Formulation of hypothesis

After interpretation of data, the students are asked to formulate some tentative hypothesis. A hypothesis is a probable solution for the problem in hand. The hypothesis should be free from bias and self-inclination.

vii. Selection and testing of most appropriate hypothesis

Students may end up with many hypotheses for the same problem. Here they can select the most tenable hypothesis by rejecting others through experimentation and discussion.

viii. Drawing conclusions and making generalization

In this step conclusions are drawn from the selected hypothesis. The result should support the expected solution .Experiments might be repeated to check the consistency and correctness of the conclusion drawn.

When the same conclusions are drawn from different sets of experimentation under similar situations, they may go for generalization of their conclusion

ix. Application of generalization to new situation

The students should be able to apply generalizations under new situation in their daily life and hence, minimizing the gap between classroom situation and real life situation.

Panel Discussion

Panel discussion technique was originated by Harry A. Overstreet in 1929. Panel discussion technique is a discussion in which few persons (the panel) carry on conversation in front of the audience. At the end of the discussion, the audience will also participate. The audience put important questions and the experts answer them and

clarify the points. In other words, a panel discussion is a specific format used in a meeting, conference or convention. It is a live or virtual discussion about a specific topic amongst a selected group of panelists who share differing perspectives in front of a large audience. Educational panel discussion is used in educational institutions to provide factual & conceptual knowledge and clarification of certain theories and principles. Some times these are organized to find out the solutions of certain problems Objectives of educational panel discussions, to provide factual information and conceptual knowledge, to give awareness of theories and principles and to provide solution of certain problem.

Seminar

Science teachers can attend seminar in science and other subjects. The seminar may be arranged on some particular topic or it can be on various problems. A working paper is prepared before hand which is presented before participants. The seminar may be held on new techniques of teaching, teaching learning process, teaching of special children, improvement of science curriculum, science practical of different classes etc., Seminars widen the professional outlook of science teachers.

Symposium

The term symposium has come to refer to any event where multiple speeches are made. A symposium suggests that more than one person is speaking. A Symposium is typically a more formal or academic gathering, featuring multiple experts delivering short presentations on a particular topic. In other words, symposium is meeting of a number of experts in a particular field at which papers are presented by specialists on particular subjects and discussed with a view to making recommendations concerning the problems under discussion. Symposium is a meeting or conference for the discussion of some subjects, especially a meeting at which several speakers talk on or discuss a topic before an audience. The different members of academic world would gather at the symposium to talk and take questions from the audience about public funding of academic institutes.

Workshop

A workshop is different from a seminar. The approach taken in workshops is practical. The work distributed among various participants divided in groups and these groups discuss it and come to conclusion. These can be arranged on lesson planning, curriculum, evaluation system etc.,

Team Teaching

The idea of team teaching is comparatively new in the field of education. It is one of the most interesting and potentially significant recent developments in education. It is an organizational structure to improve teaching learning process in the classroom. It is an innovation in school organization in which two or more teachers teach a group of students. The group is benefited by the expertise of different teachers.

Personalized System of Instruction

The Keller plan, originated by Fred S. Keller in 1965, is a plan of individualized instruction. Still it remains the merits of collective instruction to great extent. It is felt that Keller plan is definitely a better approach to learning than the conventional spoon-feeding method of lecturing in the classroom. The plan is better suited for college level instruction.

Characteristics of Keller Plan:

1. Keller plan is a sequence of three-step cycles of learning process with presentation, response and consequence arranged in such a way as to optimize learning.
2. The course policy is explained to the students in the beginning and he is given the study guide.
3. The course content is divided into about 12 to 20 units which can be mastered by a

student in about a week.

4. The student is expected to master unit by unit at his own pace.
5. The student first gets the unit-1 along with the study guide.
6. The study guide is prepared by the teacher.
7. It gives explicit objectives which the student has to achieve. When the student has achieved the objectives, he will take the unit test.
8. Unit is assessed by a test of duration 20 to 25 minutes and scoring of the same is one in 5 minutes.
9. The learning materials for each unit are text book and study guides.
10. The structure and organization of a study guide include: instruction of each unit, behavioural objectives, procedure, text supplement and test questions.

5.5 Computer Assisted Instruction (CAI)

The Computer Assisted instruction (CAI) dates back to the early 1960's. Instruction of micro-computers in 1980's generated a new enthusiasm to use it for instructional purposes. Now the microcomputers are being used on a regular basis

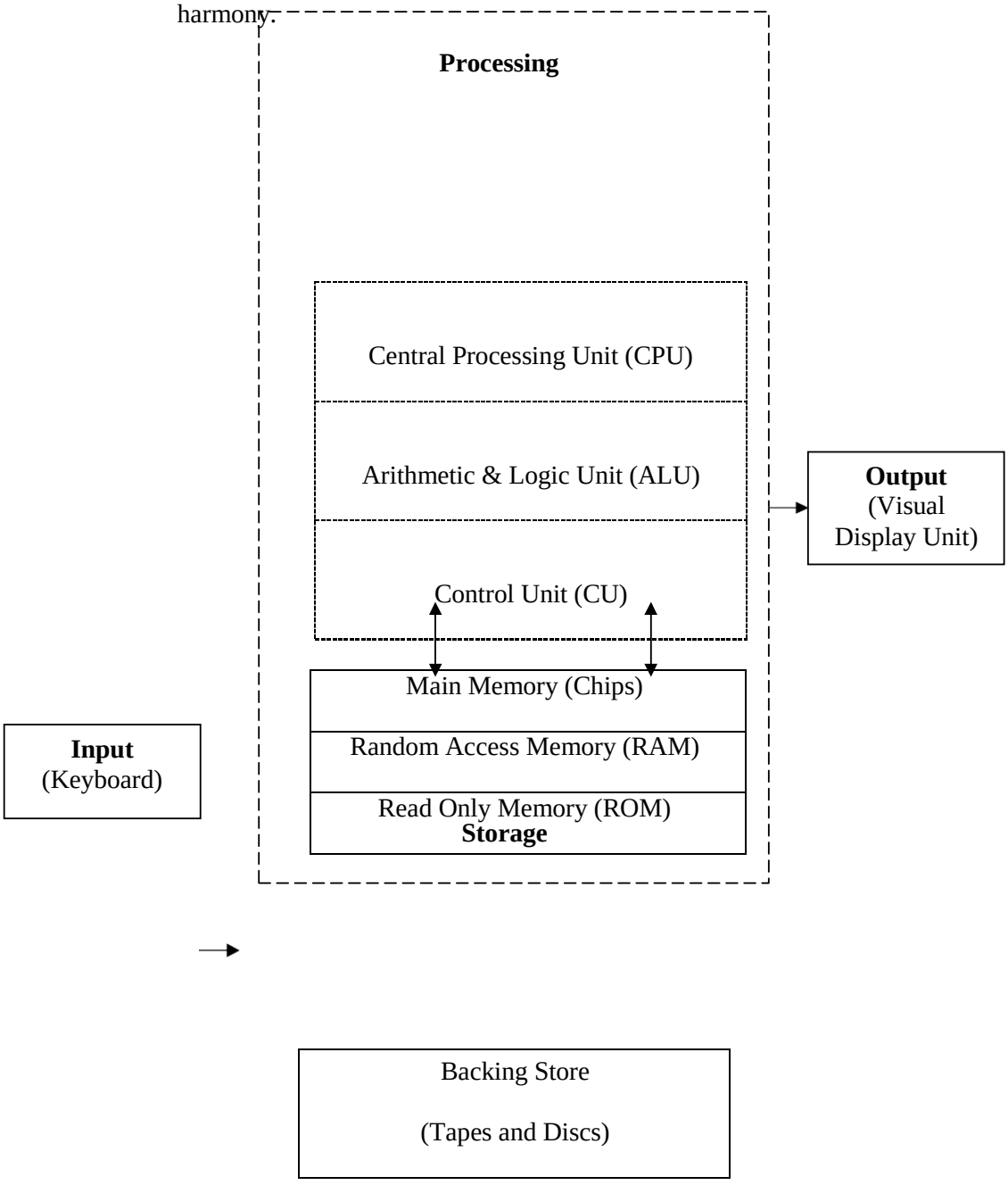
widely at all levels of education from primary to university. CAI has become an integral part of the learning process in the advanced and developed countries of the world.

Basic elements of a Computer

A computer is a power-driven machine equipped with keyboards, electronic circuits, storage compartments and recording devices for the high speed performance of mathematical operations. A computer has five basic parts.

1. Input equipments to feed information to the system.
2. Output equipment to indicate the results of processing usually on the visual display unit (TV screen) and / or print out.
3. A memory store to hold information.
4. A processing unit to perform the required information.

5. A control unit, for processing controls in such a way that all elements operate in harmony.



Basic Elements of a Computer

Statements and Facts regarding CAI

1. Providing programmed instruction through the computer is called CAI.
2. In 1961, CAI was used in the University of Illinois in the USA.
3. In 1966, Patrick supper of Stanford University computerized tutorials in

Arithmetic and Reading for elementary school children.

4. In generative CAI, the computer generates questions within a basic framework of a Topic.
5. The computer can be used as a test-item bank.
6. By quickly reviewing the performance of the students in the previous course. The Computer can be used to suggest future courses for the students.
7. CAI is therefore not merely a sophisticated type of programmed instruction but a different kind of instruction altogether.
8. Students, in general, learn well with CAI in considerably less time.

Instructional uses of Computers

Although a computer can be used in many ways in the educational programmes, the following are some of the areas where it proves to be effective in the instructional process.

1. Drill & Practice

The computer gives drill and practice to the student. The computer keeps track of each student's performance and can ‘read back' to the teacher a summation of each students work whenever the teacher wants it. Here the student learns at his own pace.

2. Tutorial & Dialogue

The subject matter is literally taught by the computer programme. Explanations are given orally through audio tapes and needed visuals represented in cathode ray tube as in television. The computer reacts to the student's response by ‘talking to him'. Student makes further response. A kind of dialogue takes place between the student and the machine.

3. Simulation and Games

Simulations are condensed learning exercises specifically designed to represent vital real life activities by providing learners with the essence or essential-elements of real situations without its hazards, costs or time constraints. They have come into effective use in education during the past decade. Here the students get an opportunity to better

understand a concept that is too abstract and too hard to imagine.

4. Information handling

Computers with their great capacity to process the data rapidly, helps us in handling the information in surprisingly less time. They can store huge data and keep a cumulative record about any specified thing.

Advantages of CAI

1. CAI not only saves time during learning but it also performs miracles in processing data.
2. The large amount of information stored in the computer is made available to the learner more rapidly than by any other medium.
3. There is always a dynamic interaction between the student and the instructional programme.
4. With CAI, we could completely individualise the learning environment.
5. Students can understand better the concepts than through any other means of teaching.

Limitations of CAI

1. The chief limitation lies in the cost that it claims.
2. Computers may also inject a non-human quality into educational programmes.
3. Hence the teaching-learning process itself might go as a mechanized process.
4. Further, all individualised instruction and CAI instruct the students in such a way, that all will achieve the same level of mastery.

5.5.1.1 Modular Approach

An approach to the design of equipment, systems, programs and the like, in which independently prepared and self-contained units, or modules, are combined to form the final product. This allows for simultaneously developing and testing the various components and also helps breaking down a large and complex system into more manageable parts. Also called modular principle, modular technique, modular design, building blocks approach or building-blocks design.

5.5.1.2 Active Learning Methodology (ALM)

Active learning refers to techniques where students do more than simply listen to a lecture. Students are DOING something including discovering, processing, and applying information. “Active learning"derives from two basic assumptions:

(1) that learning is by nature an active endeavour and

(2) that different people learn in different ways"(Meyers and Jones, 1993).

It is important to remember, however, that lecture does have its place and that active learning cannot happen without content or objectives. Education once was thought of as a process of transmission (i.e., pouring knowledge into empty vessels), research has made it abundantly clear that the quality of teaching and learning is improved when students have enough opportunities to clarify, question, apply, and consolidate new knowledge. There are many teaching strategies that can be employed to actively engage students in the learning process. Some of these are group discussions, problem solving, case studies, role plays, journal writing, and structured learning groups. The benefits of using such activities include improved critical thinking skills, increased retention and absorption of new information, increased motivation, and improved interpersonal skills.

Elements of Active Learning Methodology in the Classroom:

Active learning methodologies require that the student must find opportunities to meaningfully talk and listen, write, read, and reflect on the content, ideas, issues, and concerns of an academic subject. (Meyers & Jones, 1993).

Bonwell and Eison (1991) state that some merits of active learning are:

1. Students are involved in more than listening,

2.less emphasis is placed on transmitting information,

3. greater emphasis on developing students' skills,

4. students are involved in higher-order thinking (analysis, synthesis, evaluation),

5. students are engaged in activities (e.g., reading discussing, writing) and

6. greater emphasis is placed on students' exploration of their own attitudes and values.

5.5.1.3 Activity Based Learning (ABL)

ABL methodology is based on the pedagogic principle of learning through activities. In each subject, under ABL, the competencies are split into different parts or units called milestones that are developed into different activities. These milestones and activities are arranged in a logical sequence from simple to complex. Clusters of milestones are linked together into ladders. Each milestone has different steps of the learning processes represented by logos having six types of activities viz., introduction, practice, reinforcement, self-assessment or evaluation, remedial and enrichment activities. Group cards are used to engage students in group learning activities.

5.6 UNIT - END EXERCISES

5.6.1 Give any four merits of lecture method.

5.6.2 List out the steps involved in demonstration.

5.6.3 What are information cards? What sort of information do they contain?

5.6.4 What are the objectives of assignments?

5.6.5 Discussion method and project method are best suited for a class having many brilliant students-Justify.

5.6.6 What are the basic elements of a computer?

5.6.7 Mention the limitations of CAI.

5.7 LET US SUM UP

There are various approaches and methods of teaching science, which we have seen in detail, in this unit. Each method has its own advantages and limitations. None of these methods can be considered as the best method for all students, at all situations. At the same time we can't rule them out as useless, either. Hence the teacher must be careful while choosing the method for teaching a concept in science, during which he must consider the various parameters involved in all perspectives. It is advisable to practice each and every approach and method as far as possible, in your practice teaching.

5.8 ANSWERS TO CHECK YOUR PROGRESS

5.8.1 Mention any two occasions in which lecture method becomes more effective.

Lecture method becomes more effective while.

5.8.1.1 Introducing a new topic

5.8.1.2 Explaining abstract concepts.

5.8.2 List out the steps involved in demonstration method.

The steps in demonstration are

5.8.2.1 Planning

5.8.2.2 Introduction of the content

5.8.2.3 Experimentation and teaching

5.8.2.4 Tabulation of the results

5.8.2.5 Conclusion

5.8.3 Mention any two ways of grouping the pupils for laboratory work.

Pupils can be organized for laboratory works in two ways of grouping, which are

a. Even front system

b. Group rotation system

5.8.4 If block periods are not available what are the two approaches will you prefer for having a discussion in your class?

As the block periods are not available the time period is short. Hence it is good to follow the second approach of giving the topic to the student earlier to the day of the discussion, and letting them prepare for it.

5.8.5 State the basic principles on which the project method is based.

Project method is based on the following principles.

5.8.5.1 learning by doing, ii. Learning by living, iii. Children learn better

through association, co-operation and activity.

5.8.6 Briefly explain the importance of scientific method.

Scientific method is a well sequenced and structured method for finding the results through experiments. Scientific method of teaching helps to develop the power of reasoning, application of scientific knowledge, critical thinking and positive attitude in the learner. Scientific method offers ample opportunities to the students to solve a problem by an experimental design making use of his previous knowledge. Hence understanding a concept becomes still deeper.

5.8.7 Define hypothesis. How should a hypothesis be?

A hypothesis is a probable solution for the problem in hand. A hypothesis should be free from bias and self-inclination.

5.8.8 Ans : d. Both (b) & (c)

5.8.9 Providing programmed instruction through computer is called CAI.

UNIT 7: TEACHING RESOURCES

7.1 INTRODUCTION

Science is now one of the compulsory subjects in the secondary schools, because of its multifarious values. Good science teaching is one of the best ways to create and develop scientific attitude and thinking among citizens and workers. Enthusiastic, intelligent and well-educated science teachers inspire and prepare students for the technological world. The success and failure of a science course rests mainly with the science teacher. On the other hand, a keen and well informed teacher who loves the subject and believes in its values will succeed in spite of difficulties and handicaps.

In this regard the Kothari Commission Report (1966) says, "…..of all the different factors which influence the quality of education and its contribution to national development, the quality, competence and character of the teachers are undoubtedly the most significant".

An efficient and resourceful science teacher can carry on his work quite efficiently even with inadequate science facilities. But it is a sad commentary that the continued failures to recognize and reward merit and salary scales which always keep teachers below the margin of subsistence have all conspired to bring about a sense of frustration among science teachers. The result is an attitude of indifference towards effective science teaching. It is therefore, of primary importance that the plight of the science teacher should be improved first in order to make the science teaching most effective.

7.2 OBJECTIVES

- On completion of this unit, the pupil should be able to,
- Understand the importance of a good science teacher.
- Know the academic and professional qualifications required to become a good science

teacher.

- List out the special qualities of a science teacher.
- Understand the need for in-service training.
- Know the ground planning aspects of a science laboratory.
- Plan about proper laboratory facilities for the schools.
- Identify the basic skills required for effective management of science laboratory.
- Know about the different types of registers to be maintained.
- Realise the importance of laboratory manual.
- Understand the importance of laboratory cards.
- Acquire knowledge about various laboratory techniques.
- Acquire knowledge about the indispensability of museum in the teaching of science.
- Know about terrarium, aquarium and green house.
- Classify various types of accidents that occur in the laboratory and their safety measures.

7.3 SCIENCE TEACHER

Any teaching procedure centres around three pivotal factors; the pupils, the teacher and the subject. Out of these three, the teacher is the most important factor in the teaching-learning process, since he is the medium of communication between the other two. He teaches the subject to the pupils and has to know not only the subject but also the pupils whom he is to handle. Teaching science to different grades of pupils presents different problems and the techniques adopted for teaching science to the elementary or junior pupils differ from those to be adopted for senior pupils of the higher classes. The success of the teacher will be revealed by his ability to arouse and maintain interest of the pupils in learning science. He has to stimulate both the more able and also the less able pupils. The teaching of science is not to hand out facts and information of science. It is much more than that. The good aims of learning science should be kept by the teacher

before him and suitable learning experience should be devised for the pupils in order to attain those aims.

The science teacher should always keep in mind that the ultimate purpose is to educate the pupils through the teaching of science. Because science is no doubt, full of facts, principles and concepts, but its teaching is not just giving out information about them. Besides motivating and presenting things in an interesting way, the teacher must be able to create situations for the pupils where they have to think, do and reason out. Each pupil must be involved in the learning process, because learning results from the active involvement of the learner. The science teacher must succeed in making science a part of their activity and as science teacher he must do his part in planning and administering a continuously balanced flexible programme in science- a programme based on a sound philosophy and providing for the needs, interests and ability of the learners. Obviously, all science teachers need a thorough understanding of the basic principles that underlie good teaching.

7.4 ACADEMIC AND PROFESSIONAL QUALIFICATIONS

In the ancient days, great prestige, respect and honour was given to Guru. He was considered to be a man of ‘simple living and high thinking'. He has sound knowledge of the subject and continually renewed it.

Besides having the personal qualities, a teacher should also fulfill the following broad requirements.

7.4.1 Academic qualifications.

7.4.2 Professional Education or Training in the modern methods and techniques.

7.4.3 Practical knowledge of child psychology and process for learning.

7.4.1 Academic Qualification

The basic academic qualifications laid down by the Education departments of different states are at least B.Sc., to teach middle and High School classes and M.Sc., for

senior secondary classes.

7.4.2 Professional Education or Training in the Modern Methods and Techniques

Besides possessing basic qualification, a teacher must be familiar with modern methods and techniques of teaching. Therefore every teacher of science must have undergone teachers training course i.e., B.Ed., from a recognised university. This training helps the teacher to know methods of evaluation, improvisation of science apparatus and equipments, conducting practical work in laboratory etc., It is therefore essential that the science teacher should be trained in;

- Lesson and unit planning
- Preparation of instructional material.
- Laboratory management and organization.
- Care, maintenance, repair and improvisation of science apparatus and equipment.
- Latest method of teaching.
- Maintenance and use of science libraries.
- Evaluation Technique
- Science club activities and district and state science fairs.

7.4.3 Practical Knowledge of Child Psychology and the Process of Learning

Every science teacher should be able to deal with the students according to their needs. He should follow the psychological principles that 'No two individuals are alike'. He must be able to cater to individual differences in his class. He should be able to lead the students according to their capabilities and interests. He should also be ready to help them whenever and wherever necessary.

Besides this, a science teacher should have great patience and the ability to switch from one aspect to another. A Science teacher should frequently evaluate his teaching for improving and identifying his weak area.

7.5 PROFESSIONAL GROWTH OF SCIENCE TEACHERS

A number of programmes have been started by different agencies to help in the professional growth and development of science teachers but equally important is the personal effort of the teacher. In order to be in touch with the latest development in the field of science and science education, the teacher should take the following steps,

i. He should familiarize himself with National Policy on Education 1986 and 1992 and the thrust areas be identified.

ii. He needs to upgrade the knowledge and understanding of the subject.

iii. He should pursue for higher qualifications like M.Sc., M.Ed., M.Phil., Ph.D etc.,

iv. He should master teacher skills eg. Conducting experiments, preservation of specimens and construction of models.

v. He should develop his own style of teaching based on psychological principles.

vi. There should be exchange of teaching position, either in the same school or through exchange programmes.

vii. He should be an active participant in various science activities like science club, science excursions etc.,

viii. He should visit other schools to study various methods of teaching followed by different teachers in different schools.

ix. He should acquire professional efficiency.

x. He should follow problem solving approach.

xi. He should participate in refresher course to get acquainted with the latest developments in the field.

xii. The impact of verbal interaction of a teacher is everlasting. The teacher should always be inspiring “The hands that rock the cradle rule the world, the

teacher who inspires his pupils rule the minds".

To keep the teachers alive to new development problems, concepts, a number of opportunities are provided by the government in different forms.

7.5.1 Seminar and Conference

Science teachers can attend seminar in science and other subjects. The seminar may be arranged on some particular topic or it can be on various problems. A working paper is prepared before hand which is presented before participants. The seminar may be held on new techniques of teaching, teaching learning process, teaching of special children, improvement of science curriculum, science practical of different classes etc., Seminars widen the professional outlook of science teachers.

7.5.2 Workshop

A workshop is different from a seminar. The approach taken in workshop is practical. The work distributed among various participants divided in groups and these groups discuss it and come to conclusion. These can be arranged on lesson planning, curriculum, evaluation system etc.,

7.5.3 Refresher Courses

The refresher courses are arranged for the science teachers so that they acquire the knowledge about latest developments and researches in their field. The experts are invited and lectures are delivered by them on their respective subjects.

7.5.4 Summer Institutes

Various types of summer Institutes have been started to refresh and update the knowledge of teachers of Science and Mathematics in Secondary Schools as well as in teacher training Colleges. The different types of summer institutes are:

7.5.4.1 Unitary Institutes

These types of institutes are held once a year in science to coordinate the teachers in the development in different areas of science as well as new techniques of

teaching science.

7.5.4.2 Sequential Institutes

The best five teachers in the Unitary Institutes have been given training in imparting instructions both in modern concepts in content and in new methods of teaching intensive programmes. Hence a team of five resource persons is prepared for state level summer institutes. The stress is laid on lecture, group discussions, individual discussions, laboratory work, use of audio-visual aids etc.

7.5.4.3 Special Institutes

These institutes are organized on All India level for the improvement of textual material for the use of training colleges in science and on the development of improved techniques of teaching methods.

7.5.4.4 Project Technology Institutes

These institutes are organized for secondary school teachers on regional basis. It provides intensive training in laboratory work and workshop practice, individual group discussions. Teachers are encouraged to develop indigenous resource materials and audio-visual materials, so that they could use these materials when they go back to their respective schools.

7.5.5 Professional Writings

The teachers are encouraged to study various publications by NCERT.

7.5.6 Study Groups

Various agencies encourage the teachers to form study groups. These can be formed from various schools of district at the state level. The teachers can share their experiences on different activities, teaching-learning processes, difficulties they face during teaching.

7.6 NEED FOR IN-SERVICE EDUCATION

7.6.1 To discuss classroom problems with experts on the subjects and their fellow

participants.

7.6.2 To acquire knowledge of the latest developments and researches in the field of science.

7.6.3 To acquaint themselves with new techniques of teaching.

7.6.4 To learn the use of newly developed audio visual aids and their improvements.

7.6.5 To get knowledge of child psychology and the process of teaching and learning for different stages of growth.

7.6.6 To provide new methods of evaluation.

In-service training provides opportunities to learn specific skills, techniques and new instructional approaches that they can use in their own teaching. When a science teacher begins his career, the knowledge and skills acquired by him in college serve only as basic necessities or minimal requirements to launch his work. An excellent education can merely provide a basic tool for teaching and hence there is a need to provide in-service training to science teacher.

In-service training becomes essential to the science teacher because it,

1. Suggests remedies for inadequacies of existing teacher training programs.
2. Provide opportunities for updating the knowledge of developments in science and technology and application.
3. Helps to acquire improved understanding of generally applicable pedagogical techniques and those for reinforcing equitable teaching practices.
4. Gives opportunities to practice new teaching techniques.
5. Helps updating knowledge that particularly of teaching techniques and to share experiences with other teachers.
6. Gives teachers an exposure to effective new techniques and developments in educational; technology, such as computers, multimedia technology etc.,

7.7 MEMBERSHIP OF PROFESSIONAL QUALIFICATIONS IN SCIENCE EDUCATION JOURNALS

Membership helps teachers to develop network with other people who have the same passions and interests. Members often share ideas and materials. It provides great opportunities for professional development, outreach opportunities, trip ideas, and a way to make new friends. Often, membership fees are tax deductible. Membership might provide discounts to certain vendors. Also, many organizations publish journals or magazines to help improve the profession.

List of science education journals:

- **African Journal of Research in Mathematics**, Science and Technology Education (continues Journal of the Southern African Association for Research in Mathematics, Science and Technology Education);
- **Brunei International Journal of Mathematics and Science Education**, a new journal being started up by Editor Prof Harkirat Dhindsa, hdhindsa@shbie.ubd.edu.bn;
- **CBE-Life Sciences Education**, (formerly called *Cell Biology Education*) is an online, quarterly journal owned and published by the American Society for Cell Biology (ASCB) in editorial partnership with the Genetics Society of America. The journal publishes original, peer-reviewed articles on research and evaluation related to life sciences education, as well as articles about evidence-based biology instruction at all levels;
- **Constructivist Foundations**, a new e-journal of potential interest for science educators;
- **Cultural Studies of Science Education,** a new journal of interest for scholars interested in the intersection between cultural studies and science education;
- **Eurasia Journal of Mathematics, Science and Technology Education** (EJMSTE),

a new academic journal devoted to the publication of research articles on all aspects of mathematics, science and technology education. All research articles are reviewed by editors consisting of internationally respected science and mathematics educators, researchers, and practitioners. It is published twice a year;

- **European Journal of Science and Mathematics Education.** The Journal is intended to be an open-access, peer-reviewed, quarterly journal that will not require any charges for publication of articles. The Journal has been founded with the aim of stimulating discussions on contemporary topics in Science and Mathematics

  Education and to foster the application of the results in primary, secondary, and higher education. Research papers as well as papers on innovation of teaching techniques and technologies are all welcome for speedy publication.
- **Excellence in College Science Teaching**, a peer-reviewed journal published since 1990 by and for faculty at universities and two- and four-year colleges to increase student learning through effective teaching, interest in and enthusiasm for the profession of teaching, and communication among faculty about their classroom experiences;
- **Foundations of Chemistry**, a journal devoted to the history and philosophy of chemistry which from time to time includes articles devoted to pedagogical issues, with links to the contents of past issues and submission guidelines;
- **Gamtamokslinis Ugdymas/Natural Science Education** is a periodical, peer reviewed, scientific-methodical journal, issued by the SMC "Scientia Educologica". It is a international journal, wherein the scientific and methodical articles published in Lithuanian, English and Russian languages;
- **Interdisciplinary Journal of Problem-based Learning**, a bi-annual, peer-reviewed, online periodical dedicated to the theory and the practice of problem-based learning (PBL);

- **International Journal for the Scholarship of Teaching & Learning;**
- **International Journal of Biology Education,** published since September 2011
- **International Journal of Environmental & Science Educatio**n, now published free on-line;
- **International Journal of Math and Science Education**, a new journal that will serve as an international forum for the contemporary call of integrating science and mathematics education;
- **International Journal of Science Education**, with links to information about contents and submission guidelines;
- **Journal for Activist Science and Technology Education** (JASTE). This open-source, community-reviewed journal will be published twice a year;
- **Journal of Astronomy and Earth Sciences Education** (JAESE) (including the current issue and submission guidelines);
- **Journal of Baltic Science Education and its submission guidelines**;
- **Journal of Cities and the Environment**, a web based journal that has an education section that will focus on the sharing of educational research that contributes to our knowledge of how students understand the environment, their perceptions and beliefs regarding the environment, impact of environmental education programs/curricula on student outcomes, professional development models that support teachers in implementing environmentally focused programs in their schools;
- J**ournal of Research in Science Teaching** (the official journal of NARST) and its submission guidelines;
- **Journal of Science Education and Technology**;
- **Journal of the Learning Sciences**;
- **KHIMIYA/CHEMISTRY**, ISSN 0861-9255, the Bulgarian Journal of Chemical Education, is available by contacting the editor, Professor B.V. Toshev, at

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- **Problems of Education** in the 21st Century, an international, non-periodical, peer reviewed scientific collection, issued by the SMC "Scientia Educologica";
- **Research in Science and Technological Education**, with links to information about contents and submission guidelines;
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- **School Science and Mathematics**, official journal of the School Science and Mathematics Association (SSMA) and its submission policies;
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- **Science & Education**, the official research journal of The International History, Philosophy, and Science Teaching Group (IHPST);
- **Science Education** and its submission guidelines.
- **Science Education International**, the official journal of International Council of Associations for Science Education (ICASE).
- **Science Education Review,** a practitioner's journal for elementary and secondary science teachers. The site includes submission guidelines for contributors;
- **The American Biology Teacher** (for links to past issues and submission guidelines move your cursor over the link on the left entitled "Publications");
- **The Canadian Journal of Science**, Mathematics and Technology Education with links to the contents of past issues and submission guidelines;
- **The Chemical Educator**, another new journal with links to submission guidelines and suggestions for authors;
- **The Cypriot Journal of Educational Sciences**;
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guidelines; send manuscripts to Michael Kamen (ejse@southwestern.edu);

- **The Journal of Geoscience Education**, the official publication of the National Association of Geoscience Teachers;
- **The Journal of Science Teacher Education** (the official journal of AETS), including abstracts of articles from recent issues, and submission guidelines;
- **The Science Education Review**(SEC), a comprehensive review of the international science education literature, plus a wealth of readily-implemented classroom activities for the busy primary and high school teacher;
- **The Science Educator**, a peer-reviewed journal focusing primarily on K-16 STEM issues, with emphasis on research based studies having practical implications for the teaching of science, teacher preparation;
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- **Studies in Science Education**, a review journal based in the UK.
- **Cultural Studies of Science Education** - Examines science education as a cultural, cross-age, cross-class, and cross-disciplinary phenomenon. Springer.
- **Electronic Journal of Science Education** - Published by Southwestern University.
- **International Journal of Environmental & Science Education** - All aspects of environmental, science and technology education.
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- **Journal of Computers in Mathematics and Science Teaching** - Use of information technology in the teaching of mathematics and science.
- **Journal of Science Education and Technology** -Publishes a broad range of papers covering theory and practice in order to facilitate future efforts of individuals and groups involved in the field.

- **Journal of Science Teacher Education** - Association for Education of Teachers of Science
- **Research in Science & Technological Education** - Psychological, sociological, economic and organisational aspects of science and technological education, as well as evaluation studies of curriculum development in these fields
- **Science Education** - Issues and trends occurring internationally in science curriculum, instruction, learning, policy and preparation of science teachers with the aim to advance our knowledge of science education theory and practice.
- **Science & Education** - Research using historical, philosophical, and sociological approaches in order to improve teaching, learning, and curricula in science and mathematics.

7.8 SOME SUGGESTIONS TO SCIENCE TEACHERS

7.8.1 The first requisite for the science teacher is that he should have a thorough grasp of the subject-matter that he has to teach. Preferably he should plan his lesson before-hard.

7.8.2 He should not expect that he knows the answer to all the questions that the children ask him. It is a bad policy to dodge pupils, at least in science which is so exact and accurate.

7.9 SCIENCE LABORATORY

The laboratory is commonly regarded as the heart of science teaching. The science laboratory provides opportunities to the pupils to understand the concepts and different ideas of science.

Sood has defined, "Science laboratory is the central place where students get an opportunity to conduct experiments and search principles of science".

The laboratory helps in the development of objective reasoning and thinking, skills of experimentation, observation, problem solving and scientific attitudes among the

students.

7.9.1 Location and Types of Science Laboratories

A science laboratory should be located preferably on the school building if possible so that there is no disturbance of the laboratory. The open space outside the laboratory will be of much use to conduct some of the experiments outside, in sunlight. Biology and general science laboratory should have north-south orientation to provide adequate sunlight exposure.

- There are three important plans of science laboratory.
- Lecture room - cum - laboratory plan as suggested by Dr. R.H. Whitehouse.
- Lecture - cum - laboratory plan as suggested by the panel for science Education in Secondary Schools.
- These two plans are a combined one with a lecture room and a laboratory attached side by side. Half of the whole laboratory is used as lecture room and half as a laboratory to arrange practical classes for one or more subjects.
- All purpose laboratory: The whole laboratory is used for all purposes namely for lecture and laboratory work.

7.9.2 Planning a Science Laboratory

Before constructing the science laboratory, the following factors should be taken into consideration at the planning stage.

- The number of pupils working at a time.
- The minimum space necessary for each pupil for comfortable working.
- Limitations of number of science teachers in secondary schools.
- Need for ancillary accommodation for storage.
- Designing the science class-room and laboratory in such a way that it could be used for science teaching for middle as well as for high classes.

- Imperative need for economy.

7.9.3 Chemistry Laboratory

The plan was evolved by Dr. R.H. White House. The plan stands approved by the Punjab Education Department.

Location

It should be preferably on the ground floor.

Lay out

It should be 45 feet x 25 feet for a class of 40 students in demonstration and 20 forpractical classes. One door should be near demonstration table of the teacher and the other at the other end. Windows preferably with wire gauze should be provided, and should open outside. They should be 6' x 8'.

Ventilation

In chemistry experiments heat is required in carrying out almost all experiments. Moreover gases give nauseating smell. So ventilation should be there. Ventilators should be provided with exhaust fans. Without them conditions might become intolerable for students to work.

Walls

The walls may be about 1½ feet thick. Painting should be done or annual white washing is should be done.

Floors

They should be cemented. Slight slope helps in sweeping. Round corners prevent the dust from being accumulated.

Water Supply

Water supply is different in different places, depending upon the source of water supply. It is preferable if storage tank is built on the roof of science laboratory.

Gas Supply

Gas supply may be provided by means of petrol gas plants which are easy to operate and maintain. The gas plant must be installed outside the laboratory. Each burner should have individual gas control knob.

Work Tables

Single work table of dimensions 1.5m x 0.75m x 0.75m is ideal for individual practical classes. The tables must be arranged so that the teacher can easily see from his demonstration table what every student is doing.

Sink

Sinks must be provided in each work table in the chemistry laboratory where the students would have to clean the test tubes very often.

Demonstration Table

A long table preferably raised by means of a small platform should be provided in each laboratory at one end. The demonstration table must be provided with water supply and gas supply.

Blackboard and Bulletin board

A black board must be fitted on the wall just behind the demonstration table, so that the teacher can use it during demonstration. There must be a notice board inside the laboratory near the entrance door.

Cupboards, Fire Extinguishers and First Aid Box

There must be enough number of cupboards or almirahs to store things and chemicals. There must be at least two fire extinguishers and one first aid box in the laboratory.

Storeroom

In addition to the materials kept in the laboratory, materials which are costly and needing special care can be stored in the store room.

7.9.4. Physics Laboratory

The Physics laboratory should be equipped with

1. Working tables of about 6 feet x 3 ½ feet size with drawers.
2. One demonstration table with water and gas fittings.
3. A wall black-board behind the demonstration table.
4. Sinks in the wall.
5. Projected platform in the wall for balance
6. Animals
7. Stools.

7.9.5 Biology Laboratory

It should be equipped with

1. Table along the walls having glass-paned windows so that enough light is available for microscope study. The tables should have drawers and water fittings.
2. A demonstration table.
3. Stools
4. Sinks
5. Wall black-board
6. Shelves for keeping chemicals
7. Almirahs
8. Space for aquarium - vivarium for keeping other animals.

7.10 PURCHASE OF APPARATUS AND EQUIPMENTS

Sufficient materials, apparatus and equipment are essential for any laboratory. A list of all the required apparatus, tools, equipment, chemicals, reagents etc., should be prepared and purchased from the scientific stores.

Procedure for the Purchase

Preparation of the indent

Based on the grant and the immediate requirement either for getting a new laboratory or for a laboratory already established the list of articles equipments are to be prepared and they should be assorted into different categories. The indent should be prepared in duplicate and it should be sent to the concerned higher authorities for approval. The approved indent, with required particulars should be sent to more than three approved scientific companies asking for the price of the articles in the indent which they can supply.

Preparation of comparative statement

After receiving the quotations from at least three companies the comparative statement can be prepared. While considering the quotations the quality also should be compared and considered. Quality should not suffer at the cost of money. The company that has offered the lowest quotation is given the order to supply the materials when asking for quotations we have to give specifications. For example if we simply say dissection box one may give the rate for that made up of iron while the other may give it for stainless steel. Naturally the rate for the iron will be less and we should be going for the purchase of it and suffer later.

Placement of orders

The teacher through the headmaster should place the order of the articles to the respective companies which have offered the lowest rate. While placing the orders the time specification also should be clearly mentioned, so that they are received in time and utilized by the students.

Receipt of the articles

When the articles are received the price list is to be compared with that of the quotation to find out whether the price is the same. If there is any discrepancy, deficiency or damage if should be immediately communicated to the respective company and arrangement should be made to return the item and get a new one or reduce the price in the bill. It is advisable to get the costly article and glass wares insured against any damage. Then only the bill should be recommended for payment.

Stock registers

The apparatus purchased should be properly checked and entered. A stock register is used for the entry of items received and also to maintain a record of science apparatus. It helps in knowing the position of apparatus, chemicals and also helps while auditing. The science teacher should maintain the following registers in the laboratory.

(i) Accessing register

After receiving and checking the working conditions all the articles irrespective of consumable or non-consumable are entered in this register. The register should have the following format.

Date of purchase	Bill No. and name of company	Description of articles	Qty.	Cost	Page No. in the relevant stock register	Remarks

ii. Non-consumable register

Articles of permanent nature which are not liable to be broken are to be entered in this register. The article such as sonometer, magnets, spectrometer, electrical appliances and instruments, balances etc should be entered in this register. The register should have the following format.

Date of purchase	Bill No. and name of company	Description of articles	Qty. received	No. broken, removed	Balance	Remarks & initial

It is preferable to enter the articles in the alphabetical order. It is better to enter each type of article in separate pages. Articles if broken accidentally or during use should be removed from this register with the permission of the competent authority. Such removal must always have the sanction of the competent authority in writing.

iii. Consumable register

Articles which are likely to be broken very often and articles which have to be thrown out after use can be entered in this stock registers. For example test tubes, glass rods, glass tubes, rubber tubes, litmus paper, corks, chemicals, dry cells, bulbs, extension wire, oil, fuse wire etc. have to be entered in this. The teacher has the power to write off such articles from this register. Any such removal need not have any sanction from the higher authority. The format of the register will be as follows.

Date of purchase	Bill No. and name of company	Description of articles	Qty. Received	Issued or removed	Balance	Remarks and initial

It is better to allot one page to one type of article so that additions and deletions in future can be noted on the same page.

iv. Issue register

Whenever an article is issued to other department or teacher, it should be entered in the issue register with date and number. After it is returned it should be entered after verifying the working condition of the article.

v. Breakage register

Articles which are broken by the students and others while doing the practical work and demonstration should be entered in this register and later on can be removed from the concerned stock register.

7.10.1 Improvised Apparatus (low cost materials)

The inculcation of scientific attitudes and training in scientific methods is possible only through instruction, demonstration and experimentation. The complaint of science teachers against effective demonstration and experimentation is the lack of adequate apparatus. If practical skills have to be developed in the school going children, large amount of money has to be invested in building well equipped laboratories. But such a provision may not be possible in the years to come. One way of solving this problem is usage of improvised apparatus.

The term ‘Improvisation' refers to those teaching aids, which can be prepared from simple and readily available cheap material in the class, which can be used by the students, and teachers.

Characteristics of improvised apparatus

- The following are some important characteristics of low cost educational materials.
- They use raw material easily available in local environment either free of cost or at low price.
- Pupils, teachers or members of the community prepare the materials.
- These low-cost materials create interest and stimulate further study.

- Production is economical and saves time.

Process of developing low-cost materials

The development of improvised apparatus or the low cost materials occurs in a sequential manner. The various steps involved in are

a. Defining the objectives

The objectives of knowledge, skills and attitudes are clearly identified in the light of the need of the user.

b. Designing the product

The design for the improvised apparatus is developed based on the type of materials used, the cost of production and availability of the resources.

c. Development of the materials

After designing the apparatus the material is assembled and developed by the teachers and students with the help of each other.

d. Pilot testing

The teachers and researchers then test the prepared apparatus. Based on the results, necessary improvements are made in the materials.

e. Mass production

The materials, which successfully pass the pilot testing, are finalized for mass production.

f. Distribution

Adequate number of copies is produced and they are distributed to various schools for academic usage.

Advantages of improvised apparatus

- They are freely available, cheap and economical.

- They possess a great educational value.
- Preparation of such apparatus helps the students in gaining a deeper knowledge of underlying principles.
- It develops creative instinct in the learner.
- It inspires young students to design, explore and invent new apparatus.

Disadvantages

- The time and money involved can exceed the limits making it worthless.
- Improvised apparatus are not durable.
- They are crude and they are unable to provide accurate results.

7.11 ORGANIZATION OF PRACTICAL WORK

It is essential for a science teacher to complement her class room lessons to the practical work conducted in the lab. The success of the practical work depends on the planning and the organisation. In the organisation of the practical work, time scheduling and the actual practical work are the components.

7.11.1 Time Scheduling

The mental process involved in practical is not different from theoretical work. The time required for each experiment may differ depending on the nature of the practical.

Time is needed to prepare the material before the practical commences.

Practical procedures occupy different lengths of time.

Pupils need time for the preparation of the practical work, to sharpen the scalpels or get the apparatus.

Time should be allotted for the demonstration.

Time should be scheduled according to the working rates of the students.

The facts of the psychological mechanism ‘repetitive experiences is often more effective than single experience' should be considered.

7.11.2 Organising the Work of the Practical Class

All the preparatory works should be completed before the practical begins and the students should know before hand what work they are to do and should be prepared with the appropriate instruments, instructional materials such as work sheets and apparatus should be ready. After the arrangements the teacher should demonstrate what is to be done. During the demonstration the purpose should be defined, its method explained and its results shown but during the process itself there should be the cut and thrust of question and answer. When the process is to continue after giving the brief description of the whole process, conveniently it can be done in stages.

7.11.3 Guidelines for Teachers in Organizing Practical Work

1. The teacher should conduct demonstrations and also provide the students with instruction cards containing information about the experiments to be performed. It provides clarity to the students and saves time.
2. The experiments should be properly done. Accurate readings should be noted down.
3. In the record books, the data and the diagrams should be entered. The calculations should be worked out.
4. Teacher should check and sign every students practical book after the completion of the experimental work at the end of the practical session.
5. Teachers should explain the care and accuracy of apparatus to the students.
6. Teacher may be flexible and innovative in devising new methods or procedures, while working with large groups or with limited supply of chemicals and apparatus.
7. Teacher should be cautious about accidents in the lab and in case of accident he should provide first aid to the victims immediately.

7.11.4 Laboratory Records of Students

The records serve as self learning materials for the students. In the records they are able to condense and organize the matter. The records are the means to convey what

they know about the concepts of the experiments. The students should be properly trained to record the experiments that they perform in the laboratory.

The teacher should make the students to enter each and every observation directly into their fair note books. Recording on the rough notebook and copying later should be avoided.

The procedures for the experiment should be on the right side while the observed information should be recorded on the left side appropriately. The use of printed records should be avoided as they may contain unnecessary and more information. The method of doing the experiment and the recording pattern may be different.

Always the procedure should be written in passive voice and not in active voice or in the order form.

7.11.5 Laboratory Manual

A laboratory manual is an essential guide to laboratory work. It is a book that gives guidelines for doing practical. It gives good practical guidance regarding the procedure, observation and precaution. It is always better to follow the lab manual for systematic conduct of experimental work. The laboratory manual provide

the aim of the experiment

the apparatus and chemicals required.

The method or the procedure followed

The formula for analysis

Precautions for effective work

Illustration for the experiment

In the manual the different experiments are described with appropriate figures and tabulations and help the student to complete the record works. Wherever necessary the diagrams of the apparatus and the format of the tabulations and the procedure of the calculations for the different experiments are given.

7.11.6 Instruction Cards

Instruction cards are small postcard sized cards on which the instructions and guidelines for individual experiments are written. The size of the card is 15cm x 10cm. The instruction card is prepared for each practical and is given to the student before he starts his practical works.

The instruction cards contain

1. Procedure
2. Method to record the observations / data
3. Formulae and the method for calculations.
4. Precautions to be taken for proper working.

The instruction card is preferably covered with a polythene cover.

Benefits of instruction card

- Helps to save the time of the teacher and the student.
- Enables the student to go through it when he gets the doubt.
- Helps to enable the systematic procedure for each experiment.
- Helps the learner to become familiar with the concerned experiment.
- Helps to gather the materials before starting the actual practical.

7.12 LABORATORY TECHNIQUES

A good biology laboratory should have a good museum, life specimens, stuffed animals, preserved insects, herbarium and life corner. In a school it will not be economic to purchase all these. A biology teacher should be aware of wise techniques and the students of biology also should be familiar with such techniques. Then only teaching and learning of biology can be effective and complete.

7.12.1 Wet Preservation

Ready availability of the materials for the practical work is very important. Though the materials are locally available they should be in the laboratory ready for the

class works. For the preservation of plant materials alcohol is used. When the materials for the class practical works are fixed for preservation they are put in 50% alcohol. Depending on the materials and the water content of the materials, the materials are changed to grade alcoholic solutions of 50%, 60%, and 70% after definite time intervals in order to avoid the unwanted effects of sudden dehydration.

Similarly the soft materials are preserved in 5% formaldehyde so that formaldehyde renders the hardening effect to the materials. If the whole animal is to be preserved, the stomach should be opened and the contents should be removed. After removing the contents it should be stitched and kept in formalin.

Preserving media used for wet preservation

1. For animal specimens

   a. 70% alcohol

   b. 5% formalin

   c. 50% alcohol 90 parts

      3% formalin 10 parts

   2 drops of glycerin per cc. of the solution.

2. For plant specimens

   a. Water 6 parts

      95% alcohol 3 parts

   formalin 1 part

   b. Commercial formalin 5 parts

   glacial acetic acid 5 parts

      50% alcohol 90 partsfor preservation with original colour

      Place the specimen in 5% copper sulphate for 24 hours.

7.12.2 Herbarium

For a biology laboratory the herbarium is essential. Herbarium is the dry

preservation of the plants enabling to study the important characters of the species.

i. **Need**

For a biology teacher in a school it is not so easy to get all the plants fresh. Some plants are specific to certain area. The flowering season of the plants also vary. Under such conditions the plants are properly preserved in the form of a herbarium with required specific descriptions about the characters of the flower. During the field trips the plants may be collected with the help of a herbarium and the foot note we can know the floral as well as the vegetative characters.

ii. **Preparation of Herbarium**

The plant is collected in the appropriate size and placed between sheets of blotting paper or news paper so that the moisture is absorbed by the paper. If the plant is a small herb it is taken with the flowers and preserved. While drying the plant by keeping in between the newspapers, the plant is properly spread so that all the parts are clear with the flower. This is placed in a plant-press where uniform pressure is given for the plant. The paper in which the plant is pressed should be changed everyday till the plant gets completely dried.

When perfectly dry each plant should be mounted on a sheet of paper, by a few narrow strips of paper gummed across the stem and leaves or the plant is pasted to the sheet with gum. Before pasting to the sheet the dried plant is poisoned by treating with a mixture of 0.5gm mercuric chloride in 100ml. Ethylated spirit.

The right hand lower side of the sheet should contain the following details, Name, Genus, species, family, class, date of collection, place of collection, name of the student etc. In addition the floral characters noted at the time of collection may be given in a separate sheet which will help the identification of the plants. Collections of such plants are stored in a large folder made of cardboard.

In the maintenance of herbarium two precautions are essential. They have to be

guarded against dampness by storing in a dry place and by frequently opening the folders to allow adequate ventilation. By slightly dusting the sheets with a very small amount of powdered borax or DDT insecticide, we can guard against the insects.

7.12.3 Leaf Skeleton

Venation is one of the major characters based on which the classification of angiosperms is done. The nature of venation differs in different plants of even the same class. The leaf skeleton is nothing but the skeleton of the veins. The leaf skeleton helps the students of biology to understand the different types of veins.

Preparation of Leaf Skeleton

Sodium hydroxide is boiled and allowed to cool. The leaf for which the skeleton is to be prepared is immersed in the sodium hydroxide for 2 or 3 days depending on the thickness of the leaf and then the mesophyll (fleshy part of the leaf) is carefully removed with the help of fine brush by rubbing slowly. Care is taken to see that the fine veins are not damaged. Then the leaf skeleton is dried and preserved.

7.12.4 Stuffing of Animals

The animal is killed with chloroform. The inner contents must be removed by cutting them open on the ventral side starting from the neck. Through the opening in the skull the brain is also removed. The soft tissues like oesophagus, alimentary canal, bones are removed. Arsenic powder is applied on the inner surface of the skin. The arsenic powder is prepared with 100 grams camphor, 500 grams arsenic and pieces of washing soap.

From head to tail a long metal should be sent along with the fibres. The legs and other protruding organs are provided with metal pieces. The metal pieces are connected with each other. This is filled with dried soft stuffing materials. The eye is replaced by glass or with the polished marbles. The skin is stitched with fine fibres along with cut

open lower side. The stuffed animal is placed on a piece of wooden plank. The metal pieces protruding are drawn out through the wooden plank and are folded on the bottom. This stuffed animal gives the real external picture.

7.12.5 Preservation of Insects

There are four stages in preserving the insects

a. collecting
b. killing
c. pinning
d. storing

a. Collecting

Many insects may be collected by hand picking or by using forceps. An insect collecting net is used for catching flying insects. An insect catching net is easily prepared. One end of a long bamboo stick is bent to form a circle. It is tightly bound with wire or thread. The other end of stick forms the handle. A piece of mosquito net is stitched in the form of a pillow case. The insects should be caught when they rest on a plant.

b. Killing

i. Insects may be allowed to die in test tubes. In case of mosquitoes etc. the advantage is that the legs and wings are not damaged.

ii. Chloroform vapour may also be used. Chloroform should be introduced in the form of vapour into the tubes by means of a pipette.

iii. Cyanide bottles are used for killing insects. Some sodium or potassium cyanide is placed at the bottom of a wide mouthed bottle. Cyanide is covered with layer of plaster of paris over which liquid plaster of paris is allowed to set. This is covered with several layers of filter paper. The bottle is tightly corked. Care should be taken that cyanide vapour should not be inhaled and hands should be washed after handling insects.

iv.7% or 8% alcohol is used for killing larvae.

v. Carbon tetrachloride vapour may be used for killing insects. A little cotton soaked with vapour is dropped into the bottle. Live insects are then dropped. The vapour kills the insect.

c. Pinning

Butterflies and grasshoppers should be pinned through the throat; ants should be pinned on the head and the beetles on the side of the abdomen. The wings should be spread out in such a way that posterior or margins of the four-wings are at right angles to the vertical line of the body.

d. Storing

Before storing, insects can be immersed in a very dilute solution of mercuric chloride. Store boxes are made of teak wood with well fitting lid. A cork carpet is fixed to the floor by means of paraffin wax. Ordinary cigar boxes will make good store boxes for field work. As a preventive against mould for insects like mites and ants, creosote chloroform is commonly used. Cotton soaked in creosote chloroform solution is wound round the heads of pins and fixed at places within the box. Too much chloroform and creosote mixture may cause damage to specimens by condensation of creosote on wings and body of insects. Powdered naphthalene in packets may be placed at the corners of the box. Lysol camphor solution may be used as disinfectant. Cotton is wound round the heads of pins and they are dipped in Lysol camphor solution. Then the pins are fixed at the corners of the box.

7.12.6 Museum

The learners have to understand the things in the world and the relationship between human beings and the environment. This cannot be understood from the books alone. They should have the direct experience. They should see, touch and feel things.

Students must have the knowledge of things in the natural environment. Practically it is not easy to take the entire class to study the environment. So the natural things are brought into the school or laboratory in a place called museum. Each school should have a museum and the teacher as well as the students should have the interest in collecting and preserving the plants and animals in the museum.

i. **Benefits of museum**

1. It sublimates creative instincts of children.
2. Students get first hand experience.
3. Outside world comes within the four walls of the school.
4. Abstract ideas depicted in the classroom get a concrete shape in the minds of students. They enhance teaching learning process.
5. Students develop spirit of enquiry and curiosity.
6. The students collect materials for museum and in this way their mental horizon widens.

ii. **Arrangements of museum**

The contents of the museum are divided into sections according to subjects. There should be labelling for the items and card with less technical details. Arrangements must be made to keep them safe and free from damage. Work benches and good lighting are provided in the museum. In order to make good use of the museum class visits must be carefully organized. Articles should be labelled and the slip can have the following data.

1. Name
2. Family
3. Place from where collected
4. Time when collected
5. Collectors name

iii. **Functions of museum**

- It serves as a teaching aid
- It is a place of acquiring new knowledge
- It is a form of library and information center
- Serves as a place of records for further studies.

7.12.7 Life Corner

In this part we shall learn something about terrarium, aquarium and green house because living plants and animals are essential for the teaching of biology.

i. **Terrarium**

Terrarium is an improvised arrangement for preserving the creature living on the surface and below the earth for study. Eg.Earthworm, snail, frog, tapeworm etc. This is a type of vivaria and is called wormeries. For example the action of earthworms in relation to soil tillate and soil ventilation may be shown with a simple terrarium box. This is made of glass and wooden frames of 2cm wide and 1" thick. About 1.5cm of dark soil is put in the bottom and then 2 or 3 medium sized worms are placed. They are covered with 2cm of light coloured, sandy soil. Alternate layers of dark and light soil are used to fill the box. The movements of the worms mix up the soil layers and their furrows in places against the glass are visible, and they allow ventilation of the lower soil layers. The soil must be made wet with water. Certain small insects that will serve as food to worms may be dropped.

One terrarium cannot serve the purpose to all creatures. For example one terrarium will not be able to lodge grass hoppers and earthworms. Separate terrarium should be prepared for the creatures in accordance with the habit of their creatures.

ii. **Aquarium**

Aquarium is a life corner in which aquatic plants and animals are grown. The learners should be familiar with aquarium and also they should know about the

construction and maintenance of an aquarium.

iii. **Construction and maintenance of as aquarium**

An aquarium is a small artificial pond arranged in the laboratory which provides opportunities for unlimited spontaneous observation and enjoyment of nature. The conditions provided in the aquarium should be the same as those of the real ponds where we find the aquatic animals and plants. Some animals are adopted to well aerated water and for them the water should be constantly changed.

An aquarium is a glass trough where the glasses are fixed to the frame of iron or aluminum without leakage of water .A small amount of rich soil is placed at the bottom.

The soil is covered with sand and some different sized stones are placed. Water is taken from the pond or even the tap water is poured into the aquarium without exposing the soil. If tap water is taken it is better to allow it to stand for a day in order to let the chlorine to escape before using it. The water plants from the pond are rooted in the soil .Crowding of plants should be avoided. Some fresh water alga filaments also are put in the aquarium. Without overcrowding aquatic fresh water animals like fish, snails are put into it. If there are sufficient water plants there is no need for elaborate aerating arrangement. The snails clean the glass walls of the aquarium. Very little feeding is required for them. The fishes eat snails' eggs and other water organisms. Feeding is done by providing cattle fish bone powder, worms, pieces of meat, mosquitoes, boiled potatoes etc. The animals should be free from infection and the suspected, injured fish and snail should be removed.

The animals in the aquarium are fed every second day and the water in the aquarium should be periodically changed. A properly, cleanly maintained aquarium serves as a teaching aid and also promotes the interest of the students in biology.

iv. **Green house**

Biology is a subject dealing with living plants and animals, Effective teaching and learning can take place when the actual specimens are used. When it is beyond the reach of the teacher, the teacher can use the models and other teaching aids. Ours is a tropical country and in the natural environment and in the garden we can get only tropical plants. But it is necessary for the learners to learn about the nature and characters of the temperate plants also. For this purpose the learners cannot be taken to the temperate countries. So an artificial temperate condition is created and the temperate plants are grown in a specially constructed chamber which is called a green house.

A green house is a glass house that provides a moist atmosphere for many exotic plants and for the early stages of plant growth. It protects plants from drying conditions of sun or wind.

The size of the green house depends on the requirements and he availability of funds. Green house is built with wooden or metal frames. The sides, ends and roof are fitted with glass sheets. It is provided with a door or two adjustable roof ventilators. The house should have one or more multinozzled revolving taps so that periodically the humid atmosphere is maintained by the water spray. Along one wall there should be wooden slots or wooden shelves, arranged in tiers of three fixed for the smaller plants. The end wall opposite the door may be left free. The inner side of the glass roof, ends, sides are painted with green paints to cut down the radiation and thus reducing the temperature. On the wooden planks and shelves, the potted plants are kept. Small pots are hung from the top and plants can be kept in them. Maintenance of a humid atmosphere and moisture, reduced heat are the important factors to be considered while constructing a green house.

7.13 SAFETY PRECAUTIONS

A laboratory is a dangerous place if not managed properly as it contains explosive

chemicals and reagents, glass wares, poisons etc and with the increasing scientific progress, the corresponding hazards are also increasing. Therefore laboratory safety is the most important task that a science teacher should know. Good laboratory practices are prerequisite for the management of safety in any laboratory. For this purpose certain safety rules should be adopted and strictly followed.

7.13.1 General Safety Rules for the Lab

The science students should follow the following rules to avoid many accidents in laboratories.

1. In case of any accident immediately report to the teacher.
2. Work should be done only under the supervision of the teacher.
3. Equipment should be handled only after reading the instructions.
4. Chemicals should be used only after receiving the instructions and precautions from the teachers.
5. Laboratory apparatus should not be used without the permission of the teacher.
6. Caution should be taken while handling and pouring chemicals and reagents.
7. Never pour back the reagents or chemicals into the bottles.
8. Chemicals spilled on the skin should be immediately washed with water.
9. Working area should be cleaned before and after the experiment.

In case of accidents or injuries, first aid should be immediately provided. Therefore, first aid is an important requirement in any science laboratory. The science teacher should be trained in providing first aid to the injured students.

Safety Equipment

Along 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 blankets, etc.

7.13.2 Some Common Laboratory Mishaps and their Remedies

1. Cuts

If it is a minor cut, the affected portion should be washed with a weak antiseptic lotion such as diluted 1:10dettol. Then tincture of iodine on a pad of cotton wool may be applied.

If there is arterial bleeding, a doctor's attention is immediately needed. A thick pad of gauze or cotton wool should be pressed over the wound. Tourniquet may be used to stop the bleeding.

2. Burns

It is caused by dry heat such as hot iron, hot glass rod, by some acid or alkali, phosphorus or sodium or potassium. For small burns apply sterilized pad of cotton wool or gauge soaked in sodium bicarbonate solution which should be replaced before it gets dried gentian violet jelly may be used. In some cases special procedure is necessary as follows.

a. Acid burns

Concentrated acids will cause serious burns. The portion affected by acid must be immediately washed with large quantity of water and then treated with a weak solution of sodium bicarbonate to neutralize the acid. Alkali should not be poured over the affected area without washing it with large quantity of water as it will produce excessive heat due to neutralization.

b. Alkali burns

The affected area must be washed with water and then with 1% solution of acetic acid or lemon juice. Phosphorus burns must be immersed in water and all traces of the substance washed away. The part should then be treated with dilute silver nitrate solution.

3. Eye injuries

Any injury in the eye must be carefully attended. A drop of oil must be put into the eye.

a. Acid in the eye

The eye must be washed by a slow stream of water from a wash bottle. It should then be rinsed several times with lime water or 1% solution of sodium bicarbonate.

b. Alkali in the eye

The eye should be thoroughly washed with water and then with 1% solution of boric acid.

c. Solid in the eye

Any obvious solid may be removed gently by a camel-hair brush dipped in glycerine.

4. Poisoning

In all cases of suspected poisoning, the doctor should be consulted soon after the first- aid treatment.

a. Substance taken into the month

If a poisonous substance either solid or liquid has been taken into the mouth, it should be spit out at once and the mouth rinsed with much water followed by a wash with saturated sodium bicarbonate solution if acid or with 1% acetic acid solution if alkali,

b. Substance swallowed

In this case the poisoning can be classified into two types.

i. Poisoning due to corrosive substances.

ii. Poisoning due to non-corrosive substances.

If the substance swallowed is non-corrosive the patient may be encouraged to vomit. A table spoon full of common salt or a tea spoon full of mustard in warm water will encourage vomiting. Then white egg, rice-water etc. should be given.

If the substance swallowed is corrosive, the patient should not be encouraged to vomit. In the case of acids much water, followed by lime water or milk of magnesia should be drunk. If alkalies, much water followed by dilute acetic and or lime juice should be taken.

In the case of poisonous gases the patient should be taken into fresh air at once, clothing must be loosened and a hot stimulant like coffee should be given.

6. Fainting

It a pupil feels or looks faint after an accident, his clothing must be loosened and fresh air must be allowed to blow on his face. A little cold water or hot stimulant can be given, when he becomes conscious.

7. Electric shock

The first thing is to switch off the current. If necessary the pupil should be treated for burns and shock. He should be kept quiet and warm and made to lie down flat. In serious cases artificial respiration may be given.

8. Fire accidents

In the case of fire the following steps should be followed.

1. If a pupil's clothes catch fire, he should be wrapped with a blanket immediately.

2. Small fires due to oil, sodium etc can often be put out by putting a large amount of dry sand.

3. If some inflammable substances catch fire, it can be extinguished and

prevented from spreading by pressing a sheet of asbestos.

4. If the fire is due to gas or electricity the main source of supply should be cut off first.

5. In all cases of emergency fire buckets filled with sand and water and suitable number of fire extinguishers must be kept ready.

7.14 LET US SUM UP

In order to become an innovative science teacher, persistent work and link with other professionals is essential. The science teacher plays the knowledge and building up habits of thought and action and thereby making the teaching of science efficient and effective. It is very essential that the plight of the teacher should be improved.

The science teacher should possess the following qualities in addition to other personal qualities.

i. Basic academic qualifications.

ii. Trained in modern methods and techniques.

iii. Practical knowledge of child psychology and process of learning.

In order to keep the science teachers in touch with the recent information, seminars, workshops, refresher courses, summer institutes are organized by Extensive Service Departments. The teacher should take part in professional orgainisations, seminar reading, celebration of Teachers' Day, National Foundation for Teacher' Welfare etc.,

The science teacher should read and attend in-service training programms to remain in touch with the latest developments. Experimentation and manipulative skill of a science teacher can lead the students beyond the classroom.

In this unit, we discussed the location and types of science laboratories. A stock register is used for the entry of items received and also to maintain a record of science apparatus.

In the organization of the practical classes, time scheduling and the actual practical classes are the components. Laboratory manual is a book that gives guidelines for doing practical works. Instruction cards are small postcard sized cards on which the instructions and guidelines for individual experiment are written.

Herbarium is the dry preservation of the plants enabling to study the important characters of the species. There are four stages in preserving insects. They are collecting, killing, pinning and storing.

In this unit, we have learned about terrarium, aquarium and green house. Terrarium is an improvised arrangement for preserving the creatures living on the surface and below the earth. An aquarium is a small artificial pond arranged in the laboratory which provides opportunities for unlimited and spontaneous observation and enjoyment of nature. A green house is a glass house that provides a moist atmosphere for many exotic plants and for the early stages of plant growth.

7.15 UNIT - END EXERCISES

1. What is the present status of science teachers?
2. What special qualifications are required for a science teacher?
3. Enumerate the functions of a science teacher.
4. What are the objectives of summer Institutes for Science? What are their major limitations? Give your suggestions to improve them.
5. Describe briefly the steps that you may take for your professional growth.
6. Use rating scales to evaluate the following.
    a. Teachers' involvement in teaching science.
    b. Science Teachers' teaching effectiveness in the classroom.
7. List down the limitations in the current system of education in teaching science.
8. Draw a layout of your school science laboratory and suggest improvements.
9. In this age of scientific precision and availability of refined materials, what is the

place of improvised apparatus for science teaching? Give three examples of apparatus which you would improvise and indicate their effectiveness for the classroom teaching.

10. What are the different types of registers to be maintained in the laboratory.
11. How will you purchase a new article for the biology laboratory.

7.16 ANSWERS TO CHECK YOUR PROGRESS

1. **What are basic academic qualifications required for a primary school science teacher?**

   Any under graduate/bachelors degree in science with a B.Ed., degree.

2. A Science teacher should possess a basic knowledge of child psychology and the process of learning.

3. **State any two competencies that a science teacher should possess.**

   Discipline and work organization

4. A good science teacher should evaluate himself with a rating scale or a check list.

5. In-service programs provide with an opportunity to attend seminars, conferences and workshops.

6. A science teacher can update his knowledge level by reading, communicating with other science teachers and browsing in the internet.

7. **Fill in the blanks:**

   (a) Science laboratory helps in developing scientific attitude in students.

   (b) The number of pupils working at a time should be considered at the planning stage of the laboratory.

8. **State two considerations which one must keep in mind while planning a science laboratory.**

i. The number of pupils working at a time.

ii. The minimum space necessary for each pupil for comfortable working.

9. Write the main points to be considered when preparing an indent.

i. Choice of the supplies.

ii. Available finance

iii. The requirements of the science department

iv. The ability of the students

v. Available storage place.

10. Give any two characteristics of improvised apparatus.

i. Characteristics of improvised apparatus are,

ii. Their production is economical and saves time.

iii. Create interest and stimulate further study.

11. Write any two steps involved in the development of improvised apparatus.

i. The steps are,

ii. Defining the objectives

iii. Designing the product

iv. Development of the materials

v. Pilot teaching

vi. Mass production

vii. Distribution

12. Fill in the blanks:

a. Laboratory manual is a book that gives guidelines for doing practicals.

b. Instructional cardsare small postcard sized cards on which the instructions and

guidelines for individual experiment are written.

13. The size of the instruction card is (b)

14. Herbarium is a

a. Glass trough

b. (b) Glass house

c. (c) Dry preservation of the plants

d. (d) Dry preservation of the animals

15. What are the stages involved in the preservation of insects?

i. The stages are,

ii. Collecting

iii. Killing

iv. Pinning

v. Storing

16. State any two benefits of museum.

i. Benefits of museum,

ii. It sublimates creative instincts of children

iii. Students get first hand experience.

17. Fill in the blanks:

a. Museum is a form of library and information center

b. Terrarium is an improvised arrangement for preserving the creature living on the surface and below the earth for study.

c. Green house protects plants from drying conditions of sun or wind.

18. List out any three general safety rules followed in the lab.

i. The general safety rules are,

ii. In case of any accident immediately report to the teacher

iii. Equipment should be handled only after reading the instructions.

iv. Working area should be cleaned before and after the experiment.

19. State whether true or false.

a. Equipment should be handled only after reading the instructions. True

b. If the substance swallowed is corrosive, the patient should be encouraged to vomit. False

c. In case of accidents, first aid should be immediately provided. True

UNIT 8: TEACHING SKILLS

8.1 INTRODUCTION

Our educational program is designed to bring about desired changes in the student behaviour. Teachers playing an important role in this Teacher effectiveness directly depend on the quality of the teachers. Hence there is a need of preparing quality teachers. This is a challenge before the teacher training institutions to change the behaviour of the teachers and adopt new techniques in educational practice. In this direction micro teaching has evolved as a new technique in pedagogy.

8.2 OBJECTIVES

After studying this unit, you will be able to,

8.2.1 Define Micro teaching.

8.2.2 Define Micro teaching cycle.

8.2.3 Explain the Characteristics of Micro teaching.

8.2.4 Explain the skills namely reinforcement, stimulus variation, explaining, probing questioning, demonstration and the skill of using black board.

8.2.5 Explain the importance and need of link lesson.

8.3 MICRO TEACHINGMeaning

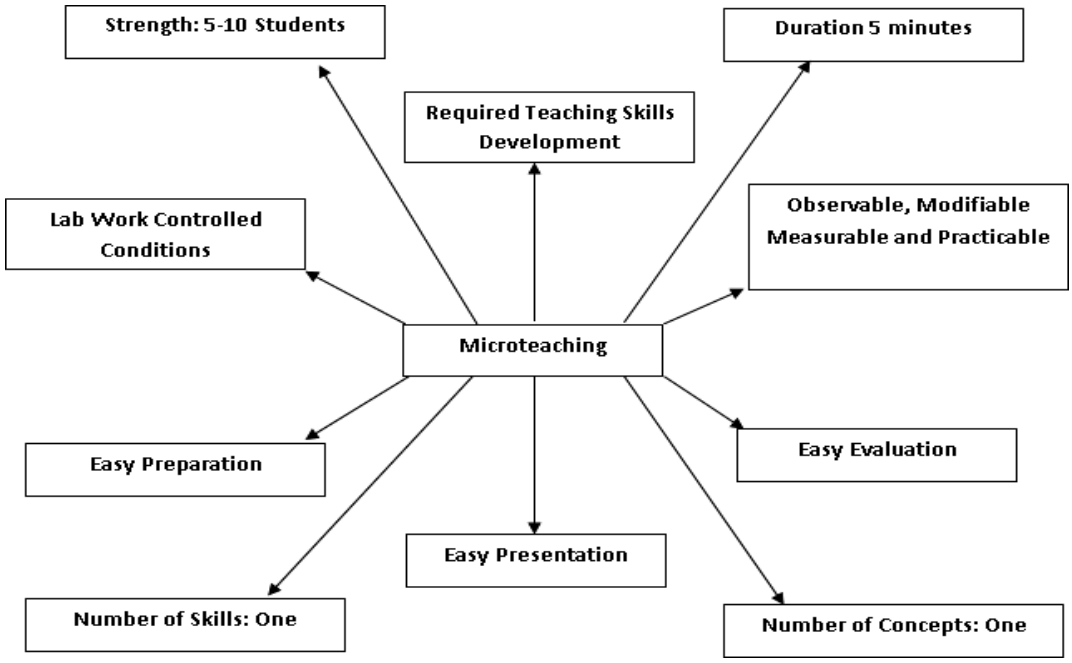
Micro teaching using is a training technique in which a student teacher is required to teach a single concept wring a specified teaching skill on a small group of pupils in a short duration of time. Micro teaching is practiced in terms of desired teaching skills.

A skill cannot become one's own unless it is practiced periodically. A.W. Dwight Allen of the Stanford University first adopted the term “Micro Teaching” in 1963.

Thomas Green has explained that learning is not possible without teaching, but without learning, teaching is not possible. Among the different practices of teacher training, Micro teaching is an important technique, which imparts intensive training in the

component skills of teaching to the teacher trainees.

The following diagram represents the meaning and properties of Micro teaching.



Representation of Meaning and Properties of Micro Teaching

Definitions

MC. Knight (1931): Micro teaching is a scaled down teaching encounter designed to develop new skills and refine old ones.

Passi, B.K. and Lalitha, M.S. (1936): Micro teaching is a training technique, which requires student teachers to teach a single concept using specified teaching skill to a small number of pupils in a short duration of time.

Encyclopedia of Education (Ed. Deighton, L.C. 1931): Micro teaching is a real, constructed, scaled down teaching encounter, which is used for teacher training, curriculum development and research.

The above definitions are very useful to know the significance of Micro teaching.

Characteristics of Micro Teaching

From the definitions stated above, the characteristics of Micro teaching can be

summarized as follows:

i. Micro teaching is a teacher training technique and not a teaching method.

ii. In Micro teaching the teacher trainee practises one specific teaching skill at a time, till he/she attains mastery over the skill.

iii. Micro teaching operates on a predecided model: Plan, Teach, Feedback, Re-plan, Re-teach and Re-feedback.

iv. Micro teaching allows for increased control of practice by providing feed back to the teacher- trainees.

v. Micro teaching is not a substitute, but a supplement to the teacher-training programme.

vi. Micro teaching is a cyclic process.

Features of Indian Model of Micro Teaching

After a lot of research studies undertaken by various institutions and efforts taken by NCERT, the concept of micro teaching has been modified to suit the needs and requirements of the Indian teacher-trainees and the facilities and infrastructure available in our teacher- training colleges.

Some of the salient features of this model have been listed below.

vii. Indian model of micro teaching is a low technology model with minimum electronic gadgetry.

viii. In the Indian model of micro teaching peers are used as students instead of real pupils.

ix. In the Indian model of micro teaching, observers, using appraisal guide, systematically record the performance and provide the feed back to the trainees.

x. It is flexible to suit the varying conditions available in teacher-training institutions.

xi. The duration of the micro teaching cycle, as adhered to in the Indian model of micro teaching varies from 35 to 50 minutes.

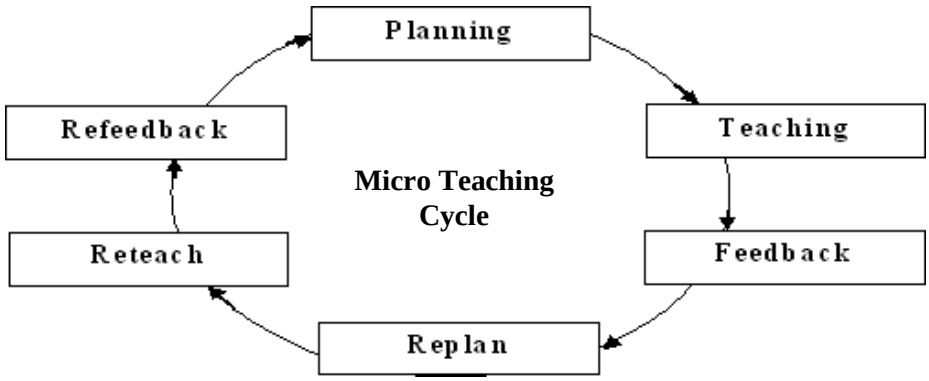
The duration of the Indian model of micro teaching as recommended by NCERT is 36 minutes as follows:

Teaching Session	: 6 mts
Feed back Session	: 6 mts
Re-plan Session	: 12 mts
Re-teach Session	: 6 mts
Re-feed back Session	: 6 mts
Total Duration of Micro Teaching Cycle	: 36 mts

8.4 MICRO TEACHING CYCLE

The training procedure for one teaching skill is called as 'Micro teaching cycle'. In this cycle, the teacher trainee chooses a specific skill, prepares a micro-lesson plan and teaches a small group of students for duration of 5-3minutes. The teacher educator and the peer group observers rate the lesson using an observation schedule or an appraisal guide.

On the basis of the performance appraisal, immediate feedback is given to the teacher-trainee by the observers. The trainee then modifies her/his lesson and re-teaches another set of students (peer or real students) This lesson is also rated by the supervisor and other observers and then analyzed and discussed with the trainee. This process is repeated till the trainee attains adequate level of the skill. The completion of these steps results in the completion of one Micro teaching cycle as shown in the following figure.



Steps in Micro teaching Cycle

The steps in Micro teaching cycle can be listed as under.

i. Planning: This involves selection of the skill to be practised, awareness of the components of the skill, selection of a suitable concept and the writing of a micro lesson plan.

ii. Teaching: The trainee teaches the lesson in the Micro teaching setting. NCERT has suggested the following setting for Micro teaching.

Time: 6 mts

No. of students: 5 to 10, Real pupils or preferably peers.

Supervisor: Teacher Educator and / or one or two peers.

The lesson is being observed by the teacher supervisor and/or peers or videotaped or audio taped

.

iii. Feedback: The observers analyse the performance and discuss it with the teacher trainee on the basis of their ratings using the appraisal guide. The supervisor can give feedback to develop the skill.

iv. Re-plan: In the light of the feedback received from the supervisor and peer observers the teacher trainee re-plans her micro lesson by writing another micro-lesson plan or modifying the existing one.

v. Re-teach: The teacher-trainee re-teaches the revised lesson to another, but comparable group of students. The supervisor checks to see whether there is any improvement in skill attainment.

vi. Re-feedback: The supervisor assesses the lesson once again and provides the feedback to the trainee. This process repeats till the teacher trainee acquires the required level of competency.

8.5 PRACTISING OF RELEVANT SKILLS

A skill is a specific activity which requires doing a particular work or job or task. Teaching activity involves different skills which are essential to teach effectively.

Classification of teaching skills

Here, we can classify the teaching skills using the areas,

1. Motivational skills.
2. Presenting and communication skills.
3. Questioning skills.
4. Skills of small group and individual instruction.
5. Developing pupil thinking
6. Evaluative skills.
7. Classroom management and discipline

There are so many classifications using area, researchers, subject-wise etc. But we are going to discuss some of the skills which are involved in science subject.

1. Reinforcement
2. Stimulus Variation
3. Explaining
4. Probing Questioning
5. Demonstration
6. Skill of using Black Board

8.6 SKILL OF REINFORCEMENT

The term ‘reinforcement' is taken from psychology. The skill of reinforcement is used to avoid the unpleasant experiences and replace with the pleasant experiences. The pleasant experiences are called positive reinforcements and the unpleasant experiences are called negative reinforcements. The positive reinforcements are used for strengthening the responses or behaviours of individuals and negative reinforcements for weakening or eliminating the undesirable responses or behaviours. These reinforcements are in the form

of verbal or non-verbal.

Components of Reinforcement Skill

1. **Positive Verbal Reinforcements (PVR)**

The verbal behaviour (statement) of teacher accepts student feelings, repeats and rephrases student responses, summarizes student ideas etc., using praise words such as ‘good', ‘very good', ‘excellent', 'fantastic', 'splendid', 'right', 'yes', 'correct', ‘fine', ‘continue', ‘go ahead', ‘carryon', ‘well done', etc. which can be considered as positive verbal reinforcements.

2. **Positive Non-Verbal Reinforcements (PNVR)**

Teachers gestures conveying pleasant feelings and approval of student responses such as smiling, nodding of head, delighted laugh, clapping, keeping eyes on the responding student and giving ear to the student-indicate positive nonverbal reinforcements.

3. **Negative Verbal Reinforcements (NVR)**

Teacher's statement such as the use of discouraging words like ‘no', ‘wrong', ‘incorrect', ‘stop it', ‘you don't know even this', ‘I do not like what you are doing', ‘do not do like this', ‘that is not good' etc. correspond to negative reinforcements.

4. **Negative Non-Verbal Reinforcements (NNVR)**

The teacher demonstrates his disapproval to indicate nonverbal expression of a student's inappropriate behaviour or incorrect response to his questions. Frowning, raising the eyebrows, hard and disapproving stares etc., are the nonverbal negative reinforcements.

In the above four components, the first two components indicate the skill of desirable reinforcements and the last two components indicate the skill of un-desirable reinforcements, which affect the students learning adversely and these are to be avoided as

far as possible.

Micro Teaching Lesson Plan No. 1

Skill: Reinforcement

Name of the teacher-trainee:

Subject : Biological Science

Class : IX

Topic : Cancer

Date: Time: Duration: 6 mts

Teaching Points:

5. Cancer - its meaning.
6. Types of agents - causes for cancer.
7. Common cancer diseases in men and women and
8. Treatments for cancer.

Steps	Teacher's activity	Student's activity	Components
1. Introduction	Hello Good morning Students (Nodding head) O.K. How are you?	Good morning, Sir Fine, Thank you, Sir	PVR PVR & PNVR
2. Presentation	All right, what is your name?	Ramesh, Sir.	PVR
	Nice, do you know about any disease?	Yes, Sir	PVR
	(Nodding head) oh! What are they?	T.B., Cancer, Heart attack etc,	PVR & PNVR
	All right, what is cancer?	I don't know Sir	PVR

	Why not? (Nodding head to the left and right)	The students listen curiously	NNVR
	Teacher explains that some cells from tumors, spread to other parts of the body and produce large number of cells in other parts of the body and this is called malignant tumor, and that condition is called cancer Teacher asks some questions. All right. At what age do we get Cancer?	At any age, Sir	PVR
	Good. Is it a contagious Disease?	No, Sir	PVR
	Right. Will it spread from person to person?	No, Sir	PVR
	Yes. Is it an inherited disease?	No, Sir	PVR
	All right. Do you know the types of agents that cause the cancer?	No, Sir	PVR
	Why? (Nodding head to the left and right) Teacher explains by showing a chart (CHART) Three types of agents that cause Cancer 1. Physical 2. Chemical and 3. Biological	Students listen Curiously	NNVR
	O.K. Now, how does the physical	Silence	PVR

	cancer happen?		
	(Angrily) see the chart and tell me how does the physical cancer happen?	By ionizing radiation	NVR, NNVR
	How does the ionizing radiation come into effect?	By ultra violet light, X-rays, radiation, emitted by radioactive material	PVR
	Nice, How does the chemical cancer happen?	By having chemicals	PVR
	Good observation. What are the Cancer-causing chemicals?	Tobacco, soot, coal, tar, Pesticides, etc.,	PVR
	Yes, How does the biological cancer occur?	Some Viruses.	PVR
	Wonder, what are the major types of cancer among men?	Digestive System, especially, mouth and throat and lungs	PVR
3. Conclusion	All right. What are the more common cancer diseases among women?	Cancer of cervix and breast	PVR
	O.K. How do we survive from cancer?	1. By Surgery 2.Killing the cancer cells with powerful x-rays	VR
	Very good. Today we discussed cancer and its remedies		

		3. by drugs Thank you, Sir	PVR

Observation with Rating

Scale Skill: Reinforcement

Name of the Teacher - trainee :

Subject : Biological Science

Name of the observer :

Class : IX

Topic : Cancer

Date: Time: Duration:

Sl.No.	Components	Rating	Comments/Suggestions
1.	PVR		
2.	NVR		
3.	PNVR		
4.	NNVR		
	Total		

Rating: Poor = 0; Below Average = 1; Average = 2; Above Average = 3; Excellent = 4

Overall General Comments / Suggestions

1. .....

2. .....

8.7 SKILL OF STIMULUS VARIATION

It is very important for a teacher to secure and sustain pupil's attention. For this purpose the teacher uses some gestures, body movements, makes certain verbal statement

etc. All these behaviour are related to stimulus variation. The skill of stimulus variation can be defined as deliberate change in the attention drawing behaviour of the teacher in order to secure and sustain pupil's attention towards the lesson. Variation in the stimulus secures more attention among the students.

The following components of the skill of Stimulus Variation the teaching-learning process effectively.

8.7.1 Teacher's Movement (TM)

8.7.2 Pupil's Movement (PM)

8.7.3 Teacher's Gesture (TG)

8.7.4 Sensory Focus (SF)

8.7.5 Change in Voice (CV)

8.7.6 Change in Interaction Pattern (CIP)

8.7.7 Pausing (P)

8.7.8 Audiovisual Switching (AVS)

(1) Teacher's Movement (TM)

The teacher should move form one place to another on the teaching dais and towards the entire student to attract the attention of the entire class and to focus the attention of students towards the teacher. The movement should be purposeful. The movement of the teacher secures and maintains attention of the students. (e.g.: Movement towards blackboard to discuss the diagram drawn on it)

(2) Pupil's Movement (PM)

A pupil moves from one place to another. The physical participation holds pupil's interest and attention in the task in which they are engaged. Physical participation can be in the form of handling apparatus, dramatization, and writing on the blackboard.

(3) Teacher's Gesture (TG)

Expression of feelings and emotions involving nonverbal behaviors are called gestures. Gesture consists of hand and head movements, eye movements, facial expressions, etc. Use of gestures is important teacher behaviour to enhance the value of the message what the teacher actually imparts. The appropriate gestures increase the effectiveness of verbal communication

(4) Sensory Focus (SF)

The movements, gestures and change in voice of teacher secure pupils attention. The verbal statements and gestures together are known as verbal-cum-gesture focusing. Verbal-cum-gesture focusing is termed as sensory focus. The sensory focus intenders the attention of the students.

Verbal Statement : Excellent

Gesture : Nodding of head

Verbal-cum-gesture: Excellent and nodding of head at the same time.

(5) Change in Voice (CV)

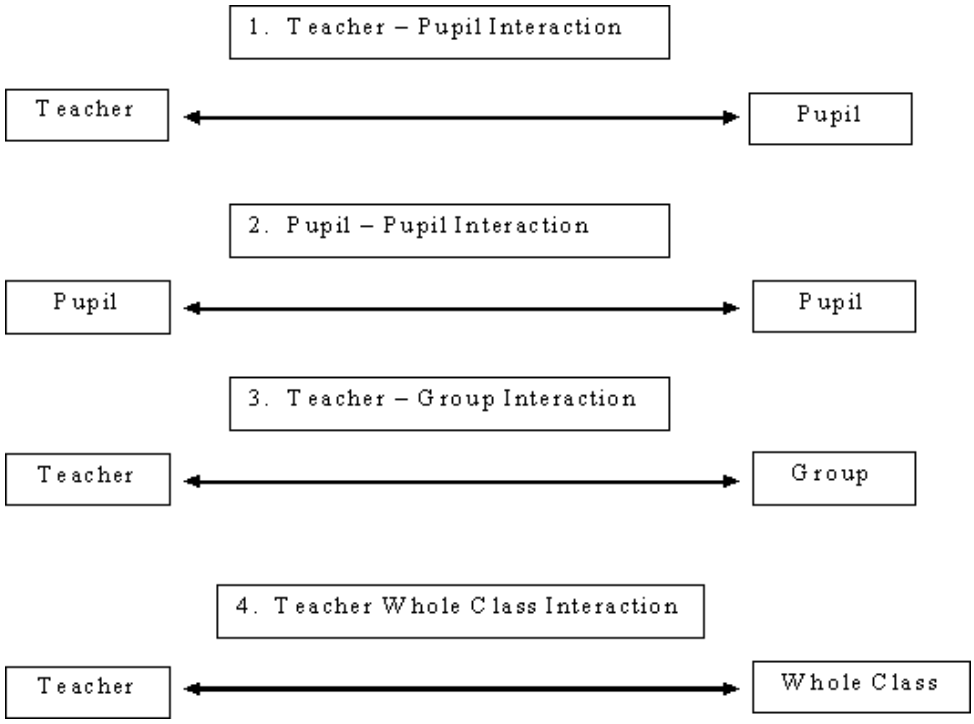
Constant use of the same level of pitchy tone and speech by the teacher makes his communication dull, inactive and has an adverse effect. So, the teachers should modulate their voice modulation of pitch, tone and speed plays a vital role in the classroom communication.

(6) Change in Interaction Pattern (CIP)

The interactive act of teaching constantly communicates between the teacher and pupils as an initiatory or responsive act.

The interaction is broadly of two types: Verbal and Nonverbal. This interaction is nothing but communication. The main patterns of interaction between teacher and pupils

are teacher-pupil interaction, teacher-group interaction, pupil-pupil interaction and teacher-whole class interaction.



The following diagram indicates the changes in interaction pattern in a classroom.

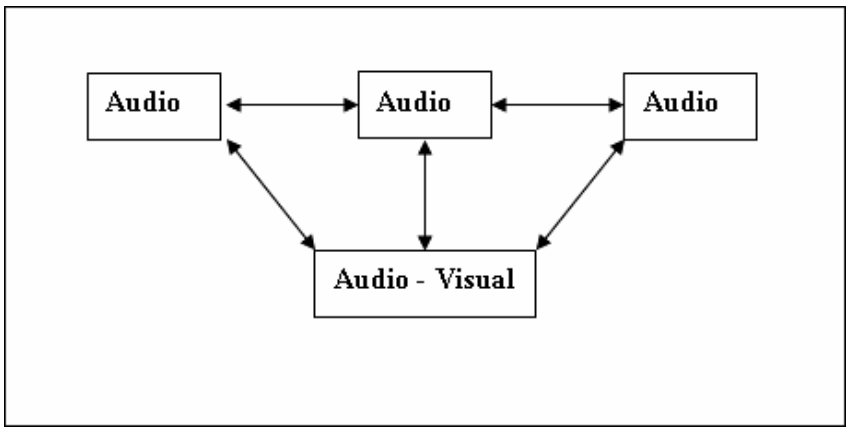
(7) Pausing (P)

Pausing is silence for some seconds. The silence indicates pause during talk. Short deliberate intervals of silence used, while conveying information, lecturing, explaining, etc. Silence has a meaning of its own and if it is used effectively, it helps in securing and sustaining pupil's attention. A pause of 3-4 seconds duration is considered appropriate for this purpose.

(8) Audio-Visual Switching (AVS)

Visual Medium can be in the form of showing a chart, picture, graph, map, and model or in the drawing pictures, figures, and graphs on the blackboard. Only audio medium or only visual medium creates boredom in the class. A teacher while imparting knowledge to his pupils uses either audio or visual medium. A teacher should vary his medium in order

to secure and sustain attention. The audiovisual switching can be diagrammatically represented as follows.



Micro Teaching Lesson Plan No. 2

Skill: Stimulus Variation

Name of the teacher - trainee:

Subject : Biological Science

Class VIII

Date: Time: Duration: 6 mts

Topic : Sense organs

Teaching Points: 1. Sense organs.

2. Functions of sense organs.

Steps	Teacher's Activity	Student's Activity	Components
1.Introduction	(with smile) Good morning students.	(moving from their seats) Good morning, Sir	(TM) (PM) (TG)
	(Raising eyebrows) How are you?	(Taking on their seats and smiling)	(TM) (PM)

		Fine, thank you Sir	(TG)
2.Presentation	How many sense organs do we have?	Five	(CV)
	Good (showing with	Eyes, ears, nose, tongue and	(TG)
	finger) Radha, can you tell me what are the different sense organs?	skin (students observe the chart)	(SF) (CIP) (P) (AVS)
	CHART (Teacher shows the chart explains it and asks) Ramana, what is the important function of a sense organ?	It receives information and sends the message to the brain	(SF) (PM)
	(Answer any one from last bench). How is a sense organ made up of?	It is made up of several hundreds of cells	(CIP)
	Lakshmi, can all the cells receive the information?	No Sir, only a few cells	(CIP) (SF) (PM)
	(Slowly) what do we call these cells?	Receptor cells or receptors	(CV)
	(Loudly) what is the specialty of these receptor cells?	Each receptor cell receives a particular type of sensory information	(CV)
	(Moving towards first bench students) How is	Several receptor cells together form a sense organ	(TM) (CIP)

	a sense organ formed?		
	(Coming back) What is the major function of a sense organ?	To sense the changes in the environment	(TM)
	(Moving eyes) Paul, the function of eyes is …?	To see	(TG) (P) (PM)
	(Answer any one in the second bench) What is the function of our nose?	To smell	(CIP) (PM)
	Ravi, can you tell me the function of our tongue?	To taste	(SF (PM)
3. Conclusion	John, which organ do we need to hear?	Ear	(SF) (PM)
	Paul, what is the function of our skin?	To touch	(SF) (PM)
	Today, we have discussed the functions of our sense organs.	Thank you, Sir	(CIP)

Observation Schedule: (Teach / Re-teach)

Name of the trainee :

Name of the supervisor:

Standard : IX

Subject :

Date : Duration: 5 mts

Concept : Sense Organs

Sl. No	Components	Tallies	Rating of Performance						
			Not at all						Very much
1.	Teacher's Movement (TM)		0	1	2	3	4	5	6
2.	Pupil's Movement (PM)		0	1	2	3	4	5	6
3.	Teacher's Gesture (TG)		0	1	2	3	4	5	6
4.	Sensory Focus (SF)		0	1	2	3	4	5	6
5.	Change in Voice (CV)		0	1	2	3	4	5	6
6.	Change in Interaction Pattern (CIP)		0	1	2	3	4	5	6
3.	Pausing (P)		0	1	2	3	4	5	6
8.	Audio-Visual Switching (AVS)		0	1	2	3	4	5	6
	Total								

8.8 SKILL OF EXPLAINING

Explaining can be defined as the use of interrelated statements about a concept, phenomenon, generalization, procedure, function and reason with a view to providing its understanding to some one else. It is a set of interrelated statements made by the teacher related to a phenomenon, an idea, principle, etc., in order to increase understanding in the

pupils about it. A teacher teaches a number of concepts generalizations and procedures. For an explanation, to be understood by students, the previous knowledge refers to the knowledge already possessed by students. The quality of an explanation depends on preparation of the teacher and the degree of understanding of the students.

Components of explaining are:

8.8.1 Cognitive Link (CL)

8.8.2 Uses of Illustrations (ILL)

8.8.3 Compare and contrast (CC) and

8.8.4 Meaningful Repetition (MR)

1. Cognitive Link (CL)

A teacher introduces a new concept using the principles of "Known to unknown", "Concrete to abstract", "easy to difficult" and "simple to complex" to establish a link between the old (already known) concept and the new one. A new concept can be introduced and developed only through a series of sub-concepts. All sub-concepts must be linked with one another logically.

2. Uses of Illustrations (ILL)

Illustrations are included with examples and non example. Only examples cannot serve the purpose of illustrating. A new concept is to be adequately illustrated in terms of different situations or life-experiences providing non-examples also. The illustrations must serve the purpose of understanding the abstract concepts.

3. Compare and Contrast (CC)

While teaching different concepts, one should note that some of them are closely interrelated. There may be some similarities and dissimilarities between them. The pupils may find it difficult to discriminate between them. This component serves the purpose of discriminating between two related but different concepts.

4. Meaningful Repetition (MR)

By repeating a brief description of a concept, a term or a definition at regular intervals, the idea gets fixed in the minds of the learners. Repetition must be purposive, deliberative, meaningful and relevant.

Micro Teaching Lesson Plan

No. 3 Skill: Explaining

Name of the teacher-trainee :

Subject : Physical Science

Class : IX

Unit : Units of Different Systems

Topic : Measurement

Date : Time : Duration: 6 mts

Teaching Points:

1. Fundamental units - Length, mass, time.
2. Different systems of units: CGS, MKS and S.I. systems.
3. Additional Units in S.I. System.
4. Definition of Standard unit of length (meter).

Steps	Teachers activity	Student's activity	Components
1. Introduction	Good morning students	Good morning Sir	
	How are you children?	Fine, thank you Sir	
2. Presentation	Kishore, How much, do you need to get your shirt stitched?	1.5 meters Sir	(C.L) (ILL)
	What 1.5 meters length or breadth?	Length	(CL)

	What is its breadth?	I don't know Sir	(CL) (CC)
	The breadth is the standard width of 1 meter, so we measure only length when we mean 1.5 meters it is 1.5 mts length and 1mt breadth	Observe it	(CC) (MR
	(showing chart)(Repeating) How many fundamental units of measurements are there?	Three	(CL)
	What are they?	Length, mass, time	(MR)
	How many systems of units are there?	Three	(CL) (ILL)
	What are they?	C.G.S., M.K.S and S.I Systems	
	What are the units of measurements in C.G.S system?	Centimeter, Gram and second	(CL)

l. No.	**Components**	**Tallies**	**Rating of Performance**						
			Not at all						**Very much**
1.	Cognitive Link (CL)		0	1	2	3	4	5	6
2.	Uses of Illustration (ILL)								

			0	1	2	3	4	5	6
3.	Compare and Contrast (CC)		0	1	2	3	4	5	6
4.	Meaningful Repetition (MR)		0	1	2	3	4	5	6
	Total								

8.9 SKILL OF PROBING QUESTIONING

When the teacher puts a question to a class, he gets various types of responses. The skill of probing questioning involves going deep into student responses through step-by-step questioning with a view to eliciting the required response. Each question is followed by a variety of student responses, such as no response, wrong response, partially correct response, incomplete response and correct response. Let us consider the fire response situations one by one.

No response situation

This situation may be due to student's inability to understand the question, to structured response, or due to lack of requisite facts needed for the purpose or responding or the failure to recall the related facts.

Wrong response situation

Wrong response to a question indicates the lack of knowledge of facts concepts and generalizations on the part of the student.

Partially correct response situation

They represent a partial knowledge of facts, concepts and generalization on the part of the students.

Incomplete response situation

Sometimes when an incomplete response situation occurs, we infer that either the student is not having the necessary facts, concepts or generalization in his memory or it

may be due to his inability to understand and structure response to the question.

Correct response situation

Correct response situation refers to the statements expressed by the student.

Steps	Teacher's Activity	Student's activity	Components
	What are the units of measurements in S.I. System?	It is also a meter	(CL)
	How many fundamental Units are there in S.I. system?	Six	(CL) (CC)
	O.K, in C.G.S and M.K.S systems there are only 3 fundamental Units. What additional units are there in S.I. System?	Current, Temperature, and luminous intensity	(CL) (1LL)
	What are the unit measurements of current, temperature and luminous intensity in S.I. system?	Ampere, Kelvin, Candela	(CL)
	Can you define a meter, Anil?	1 meter = 100cm	(CL)
	O.K.(Showing a Chart) It is certain length of platinum rod maintained at 0 degree Celsius kept in the Achievers of Serves near Paris.	Students observe the chart	(ILL) (CC) (MR)
	It is taken as the standard unit of length called meter (Repeating		

	once again)		
	It is more accurately defined as 1,650,363.33 times the wavelength of orange light emitted by krypton atom at normal pressure (Repeating) To day we have discussed the different systems of Units M.K.S. SI and C.G.S. Systems and also the definition for meter.	Students observe the chart	(ILL) (CC) (MR)

Observation Schedule

Skill: Probing Questioning

Name of the Teacher-Trainee :

Name of the Observer :

Subject : Physical Science

Class : VIII

Unit : Measurement

Topic : Unit of different Systems

Date : Time : Duration: 6 mts

The skill of probing questioning comprises of the components of behaviours of seeking further information, redirecting, refocusing and developing critical awareness.

The components are:

5. Prompting (P)
6. Seeking Further Information (SFI)
7. Refocusing (RF)
8. Redirecting (RD)

9. Developing Critical Awareness (DCA)

1. Prompting (P)

Questions where there is a hint for the pupil(s) which helps in reaching expected response.

2. Seeking Further Information (SFI)

Dealing with an incomplete response situation and partially correct response situation consists of eliciting additional information from the responding pupil t bring the initial response to the expected response in more complex and novel situations.

3. Refocusing (RF)

Questions which seek the pupil to compare the phenomenon in his response with other phenomena either for similarity or contrast or for any other relationship.

4. Redirecting (RD)

For more students involvement and to deal with ‘no response' incomplete response' and ‘partially correct' response, the same question is redirected to more students fro response.

5. Developing Critical Awareness (DCA)

This involves asking ‘why' and ‘how' of the correct response. The teacher expects the pupil to justify his response or explain its rationale. This process develops his critical awareness.

SKILL OF PROBING QUESTIONING

Micro Teaching Lesson Plan No. 4

Skill: Probing Questioning

Name of the Teacher-Trainee :

Subject : Biological Science

Class : VIII

Topic : Non-renewable Resources

Date : Time : Duration: 6mts

Teaching Points:

1. Types of fuel.

2. Coal formation in earth.

Steps	Teacher's activity	Student's activity	Components
1.Introduction	Good morning students	Good Morning sir	
	How are you?	Find thank you sir	
2. Presentation	Ramu, how do you cook your food?	With Kerosene, gas and with wood etc.	(DCA)
	Which fuel is used in rail engine?	Coal, electricity, diesel etc.	(RF), (DCA)
	Good which fuel is used in scoters?	Petrol	(SFI)
	Where do you find the coal?	In the deeper layers of the earth	(DCA)
	Ok Where is coal mined out?	Coal is mined out from coalmines	(DCA), (RF)

	Where do we find coalmines in AP?	Singareni, Godavarikhani, Bhoopal pally, Man chiryal etc.	(DCA), (SFI)
	In which states do we find coalmines?	Bihar, Orissa Madhya Pradesh, and Andra Pradesh	(DCA), (SFI)
	Do you know how the coal is formed?	Yes, the coal is formed from dead plants	(SFI), (RF)
	What is that process called?	Destructive distillation and Carbonification	(SFI), (RD)
	How were the large tracks of forestland buried in earth?	Due to Volcanic activity and earthquakes	(DCA), (RF)
	How long was the dead plant buried?	For Several thousands of years	(DCA)
	How did the moisture squeeze out from the buried plants	The moisture was squeezed out due to the weight of rocks and great pressure exerted by soil on the buried plants.	(DCA), (RD)
	Was oxygen available in the deeper layers?	No, Oxygen was not available in the deeper layers	(SFI)
	What results from intense heat and pressure and absence of oxygen in the deeper layers of earth?	The plants were burnt partially and were converted into coal.	(SFI)

3. Conclusion	To day we discussed how the coal is formed and where it is available	Thank you, Sir.	

Observation with Rating Scale

Skill: Probing Questioning

Name of the teacher - trainee:

Sl. No.	**Components**	**Tallies**	**Rating of Performance**						
			Not at all						**Very much**
1.	Prompting (P)		0	1	2	3	4	5	6
2.	Seeking Further Information (SFI)		0	1	2	3	4	5	6
3.	Refocusing (RF)		0	1	2	3	4	5	6
4.	Redirecting (RD)		0	1	2	3	4	5	6
5.	Developing Critical Awareness (DCA)		0	1	2	3	4	5	6
	Total		**0**	**1**	**2**	**3**	**4**	**5**	**6**

8.10 SKILL OF DEMONSTRATION

A demonstration is a showing. The demonstrations may be set up on a demonstration table which is usually kept in an elevated place so that all can closely watch the demonstration. It is an activity or process of teaching involving the showing of specimens or experiments to explain and describe the concerned concept, idea, teaching point etc., in the teaching learning process. This process makes the subject matter concrete with the real life satiations.

The Components are,

1. Appropriate Topic, Concepts, Ideas and Teaching Points (A)

2. Sequence, Order of Presentation (SOP)
3. Adequacy of Manipulative Skill (AMS)
4. Creation of Appropriate Situation (CAS)
5. Generalization (G)

(1) Appropriate Topic, Concepts, Ideas and Teaching Points (A)

It should be Appropriate to the Topic, Concepts, Ideas and Teaching Points.

(2) Sequence, Order of Presentation (SOP)

The sequential procedure in presentation of material indicates better preparation of the teaching learning activity.

(3) Adequacy of Manipulative Skill (AMS)

In the demonstration of experimentation the instruments or equipments should be repeatedly displayed in the teaching learning process.

(4) Creation of Appropriate Situation (CAS)

In the demonstration process appropriate physical situation with proper aids, instruments, diagrams, gestures etc., should convey the idea appropriately.

(5) Generalization (G)

Whenever the demonstration comes to an end, the teacher should conclude the theory and frame a rule or a principle. It can be called as generalization.

Micro Teaching Lesson Plan

No. 5 Skill: Demonstration

Name of the teacher trainee :

Subject : Physical Science

Class : VIII

Concept : Archimedes Principle

Date: Time: Duration: 8 mts

Teaching points:

8.10.1.1When a body is wholly or partially immersed in a fluid it experiences an upward thrust equal to the weight of fluid it displaces.

8.10.1.2 Weight of a body in the air is more than its weight when immersed in water.

8.10.1.3 When a body is immersed in water it displaces the water equivalent to its volume.

Steps	Teacher's activity	Student's activity	Components
1. Introduction	Good morning children	Good morning, Sir	
	How are you children?	Fine thank you, Sir	
2. Presentation	Does any one know swimming?	Yes. I can swim,Sir	CAS
	O.K. what do you feel when you dip in water?	I feel that I have lost some weight	CAS
	Today we discuss these phenomena and prove that result	Archimedes Principle	A
	Which Principle will explain this factor		
	CHART ARCHIMEDIS PRINCIPLE When a body is wholly are partially immersed in a fluid it experiences an upward thrust equal to the weight of the fluid it replaces		

	The teacher asks a boy to find out from the chart what apparatus are required for the experiment.	1. Spring balance 2. Stone 3. a vessel full of water 4. an empty vessel	SOP
	(The teacher explains the process) first we weight the stone in air, then we take a vessel and weigh it, we immerse the stone in water and note down the weight, we collect the overflowed water and weigh it; and then we verify the result.	Students observe it	SOP, CAS
	The teacher calls a boy to come to the dais, and asks to weigh the stone using the spring balance, and asks what does it read?	W1 gram	AMS
	The teacher takes an empty jar and asks the boy to weigh it.	W2 gm	SOP
	Then he asks the students to immerse the stone in water by means of a thread, and asks to read its weight on the balance.	W3 gm	AMS
	Then he asks the student to weigh the overflowed water along with the vessel	W4 gm	AMS
	The teacher asks "which weight is	In air	

	more, weight in air or weight in water?		A
	What happened when the stone is completely immersed in water	It appeared to lose some weight	SOP
	How much does it lose?	W1-W3	SOP
	What is the weight of empty Vessel?	W2	SOP
	What is the weight with water?	W4	SOP
	What is the weight of water alone?	W4-W2	SOP
	Compare the results W1-W3, and W4-W2 and what is your inference?	They are equal	G
	The teacher concludes that the weight appeared to be lost by stone when immersed in water is equal to the overflowed water collected in the jar, the water, which is displaced by the stone.	Thank you, Sir.	G

Observation with Rating

Scale Skill:

Demonstration

Name of The Teacher - Trainee :

Name of The Observer :

Subject : Physical Science

Class : VIII

Concept : Archimedes Principle

Date: Time: Duration : 8 min

Sl. No	Components	Tallies	Rating				
			Poor	Below Average	Average	Above Average	Excellent
1.	Appropriate topic, concepts, ideas and teaching points (A)		0	1	2	3	4
2.	Sequence order of Presentation (SOP)		0	1	2	3	4
3.	Adequacy of Manipulative Skill (AMS)		0	1	2	3	4
4.	Creation of Appropriate situation (CAS)		0	1	2	3	4
5.	Generalization (G)		0	1	2	3	4
	Total						

8.11 SKILL OF USING BLACKBOARD

Blackboard is the powerful teaching aid to teach from schooling to higher education and the blackboard as a visual aid is widely used in all sectors of education and training. The development of ICT is reducing the chalkboard work. A good blackboard work brings clearness in perception and it can be suitably used for displaying notes and diagrams during a lesson.

The components of the skill of use of blackboard are:

1. Legibility (L)
2. Size and Alignment (S.A)
3. Highlighting Main Points (HMP)

4. Utilization of the Space (US)
5. Correctness (C)
6. Position of the Teacher (PT)
7. Eye Contact with Pupils (ECP)
8. Cleaning of Blackboard(CB)

1. Legibility (L)

The teacher should see that a clear distinction is ensured between every letter adequate Space is maintained between individual letters and words etc., to make handwriting more legible.

2. Size and alignment (SA)

In black board writing the size and alignment of the letters is very important. The letters should be uniform. The size of the capital letters should be as nearly vertical as possible with out being diverged from a line.

3. Highlighting Main Points (HMP)

The teacher should underline to highlight the main points or words on the blackboard. Colored chalks should be used suitably to draw the learners attention to the main points.

4. Utilization of the Space (US)

Overwriting on the letters should be avoided as it makes the blackboard work untidy. Only essential material should be retained on the blackboard.

5. Correctness (C)

The teacher should be careful about correct spelling, punctuation, grammar, etc, in constructing sentences on the blackboard while writing on the blackboard, inadequate knowledge of English grammar or mistakes done by the teacher reduces the attentiveness of the learners in the class room.

6. Position of the Teacher (PT)

At the time of writing, the teacher should stand on one side of the blackboard at an angle of 45 degree, so that the written work in the Blackboard is visible to the learners.

3. Eye Contact with Pupils (ECP)

The teacher should maintain eye contact with his learners at the time of writing on the board. This maintains discipline and sustains the attention of the learners.

8. Cleaning of Blackboard (CB)

A Teacher should clear the blackboard from top to bottom and not spread dust in the room. After completion of the lesson, the teacher should clean the entire blackboard before leaving the classroom.

8.11.1 Micro Teaching Lesson Plan No. 6

Skill: Use of Blackboard

Name of the teacher - trainee	:	
Subject	:	Physical Science
Class	:	VIII
Concept	:	Balancing Chemical Equations

Date : Time : Duration : 6 mts

Teaching Points

8.11.1.1 Formation of Magnesium Oxide.

8.11.1.2 Formation of Ammonia.

8.11.1.3 Number of atoms on protestant side and reactant side must be equal.

Black Board

Balancing Chemical Equations

Date :

Subject :

R. No.

Class :

Topic :

Formation of Magnesium Oxide	Formation of Water
1.$Mg+O_2$->MgO	1. $H_2+O_{2->}H_2O$
2.$Mg+1/2O_2$->MgO	2.$H_2+1/2O_2$->H_2O
3.$2Mg+O_2$->2MgO	3. $2H_2+O_2$->$2H_2O$

Steps	Teachers activity	Students activity	Components
1. Introduction	Good Morning Children	Good Morning Sir	ECP
	How are you children?	Fine thank you Sir	ECP
2. Presentation	To day we discuss balancing the chemical equation (He writes in the middle of the Blackboard)	$2H_{2+}O_2$->$2H_2O$	L,US,C,SA
	What happens when magnesium is burnt in Oxygen?	Magnesium Oxide is formed	ECP
	Ramana, how do you write the equation?	Ramana writes on the blackboard $Mg+O_2$->MgO	L,C,SA
	How many Magnesium atoms are there on product side?	Same	ECP
	How many atoms of Mg are there on the reactant side?	One	ECP
	How many Oxygen atoms are there on the reactant side?	Two	ECP
	Are they equal?	No	ECP
	How to make them equal?	By taking half of Oxygen	ECP

		molecule	
	Write the equation on B.B.	$Mg+1/2O_2->MgO$	L,USA
	O.K, but molecules exist in whole numbers, How to balance the equation?	By multiplying with 2	ECP
	Now write the equation on B.B?	$2Mg+O_2->2MgO$	C,SA
	Write the equation of formation of water	$H_2+O_2->H_2O$	C,SA
	How many atoms of Hydrogen are present on the reactant side and product side	Two	ECP
	How many atoms of oxygen present on the products side?	One	ECP
	How many atoms of Oxygen are present on the reactant side?	Two	ECP
	Are they balanced?	No sir	ECP
	Balance the equation as per the previous example?	$H_2+1/2O_2->H_2O$ $2H_2+O_2->2H_2O$	US,SA PT
	Showing B.B repeats the formation of Magnesium	Students observe it	HMP
	Oxide and water as main points		
	Well try one more example. Write the chemical equation of formation of ammonia?	$N_2+H_2->NH_3 1/2N_2+3/2H_2->NH_3$ Multiplying by two	C,US,SA,PT

		$N_2+3H_2->2NH_3$	
3. Conclusion	The teacher cleans the blackboard, and wishes Good day children.	Thank you Sir	PT,CB

8.11.2 Observation with Rating Scale

Skill: Use of Black board

Name of the teacher - trainee :

Name of the observer :

Subject : Physical Science

Class : VIII

Concept : Balancing Chemical Equations

Date: Time: Duration: 6 mts

Sl. No.	Components	Tallies	Poor	Below Avg.	Avg.	Above Avg.	Excellent
1.	Legibility (L)		0	1	2	3	4
2.	Utilization of the Space and Alignment (USA)		0	1	2	3	4
3.	Size and Alignment (SA)		0	1	2	3	4
4.	Highlighting Main Points (HMP)		0	1	2	3	4
5.	Cleaning of Blackboard (CB)		0	1	2	3	4
6.	Correctness (C)		0	1	2	3	4
3.	Position of the Teacher (PT)		0	1	2	3	4
8.	Eye Contact with Pupils		0	1	2	3	4

	(ECP)						
	Total						

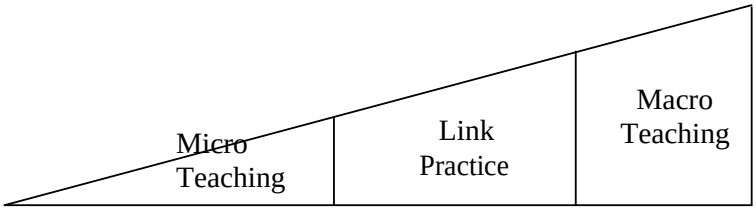
8.12 NEED FOR LINK LESSON IN MICRO TEACHING

There is a very big contrast between micro teaching and macro teaching (Full class teaching). Micro teaching is kind of a scaled down teaching process in terms of using teaching skills, content and strength of the class and time duration. But macro teaching is totally different from micro teaching in the form of content, class size and all other skills. Hence the bridging the gap between micro teaching and macro teaching is essential.

After getting training in different Micro teaching skills, the teacher trainees should integrate those single skills. For this purpose ‘Link lesson practice' is essential ‘Link (lesson) practice' is the term used to bridge the gap between micro teaching and macro teaching. It normally involves the integration of all the skills.

In Link practice the trainee practices 3 to 5 teaching skills together and observations are made on components of the selected teaching skills by his peer group and the experts.

Diagram showing the various stages of teaching practice.



1.	Time	:	5-10 mts	20-25 mts	40-45 mts
2.	Class Size	:	5-10 students	20-25 students	40 and above
3.	No. of skills	:	1	3-5	All the skills

In the link practice, trainees gain sufficient control over the use of the components of the skills particular to the topic.

At the end of link practice, the trainee should have a review with the supervisor. This will help the trainee to handle the lessons in the macro situations effectively.

8.13 LET US SUM UP

You have studied the concept of micro teaching and it skills which are related with science such as Reinforcement, Stimulus Variation, Explaining, Probing Questioning, Demonstration and the Skill of Using Blackboard. You have learnt about how to make these skills effective by following desirable behaviours and avoiding undesirable behaviours.

In addition to that we have discussed link lesson link lesson practice which can be considered as a bridge between Micro and Macro teaching and studied about the integration of skills in Link practice.

8.14 UNIT - END EXERCISES

1. What is ‘micro teaching'? What are its uses?
2. Explain the concept of ‘micro teaching cycle'?
3. Write a short note on the skill of Demonstration.
4. What is the need for link lesson?

8.15 ANSWERS TO CHECK YOUR PROGRESS

1. Micro teaching device is designed by Allen

2. (a) Role of re-plan in micro teaching cycle.

In the light of the feed back received from the supervisor and peer observers the teacher trainee re-plans here the Micro-lesson by writing another micro-lesson plan or modifying the existing one.

(b) Do you think that we can teach a single concept within 6 mts?

Yes, certainly we can teach a single concept within 6 mts in a nutshell. Then only we can be precise and compact towards the content.

3. What are the desirable behaviours in the Skill of Reinforcement?

Positive verbal Reinforcement and positive Nonverbal Reinforcement are the two

desirable behaviours in the skill of Reinforcement.

4. (a) What is the use of Stimulus Variation?

Stimulus Variation is an important process in a classroom teaching Variation in stimulus secures more attention among the students. This can be considered as a deliberate change in the attention drawing behaviours of the teacher in order to secure pupil's attention towards the lesson.

(b) Write down the Interaction Patterns in the Classroom

1. Teacher <-> Pupil
2. Pupil <-> Pupil
3. Teacher <-> Group

5. (a) Define the Skill of Explaining

Explaining can be defined as the use of interrelated statements about a concept, phenomenon, generalization, procedure, function and reason with a view to providing its understanding to some one else.

(b) What is the role of the component Compare and Contrast (CC)?

While teaching different concepts, one should note that some of them are closely interrelated. There may be some similarities and dissimilaries between them. This component serves the purpose of discriminating between two related but different concepts.

6. How will you stimulate pupils to complete their responses?

We can ask following questions to motivate them to complete their responses.

i. What more can you add to your response?
ii. State your answer in other words.
iii. Will you please elaborate your answer?
iv. How can you make your answer more clear?
v. Add some examples to support your response.

7. (a) Write down the undesirable behaviour in the Skill of Demonstration

Inappropriate topic and illogical order in the presentation don't allow the students to participate.

(b) Demonstration is a showing.

8. (a) Write down the components of the Skill - Use of Blackboard.

1. Legibility (L)
2. Size and Alignment (SA)
3. Highlighting Main Points (HMP)
4. Utilization of the Space (US)
5. Correctness (C)
6. Position of the Teacher (PT)
7. Eye Contact with Pupils (ECP)
8. Cleaning of Blackboard (CB)

(b) What should be the position of a teacher while using Black board?

At the time of writing, the teacher should stand on one side of the black board at an angle of 45 degrees. So that the written work on the blackboard is visible to the learners.

9. (a) Link Practice is the term used to bridge the gap between micro teaching and macro teaching.

(b) The link practice sessions are normally arranged with about 20 students and for about 20 minutes.