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PEDAGOGY OF BIOLOGICAL SCIENCE

Unit I	**Nature and scope of science**
Unit II	**Planning for Science Teaching**
Unit III	**Methods and Techniques of Teaching**
Unit IV	**Learner Centred Teaching Method**
Unit V	**Science Curriculum**
Unit VI	**Science Laboratory**
Unit VII	**Resource for Teaching Biological Science**
Unit VIII	**Educational Technology**
Unit IX	**Science Teacher**
Unit X	**Evaluation**

UNIT 1

Objectives

i) Explain the concept of science

ii) Classify the thrust area of science

iii) Describe the importance of science in modern communities

iv) Justify the including the science as the subject

Identify the aims of teaching biology at different levels

UNIT II

i) Define Microteaching

ii) Explain the concept, characteristics, procedure of micro-teaching and link practices

iii) Identify the ways of training in teaching skills.

iv) List the components of micro teaching.

v) Analyse various aspects of the skills namely stimulus variation, probing questioning, reinforcement, explaining and illustrating with examples.

vi) Understand the objectives of teaching biology.

vii) Explain the Bloom's taxonomy in class.

viii) Application of Bloom's taxonomy in class room teaching.

ix) Relate the concepts of developing year plan and unit plan

x) Explain the development of improvised apparatus.

xi) Describe the selection and use of teaching aids.

UNIT III

i) Identify the different approaches of teaching

ii) Compare and contrast between Inductive and Deductive methods of teaching

iii) Organise various types of teaching

iv) Organise the projects

v) Explain the merits and demerits of different approaches of teaching

UNIT IV

i) List out the individualized instructions.

ii) Prepare CAI Packages and programmed learning materials

iii) Explain the various activities in team teaching

iv) Explain the concepts of E-learning.

v) List out the steps involved in scientific attitude

vi) Explain the procedure of planning ABL and ALM learning strategies.

vii) Compare and Classify the steps involved in co-operative and collaborative method.

UNIT V

i) Differentiate the concepts of syllabus and curriculum

ii) List out the principles involved in curriculum

iii) Compare and contrast the NCERT curriculum and curricular projects BSCS.

iv) Identify the local resources of curriculum construction

UNIT VI

i) Explain the structure and design for science laboratory.

ii) Applications of safety measures in science laboratory.

iii) Explain the types of science laboratory.

UNIT VII

i) Explain the innovations in teaching biological science

ii) Preparation of improvised apparatus.

iii) Describe the significance of improvised apparatus.

iv) List out the improvised experiments.

UNIT VIII

i) Explain the meaning of educational technology.

ii) Differentiate hardware and software aspects of educational technology.

iii) Describe the audio visual aids in education

iv) List out the merits and demerits of projected and non projected aids.

UNIT IX

i) Give an account on special qualities of a science teacher.

ii) Describe the professional development of a science teacher.

iii) Jutify the significance of in service training

iv) Explain the Flander's interaction analysis

UNIT X

i) Explain the meaning of evaluation

ii) Distinguish between formative and summative evaluation

iii) Preparation of blue print

iv) Preparation of test items

v) Explain the scoring procedure

vi) Finding the measures of central tendency

vii) Finding the measures of variability

viii) Find the correlation co-efficient

Unit I

Nature and scope of science

Meaning

Today when the society is a state of daze with the scientific achievements like rockets atomic power, space travel etc, at the same time every individual is finding ways and means to get rid of superstitions, save himself from the clutches of destruction and misuse of atomic power. By saving the mankind in from destruction, the knowledge of various functions of plant, animals and human beings has brought biology in the category of higher sciences of the useful type. Biology helps in the control of natural calamities like diseases, wars, famine and increase of population. Biology eradicates our natural doubts e.g. how is a child born? How does a chick hatch from an egg? Why do children resemble their parents? Why does the body become feeble in old age? In what forms is energy present in the food? How does a plant obtain food and how does it breathe? Etc-etc.

Definition of biology

In order to define Biology, the meaning of science will have to be understood, 'Science is a systematic study of the facts and discovery of the reason of a happening'. Lamark and Treviranus were two scientists of 1802AD, who had given the name 'Biology' to the systematic study about the creatures/living things.

Biology is formed by the synthesis of two Greek words 'Bios' and 'Logos', 'Bios'. Means 'Life' and 'Logos' is 'Discourse' or 'study'. Thus biology is also known as science of life today.

The advent of biology took place when man came in contact with the forests. He was dependent for his living on the plant was and animals. For diseases and wounds, he depended on herbs and for food on animals and plants.

Science is the activity where truthfulness is obviously an essential condition for success. Its success in fact is measured by its truthfulness. –J.W.N. Sullivan

What is science and how does it grow are the basic questions which all students of science must understand. Science the very dawn of civilization, man was curious to know about the things around him. The curiosity of man is to know about the things around him. The curiosity of man to know about nature and unveil its mysteries led to the establishment of certain knowledge based upon facts. He also tried to understand its laws and utilize them to his daily life. Genius persons, by their persistent efforts, careful experimentation and exact reasoning have collected a mass of information.

What is science?

There is no one definition of science which is universally accepted. There are, perhaps, as many definitions of science as there are scientists. We shall discuss some of the definitions in order to understand the nature of science.

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 modification in the light of further empirical observations. Science is both a body of knowledge and the process of acquiring it.

Science is an accumulated and systematized learning in general usage restricted to natural phenomenon. The progress of science is marked not only by an accumulation of fact, but by the emergence of scientific method and of the scientific attitude.

Henri Poincare explains the idea that way: “science is built of facts as a house is build of stones; but an accumulation of facts is no more a science that a heap of stones. “The true nature of science is revealed more in the way it is sought rather than in what is found, although the two efforts cannot be truly separated. In another way, it could be said that science is more a verb than it is a noun. Science is the cyclic enterprise consisting of the formulation of model or explanation from facts which in turn predict the occurrence of modern science teaching.

Science can also be defined in terms of what scientists do or in other words. “Science is what scientists do”. But in order to understand this unsuspected fact. If these new facts are indeed found, the value of the model is increased. If the facts are not found, the model is changed, and new model is suggested to predict new fact and so on. Definition of science we have to understand how scientists work. There are at least there basic things that the scientists do. They are briefly discussed here.

1. **Scientists make descriptions:** The scientists in different fields search for the answers to questions such as what is in the universe. How many? How much? How long? How frequently? Where? When? Under what circumstances etc. the scientists try to describes the phenomena in nature and establish relationships. In order to do that they use what we call the scientific method. The descriptions made by one scientist on the basis of his observation’s and critical thinking are open to verification and change by other scientists.
2. **Scientists make explanations:** The scientist aster having described an event or phenomenon, attempt, to find out the ‘reason’ or ‘why’ such event and phenomenon occur the way they do. This usually involves careful observation of interactions and inter-relationships between different things and the conditions under which such phenomena occur. In other words, an explanation is a very careful description which involves knowledge of the different factors or variables. For example, to explain why water evaporates from an open dish requires knowledge about the physical structure of water, the nature of molecular action, the capacity of air to hold water molecules, the behavior of water molecules when heat energy is increased, and the like.
3. **Scientists make predication:** extending our knowledge to new situations involves predication. For example, we observe that water in an open dish evaporates faster when wind is blown over it. We may predict that it will also evaporate faster when placed near a warm heater. We test it. If it principles that apply in one situation will apply in another. Making use of a concept of generalization or law in a situation which has not yet been tested involves predictions.

Thus, scientist uses ideas of their own and of others as tools for testing and gaining knowledge. They use many resources to get valid answers to their questions and problems. They design their own experiments and invent new tools with which they observe and check different phenomena. In other words, science can be defined as 'the process by which we increase and refine understanding of ourselves and of the universe through continuous observation, experimentation, application and verification.

Nature and structure of science

The questions that a scientist asks are what and how of a phenomenon. He cannot answer why questions which are matters of religions and metaphysics. A science teacher may ask 'How do blood corpuscles keep mammals alive? But not "Why do mammals have red blood corpuscles?

Nature of science

From definitions three basic principles of the nature of science can be identified (1) an accumulated and systematized body of knowledge, (2) the scientific method of inquiry, and (3) the scientific attitudes. The first point indicates the product of science, while second and the third points indicate the process of science. In other words, science is both a product and a body of knowledge that has been accumulated by scientists, and the process in which they acquire this knowledge.

The body of scientific knowledge

The body of scientific knowledge can be classified into facts, concepts, generalizations, theories and laws. These form the structure of science which has been discussed in the later part of this chapter.

The process of science

The second dimension of science is the process by which knowledge is acquired. In an attempt to define processes of science, the American association for the advancement of science (AAAS) asked scientists to say what they actually do. The following list of thirteen processes came from this inquiry.

(i) Observation (ii) classification (iii) number relations (iv) measurement (v) space/time relations (vi) communication (vii) prediction (viii) inference (ix) making operational definitions (x) formulating hypothesis (xi) interpreting data (xii) identifying and controlling variables (xiii) experimenting.

Major thrust areas of biological sciences

Along with satisfaction of intellectual curiosity, the aim of biology is the survival and welfare of man. The knowledge of plants, animals and of his own body has contributed to human welfare from his early animal behavior. There are four chief problems of human race: (i) diseases, (ii) wars, (iii) over population.

From man's point of view, biology is the most fundamental and important of all science. Developments in biology affect vital state polices on matters like conservation of natural and human resources, radiation experiments, population control, quarantine and health programmes. Biology also helps us to answer such personal questions as: what determines sex? How are twins born? Why do babies resemble their parents? How do we acquire immunity against diseases? Why do we become enfeebled in old age? Sanitation, nutrition, pest control and other attributes of intelligent citizenship, all require knowledge of biology.

Thrust areas of biological science

Thrust of biological science may be seen in the following areas of modern life:

1. Population explosion- expanding population is the root cause of unhappiness and war. Japan joined Second World War to find additional land for its population. Germany declared war with Russia as it had eyes on the vast wheat fields of Ukraine.

It is estimated that in the Stone Age, there were only 10 million people in the world. Around 4000 B.C., when Mahabharata war took place, the world population was 1000 million. It increased to 200 million when Christ was born; today it has grown to more than 6000 million. Three new babies are being born every second who means 180 new babies to feed every minute. In India an average couple has four children. With this rate of growth in population, the population of the world will be 25 million of millions in the next 600 years. There will be just about 5 square meters of land for each person to stand on. The situation is more tragic in the sense that rate of population growth is more in already populous countries like china and India.

If we are to survive the population cannot be allowed to increase indefinitely. Biologists have a responsibility in educating people. They have to devise methods of controlling high fertility. There is a need to develop safe contraceptive devices, pregnancy termination methods and drugs, and educating the masses, regarding the magnitude of the problem.

2. The food problem with the increasing population of the world, men must look for ways and means of increasing food supply. This requires an active cooperation of agriculturist, botanists, biochemists, zoologists and genetics. The role of biology in connection with food problem can be considered under the following heads

i) Growing healthier crops increase in agricultural produce needs high yielding varieties, necessary fertilizes and earth surface to grow crops. As land surface cannot be increased, we have to use improved varieties of the crops, fertilizers and better tools and techniques of farming to increase our production. A lot of work has been done in the fields of soil chemistry, plant breeding and production of nitrogenous and other fertilizers artificially. Production is low in India as agricultural practices are traditional, in America, one farmer produces food for himself and 25 other people. In India, most of the population is engaged in farming but people still starve at times. Indians can double or triple grain production, without clearing more forests. This requires soundly trained biologists and an agriculturist who may develop better varieties of crops and educate the masses about application of fertilizes and better agricultural practices.

ii) New sources of food- botanists study the process of photosynthesis in detail. It is estimated that out of the total light energy falling on plants, only 0.5% is utilized by crops on the average and only 2% by the best crops. Most of the light falls on the ground. Much of the organic matter produced is inedible. Experiments in America to located new sources of food show that chlorella can utilize 20% of light energy falling on it and the whole of plant is edible. It is estimated that a cadre can produce 40tpns of dry matter out of which 20 tons is protein. But farming of chlorella involves technical difficulties and is impracticable. Growing of anabaena and nostoe can be more useful as they can also fix nitrogen from the atmosphere. All this requires a change in food habits.

iii) Improving live stock- though India cattle production is the largest in the world, there is inefficiency in live stock management. A cow in Netherlands produces 10kg. Milk per day but in India it is ¼ Kg. Religious sentiments in India demand retention of useless cow for the entire life period. India poultry also needs improvement. Scientific methods should be adopted to grow fish and meat producing animals. Our non-vegetarian eating habits require more land to be cultivated. It requires about seven times of the land required to grow food in the form of meat, egg, milk and poultry. If people make adjustments, much land can be freed from inefficient production of live stock and poultry.

3. Conservation of natural resources-the forests buried millions of years ago provide us with the coal and oil that power much of our industry and home comfort. Today's forests give us timber for furniture, raw material for paper industry, rubber, drugs, gums, resins, turpentine and camphor etc. they also help in distributed rains and check soil erosion and floods. But most forests have been cleared for making towns, cities, farming and early money making projects. The need of forests has been recognized by biologists and national policy makers. In India the central as well as state governments employ hundreds of men to conserve forests. Extensive areas are being replanted with trees. Attempts are being made to eliminate insect pests and fungal diseases.

   The clearing of forests has led to the extinction of several species of plants and animals as that of ferns, conifers, birds and mammals. Tigers, manned lions and wild elephants are becoming extremely rare in India. Zoologists estimate that one species of mammal is becoming extinct every year somewhere in the world. Knowing the importance of forests and wild life in the balance of nature, most countries maintain wild areas designed as national forests and national parks where hunting and other similar activities interfering with animal life are banned.

4. Health and nutrition – to live active and efficient life, it is absolutely necessary to remain healthy and free from hazard of ill nutrition and diseases. In India average life expectancy is 41.2 years. There is maximum death rate in the world due to several diseases like cholera, pneumonia, typhoid, tuberculosis etc. one out of every four children is born dead. We face diseases due to ill nutrition on a large scale.

Biology has contributed a lot in the field of medicine. Today we have several life saving drugs like antibiotics such as penicillin, streptomycin, Chloromycetin, etc. sulpha drugs, antiseptic surgery and blood transfusions etc. we know several vitamins and proteins that check deficiency diseases. But in Indian villages, people still believe that diseases are caused by ghosts, which craft and due to wrath of gods.

Biologists and government personnel should educate people insanitary habits and control of diseases and a scientific attitude towards their cause. In U.S. A. and Denmark, life expectancy is about 70 years and death rate has been reduced to one third.

Trained biologists may be employed in sewage disposal and water supply departments and for checking food adultrations, so that health hazards may be avoided in large cities. Medical facilities should be extended to the villages. There should be education for the masses regarding sanitary habits and planned diet so that health of a large section of population may be improved.

Improvement of plants, animals and humans – today, there have been great advancements in genetics and plant breeding. Hybridization and selection for diseases, drought, and frost resistance and for increased yield have become usual routine for agriculturists. Since these practices were adopted, the yield of maize, cotton, sugarcane, wheat, rice and of fruits and vegetables has been nearly doubled. Breeding is a rearing process. Never high yielding varieties are in constant demand. We need disease resistant varieties as strains of pathogens are developing constantly and one crop disease resistant today may fall victim to some pathogen tomorrow.

Today induced mutations and cross breeding have produced high milk, meat and egg yielding varieties of domestic animals. Genetics have employed radiation and chemical for inducing mutations. Interspecies and intraspecies crosses are constantly being tried.

The science that deals with improvement of human race is called 'eugenics' and this has two approaches, positive and negative. Positive approach requires selected crosses and discourages the inferior ones. But in our social set-up, it is not possible socially and legally. We cannot improve human race by just allowing healthier and intelligent people to produce children as it has social and legal implications. Pregnancy termination is recommended, when it is expected that a child that will be born, has some disease or disorder.

Check on atomic radiation – a very significant advancement during the 20th century has been exploitation of atomic energy. This energy has been used for large scale generation of power and other economic purposes. It is also used in preparation of nuclear bombs which may explode in seconds and destroy large cities like New York, Moscow and Calcutta in no time. The radiation fall out is more important from biological point of view, as it causes genetic and physiological hazards in the organisms. In Japan, due to the effect of atomic explosions that took place in 2nd world war, deformed babies and still being born. Since the nuclear tests were started, there has been increase in radio-activity in our environment. As experimental testing has been increasing, radio-active pollution has increased. Today we find more radio-activity in organisms than ever before. It may reach the magnitude of affecting human race genetically and physiologically. Radiation biology is the result of necessity of studying organism in relation to radio activity.

Space travel – today space travels are mainly undertaken for military purposes. But satellites and rockets can be used for communication, geophysical survey and fast travel. In the space ships the human passengers face several difficulties like that of low pressure, high temperature, natural radioactivity, gravitational force, jerks, food and oxygen etc. biology have contributed to overcome several of these difficulties, it has been suggested that in order to avoid draining of blood in upper and lower part of the body during landing and take-off, people should lie parallel to the direction of flight so that heart may function normally. Pressurized cabins and pressure-suits have been recommended for high altitudes. Insulators are used for high temperature and radioactivity. Compact food material and compressed oxygen is used in space travels today. Attempts are going on to provide closed ecosystems in the spaceships in which algae like chlorella can recycle the human wastes and provide food and oxygen in the space.

Justification for including science as a subject of study in the school curriculum

Some people opine that biological science should be made a subject of study only up to eight classes that is up to the first eight years of education. After which it should be accorded a place of elective subject. However, several scholars have emphasized on its inclusion as a compulsory subject up to class tenth. The following arguments are given in its favour:

1. Complexity of Knowledge: Knowledge is rapidly exploding in science subjects, which include biological sciences. This knowledge is so extensive and complex that it can be attained and acquired by the students of higher classes only. They would get optimum time to acquire the essential knowledge and proficiency relating to biological sciences.
2. Desirable Basic knowledge: It is not only desirable but also essential to include biological sciences as it would open the path for the students for further higher study and admission into professional courses for further higher study and admission into professional courses for their basic knowledge and proficiency. The students need the knowledge of biological sciences for higher studies and professional courses, such as medical, biotechnologist, pharmacy, veterinary, etc. fields. This knowledge cannot be imparted in classes lower than high school. So, there should be proper arrangement for the inclusion of biological sciences up to class tenth. In fact, it cannot be predicted which student would opt for which professional course in the future. If the student is deprived of the study of biological sciences, several useful courses and professions would be closed to him forever. So, the education of biological sciences up to class tenth should be imparted to all students necessarily, so that they may not have to repent at leisure later in life.
3. Necessity of Comprehension: The scholars opine that the students in classes lower than class tenth are not mature enough to take proper decisions regarding their option of professions for the future, and the field in which they desire to acquire specialty. It is natural for them to have maturity in mental level, viewpoint and interests and their selection. So, the task related to election of subjects should be postponed until after secondary classes, and not prior to it.
4. Essential for progress: At present, due to technological use and knowledge of biological sciences, the world is progressing rapidly. The future citizens of the country should be prepared for it. The today's students are the harbinger of coming tomorrow who should not be deprived of this learning, which is essential for their keeping pace with the progress of the world. So, their study should be included in the

school curriculum for the necessity, welfare and progress of the country considering it very important, so it would be meaningful to impart this knowledge up to class tenth.

Kothari Commission

If the warning given by Kothari Commission at page 451 of its recommendations is kept in view and science teaching is adopted, it would certainly become the foundation for the development and prosperity of the country.

If science has to progress with zeal and it has to acquire a strong place in Indian renaissance, then it has to acquire its 'nutrient factor' in association with cultural or spiritual folds. Science should be inseparable part of our cultural fabric. It is impossible that science roots in our country's soil without having a plant grow outside, and then its clear effect would be visible on the form of our development which has been the characteristics of our spiritual thinking and civilization. Whatever fashion we adopt of science, Indian customs and standards should be reflected from it. It should be remembrance that preconception plays a vital role in thinking and creativity. The way science has developed in the western world (northern world) is not fully right. There are such people also who are unhappy with the imbalanced growth and development of science as related to the welfare and advantages to the whole of humanity. The balance between knowledge and conscience, power and mercy has become unequal. One of the finest scientists of our times, Max Barn has expressed this fear and suspicion. Though I love science, but it appears that is so against history and tradition that it cannot become pervasive in our civilization, the terrible political and military talks and moral degradation that I have seen in my life, cannot be a momentary social weakness, but is the result of scientific progress that is highest intellectual achievement. If it is only this then man would cease to live as a responsible person. If humanity is eliminated by a nuclear war, then it would suffer at the hands of atrocities of dictators by being dull, dumb, and animal-like because they would rule with the help of machinery and electronic computes.

Objectives of Teaching Biology at Different Levels of Education

The objectives of teaching, biology are different for different levels of education. Primary level, secondary level and higher secondary level are the different levels of education. At the primary and secondary levels of education biology is not taught as a separate subject and it is taught with other branches of science, which is called, General Science. The objectives of teaching science are almost similar to those of biology. They are also different for different levels of education. We shall discuss the objectives of teaching sciences at various levels as suggested by the Indian Education Commission (1964-1966).

Objectives at Primary Level

(a) At this level the importance should be on the child's environment- namely social, physical and biological.
(b) In classes I and II the accent should be on cleanliness and formation of healthy habits.
(c) Power of observation should be developed.
(d) In classes III and IV the study should also include personal hygiene and sanitation.

(e) In classes V the children should be taught the Roman alphabets. This is essential as the internationally accepted symbols for the units of scientific measurement and the symbols for chemical elements and compounds are written in the Roman alphabet.

Secondary Level

(a) At this stage the emphasis may shift to the acquisition of knowledge together with the ability to think logically to draw conclusions and to make decisions at a higher level.

(b) Science should be taught as Physics, Chemistry, Biology and Astronomy. A disciplinary approach to science learning instead of general science would be more effective in providing the necessary scientific base to children.

Higher Secondary Level

(a) At this stage science should be to taught as a discipline of the mind and a preparation of a higher education.

(b) At the lower secondary classes, Physics, Chemistry, Biology and earth science should be taught as compulsory subjects.

(c) At the higher secondary stage there should be diversification of courses and provision for specialization.

Unit II

PLANNING FOR SCIENCE TEACHING

Microteaching is one of the most important developments in the field of teaching practice. It is originated in Standard University in 1963. The workers in the centre for Research and development in teaching have evolved and approach to practical teacher-training. it is more analytical method and completely new approach to provide the feedback. It is considered as a mechanism of feedback device for the modification of teacher trainees.

The Origin

A doctoral candidate Leith Achenson got information through a newspaper article about portable video-tape-recorder invented by German scientist in 1961. He was working with Robert Bush and Dvight /Allen who had received a grant to study those experiences which might be relevant a grant to study those experiences which might be relevant for teaching in terms of an innovative teacher-education programme. Achenson saw the possibility of using the video-tape to provide immediate feedback to the teacher trainees in term of what occurred in the demonstration lesson. Achenson saw the possibility of using the video-tape to provide immediate feedback to the teacher trainees in term of what occurred in the demonstration lesson. Achenson and other Standard graduate students started to explore several uses of the portable video-tapes-recorder and its potentiality in modifying the behavior of pupil-teachers towards desired objectives.

The conception

Micro-teaching is like a simulated social skill teaching to provide the feedback to teacher trainee for the modification of teacher behavior. It is training concept that can be applied at various pre-service and in-service stages in the professional development of teacher. Microteaching provides teachers with a provide setting or instruction in which the normal complexities of classroom are reduced in which the teacher gets feedback on his performance.

Basically microteaching is a scaled down teaching encounter in which a teacher teaches in small unit to a group of 5 to 10 students for a small period of 5 to 10 minutes and one teaching skill is practice during teaching. Micro-teaching is a new training design for pupil-teacher which provides an opportunity to practice one teaching skill at a time and with information about their performances immediately after completion of their lesson.

Micro-teaching is a clinical teaching programme which is organized to explore the trainee to an organized curriculum of miniature teaching environment encounter moving from the less complex to the more complex.

The basic principles of micro-teaching are simple. A pupil-teacher teaches a short lesson of about five minutes duration to small group of pupils. At the end of the lesson, the pupils are left and student-teacher discusses the lesson with their supervisor. After a short interval, the pupil-teacher reteaches the lesson with a different group of pupils making use of the feedback from the supervision and attempts to improve this previous lesson.

The definitions

Allen (1966) defines microteaching as a "scaled down teaching encounter in class size and period"

Clift and other (1976) have recently defined "Microteaching is as a teachers' training procedure which reduces the teaching situation to simpler mid more controlled encounter achieved by limiting the practice-teaching to a specific skill and reducing teaching time and class size"

Mc Aleese and Unwin (1970) suggest that the term micro-teaching is most often applied to the use of closed circuit television (CCIN) to give immediate feedback of a trainee teachers performance in a simplified environment but suggest that microteaching is the best viewed as a form of simulated teaching usually incorporating reduced complexity and some feedback placed along a simulation specter ranging from the purely abstract textbook of teaching practice through the actual classroom teaching".

Microteaching is defined as "a teacher-education technique which allows teacher to apply well defined teaching skill to a carefully prepared lesson in a planned series of five to ten minutes counters with a small group of real classroom students often with an opportunity to observe the performance on video-tape"

Salient Features

The above definitions indicate the following features of micro-teaching:

1. It is a real teaching but focuses on developing teaching skills and competencies.
2. It is a scaled down teaching.
    a. To reduce the class size 5 to 10 pupils.
    b. To reduce the duration of period 5 to 10 minutes.
    c. To reduce the size of the topic.
    d. To reduce the teaching skills. A single skill is practiced.
3. It is a highly individualized training device.
4. It provides the feedback for trainees' performance.
5. It is training device to prepare effective teachers.

The Speculations

Micro-teaching is an idea at the core of which lie five essential propositions:

1. Micro-teaching is a real teaching but its focus is on the development of certain teaching skills and not the development of pupils-abilities.
2. Micro-teaching lesson reduces the complexities of normal classroom by scaled down class size, content and time.
3. Micro-teaching focus on training for the development of specific teaching skills. One skill is practiced during course of teaching and brings it up to the mastery level.
4. Micro-teaching permits for the increased control of practice by providing the feedback to the pupil-teachers. A high degree of control can be imposed on the training programme.

5. Micro-teaching greatly expands the normal knowledge of results or feedback to teaching. It is highly individualized training programme.

The Process

Clift and others (1976) have given three phases of micro-teaching procedure:

Knowledge Acquisition Phase: It involves two major activities:

(a) To observe demonstration skills and
(b) To analyze and discuss demonstration

Skill Acquisition Phase: Three activities are performed under this phase in the following sequences:

(a) To prepare micro-lesson
(b) To practice-teaching skills and
(c) To evaluate the performances.

The evaluation activity provides the basis to re-plan the lesson for re-teaching the same topic to practice the same skill.

Transfer phases: After acquiring skills in the second phases the trainees are given an opportunity to use the skills in normal classroom teaching situation.

The micro teaching procedure involves the following steps:

1. A particular skill is defined to trainees in terms of teaching behavior to provide the knowledge and awareness of teaching skills.
2. These specific skills are demonstrated by an expert or shown through video-taped or film to the teacher-trainees.
3. The student-teacher plans a short lesson in which he can practice a particular skill.
4. The pupil-teachers the lesson to a small group of pupils which is observed by supervisor or peers or video-tape or audio-tape.
5. The teaching is followed by discussion to provide the feedback to the trainees. The video-tapes or audio tape may be displayed to observe their own teaching activities by the trainees. The awareness of own teaching performance provides the reinforcement to the pupil-teacher.
6. In the light of the discussion and suggestions the student-teacher replans his lesson in order to practice the same skill effectively.
7. The revised lesson is retaught to different group of same class for the same duration to practice the same skill.
8. The re-teaching is followed by discussion, demonstration suggestions and encouraging the teaching performance. In this way the feedback is provided again to the trainee.
9. The teach-reteach cycle is continued till desired level of skill is achieved. It is the mastery of teaching skill.

The merits

The following are the main advantages of micro-teaching:

1. It is scale down teaching hence it is called micro-teaching.
2. It is real classroom teaching which is used for developing teaching skills.
3. It is highly individualized training device. The cycles of reteaching and replanning are determined by pupil-teacher or teacher-trainee.
4. One skill is developed in one time by reducing the complexity of teaching process.
5. Under this device attempts are made to develop the mastery of teaching skills.
6. There is a provision for integrating skills after developing mastery of teaching skills.
7. It is an effective feedback device for developing teaching skills.
8. An observation technique is used for teaching cycles. The trainee can observe and analyse his own teaching.
9. Under this device demonstration can be down by an expert to improve his teaching skill.
10. The close circuit television (CCTV) is used to provide immediate feedback to the trainee.

The demerits

It has the following limitations.

(1) Teaching is very complex situation but it employs very simple teaching situations. It may not work in actual class.

(2) It requires teaching laboratory or small classes for re-teaching which are not available in our schools.

(3) It is very time consuming device for developing teaching skill. A large number trainee cannot be given such opportunities of re-teaching and re-planning.

(4) It employs more controlled situation with a limited practice-teaching to specific teaching skill.

(5) It deviates from normal classroom teaching for which trainee are prepared. He may not face real situation.

Suggestive Measures

Micro-teaching can be used effectively by employing the following suggestions:

1. Micro-teaching is to best view in the form of simulated teaching incorporating reduced complexity of teaching.
2. In our schools, micro teaching can only be used in simulated conditions. The student-teachers have to play the role of teacher as well as students.
3. Micro-teaching can be used in the actual classroom teaching by reducing the size of topic, duration of time and one skills can be practiced. The size of the class should remain the same it should not be reduced.
4. Under this device attempts are made to move from the less complex teaching to the more complex teaching.

5. More than teaching skills are to be practiced in organizing teaching simulated conditions.
6. The best way that micro-teaching should be incorporated by simulated social skill training. It is highly feasible.

Competent Teaching

Micro-teaching is used for developing certain teaching skills. A teaching skill is defined as a set of teacher behaviors which are especially effective in bringing about desired changes in pupil-teachers. There are various teaching skills which can be developed among pupil-teachers. Allen and Ryans (1969) have suggested the following fourteen teaching skills;

1. Stimulus variation
2. Set induction
3. Closure
4. Silence and non verbal cause
5. Reinforcement
6. Asking questions
7. Probing questions
8. Divergent questions
9. Attending behavior
10. Illustrating
11. Lecturing
12. Higher order questions
13. Planned repetition and
14. Communication completeness

B.K.Passi (1976) has described the following thirteen skills in his book 'Becoming better Teacher –A micro teaching approach'

1. Writing instructional objectives
2. Introduction of a lesson
3. Fluency and questioning
4. Probing questioning
5. Explaining
6. Illustrating with examples
7. Stimulus variation
8. Silences and non verbal cause
9. Reinforcement to students' participation
10. Increasing pupil participation
11. Using Black Board
12. Achieving closure

13. Recognizing attending behavior

The meaning of importance teaching skills has been discussed here:

Stimulus variation: This skill involves deliberate changing of various attentions producing behavior by the teacher in order to keep pupils attentive at high level.

Set Induction: It refers to the development of cognitive rapport between pupils and teacher to obtain immediate involvement in the lesson.

Closure: This skill is complementary to set induction. It is more than a quick summary of the portions taught and the pupils are able to relate new knowledge with the previous one.

Silence and non verbal cause: The use of silence and non verbal cause is powerful device in order to encourage pupil participation in classroom teaching.

Skill of Reinforcement: It involves teacher encouraging pupils response using verbal praise, accepting their responses or non-verbal causes like smile.

Fluency in questioning: This is a skill in asking questions. By fluency means the use of as many questions as possible in a given period of teaching.

Probing Questions: Probing question requires the teacher asks question that need pupils to go beyond superficial first answers of question.

Recognition and Attention behavior: The successful teacher is more sensitive to note the interest of boredom of pupils through visual causes.

Skill of Explaining: An explanation is a set of interrelated statements made by teacher in order to increase the understanding in the pupils.

Skill of Increasing Pupil participation: This skill involves the four components creating set questioning, encouraging pupil activities and pausing in such a way that pupil participation is maximized.

Skill of writing objectives: It involves the following activities identifying objectives, analyzing the task and writing objectives in behavioural terms with regard to adequate learning.

Skill of using Blackboard: This skill requires legibility, neatness appropriateness continuity simplicity of blackboard work. It is very essential skill for a successful teacher. The effectiveness of presentation depends upon the proper use of blackboard.

Skill for class Management: This skill involves a number of activities that a teacher performs for creating and maintain conducive environment for learning in the classroom.

Skill of Using Audio-visual aids: It implies the effective use of appropriate teaching aids to make teaching interesting and desired objectives can be achieved. The effective use of audiovisual aids makes the pupil active and attentive in classroom.

Skill for giving assignment: This skill consists of the pupils to organize and assimilate the learnt material.

Skill of Pacing Lesson: The pacing of a lesson means variation in the teaching speed. This skill involves adjustive devices for satisfying the needs of the pupils or student variation.

The use of higher order questions: This skill involves the questions which can be answered by memory or sensory description. The questions consist of rules, principles, and generalization.

Divergent questions: It requires the respondent to organize elements into new pattern, predict and infer from the situation. This skill involves higher order of thinking creativity.

Lecturing: It requires the effective presentation of content by using appropriate techniques and devices of teaching aids. This is known as communication competency.

Planned repetition: It is a powerful skill in focusing and highlighting important points of teaching.

Competencies of Communication: It is a skill which is developed by sensitivity training for a clear communication of ideas and concepts in teaching. The teachers are more-responsive to possible miscommunication.

Skill	components
writing instructional objectives	Clarity, relevance to the content, adequacy with reference to the domains and level of objectives, attainability in terms of pupil outcomes.
Organising the content	Logical organisation according to content and psychological organisation as per need of the pupil.
Creating set for introducing the lesson	Greeting, accepting creating securing attention and giving instructions, establishing rapport, ensuring facilities like chalk, duster, aids, apparatus etc.
Introducing the lesson	Linking with past experiences, link between introduction with main parts, use of appropriate devices/techniques like questioning, examples, exhibits arousal.

structuring classroom questions	Structuring questions at different levels which are grammatically correct, precise and relevant to content
Question delivery and distribution	Questions delivered with appropriate speed, with proper intonation and pitch , allowing pause for thinking and questions well distributed covering even non-volunteers
Response management	Management of pupil responses using techniques like prompting, eliciting further information, refocusing and asking critical awareness questions, accepting - rejecting, redirection.
Explaining	Clarity, continuity, relevance to the content using beginning and concluding statements, covering essential points.
Illustrating with examples	Simple interesting and relevant to the point being explained.
Using teaching aids	Relevant to content, appropriate to the pupils' level, proper display and appropriate use.
Stimulus variation	Body movements, gestures, change in intonation and pitch, change in interaction pattern and pausing.
Reinforcement	Use of praise words and statements, accepting and using pupil ideas, repeating and rephrasing pupil ideas,. Use of pleasant and approving gestures and expressions, writing pupil answers on the blackboard.

Pacing of the lesson	Adjusting the speed of the lesson to the level of the pupils and difficulty level of the content
Prompting pupil participation	Providing opportunity to pupils to increase participation through asking questions creating climate of participation, use of silence and nonverbal cues, calling upon pupils' physical participation
Use of blackboard	Legible, neat, adequate with reference to the content covered.
Achieving closure of the lesson	Summarization, establishing link between the present learning with earlier as well as future learning, creating a sense of achievement in pupils.
Giving Assignments	Relevant to the content covered and level of pupils.
Evaluating the pupils' progress	Relevant to the instructional objectives. Use appropriate questions and observations
Diagnosing pupil learning difficulties and tasking remedial measures	Identifying learning difficulties along with causes, remedial measures suited to the type of the learning difficulties and the level of pupils.
Management of the class	Attention behaviour reinforced and directions given to, eliminate non attending behaviour, clarity of directions, appropriate handling of pupils disruptive behaviour

Action Oriented Programme

After completing the preparation along the lines indicated above implementation of the programme of micro-teaching in an institution require the following steps.

The Orientation: Orientation of the faculty was envisaged under step above. Now it is the turn of the student-teacher. They need to be given an overview of the concept and procedure of micro-teaching, analysis of teaching skills to be practices and the skill learning strategy. This may be done in an atmosphere of free and fair discussion.

Skill presentation: The teaching skill selected for practice by the student-teachers may be presented. The presentation or the modeling exercise includes discussion about its rationale and role in teaching, its meaning and definition of the allied terms, component teaching behaviours comprising the skill, sample illustrations of the component behaviours , sample micro lesson, plans and observation tools. Materials on selected skills have been provided in the second section of this handbook. Material is available in Passi (1976) and "Special package on core teaching skills" being prepared in the NCERT.

This step is also a part of the modeling. After discussion of the teaching skill the teacher-educator gives a demonstration lesson on the use of the teaching skill. This lesson is observed and the teacher-educator is provided feedback on the lesson based on systematic observation and recording as pointed out.

Preparation of Micro-lesson Plan: the student teacher selects a concept for the preparation of micro-lesson plan. The concept has to be such that it is reasonably amenable to the practice of the skill. The component behaviours of the skill may be made conspicuous in the micro-lesson through labeling in brackets. Samples are available in section two of the handbook. The lesson is confined to six minutes of teaching.

Creating Micro-teaching setting: Seating arrangements for the pupil for practicing the skill, the college supervisor and the peer supervisor may be made. Blackboard, chalk, duster and other materials required for the micro-teacher maybe arranged.

Practice of the skill: The student teacher the lesson for six minutes. The lesson is observed using observation schedule.

Providing Feedback: On the basis of the observations, the student-teacher is provided feedback on his teaching performance. The feedback is provided in terms of his use of the component behaviours comprising the skill under practice.

Replan – Reteach - Refeedback: The student teacher replans his lesson in the light of the feedback received. The lesson is retaught and refeedback is provided as in (f) and (g) above.

Repeat the Cycle to Master: The student teacher repeats the micro-teaching cycle till he attains mastery over the skill under practice. The mastery level will depend upon the efficiency with which he can use it and the time available for practice.

Integration of Skills: The skills are mastered as outlined under step (a) to (i) above. The training in the integration of teaching skills may be provided as indicated in UNIT IV of the handbook.

Instruments of Assessment

The teaching skills being developed through micro-teaching lessons are to be evaluated or observed by the peers of supervisor. The rating schedule is used as criterion measure. The most popular evaluative instrument for assessing the effectiveness of micro-teaching is the Stanford Teacher Competence Appraisal guide (STCAG).

The problem of evaluation of micro-teaching effectiveness is much more difficult. The more important question is whether micro-teaching experiences lead to improve the teaching skills in a normal classroom teaching.

Allen and Ryan (1969) have given all evaluation sheets for assessing the skill of reinforcement. It consists of four dimensions of the reinforcement skills.

1. The correct responses of the students are praised or rewarded by saying ‘fine’, ‘good’ ‘excellent’ etc.
2. The teacher use non verbal cues (smile) to encourage students.
3. The teacher gives credit to students answering a question partly correct.
4. The teacher refers to positive aspects of students’ previous responses.

These dimensions are recorded by the teacher has used to category number of times. The categories are assessed on scales ranging from three to seven points. The STCAG consists of a number of scales rating the broad aspects of teachers’ performances.

The following are the main uses of micro-teaching:

1. It is an effective feedback device for the modification of teacher behavior.
2. The knowledge of practice and teaching skill can be given by the use of microteaching.
3. It is useful for developing teaching efficiency in pre service and in-service teacher-education programmes.
4. The specific teaching skills are developed by the micro-teaching experiences e.g. reinforcement skill, probing question
5. It is a training device for improving teaching practice and to prepare effective teachers or better teachers.
6. The mechanism of feedback device can be combined with other devices such as stimulated social skill training and interaction analysis device which provide continuous reinforcement to the trainee performances.
7. The training of teacher becomes individualized. Each trainee makes progress in developing teaching skills at his own rating depending upon his ability.

8. It permits increased control and regulates teaching practice.
9. Micro-teaching can be done either in real classroom conditions or in simulated conditions

10. It is an economical device and use of videotape enables the trainee to analyse his own teaching performance.

11. It lessons the complexities of the normal classroom teaching by scaled down teaching

12. It focuses attention on teaching behavior to modify and improve in a desired direction.

Quality if Reinforcement

The meaning: While teaching, a teacher encounters a variety of pupil behaviours. Obviously, he would like the pupils' desirable behaviors and criterion responses to be retained and undesirable behaviors to be eliminated. For reinforcing pupil's desirable behavior and criterion responses, he uses positive verbal and non verbal reinforces. These reinforces not only strengthen the pupils' desirable behaviors but also develop confidence in them. Besides they enhance their positive self-concept. Absence of a positive, reinforce for pupils, desirable behaviors may erode their confidence and lead to poor self image. Positive reinforcement encourages pupils to participate actively in classroom transactions. It stimulates them to achieve more thereby creating a sense of achievement.

Skillful management of reinforces helps a teacher to promote pupils learning. The skill of reinforcement refers to the effective use of reinforces. It can therefore be defined as "the effective use of reinforces to modify pupils' behavior in the desired direction"

Skill components: In order to learn the effective use of the skill of reinforcement, it is desirable to specify its component behaviors which are presented in this section.

Positive verbal reinforces can be further divided into two broad categories. The first category includes the use of praise words such as 'good' 'excellent' 'fantastic' splendid' 'right' 'yes! Correct' 'continue' 'go ahead' etc. The second category of positive verbal reinforces refers to a teacher's verbal behavior other than the use of praise words. The statements accepting pupils' feelings, repeating and rephrasing pupil responses, summarizing pupil ideas etc fall in this category of positive verbal reinforces.

Micro-lesson: You have learnt about the specific component teaching behaviors of the skill of reinforcement. Read the lesson given below and identify the components of the skill used in the behavior. Write the components against the teacher behavior in the space provided for the purpose.

Concept : Factors of Production class:IX

Pupil : What are the factors that contribute to production?

Teacher : Yes any other factor.

Pupil :

Teacher nods while the pupil was responding. After pupil's he says very good. Land, water, air and light. So natural resources are important factors of production. But can we have production with the help of natural resources only?

Pupil : No sir

Teacher : Yes what are other factors of production then?

Pupil : Labour.

Teacher : That is right. Do we need skilled or unskilled labour for production?

Pupil : Production can be more with the help of skilled labour. So we need skilled labour.

Teacher :

(Moves nearer to the responding pupil) says very well after the response and also pats him on his back. We therefore need skilled labour for more production. No doubt that natural resources and the skilled labour manpower are important factors of production. But we cannot have production with the help of these things only. We need something more for production. What is that?

Pupil : Production is not possible without capital

Teacher : Smiles and nods when the pupil was responding. After the response was complete says: "you are correct" can you think of any other factor or production?

Pupil : Another important factor of production is management

Teacher : Excellent. Teacher writes on the blackboard 'Management' and then says 'qualitative production'

Pupil : Can the government also help in increasing production?

Teacher : (Addressing the particular student) you have put a very important question. These days the government can help in a number of ways to increase the production like enacting and enforcing laws which may be helpful in production.

Observation Tool

Name of the student Teacher Class……………

Concept Time……………

Session Teach/Reteach Supervisor………

Date …………………

Instructions: The observation schedule cum rating scale for skill of reinforcement comprises three columns. The first column indicates the tallies against different components of the skill. The second column specifies the components of the skill and the third column contains rating from one to seven against each of the components. The points on the scale indicate to following:

1. Extremely weak
2. Very weak
3. Weak
4. Average
5. Good
6. Very good
7. Excellent

Tallies	Component	Rating
(i)	Use of praise words	1 2 3 4 5 6 7
(ii)	Repeating and rephrasing pupil responses	1 2 3 4 5 6 7
(iii)	Use of positive non-verbal reinforces (including extra verbal cues) but excluding writing pupil answers on the blackboard	1 2 3 4 5 6 7
(iv)	Writing pupil answers on the blackboard	1 2 3 4 5 6 7
(v)	Use of discouraging words	1 2 3 4 5 6 7

(vi)	Use of negative nonverbal reinforces	1	2	3	4	5	6	7
(vii)	Inappropriate use of reinforcement	1	2	3	4	5	6	7

Capacity for probing

The meaning: When a question is put in the classroom there are a number of possible pupil response situations such as no response, wrong response, partially correct response, incomplete response or correct response. The skill of probing questioning is going deep into pupil responses through step by step questioning with a view to eliciting the criterion response. Let consider various response situations one by one.

No response situation: no response situation refers to the failure on the part of the pupil to frame and express verbally a response to the question that he required to answer. The opportunity to respond is the essential condition to identify and response situation. Special reference to opportunity for responding has been mentioned because it is observed that teachers tend to think a no response occurrence even without providing opportunity to the pupils to give response. They put questions to the class pause for a few second and taking the silence in the class as indication of no response, start explaining, repeating or restructuring the question. This is an unhealthy practice mid should be avoided. Only after a designated pupil fails to answer we may infer a no response situation.

Micro-lesson plan probing questioning skill

Concept	:	Factors determining the supply of labour in a country
class	:	IX
Teacher	:	What are the factors which determine the supply of labour in our country?
Ramesh	:	Birth and death rates, social traditions and wage level determine the supply of labour in a country.
Teacher	:	Any other factor?
Ramesh	:	I do not know
Teacher	:	If some persons from a village come to your city for seeking employment, what would be its effect on the position of labour supply in your city?
Ramesh	:	It will increase the number of person seeking employment in my city

Teacher	:	If some persons leave your city and go to another city for seeking employment, what would be its effect on supply of labour in your city?
Ramesh	:	It will reduce the supply of labour in my city
Teacher	:	In the light of your answers to these questions now think of any other factor which affects the supply of labour in a country
Ramesh	:	Labour supply in a country gets affected if some people go out of the country or come to that country from another country
Teacher	:	Yes immigration. i.e. coming of people in the country and emigration, going of people out of the country affect the supply of labour in a country. Tell any country where labour supply is on the increase on account of immigration
Ramesh	:	Labour supply in U.K is increasing on account of migration of Asians to that country
Teacher	:	Why are Asians emigrating to U.K?
Ramesh	:	Because of unemployment and under employment in their own countries
Teacher	:	Why has the Government of U.K imposed certain restrictions to check immigration in their country?
Ramesh	:	Because immigrants have affected the supply of labour in U.K. They have affected adversely the employment opportunities of their own people.
Teacher	:	Does the country from where people go to other countries get benefited by such emigration of men and women?
Ramesh	:	Yes it checks the supply of labour in that country
Teacher	:	Any other benefit?

Ramesh : These people usually remit money to their dependents in their home country either in dollars or pounds. The remittance in these currencies improves the foreign exchange resources of the home country.

Observation Tool

Name of the student Teacher…………………….………

Class…………………………………………………..

Concept…………………………..

Duration……………

Supervisor………

Session Teach/Reteach

Date …………………

Instructions: The observation schedule cum rating scale for skill of probing pupil responses comprises four columns. The first column indicates the tallies against different components of the skill. The second column specifies the components of the skill and the third column contains rating from one to seven against each of the components. The rating scale indicates mastery of the different components of the skill. The fourth column is meant for comments. The observer may give the comments when there is any distance of wrong-use of any procedure of probing pupil response or there is any occasion when there is a need to use some components of the skill but the student-teacher failed to use component. The points on the rating scale are:

1. Extremely weak
2. Very weak
3. Weak
4. Average
5. Good
6. Very good
7. Excellent

Tallies	Component	Rating						
(i)	Prompting	1	2	3	4	5	6	7
(ii)	Seeking further information	1	2	3	4	5	6	7
(iii)	Refocusing	1	2	3	4	5	6	7

(iv)	Increasing critical aware	1	2	3	4	5	6	7

Examples of Explanation

Definition of skill : Many a time it happens that a teacher explains in the classroom a scientific principle or a mathematical rule or an abstract idea and observes that his pupils are not comprehending it. In such a situation the teacher attempts to explain the concept or generalization more and more but he fails in his attempt. The concept or generalization requires more than mere explanation for the pupils to understand. This presents a challenge to the teacher. An unskilled teacher may deal with this challenging situation by rebuking the pupils for be inattentive in the classroom and asking them just to memorise the concept or rule. But a skillful teacher handles this situation in a different way. He illustrates the scientific principle, generalization. This makes them easier to understand for the pupils. Obviously examples are one of the most effective tools in the hands of the teacher to make the concept or generalization simple and easier for pupils to understand. Thus examples can be defined as the observation or situations of occurrence of a concept or generalization and the skill of illustrating with examples can be defined as the selection and presentation of the example relevant to the concept or generalization to be taught to the pupils so as to make it easier for them to understand it. The examples of courses may be drawn from the pupil's experiences.

Components of the skill: The next logical question is as to whether all examples make the concept or generalization easier to understand? If not what type of examples are helpful and appropriate in realizing this objective? Experiences with the use of examples for illustrating concepts and generalizations have shown that effective examples have definite characteristics. A teacher should known these characteristics and keep them in mind while formulating examples for illustrating a particular concept or generalization. The component behaviors based on these characteristics are presented in this section.

Micro Lesson plan

Concept	:	Island
class	:	VI
Teacher	:	Pupils open your book of social studies. You may see that there is a map of India. Locate Andaman on this map. What do you find around Andaman?
Renu	:	There is water on all four sides of Andaman
Teacher	:	Yes there is water on all four sides of Andaman. Now locate Nicobar in you map. What do you find around Nicobar?

Raju	:	There is water on all four sides of Nicobar
Teacher	:	Very good. Like Andaman there is water on all four sides of Nicobar. Locate Lakshadweep on the map. What do you find around Lakshadweep?
Ameeta	:	There is water on all the four sides of Lakshadweep
Teacher	:	What is the similarity among Andaman, Nicobar and Lakshadweep?
Ameeta	:	There is water on all the four sides
Teacher	:	What do we call the places which are surrounded by water?
Manjeet	:	No response
Teacher	:	These places are called islands. Now define an island.
Rakesh	:	An island is piece of land which is surrounded by water.
Teacher	:	Can you locate any other island on you map?
Anil	:	Minicoy

Rating scale for the skill of illustrating with Examples

Name of the student Teacher……………………….………

Class…………………………………………………..

Concept…………………………..

Duration……………

Supervisor………

Session Teach/Reteach

Date …………………

Illustrations: The rating scale given below for the skill of illustrating with example comprises two columns. The first column indicates the components of the skill and the second column indicates the rating from one to seven against each of the components. The points on the rating scale indicate the following.

8.	Extremely weak
9.	Very weak
10.	Weak

11. Average
12. Good
13. Very good
14. Excellent

An observation should indicate his rating against each component by encircling the numbers which represents his assessment.

Tallies	Component	Rating						
(i)	Example used were simple	1	2	3	4	5	6	7
(ii)	Examples used were interesting	1	2	3	4	5	6	7
(iii)	Examples used were relevant	1	2	3	4	5	6	7
(iv)	Approach used was appropriate	1	2	3	4	5	6	7
(iv)	Pupil involvement was adequate	1	2	3	4	5	6	7

Varied Stimulation

Meaning of the skill: Learning in the classroom depends to a large extent on the attention of the pupils on the learning task. It is therefore essential for the teacher to secure and sustain pupil attention for making his teaching effective. Continued used of the same stimulus or activity for longer period induces inattention. The same inattention is caused in two ways. Firstly continued focus of the pupils on the same stimulus for a long time restricts his postural mobility. As a result they feel fatigued. Secondly the continued use of the same stimulus for longer duration introduces the element of monotony which brings n dullness. The problem of inattention is further aggravated because of the short span of pupil attention. Their attention tends to shift from one stimulus to another frequently. They find it difficult to attend to one stimulus for more than a few minutes. The problem of inattention is a challenge to the teacher. Unless he is in a position to secure and sustain pupil attention, optimum learning cannot take place. It is therefore essential for the teacher to secure and sustain pupil attention to what he is discussing in the classroom. How to accomplish this task during classroom teaching is a problem that confronts ever teacher?

Concept : Formation of Rainbow

class : VIII

Teacher	:	Some of you must have seen the rainbow. It is like a bow (teacher expresses the shape of the bow with the help of his hands and move to the blackboard). He writes bow and draws it on the blackboard. It appears during…..rainy season before or after rain. We shall study today the phenomenon of rainbow i.e. how is rainbow formed? You have already studied the law of dispersion of light. When a ray of light passes through a prism it gets dispersed into seven colours. What are these colours?
Pupil	:	The colours are violet, indigo, green, blue, orange, yellow and red
Teacher	:	Good formation of rainbow is based on the law of dispersion. Teacher moves to the blackboard and writes dispersion of light. (Teacher comes back to his earlier position) You know that water vapours are in the air. (Teacher again moves to the blackboard and writes vapours and underlines this word to emphasis it.) How do these vapours suspended in air?
Pupil	:	There are dust particles in the air. Water vapours settle on these dust particles and thus remain suspended in the air
Teacher	:	Soon after the rain if the sun rises, these suspended water vapour in the air as prisms. The rays of the sun pass through these suspended vapours in the air. Teacher stresses these words "these suspended vapours" and through the movement of the hand and fingers show how the rays of the sun pass through these suspended water vapours. He then moves to the black board and writes suspended vapours and draws a diagram showing the rays of the sun passing through the water vapours. These rays then get dispersed into seven colours forming a rainbow. Do you always see rainbow after rain?
Pupil	:	No sir it is not seen always after rain

Teacher	:	Why?
Pupil	:	Its formation depends upon the presence of water vapours in the air.(Without commenting on the correctness of the pupil's response
Pupil	:	Besides the presence of water vapours in the air its formation depends upon the angle at which the rays of the sun pass through these water vapours. If they pass through at the critical angle then only the rainbow is formed.
Teacher	:	It is a rare phenomenon. Its formation thus depends upon two factors i.e the presence of water vapours in the air and passing of the sunrays at the critical angle through these vapours. Now each of you may draw a diagram in you exercise work showing the formation of a rainbow?
Pupil	:	(All start working on the given assignment)

Observation Tool

Name of the student Teacher…… Class……………………

Concept………………… Duration…………………

Session……………….. Teach/Reteach………….

Date………………… Supervisor……………….

Instructions: The observation schedule cum rating scale for skill of stimulus variation comprises three columns. The first column indicates the tallies against different components of the skill. The second column specifies the components of the skill and the third column contains rating from one to seven against each of the components. The rating scale indicates the adequacy and appropriateness of the occurrence of the components. The points on the rating scale indicate the following:

1. Extremely weak
2. Very weak
3. Weak
4. Average
5. Good
6. Very good
7. Excellent

Tallies	Component	Rating						
(i)	Movement	1	2	3	4	5	6	7
(ii)	Gesture	1	2	3	4	5	6	7
(iii)	Change in Voice	1	2	3	4	5	6	7
(iv)	Focusing	1	2	3	4	5	6	7
(v)	Change in interaction pattern	1	2	3	4	5	6	7
(vi)	Pausing	1	2	3	4	5	6	7
(vii)	Pupil physical participation	1	2	3	4	5	6	7
(viii)	Visual switching	1	2	3	4	5	6	7

Capacity to interpret correctly

Meaning and definition of the skill: A Pupil is required to learn a number of concepts, phenomena, generalizations, procedures, functions and reasons for certain occurrences. He is to learn about their attributes, constituent elements, relationship and applications. A teacher organizes a number of learning experiences in the classroom towards this end. He uses a number of interrelated statements related to the concepts, phenomena, generalizations and functions with a view to developing in pupils an understanding about them. The set of interrelated statement used for this purpose is termed as explanation and the process is termed as explaining. The term explaining can therefore be defined as the use of interrelated statements about a concept phenomenon, generalization with a view to providing its understanding to someone else.

An explanation to be understood by pupils the explainer has to keep in mind the previous knowledge of the pupils. The previous knowledge refers to the knowledge already possesses by the pupils. Since previous knowledge of the pupils of different grades, cultural background and geographical regions is always different an explanation about a concept which is appropriate for one group of pupils may not be appropriate for another group. The quality of an explanation however depends on the degree of understanding it generates in the explainers.

Micro-lesson plan for explaining skills

Concept : Meaning of consumption

class : XI

Teacher : We have already studied that economics is a study of man related to wealth i.e economic activities of man. These economic activities may be in terms of consumption, production, exchange and distribution. We shall study today the meaning of consumption (beginning statement) Man has wants and these can be satisfied by the used of goods. For instance when an individual is hungry, satisfies his hunger by taking food. He is said to have consumed the food. Similarly (explaining link) a smoker when uses a cigarette and gets satisfaction he is said to have consumed a cigarette. Thus (explaining link) the direct use of goods and services for the satisfaction of human wants is known as consumption. Whenever we consume eatables they lose their utility. Food, rice, fruit and vegetables get destroyed when these are consumed. Therefore (explaining link) some confuse consumption as the destruction of utilities. But (explaining link) this is not so. Sometimes (explaining link) utility of certain commodities are destroyed of their own. For instance (explaining link) when any fruit decays, it loses its utility. A house may catch fire and get destroyed. The decayed fruit and the burnt houses have lost their utilities. But (explaining link) these cannot be said to have been consumed. Because (explaining link) an act of consumption implies satisfaction of human wants. The decayed fruit and the burnt house have not satisfied human want while losing their utilities. Besides (explaining link) goods, services are also consumed. When a person travels in a bus and pays for the ticket he consumes the transport services. A teacher’s services are consumed by the pupils when they learn from him in the school. In the same way (explaining link) a doctor's, a lawyer's and a tax consultants services are consumed by the need consumers who pay fees for their services. Consumption therefore (explaining link) stands for the satisfaction of human wants. A commodity which loses its utility without satisfying a human want cannot be said to have been consumed. Besides good services are also consumed (concluding statement)

Rating scale

Name of the student Teacher…… Class……………………

Concept………………… Duration…………………

Session……………….. Teach/Reteach………….

Date………………… Supervisor……………….

Instructions: The observation schedule cum rating scale for skill of explaining comprises three columns. The first column indicates the serial number of the desirable and undesirable component behaviours of the skill of explaining. The second column specifies the components behaviours. The third one contains rating from one to seven against each of the components. The rating scale indicates the adequacy of the acquisition of the components of the skill. The seven points on the rating scale indicate the following. The rating may be indicated by encircling the number which represents the observer's assessment.

1.	Extremely weak
2.	Very weak
3.	Weak
4.	Average
5.	Good
6.	Very good
7.	Excellent

S.No	Component	Rating						
	Desirable behaviour							
(i)	Using appropriate beginning and concluding statement	1	2	3	4	5	6	7
(ii)	Using explaining links	1	2	3	4	5	6	7
(iii)	Covering essential points	1	2	3	4	5	6	7
	Undesirable behaviour							
(iv)	Using Irrelevant statement	1	2	3	4	5	6	7
(v)	Lacking Fluency	1	2	3	4	5	6	7
(vi)	Lacking Continuity in statement	1	2	3	4	5	6	7
(vii)	Make use of inappropriate vocabulary, vague words and phrases	1	2	3	4	5	6	7

Teaching Skill Assessment Battery (TSAB)

You have just taught the lesson. You would like to assess your performance. Below are given 20 items about different aspects of teaching. Read the items one by one. Each item so to be rated on seven point scale. Encircle the number that represents your assessment.

Topic………Teacher………..Class…………..Date…………

	Item	Rating				
		Extremely weak	**Very weak**	**Weak**	**Average**	**Goo**
1	My lesson was effective	1	2	3	4	5
2	I was clear about the relevance of the instructional objectives to be realized through my lesson	1	2	3	4	5
3	I could organize the lesson according to the needs of the subject matter and level of my pupils	1	2	3	4	5
4	Before introducing the lesson I could secure pupils attention and ensure availability of the material required	1	2	3	4	5
5	I could introduce the lesson effectively	1	2	3	4	5
6	I phrased the questions properly	1	2	3	4	5
7	I distributed the questions well in the classroom	1	2	3	4	5
8	I could lead the pupils to correct and complete answers when they failed to do so	1	2	3	4	5
9	I could explain major points of my lesson clearly in a coherent manner	1	2	3	4	5

10	I have used simple and interesting examples to clarify difficult points in the explanation	1	2	3	4	5
11	I have used appropriate aids for making my explanation easier and interesting	1	2	3	4	5
12	I could secure and sustain pupils' attention through variation in my voice, meaningful gestures and movements and pupil involvement	1	2	3	4	5
13	I appreciated pupil's correct responses and desirable behaviours	1	2	3	4	5
14	My blackboard work was neat and it made the lesson easier and interesting for the pupil	1	2	3	4	5
15	While concluding the lesson I summarised the main point and created a sense of achievement in the pupils	1	2	3	4	5
16	Assignments were suited to the content covered in the lesson and needs of the pupils	1	2	3	4	5
17	I could evaluate pupil learning through appropriate questions and observations	1	2	3	4	5
18	I tried to locate learning difficulties of the pupils and took appropriate steps to remove them	1	2	3	4	5
19	I adjusted the speed of the lesson to the level of my pupils	1	2	3	4	5
20	I could handle discipline problem in the class effectively	1	2	3	4	5

Objectives of teaching Biology

The objectives imply the changes we try to produce in a child through education. Education is a tripolar process. The educational objectives determine the learning experiences, which bring about a change in the behaviour of the learner. The learning experiences are provided by the teaching activities to achieve the educational objectives. The change of behaviour of the learner is evaluated by the educational objectives.

The objectives of teaching science are mainly directed to achieve the broader goals of education. The aims and objectives of education are based on the philosophy of life and the needs of the society. The aims and objectives are always subject to change in the changing scenario of the modern world. They are undergoing many changes as the goals and the needs of the society are also changing with the modern times. There are a number of pressures being exerted by the society to bring a conceptual change in the methods of teaching science.

Today science is not taught as a theoretical subject or as a research discipline but as a medium, which helps in developing the complete potentialities of the learner and in making him a useful and efficient citizen of the modern society. More stress is being given to the practical aspects of science teaching. The knowledge, skills, ethics and values are given more prominence in the curriculum today. The teaching of science should prepare the individual to face the challenges of this modern technological world. The science education aims at making the individual develop critical thinking and logical reasoning.

In this scenario of continuous change the subject of science can justify its importance only when it aids in modifying the ways of thinking of the student, their approach towards life, the values they inculcate and the scientific attitudes they develop. For achieving all the above ideals, the objectives of the science education have to be continuously modified based on the needs and requirements of the society.

What are Aims and Objectives of Education?

All activities have a purpose. A purposeless activity is ineffective. Purpose of the activity is nothing but a goal or an aim or an objective. For effectively achieving a goal, we need to clearly identify the purpose of the activity. Only when we have clear goals we can compare the success of our endeavour in achieving the planned activity.

Every science teacher has to know about the aims and objectives of teaching science. This will help her to be more systematic and effective in her teaching. This will help the teacher to frame the curriculum, identify the teaching methodology, observe the learning experiences and evaluate the learning outcomes.

Aims of teaching science

Aims are ideals or long-term goals. They are the high expectations that we like to realize as learning outcomes of imparting the knowledge of the science. Their realization may or may not be possible to the expected extent. Aims are broad ideals which direct the teaching programme. Aims are indefinite. They are vague. They take a long time for achievement.

The National policy on Education(1986) says "Science education will be strengthened so as to develop in the child well defined abilities and values such as the spirit of enquiry, creativity, objectivity, the courage to question and an aesthetic sensibility".

Redden explains the aims of education to be achieved through formal schooling as – "Education is the deliberate and systematic influence exerted by the mature person upon the immature through instruction, discipline and harmonious development of physical, intellectual, aesthetic, social and spiritual powers of human being according to individual and social need directed towards the union of the educand and his creator as the final end."

What is an Objective?

The aims of education which can be achieved in a school are called as objectives. An objective is a part of an aim. It indicates an end point of possible achievement. Objectives are immediate attainable goals. They vary from subject to subject and they are specific, precise and clearly defined and become meaningful to the students and teachers in a teaching-learning situation. Objectives make a teaching programme meaningful. They indicate the behavioural changes in the pupil after completion of instruction. It is the expected terminal behaviour or a learning outcome of the pupil at the end of teaching- learning process.

The terms 'aims' and 'objectives' are usually taken as synonymous terms in education. Aims are ideal whose realization may or may not be possible to the expected levels. They need long term planning. Objectives are a means of achieving these aims and in a definite way. The aims of teaching science can be broken into smaller objectives, which may be helpful in providing the learning experiences and bringing desirable changes in the individuals.

Differences between aims and objectives

S.No	Aims	Objectives
1.	Aim is to answer to the question of why a topic is taught	Objective answers what will be achieved after the topic is taught
2.	Aims are long-term goals. They are close to the ideals to be realized	They are short-term goals to be achieved through class instruction
3.	They give a direction to the education	They are a step in reaching the direction.
4.	They are vague and indefinite in nature.	They are definite and specific in nature.
5.	The school and society are responsible for their fulfillment	The teacher is responsible for their fulfillment

The objectives of the science teaching are formulated on philosophical, sociological and psychological bases. The main considerations for formulating them are:

i) **The capabilities of the learners:** The needs and the abilities of the learners are important when we frame the objectives. The psychological principles need to be taken into consideration.

ii) **The requirements of the society:** The influence of science and technology on the society and its improvement may be considered.

iii) **The nature of the content:** The content and the subject matter should not be too simple or too complex and abstract. It should be able to develop the scientific values in the learner.

iv) **The aims of the educational system:** The objectives should be able to achieve the aims of education.

v) **Constraints in implementation**: The objectives should not be difficult in implementation. They could be achieved in a classroom.

The objectives thus formulated should be appropriate for the age and ability of the learners, they should incorporate the practical experiences and they should suit the modern needs.

Criteria for selecting the objectives:

i) Specific: A good objective should not be vague. It should be specific.

ii) Unambiguous: A good objective should be ambiguous. It should be clear in specifying the required outcomes.

iii) Appropriate: The objectives should provide appropriate learning in tune with the age and maturity of the learner.

iv) Practicable: The objectives should provide practical experiences in learning.

v) Feasibility: Objectives should be easy to be achieved in the classroom.

Main objectives of teaching Biology

i) Providing practical knowledge of the content.

ii) Providing advanced information

iii) Developing skills, knowledge, interests and appreciation, application and understanding through the teaching of life science.

iv) Stimulating the spirit of investigation and invention

v) Improving the power of observation and experimentation

vi) Developing the problem-solving capacities

vii) Understanding the utility of biological science to the modern life

viii) Inculcating the ideals like truthfulness, open-mindedness and reflective thinking in the learner.

Writing Instructional Objectives and Specifications

Instructional objectives form the core of an instructional procedure. The instructional objectives are developed and set before an instruction is planned and delivered. These objectives help in identifying the expected behavioral outcomes of the learners through that particular instruction. The instructional objectives are the terminal results of the learning stated in terms of changes observed in the learner's behaviour. The instructional objectives are developed based on the following factors:

- The age and the maturity of the learner
- The physiological and psychological parameters
- The previous learning experiences
- The availability of resources for imparting education.

Important character of instructional objectives

- Instructional objectives are the statements of students terminal behaviour – the change in their behaviour which is a result of learning
- Instructional objectives indicate he outcomes of teaching learning process
- Instructional objectives are the skills that are imparted to the learner through the content
- Instructional objectives indicate the end result of learning.

Specifications

These are specific learning outcomes of teaching learning process. They denote the learning outcome of the pupils and indicate how far an objective is achieved in a classroom situation. Specific learning outcomes are the observable, measurable behaviour changes in the learner and help in better communication between the teacher and the learner. Specifications are an important tool in lesson planning. Specifications are required to develop course material, teaching strategy and evaluate the learning outcomes.

Important characters of specifications

- Specifications are precise and unambiguous statements
- Specifications are observable and measurable and are stated in terms of their action verbs
- Specifications refer to only one instructional objective at a time.
- Specifications are simple and feasible learning outcomes which are attainable in a stipulated time and class allotted in a school

Need of writing objectives in behavioural terms

Writing the statement of instructional objectives in behavioural terms or performance terms is called as writing objectives in behavioural terms. Taxonomic categories of objectives do not specify the form of teaching and learning activities. Behavioural objectives indicate learning activities in a classroom situation. In the present scenario there is utmost need to write objectives in behavioural terms. The teacher has to decide –

- What the child should be able to do in the classroom after the learning activity?
- What are the conditions required for developing this behavioural change?
- What will be the expected level of performance?

For answering the above questions the teacher has to write down the instructional objectives in behavioural terms. Hence the need for writing these objectives is:

- Teacher activities are determined and delimited.
- Teaching and learning process may be integrated for effective learning outcomes.
- Selecting teaching strategies for effective learn make teaching and testing objective-centered.

Guidelines for writing the behavioural objectives

- The entry level of the learner should be known.
- The topic, the content and the learning experiences should be considered.
- The teaching learning objectives should be followed.
- Appropriate mental processes and abilities should be considered for writing the behavioural objectives.

Advantages of behavioural objectives

- Specify the objectives
- Select the items for the test
- Integrate the learning experiences with changes in the behaviour
- Designing the teaching strategies and the teaching aids

Approaches of writing the behavioural objectives

There are a number of popular approaches for writing the instructional objectives in behavioural terms. Some of them are:

i) Robert Mager’s approach
ii) NCERT approach
iii) R.C.E.M approach

Robert Mager’s approach

It is a popular approach which lays emphasis on action verbs rather than the mental process. The associated action verbs are used in describing and formulating the education objectives. They are included under knowledge, understanding and critical thinking.

- To acquire knowledge of concepts, facts, events, ideas etc the behavioural outcomes are: recalls facts, concepts and terms recognizes facts, concepts and terms.
- To develop understanding of facts, terms, concepts, principles, the behavioural outcomes are
    - Classifies facts, concepts
    - Compares them
    - Discriminates between the facts, concepts, events
    - Identifies relationships
    - Arranges facts, trends
    - Detects errors
    - Interprets maps, charts

    - Summarizes
- To develop critical and logical thinking. The student
    - Identifies the problem
    - Analyses the problem
    - Sets up hypothesis
    - Selects facts
    - Draws inferences
    - Verify
    - Predicts
    - Evaluates

NCERT approach

The NCERT uses the following taxonomy which is the condensed form of Bloom's taxonomy:

- Knowledge
- Understanding/comprehension
- Applica

The specifications for the above objectives are

- Knowledge – the pupil recalls recognizes
- Understanding - the pupil translates, cites examples, identifies the relationships, compares, classifies, distinguishes, explains and interprets.
- Application – the pupil applies to new situations, analyses, establishes relations, gives reasons, draws conclusions, predicts and judges the consistency and relevance.

Regional college of Education Mysore (RCEM) approach

This approach has been developed to suit the needs of the Indian schools.

It emphasizes more on mental abilities and processes and is applicable to all the three domains i.e., cognitive, affective and psychomotor. This approach makes teaching and learning interesting and it becomes easy for the teacher and learner to achieve goals. This approach has made evaluation and testing simple, objective and easy to be administered. This approach includes four categories of objectives. They are:

- **Objective knowledge:** includes
    - Recall and Recognize
- **Objective Understanding:** includes
    - Seeing relationship
    - Citing examples
    - Discriminate
    - Classify
    - Interpret
    - Verify and
    - Generalize

- **Objective Application:** includes
    - Give reasons
    - Formulate
    - Establish
    - Infer
    - Predict
    - Analyze
- **Objective Creativity:** includes
    - Synthesize
    - Evaluate

RCEM approach is based on Bloom's taxonomy. It takes up three categories of objectives: knowledge, understanding and application from it. The fourth objective creativity replaces the last three objectives of Bloom i.e. analysis, synthesis and evaluation.

Instructional Objectives and Specifications for teaching Biological science

- **Objective knowledge:** The pupil acquires the knowledge of biological terms, concepts, facts, processes etc,

  Specifications:

  The pupil recalls – the terms, concepts, facts and processes.

  Recognizes – the terms, facts, concepts, processes etc,
- **Objective Understanding:** The pupil understands the biological terms, concepts, facts and processes

  Specification:

  The pupil translates the data
    - Illustrates with examples
    - Identifies the relationships of various concepts and processes
    - Compares the concepts and processes
    - Classifies the groups
    - Distinguishes between different closely related processes
    - Explains the concepts and
    - Interprets the biological data, concepts, processes, floral diagrams, and formulae, charts and models.
    -
- **Objective Application:** The pupil applies the knowledge of biology to new and real life situations.

  Specifications:

  The pupil analyses the problem
    - Predicts the hypothesis
    - Suggests possible methods
    - Gives reasons for various phenomena
    - Establishes the cause and effects

- Draws inferences for biological problems
- Analyze

- **Objective Skills:** The pupil develops skills like drawing, manipulating, collecting and preserving, dissecting, observing and reporting skills.

Specifications:
The pupil develops skills of drawing. The pupil
- Draws neat and well labeled diagrams
- Draws with a sense of proportion
- Draws accurately and appropriately

Specifications:

The pupil develops the skill of manipulation. The pupil

- Handles the apparatus carefully
- Arranges them systematically
- Observes the readings precisely
- Develops improvised apparatus

Specifications:

The pupil develops the skills of preserving the specimens. The pupil

- Identifies the particular specimen
- Collects specimen carefully
- Mounts the specimen using relevant procedures
- Preserves the specimen following the appropriate technique.

Specifications:

The pupil develops the skill of dissecting. The pupil

- Selects the material for dissection
- Fixes the specimen appropriately
- Handles the instruments with precision
- Dissects carefully
- Displays the relevant parts

Specifications:

The pupil develops skill of observation. The pupil

- Distinguishes between the different parts of the specimen.
- Identifies various parts of the specimen
- Notices the relevant parts carefully
- Reads an instrument accurately
- Detect errors in the experimental setup

Specifications:

The pupil develops the skill of reporting.

- Uses appropriate biological terms in describing the specimens
- Organizes the thoughts systematically
- Puts forth the opinions in a clear perspective.

- **Objective Interest:** The pupil develops interest in the study of plants and animals.

  Specifications:
  The pupil develops interest in
  - Collecting and preserving plant and animal specimens
  - Observing natural phenomena
  - Reading books, magazines and journals on biology
  - Visiting places of nature like forests, zoos, botanical gardens and museums.
  - Participating in biological science activities in school

- **Objective scientific Attitude:** The pupil develops scientific attitudes

  Specifications:
  The pupil develops
  - Curiosity to know the biological concepts
  - Honesty of expression
  - Appropriate reasoning
  - Critical thinking
  - Unbiased judgment

- **Objective appreciation:** The pupil develops appreciation of nature and its utility to the human beings.
  Specifications:
  The pupil appreciates the knowledge of biology; the role played by biology in human improvement and realizes the significance of the study of biology. The pupil appreciates the
  - Wonderful nature
  - Importance of plants and animals
  - Need for microorganisms and their use in our daily life
  - Utility of biology to human beings
  - Ecological balance
  - The role of biology in enhancing the welfare of mankind.

Planning for biology teaching

According to Ivor K. Davies, "In teaching planning is the work a teacher does to establish learning adjectives." There are two assumptions regarding teaching __ traditional and modern.

1. **Traditional assumption___**

According to traditional assumption, the teacher occupies primary and the pupil secondary place. It is expected that the teacher must give more and more knowledge to h pupils in order to develop them mentally. The pupil gain such knowledge but their all round development does not take place. The teacher tries to induct knowledge from outside by suppressing the interests, aptitudes, abilities, need and freedom. This hampers their natural development. Special emphasis is laid upon teaching by the teacher.

2. **Modern Assumption___**

In modern concept of teaching, more importance is given to the learning instead of the teaching. The influence if developed science and technology has changed not only the life philosophy of human being but also the system if working in every field of human life. Teaching management was also influenced by developed science and technology. Now the main function of teacher is to reach at those decisions which are necessary for the management of learning process and guidance. He should do those tasks which motivate the pupils. He should care for those specific objectives which cause desired behavioural changes.

In the word of Ivor. K. Davies, "teaching is a highly skilled professional activity and a great deal of what teachers and instructors do, both within and outside the classroom, involves making decision of one kind or another."

The teacher should development professional sensitivity which makes the teaching so much active and dynamic that all the pupils of the nation become brave, intelligent scholar and of high character citizens by system helps the teacher in making correct decisions as well as develop responsible professionalism. To pay attention or such a learning system, one should make necessary changes in the concept of teaching training strategies and tactics of teaching, functional of the teacher as a manager etc. in place of teacher's teaching, I.K Davies has stressed upon, the pupil-learning.

Teaching management

In teaching management teacher functions not as an aid to teaching, but as a manager. He determines teaching objectives. Then he defines those objectives in clear term so that he may come to know what changes are to be brought in the pupils regarding their development through these determined objectives. How, he creates an environment in which acquiring appropriate learning experiences, pupils experience desired behavioural changes and achieves predetermined and defined objectives successfully. I.K Davies has divided the functions of the teacher as a manager into the following four steps.

1. Planning -

In this step, the teacher analysis the content, determines and defines the learning objectives and writes those objectives in clear terms. He performs threw activities in this phase-

(i) Task analysis
(ii)Identification of teaching objectives,
(iii) Writing, learning objectives. In the words of I.K Davies, "Interacting planning is the work a teacher does to establish learning objectives."

2. Organization-

In the words of I.K.Davies, "Organization is the works teacher does to arrange and relate learning resources, so as to realize learning objectives in the most effective, efficient and economical way possible." In this phase for learning experiences, teacher creates such an effective environment by selecting teaching methods, strategies, tactics and essential aids and pupils, acquiring proper experiences again learning objectives while living in such an environment.

3. Leading-

According to Ivor K. Davies, "Leading is the works teacher does to motivate, encourage and inspire his students, so that teacher motivates the pupils, so much at each and every step that they start showing interesting the teaching and the learning objectives are achieved.

4. Controlling-

I.K. Davies writes, " In teaching controlling is the work a teacher does to determine whether is plans are being carried out effectively, organization is sound, realizing is in right direction and that ;how far these functions are successful in relisting the set objectives." In this phase, pre-determined and defined objectives of learning remain the same. But, the teacher observes the extent to which the organization Leading activities have achieved the pre-determined objectives. To accomplish this great task, the teacher seeks the help of various techniques of evaluation and measurement. If he concludes that the learning objectives have not been achieved, then he should ring necessary changes in the activities of "organization" and "leading" phases.

Unit planning and unit test

Woodrow Wilson said that, there are elements in teaching learning nits, " The objective on which the unit is focused the subject matter which is selected as significantly pertinent the objectives and activities or the things to do with the subject matter which are included to lead a student to attainment of objectives." Unit planning came into existence as a rebellion against treating learning of everyday as an isolated segment.

What is a unit?

1. **Preston**, "A unit is as large a block of related subject matter as can be over-viewed by the learner.

Behind this unit planning or the unitary concept of learning, the concept of learning that has been very much influenced b the rapidly growing acceptance of Gesalt Organism filed theories of learning. In this case, we assume that ***effective learning takes place in which the goals of learning are well known,*** we know where we have to reach it leads to complete attainment of a skill known, we know where we have reach. It leads to ***complete attainment of a skill, and insight*** so that he can equip the skill or insight to other various situations. This ***Unitary concept has given*** birth to unit technique.

2. **Bossing, "**A unit consists of a comprehensive series of related and meaningful activities so as to achieve pupil's purposes, provide significant educational experiences and results in appropriate behavioral changes."
3. **Heidgerken,** "The most important aspect of the unit concept is the implication that what is learnt is larger and more involved than a few scattered facts."

Characteristics of a good unit

1. Its objectives are clear and well defined.
2. The aids, to be used are very clear "A Multiplicity of materials," according to Hanson, "is almost a necessary for teaching process if the class is to realize the objectives."
3. There is provision of evaluation and follow-up.
4. It is always a complete integrated whole in its organization.
5. It provides activities for students. Students do not sit as me passive recipients of knowledge.
6. According Toschorting, a good unto leaves pupils free to work. They have chance to plan, organize and execute.
7. It provides correlation with the life and other subjects of children.
8. There is beginning as well as an end.
9. It is always comprehensible within the access of pupils.
10. It provides for individual differences.
11. It permits some place for field-trips, excursions, projects and demonstrations.

Advantages of unit planning

1. It clears the general as well as specific aims of teaching.
2. It caters to the needs, aptitudes and attitude of different students.
3. It works and develops in democratic atmosphere i.e. the students as well s the teacher work in a co-operative way.
4. It saves time.
5. It develops among students interest in learning as they actually know the value of contents learn by them.
6. It develops certain skills among the students and sharpens there in sight.
7. The students learn independently it gives confidence, develops resourcefulness and reliance.
8. As student learn independently, it gives confidence, develops resourcefulness and reliance.

Limitations of unit planning

1. It requires efficient hard working and trained teachers who are to always available.
2. Units not systematically arranged, confuse and discourage students.
3. Evaluation is not possible at lower stage.

Steps involved in developing a unit

1. **Preparation-**
   It is to motivate the students for learning. Motivated spirit should be maintained throughout and not only in the beginning.
2. **Previous knowledge test-**
   The back-ground of students should be questioned. A unit should start from the ladder where the students are standing at present, pupils where they are.
3. **Presentation-**
   In order to add new experiences to the knowledge of students, subject matter is presented to students with the help of aids or indirect experiences. Presentation leads to organization of subject matter in which old experiences are intermingled with new ones and students assimilate these.
4. **Summarization-**
   At the end of unit, the whole content is summarized. Sectional summaries may also be provided.
5. **Drill or recapitulation-**
   This is done in order to revise the facts discussed, so that students review the whole unit.
6. **Evaluation-**
   This informs the teacher about how much students have gained and what discrepancies are left in a nit and how to improve them. It can be done by Questionnaires, tests etc.

Proforma of a unit

Subject

Class

Name of unit

Major Objectives of the unit.

S.NO.	Conceptes (Topics)	Number of lessons required	Time required	Scope of subject Content	Method	Aids

Unit test

In order to produce a good test, the teacher should be very carefully in its planning, as it is not a simple procedure.

Stages of test construction

1. **Planning the test-**

   Objectives and aims of science teaching should be clear. When a particular portion is to selected, aim of teaching science should be kept in view. The contents chosen should be from syllabus and specified before had. Whether it is for classifying of studies or only memorization of certain portion ,the purpose of test should be clear. Time, duration, choice and range of subject matter should be planned before-hand.

2. **Preparing the test**—

   While preparing the test, a teacher should see that-

   (i) Directions are very clear.

   (ii) Questions are well phased.

   (iii) Individual differences are provided but most of items should be of 50% difficulty.

   (iv) Items of matching type or multiple choice types are give to reduce guessing.

   (v) Tests are of proper length, neither too lengthy nor too short.

   (vi) Test include more than one type of questions e.g. short answer type, objective type etc.

3. **Administration of test-**

   (i) Good seating and lighting arrangement.

   (ii) Instructions about division of marks, scoring procedure clearly given.

4. **Scoring- It may be in the forms of following grades-**

   A= Excellent

   B= Good

   C= Average

   D= below average.

5. **Evaluating the test- After the scoring is making, evaluation should be done by the teacher about.**

(i) Whether particular aim is achieved or not?

(ii) What type of test was it?

(iii)What is the quality of student's achievements?

Lesson planning

A lesson plan is the systematic preparation done in a scientific manner. Without a lesson plan even the most competent of the teacher in unsuccessful. There may be differences among the scholars regarding need. There is a description of the acquired knowledge, new knowledge, question method, means, materials etc. in the lesson plan. In reality the lesson plan can be called the heading of that description which tells about what achievements of the teacher and but the help of what means and class activities they can be achieved within an hour. “A lesson plan is not a blue print that one has to adhere to at all costs. It is, rather, a guide, an index of sequence of class room activities, a list of important teaching points; suggestions for procedures that may be followed during the period. The teacher may and should modify the plan or change any part of it whenever necessary”

In the beginning, the lesson plan should be detailed. After that the teacher should organize the subject-matter and make a shorter lesson plan. The lesson plans are for use of student-teachers. Thus, they should be prepared in such a manner that they can make maximum use of these in their teaching.

Advantages of lesson planning

1. It stimulates the teacher to think in an organized manner.
2. It helps the teacher to understand the objectives properly/fully.
3. It helps in creating the interest of students towards the lesson.
4. A proper relation is established between the new and ole lesson.
5. It provides guidance to the teacher as to what and how he should teach.
6. It compels the teacher to think about and use teaching aids.
7. It helps the teacher to choose the best teaching method.
8. It helps the teacher to teach, keeping in mind the individual differences.
9. It inspires the teacher to ask proper and important questions.
10. The teaching matter is organized in a time frame.
11. Proper care is taken to take into consideration, the level and previous knowledge of students.
12. It develops self-confidence in the teacher.
13. It helps the teacher in teaching about formals articles.
14. It clarifies the outlook of the teacher.
15. It helps the teacher in teaching about formals articles.
16. It lays stress on instructional material.
17. It brings about certainty and regularity in the thinking of the teacher.
18. It inspires the teacher to improve the forthcoming lessons.

Characteristics of good plan

1. It prepares the draft carefully of the instructional knowledge in a time frame.
2. It should indicate what and how we have taught.
3. It should have flexibility so as to be executional in new circumstances.
4. It should be written.

Limitations of lesson planning

1. It traps/enables the teacher. In the traditional instructional colleges, there is no mention of flexibility, thus, the teacher finds himself helpless in new situations.
2. Sometimes, it reduces the independence of the teacher.
3. As simple matters become complicated, the teaching process becomes more difficult.
4. It is exploitation of knowledge, more than required time is taken in its planning.

PRECAUTIONS IN PREPARING LESSION PLANS

1. The teacher should have full control/mastery of the subject matter and related subjects of the topic which he is about to teach.
2. He should have knowledge of psychology. He should plan his teaching work according to the psychology of the children.
3. He should have knowledge of the social and philosophical bases education. He should select teaching method with the help of psychology and philosophy. He should also have full knowledge of teaching objectives.
4. He should take care of the individual differences while preparing a plan.
5. Prior to preparing the plan, the available material should be kept in mind. The teaching aids required for that teaching topic should be pre-planned and the teacher should have full knowledge of it. The lesson should be planned on the basis of teaching aids available.
6. The time duration of the period should be found out from the school, and the plan should be prepared accordingly.
7. The information regarding the previous knowledge should be obtained before preparing the plan.
8. More than required fullness should not be brought into the lesson plan.
9. There should be co-ordination among the various part of the lesson plan.
10. The lesson plan should be based on the nature of subject matter.

Biology lesson plan (Herbertian five steps)

The methods which are being used by the training institutes are as suggested by Herbert.i.e. Five steps of Herbert-

(a) Introduction
(b) Presence/Presentation
(c) Comparison.
(d) Principle Detection
(e) Application

1. Titles of a Lesson—

(i) Place and Name of School
(ii) Enterprise or Subject
(iii) Unit
(iv) Sub-Unit
(v) Topic
(vi) Class
(vii) Period
(viii) Duration
(ix) Date

Writing of school, class, period, duration etc. Lesson indications are in practice these days. In the traditional training institutes, writing all the above mentioned titles is compulsory. Now, it is being felt as to what is the use of writing class in the lesson plan, when does students-teacher know which class he is going to teach do the students know which class they are studying in. The examiner also notes in his time-table for whom is the class being written. The same applies for school, period etc.

To prepare a lesson plan each topic is divided into units. If the unit is short, the plan is prepared for a day, but if the unit is large, it is subdivided into sub-units. If the sub-units are also large the lesson or topic is fixed for the day example.

Subject- Botany.
Unit- Leaves
Topic-Modification of Leaves.

2. Objectives of a Lesson-

What benefit will the students get by studying the lesson? Which powers will be developed? What type of knowledge will be imparted? All these indicate towards the objectives. It is very important that the teacher fixes the objectives because-

1. Teaching cannot be successful without an objective.
2. If the objective is clear the teacher can prepare the lesson plan properly. He collects all materials related to the topic according to the objective.
3. An appropriate teaching method is selected, keeping in mind the objective.
4. The teacher achieves maximum success.
5. Clear objectives help in understanding and knowing the lesson properly.

Thus, it is very clear that the objectives of the lesson are an integral part of a lesson plan. The teacher should find out in advance regarding the changes in behavior of the students after teaching of the lesson. These changes can be of any type as-

1. The children to be given knowledge of facts and information or giving knowledge to the students about a particular object.
2. To explain to the students about a particular object.
3. To impart competence and efficiency to the students.
4. To create interest in students.
5. To teach students the application of knowledge.

The objectives of the topic should be fixed and clear. The objectives can be divided into two sections-

1. General Objectives-

Means our objective to teach a particular subject. These objectives will be applicable while teaching any topic of the subject. These are related to the subject. These objectives are fixed.

2. Specific Objectives-

These are the objectives which should be kept in mind while teaching a particular topic. If you are teaching the students about the diseases of animals, then our specific objective will be to teach them the cause, symptoms, means, remedy and safety measures and arouse a feeling of affection for cleanliness of animal husbandry. The specific objectives, unlike general objectives, are not as has been done in the lesson plans shown ahead.

3. Teaching aids-

After writing the objectives, a brief description of all the apparatus to be used should be given. The apparatus should be written about in the sequence in which it is to be used in the class-room.

4. Previous Knowledge-

Previous knowledge means, the subject matter already studied along with all previous experiences. While indicating the previous knowledge, we should keep in mind the present lesson and the teaching objectives. The lesson plan should be prepared keeping in mind the previous knowledge and previous experiences.

5. Introduction-

The teacher should find a suitable way to draw the attention of students. The format of the introduction should be such that the student takes interest in the lesson and gives his complete concentration to study. The teacher can easily accomplish this job with the help of questions based on previous knowledge and previous experiences. As far as possible the introduction should be brief.

In order to bring the chain of thought according to the topic to be taught, question-answer, teaching aids and excursion reports can be used. The questions asked in the introduction should be inter-related. It is not necessary to have an introduction for all topics. At times, it is best to start the lesson straight away. For example if the teacher has taught about seven-eight vegetables then he can start about the ninth starting 'we have already studied such and such vegetables and today we will study about 'this' vegetable.

Mainly the introduction has 3 parts-

(a) Relation- To develop a relation with previous knowledge and previous experiences.
(b) Considering the relationship to give inspiration for the new topic.
(c) To give full/complete chance to the students to develop insight about the topic or heading.

6. Development of a Lesson-

The teacher should develop the lesson with the help of students. As far as possible proper and useful teaching method should be used. If theoretical facts and information is to be given to the students, lecture method should be used. If varieties of flowers are to be taught, problem-solving method can be used. The subject-matter should be divided into small portions and should be taught at proper places and in correct sequence. While teaching, reference of magazines should be given along with books. As far as possible give correct and latest knowledge. The questions should be easy and effective. For each question of the lesson, there should be an objective. In the development of the lesson, complete use of black-board should be made. In practical lesson, the students should be given time for practice.

7. Black-board summary-

The black-board summary should be developed with the help of students along with the development of the lesson. Some people give the summary in the end of the lesson. Both these methods are incomplete in themselves. Then, too the development of Black-Board summary along with the lesson is considered best. The teacher should write only the main points, thoughts, diagrams, formulae etc.

8. Evaluation-

After the teacher has taught the complete lesson, he should then repeat the main and important facts. This should not merely be a repetition of the lesson by a test of application of knowledge gained. Evaluation may be written or oral. Objective type of questions is best for evaluation.

9. Home assignment-

To give home assignment is not always important. If home assignment is to be given, it should be such that it motivates the student to read, understand and learn more. Just to write sense. Home assignment, for practicing the class-work should seldom be given. Home assignment should be given based on the application of the acquired knowledge and related to daily life activities. Home-work should be proper, fixed, according to capability, challenging, related to the objectives of the lesson. It becomes the duty of the teacher to check and rectify the home assignment.

10. References-

In the end of the lesson, the teacher should give a reference of those books, magazines, pamphlets etc., so that with their help the recentness and authenticity of the imparted knowledge can be checked and the mentioned books may be used as per requirement. For writing the references, the following system should be used.

(a) Name of author
(b) Time of Publication
(c) Name of Book
(d) Place of Publication
(e) Publisher's Address
(e) Edition
(g) Page.

11. Self-Evaluation-

This is the last step of the lesson plan which the teacher writes after the completion of the lesson. After teaching each lesson, the teacher thinks about his success and weakness, expertise and effectiveness and faults. This self-criticism should be written in the step of self-evaluation. With complete honesty along with the criticism he should also mention the improvements he would make if he gets a chance to re-teach the lesson. True self-evaluation invites a golden future for teaching.

In the end of the lesson, a self-evaluation form is given which has been prepared by Regional College of Education, Ajmer.

The design of lesson plan

Subject Unit Class and Section
Topic Date
General Objectives Duration of Period
Previous Knowledge
Specific Objectives
Teaching Aids
Content Structure.

Expected Behaviour	**Learning**	**Real Learning**
Objectives	**Experience**	**Outcomes**

Class Work
Home Work/Assignment
References
Self-Evaluation.

In the forthcoming table, the facts which should be written in (on theoretical basis) the lesson plans are given/shown. These basics were resolved in the seminar conducted in 1975 on the topic 'Skilful teaching' by Meerut University.

I.K.Davies, has written that the following three activities are to be followed by the teacher during planning teaching.

1. Task Analysis
2. Content Analysis
3. Identification of Teaching Objectives.
4. Classification of Learning Objects.

(1) Input	**(2) Teacher process**	**(3) Students process**	**(4) Output**
Instruction, objectives and expected behavior objectives. 1. Knowledge recalls recognition.	Teaching material, method, process medium, learning experience. 1. Lecture 2. Chart display	1. Observation 2. Listen	Evaluation related learning outcomes. Question repetition of

	3. Demonstration 4. Interpretation 5. Film show 6. Programmed learning	3. Take notes 4. Interaction	questions (through teaching) definition, description, answer.
2. Understanding citation, discrimination, classification, description, attestation, Generalizations.	1. Debate 2. Demonstration debate 3. Problem solving	**Guidance Questions** 1. Know facts, recognition of facts and principles. 2. To locate inter-relations. 3. To give advice for using items to demonstrate. 4. To find the hidden principles by indicating their resemblances with the process.	To great problem based situation. Experiments, apparatus, article etc. with which students is unfamiliar but contain similar principle.
Application reasoning formation of hypothesis establishment of hypothesis, draw conclusion prediction.	Interaction or two way communication teacher taught .	1. Recognition of previous achievement/attain ment elements, Facts, methods, technics and sets.	Unknown problem which has similar principles an d contains previous achievement/ experience.
4. Creative 1.Analysis 2. Synthesis	1. Unfamiliar problem, apparatus system experiments. 2. Problem solving 3. Observation laboratory work. 4. Tutorials Multi-dimensional interaction 1. To pose a	2. To interact using models material, apparatus specimens etc. 3. To make intelligent of probable relation	

	problem for solving besides / outside the syllabus 2. Programmed instruction 3. Individualised work instruction 4. Tutorial multiple interaction.	for problem solving 4. To develop a process to check the format relations. 5. Observation, collection, analysis of data and draw conclusion **Sequential questions** 1. To analyze the problem into sub elements e.g. known and unknown elements, principles, process. Technique and theoretical aspect and separate them. 2. To recognize the relation between elements. 3. To tell the probable relation between known and unknown 4. on bias of citation of theoretical structures to reject improbable facts. 5. to combine facts in the experiment tested / proved new structures.	

1. TASK ANALYSIS

In task analysis, the activities related to the contents are analysed. Expected achievement is not possible if task analysis is not carried out properly. Hence, task analysis has special importance in the planning process. According to I.K. Davies, four activities are included in task analysis-

(i) Description of activities which are to be learnt by the pupil.
(ii) Identification of expected behaviors.
(iii) Identification of those stimuli and conditions with the help of the pupils may show expected behaviors.
(iv) Determination of norms for expected performance or achievement.

Through task analysis, proper decisions are made regarding learning objectives, teaching strategies and tactics.

Types of Task Analysis

(i) Content Analysis or Topic Analysis-

In content analysis, the content or topic is analysed on educational and intellectual basis. Intellectual activity concerned with some specific topic is analysed, for example, some law or principle in the Biology teaching and administration

(ii) Job Analysis-

It is concerned with ' what is to be done in the task.' Hence, in this type, physical and psychomotor activities are determined and sub-processes are analyses.

(iii) Skill Analysis-

In this type, is emphasized how the work is accomplished. It includes all those tasks which need skill. The skill analysis is done only for questioning and diagnosis activities.

2. CONTENT OR TOPIC ANALYSIS

In the words of I.K. Davies, "it is the analysis of topic or content unit to be taught into it s constituents or elements and synthesize into logical consequence."

Many techniques have been used for content analysis by Honey (1962), Glaser (1963) and McNer (1965) etc. but matrix technique of I.K. Davies is considered most useful. According to this technique, content is divided into sub-topics are psychologically arranged in a sequence. Now, each sub-topic is divided into its elements and arranged in a sequence. Each element of the sub-topic is meaningful, complete and separate from each other like sub-topics is over, the elements of each sub-topic are arranged in a sequence on the basis of certain laws and maxims of teaching. Hence, both activities of analysis and synthesis are included in content analysis. According to I.K. Davies, by matrix technique one can represent the content analysis in the following chart-

Topic

Sub-Topic(1)	Sub-Topic(2)	Sub-Topic(3)	Sub-Topic(4)
Ele. Ele. Ele.	Ele. Ele. Ele. Ele	Ele. Ele. Ele.Ele.	Ele. Ele. Ele.Ele.

(1) (2) (3) (1) (2) (3) (4) (1) (2) (3) (4) (1) (2) (3) (4)

Note: (Abr: Ele.= Element)

According to the above chart 16.1 one can present an example of "Teaching-Learning Management" which helps the teachers, especially pupil-teachers in understanding easily the content analysis.

Arrangement of Tpic Elements in Logical Sequence

Each sub-division's elements should be arranged keeping in view certain laws. Here, it is important to tell the pupils to follow the following maxims of teaching-

(i) From simple to complex
(ii) From known to unkonwn
(iii) Form concrete to abstract
(iv) From whole to part
(v) From Psychological to Logical.

Source of Topic Analysis

In order to analyse the contents, the teacher must have the knowledge or mastery. He must use some resources to present the

Management of Teaching and Lerning

Sub-topic(1)	Sub-topic(2)	Sub-topic(3)	Sub-topic(4)
Planning of Teaching	Organizatin of Teaching	Leading the Teaching	Controlling Teaching
Elements	Elements	Elements	Elements
1. Task Analysis	1.Structure of learning	1. Harnessing Students Motivation	1. Evaluating the Learning System
2. Identification of	2. Selecting of	2. Selecting	2.Measuring

Teaching Objectives Appropriate Appropriate Learning

Teaching Tactics Motivational

Strategies

3.Writing the Learning 3. Selection of 3.Managing by

Objectives Apppropriate Learning Objectives

Audio-Visual Aids

completed picture of the contents by analysis. He should follow the following resources to present the contents by analysis-

(i) Study of Standard Text-Book.

(ii) Knowledge of Student's Needs.

(iii) Understanding Educational Needs.

(iv) Utility of Teaching Aids.

(v) Possibilities of Examination System.

3. IDENTIFICATION OF TEACHING OBJECTIVES

According to NCERT's Evaluation and Examination Issue, "An objetive is a point or end in view of some thing towards which action is directed, a planned change sought through any activity what we set out to do."

According to this definition, teaching objective includes three things-

(i) Direction

(ii) Planned Change

(iii) Activity.

The objective has a power due to which all the teaching activities of the pupils are managed towards a definite direction. Due to this, desirable change goes on occurring in his behaviour. Aim-less activities lack management. These activities are mis-manages.

Through teaching, we wish to bring changes in the pupils by developing their personality. Therefore, teaching must have one or the other objective. Definite and clear objectives bring the expected changes in the pupils-

(i) In the area of Knowledge

(ii) in the area of PPlication,

(iii) In the area of skill

(iv) In the area of interest

(v) In the area of attitudes

(vi) In the area of appreciation and

(vii) In the area of personality.

Education increases the new knowledge of the pupils. This develops ability and efficiency of solving complex problems. They modify their attitudes towards life and society by showing new interests. After gaining education, pupils do such activities which they were unable to do before entering the school. Teaching process can bring changes in the various areas like knowlege, application, interest, ability, efficiency, attitude, appreciation, personality and character etc. of the pupils. As all these areas are important, therefore, such should be the objectives of teaching which may develop each areas of the pupil while these are being acquired.

Teaching objectives occupy important place in the teaching process. Its Revolutionary changes which have occurred in the nature of teaching, functions of the pupils and the teachers and the traditional training attitudes. According to the new attitude, learning experience of the pupils are more emphasised so that expected behavioural changes in them may be brought about. During planning of teaching, after topic analysis, learning objectives are specifically defined. Strategies of teaching, tactics and teaching material aids are decided keeping in view the learning experiences. And, in the end, the evaluations and measurement of the begavioural changes by learnt experiences are carried over.

According to B.Z Bloom, teaching objectives mean forming those clear plans which make possible behavioural changes in the pupils. Teaching objective is definite and clear. It provides concrete help to the pupil and gives direction for action. It helps in planned changes while providing help in managing the activity. It is directly concerned to that content which a teacher intends to teach the pupils through teaching. Contrary to this, goal is the general description of some task. It is not definite and clear. It neither helps in determining strategies of teaching nor in evaluation. As the nature of a goal is comprehensive, therefore, it is merely an 'ideal' which is difficult to achieve.

Reasons for Specifying Objectives

(i) It facilitates restrictions.

(ii) All the uncertainities regarding interpretations eliminate.

(iii) It helps pupils and teachers in differentiating various begavioiurs, It helps in determining strategies of teaching.

(iv) It presents the complete level of the curriculum. The level of the curriculum functions as conceptual management and future management in learning.

(v) It helps in making the learning objectives definite by turning the curriculum effecive.

(vi) It helps in measurement and evaluation of teaching.

Difference between educational and teaching objectives

The objectives are mainly divided into two parts-

(i) Educational Objectives and

(ii) Teaching Objectives. Both types of objectives are different as shown in the following Table 16.3.

Teaching objectives are specific, direct and practical. Remember tht the teaching objectives are directly concerned with learning objectives. The real position is that in class-room teaching, learning objectives are important. According to I.K.Davies. " Learning objectives is a statement of proposed change". Therefore, the teacher should determine the learning objectives before starting the task of teaching. It helps in selecting the activities which create the learning experiences for pupils. It helps in collecting those evidences on the basis of which it can be proved whether the class-room activities have achieved the desired objectives or not.

Educational objectives	**Teaching Objectives**
(i) Expect more the philosophical basis.	(i) Expect more psychological
(ii) These are concerned with entire education.	(ii) These are restricted to the class-room and these are used for teaching various subjects.
(iii) These are broad and general.	(iii) These are narrow and specific
(iv) These are formal.	(iv) These are functional.
(v) These are theoretical and indirect.	(v) These are direct. These are concerned with class-room teaching. Hence, these help in changing the behaviour by providing speed to the learning process.
(vi) Their acquisition needs long duration i.e. These can be achieved from primary to University level education.	These can be achieved in short duration i.e. only in the period of 40 minutes only.

CLASSIFICATION OF LEARNING OBJECTIVES

Although Mager and Karthwohl have done appreciable work regarding classification of learning objectives, Prof. B.S. Bloom's classification is directly related to the problems of curriculum and evaluation. It has proved more helpful in formulating the techniques of communication, evaluation and the development of the curriculum.

Table 16.4 Taxonomy of Educational Objectives

Congitive Domain	**Affective Domain**	**Conative Domain**

Category	Category	Category
1. Knowledge	Receiving	Impulsion
2. Comprehension	Responding	Manipulation
3. Application	Valuing	Control
4. Analysis	Conceptualisation	Co-ordination
5. Synthesis	Organization	Naturalization
6. Evaluation	Characterisation of a Value System	Naturalization Habit-Formation

Development of improvised apparatus

The important objective of teaching biology is to arouse the student's attitude and interest towards science. It is possible to achieve these objectives only if the students do something themselves, use some improvised apparatus and make some improvements in them. Unless the students perform this type of practical activities themselves, they will not understand the facts, laws and principles of biology and will not have the practical knowledge of the subject and objectives of teaching of biology will not be achieved. Thus, it is important that the students prepare/improvise apparatus after studying the theory properly according to their interest and ability. These apparatus can be prepared out of ordinary items (which people discard as useless) or unexpressive items (having low cost). Such apparatus, which students prepare themselves or with help from their teachers, which are inexpensive and display some process of science, are called improvised apparatus.

High ranking scientists had to prepare some or the other such apparatus to convey their thoughts. Edition, Priestky , and madam curie and other scientists had to prepare such

In order to prepare such apparatus, the teacher should provide proper guidance. The students should have restricted freedom to use the laboratory and workshop in the school.

UTILITY OF IMPROVISED APPARATUS

Self-improvised apparatus have a number of advantages out of which the main are___

1. Educational and psychological utility
2. Economic utility
3. Social utility

4. Recreational value
5. Scientific utility
6. Practical utility
7. Identification of talented students in science.

1.educational and psychologicalutility :

A child alwys learn by doing and is active by nature. In assempling of the apparatus, the children get some constructive work to do and creating something new gives them satisfaction. As a result of satisfaction the students are motivated to make new discoveries and find themselves psychologically more competent .a co-ordination between the mind and hand develop and he apparatus with his own hand and as such also attain knowledge of the theiores and principles related to that apparatus. In this manner , the construction of improvised science apparatus develops a co-ordination of hands and mind, while gaining knowledge of the practical aspect of science is interest iscreated in scientific hobbies and interest.

2.economic utility:

In the assempling of these apparatus those items are used which are considered to be waste and thrown or those items which have low cost and a biology teacher, without burdening school with extra expenditure, prepare the apparatus for experiments and thus, make his school laboratory morepowerful and well equipped.

3. social utility:

self -improvised apparatus have a social utility because the construction of these material forms the habit of doing the work by own hands. Loyalty towards labour increases. The habit of work together without any disparity is formed and the child moulds himself according to the needs of the society and moves towards the goal of socialism.

4.Recreational utility :

The students derive pleasure while working. Thus when they start working on the construction of an apparatus they do so happily. In this wys keep themselves busy and preparing such as apparatus in their leisure and even an holidays and recreate themselves.

5.Scientific utility :

when the children work themselves, they develop interest in scientific activities and apparatus, as a result they attain scientific knowledge and develop scientific outlook. The students help confidence is increased and they can prepare and use apparatus according to their requirements. This way, they try to relate science to their daily lives. It enhances the qualities of liking towards discovery and exploration, correct evaluation etc., it enhances the concrete ability, interest, invention and discovery and the quality of correct evaluation of students.

6.practical utility :

the construction of any apparatus inspires thestudents to work in an organized manner. They can discover new apparatus, can produce them according to needs , repair old apparatus, they can also tk=ake interest of upkeep of the apparatus and decorating them.

7. identification of talented students in science:

self improvisedapparatus is prepared under the supervision of the teacher. Thus, teacher can easily find out which students have scientific potential/talent. The students having potentialcan be given proper oppertuities and help them capable scientists and thus take constructive steps to help these students. By the constraction of such improvised apparatus, scientific talent can be tapped and care can be taken to promote and patronize them.

SOME IMPROVISED APPARATUS

1. Apparatus to understand the respiratory systemin plants
   Material required
   (a) A glass jar
   (b) A glass funnel
   (c) Empty tupe of distilled water for injection.
   (d) Hydrilla plants
   (e) Water

PROCEDURE

fill the class with water, place the hydrilla plant inside the glass. Invert funnel over it. Then break the neck of the distilled water tupe carefully so that it becomes a symmetrical tube(resembling a test tube). Fill water in the tube and convert it over the funnel and carefully and the whole assembly is kept in the sun.

after some tmes we will see that some bubbles or arising andlevel of water in the tube is decreasing. If a glowing splinter is brought near the collected the gas it kindles. This shows that the evolved gas is oxygen which is expelled by hydrilla plant as aresult of respiration.

2. Apparatus to understand the functioning of the Lungs__
Material required___

(a) A large sized bottle
(b) ‘Y’ shape tube
(c) A elastic membrane
(d) Two balloons
(e) Rubber cork
(f) Sand
(g) Blotting paper
(h) Stove

Method

first of allwe remove thebottom of the bottle. For this we mark, the portion to be removed with the help of a file. Then, wet a blotting paper and stick it on both sides of the mark. Heat the bottle with help of rubber cork having holes in it. The balloons are then tied to the inner arms of ‘Y’ shapped tube. The bottom of th bottle I covere with an elastic Membrane having a small hole in the centre to allow a thread with knot at one end so that the elastic membrane can be pulled.

Procedure :

when the thread pulled, the elastic membrane also is pulled and a vacuum is created in the bottle. The air enters the bottle through the ‘Y’ shapped tube and the balloons inflate. This prosess is similar to the functioning of lungs. The lungs inflate when diaphramis enlarged .

3. **Apparatus to measurethe growth of a plant material required**

(a) An empty delda tin of 4.1/2 k g.
(b) two wooden bars of 3 ft length, 2.1/2 inch breatdh and ½ inch thickness.
(c)02 mm thick two nails
(d)scale
(e)pencil
(f) nails and hammer.

Method :

close the lit of the dalda tin tightly. Locate the centre of the tin on both sides as shown in the figure.

Then on both sides of the tin make two holes of a little more than 2mm diameter at the centre of point located.

After drilling the holes, the wooden bar and at equal height fix the tin in the nails in such a manner that it rotates freely. Then fix the bars in the ground or with the help of bricks ensuring that the tin rotates freely. Tie a threadto the upper most tip of the potted plant on one sde and a weight on other sideof the thread. Thht over thew tin.after place the plant near the wooden bars. Put the end of thread having the weight over the tin. After assembling the apparatus , measure the height of the weight from the ground (base) a cm. later on after a number of days re-meaure the height from the ground (base) b cm. the difference in the reading (a__b) is the increase in height of the plant. Thus, by the observation of the difference in the heights, the actual groth of the plant can be studied.

4. **Apparatus to understand the function of the Muscles-**
   Material required-

(a) An old cycle tube.
(b) Two wooden pieces/blocks.
(c) Thumbs pins(drawing pins)
(d) Screws
(e) Nut socket

Method___

cut to pieces of rubber tubing equl to the size of the woodern pieces. Place the woodern pieces one on top of the other (as shown in the following diagram) and make a hole. Screw them together so that the joint is movable. Fix the pieces of rubber tubing on both the ends of the wooden pieces with the help of thumbs pins (drawing pins). Now the tube fixed on the wooden bars is fixed on the other bar in the same sequence with drawing pins.

Procedure :

when wooden bar is raised up then the tube on that side contracts and the other side expands. If the wood is considered as bone and tube as muscle, then the apparatus help in understanding the functioning of muscles.

5. **Butterfly trap:**

   Material required :

   (a) 4 ½ feet long iron wire (which can bend with pliers)

   (b) Pliers.

   (c) Cloth used for mosquito nets.

   (d) Needs and thread and wooden handle

Method :

the wire is bent to make a circle of about 1 ¼ feet and the edges should be tightened with the help of pliers. Then double fold the rest of the wire about 8" long to make a handle. Them, the net clothshould be made into a cone of about 1 ½ feet height height stitched along the wire circular frame. Then the wooden handle should be fixed on the wire handle and tied with a thread. The trap is ready.

LIST OF SOME TIME WHICH CAN BE IMPROVISED

1. Auxonometer.
2. Models of different plants and animals and various organs.
3. Osmometer
4. Potometer
5. Slides of plants and insects.
6. Construction of aquarium, Terrarium and vivarium and their decoration.
7. Preservation of plants, animals and insects
8. respirometer

Aids to science teaching(Audio-Visual Aids)

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

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

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

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

Experience is what happens to us, what goes on in our mind. Every experience has three aspects-cognition, affection and conation. None of these can be experienced independently. Montessori stressed the importance of senses. From the day of his birth child begins to learn with the help of his senses. At first stimulation of sense produces in him just a sensation but later his sensation has a meaning added to it and sensation plus meaning becomes perception. Perception leads to ideas or concepts. The child is interested to see concrete things. He wants to handle, manipulate and the teacher should provided occasions for the pupils to satisfy their curiosity of doing things. The learning through sense is more permanent than mechanical learning. Out of five senses it is through the hearing and seeing that 86% of knowledge is gained.

Rulon studied the effect of audio visual aids in science teaching. He reported that there was 20% gain in pupils achivements and 38% greater relation of subject-matter over a period of weeks as a result of sound films.

Charters claimed that 2nd and 3rd grade children, at the end of six months, remember 90% of what they knew on the day following the moving picture show. Very young children tend to remember correctly 50-60% of what they see.

Definition of Audio-Visual Aids

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

"Audio-visual aids are those sensory objects or images which initiate or stimulate and reinforce learning." **-**
Burton

"Audio-visual aids are anything by means of which learning process may be encouraged or carried through the sense of hearing or sense of sight." **-Good's Dictionary of Education.**

Importance of Audio-Visual Aids

"I hear, I forget,

I see, I remember,

I do, I understand"

Audio-visual aids are instructional devices which can be heard as well as seen (Audio means to hear, and Visual means to see). These aids are intended to impart knowledge to the pupils through senses to ensure quick and effective learning. No wise teacher can ignore the use of aids in order to make his lesson mre interesting and real. It is an admitted fact that we learn through the senses and the senses of sight and hearing have agreater share in this process. We might recall that man depended upon the sight long before he felt the need of speech, and that the alphabet was derived from the picture sign language. But it should always be borne in mind that these aids should be used as aids to teaching and should not replace the teacher but revolutionise methods of teaching.

1. The audio-visual aids are best attention compellers. They arouse interest and motivate the pupils to action and stimulate physical and mental activity.

2. It saves time and the learning is more solid and durable. The pupils learn about 35% more in given time and the knowledge learnt is retained for 55% longer time.

3. It reduces verbalism or the meaningless use of words and phrases and contributes towards the clearness of perception and accuracy in learning.

4. It extends first hand experience when the students see a demonstration, handle the apparatus, perform the experiment themselves and prepare charts, sketches and models etc.

5. By reviewing and rehearsing the aids used, pupils get opportunity to correct miscorceptions and secure additional ideas. A film after having been shown to the students can be reviewed by the active discussion among students and with the teacher. By showing the film again the pupils correct their mist6akes and get a chance to revise what they have learnt and at the same time gather some additional information which they had unconsciously overlooked.

6. It helps in bringing vivid reality into the classroom. Mere chalking and talking do not help much and it is imprtant to make use of the aids.

7. It is the most natural and the easiest way of learning. Image is the greatest instrument of instruction. When a child sees and object, he forms and image of that object.

Aids to Science Teaching

8. Though first hand experience is the most educative type of experience but always it is neither desirable nor possible for the pupils. For various reasons it may be necessary to provide various experiences. In may cases the actual material is inaccessible, very expensive, or physically so constituted that they cannot be easily studies. So at such occasions it becomes essential to provide a representation of the real resource. If it is readily available and less expensive, it may be even more desirable. For example, it is not desirable that the students should have the direct experience of recognising the characteristics, actions, affects and remedies of any fatal disease, say plague, typhoid etc. It is always affects and remedies of any fatal disease, say plague, typhoid etc. It is always useful to give them vicarious experience. Similarly it is not possible for everybody to climb up the Everest but the children have vicarious experience of climbing even by seeing a film. So, in such situations

reproduction is better for the original may be too complex, too large, too small, too slow, to be successfully experienced first-hand.

9. It breaks monotony and gives variety to the class-room technique which is always attractive to the children.

10. Longing for mastery and ownership is, to some extent, satisified. The pupils get chance to touch, feel, handle and manipulate things.

11. Some type of freedom prevails in the classroom. Pupils can laugh, talk, question, comment and discuss. The students are motivated to do work and they work of their own accord and not out of the fear of the teacher.

12. The large number of pupils and shortness of teachers require some aids that can simplify teacher's work.

13. New curricula have broadened and extended the field of education which can be satisfactorily covered only with the help of teaching aids.

14. It provides opportunity to inclucate scientific attitudes and give training in the scientific method.

Principles for the Selection and use of Audio-Visual Aids

We learn

1.0 per cent through TASTE

1.5 per cent through TOUCH

3.5 per cent through SMELL

11.0 per cent through HEARING

83.0 per cent through SIGHT

We remember

20 per cent of what we HEAR

30 per cent of what we SEE

50 per cent of what we SEE AND HEAR

80 per cent of what we SAY

90 per cent of what we SAY AND DO.

Emphasis is now laid on the use of audio-visual aids in teaching because of heir multifarious values in making the teaching learning process interesting and effective. But wrong us of these aids will invite adverse criticism. So precautions must be taken while selecting and using these aids. Some of them are discused below.

Principles for selection

1. The aids should be integrated with learning. It should be an integral part of eductive process and appropriate to the curriculum of the class. It should not be merely recreational

but should accomplish some significant end and co-ordination with day-to-day lessons. For example, while reaching about a scientist, the taperecorded speech may be reproduced in the classroom. This will provide life-like situations and the pupils will feel interested.

2. It should be acording to the age, intelligence and experiences of the students. It should neither be too simple nor too complex. It should suit to the physical, psychological, intellectual and social development of the group with which it is used.

3. The language should be familiar and understandable to the pupils.

4. It should be truthful, accurate and realistic and should be a substitute for reality. For example, a model of red-rose should represent a true flower in its proportion, colour, symmetry etc. If the aid used is just a misrepresentation of the actual thing the whole aim of the aid or teaching is defeated for the children will learn wrong things.

5. It should be motivatinal and highly informative. The aid used should attract and capture the attention of pupils.

6. It should be available where and when required.

7. It should have desirable utility and should be according to local conditions and needs. The aid selected should satisfy the purpose with which it is used.

Principles for the Use

1. Tklhe teacher should be well skilled in the use of aid. Aid should be actually taught and not merely displayed. It should not substitute but supplement the teacher's work.

2. While using the aid active participation of sudents should be sought. There should be adequate preparation on the part of pupils. They should be told what they should look for. The pupils should ask questions, answer questions, comment and discuss.

3. The aid should be properly protected and preserved for nothing discourages or mars the interest of the students more than a spoiled picture, broken model or a cracked slide.

4. It should be located conveniently so that it is easily available when need arises. The teacher should keep the aid at such a place as is easily acesible and find no difficulty in getting it when he requires it.

5. The aidsshould be evaluated at regulaar intervals in order to know their use and effect on learning.

Types of Audio-Visual Aids

For the sake of converience, we can clasify the aids into the following categories:

A. visual Aids.

B. Auditory Aids.

C. Audio-visual Aids.

D. Information and educational Technology.

Classification (types) fo Audio-Visual Aids

Visual Aids **Auditory Aids** **Audio-Visual Aids** **Information Technology**

Visual Aids

These aids involve the use of the sense of sight and hence called as visual aids. The type of aids include

(i) Chalk-board.

(ii) Charts, diagrams, sketches, models etc.

(iii) Motion pictures, film strips and slides.

(iv) Flannel graph, Bulletin board and scrap book.

Auditory Aids

(i) Radio

Gramophone

Tap-recorder

Linguaphone

Dictaphone

Audio-Visual Aids

Films (sound Motion pictures)

Television

video

Information Technology

A. Visual Aids

These aids involove the use of the sense of sight and hence called as Visual aids. The type of aids include.

Chalk-board

Charts,diagrams,

Motion picture, film strips and slides.

Importance of visual Aids

visual aids can be very successfully used and are indispensable

(i) where the subject is far too distant to be actually seen as in Geohraphy and astronomes etc..

(ii) Where the subject is far removed in time as in history. For example. the discovery of atom can be very effectively shown with the help of slides and motion picture.

(iii) where the subject is too small to be seen with naked eyes, e..g the germs, structure of atom, the chromosomes etc.

(iv) Where the subject is too small to be seen by the whole class at a time

for exmaple, the structure of gram seed.

(vi) Where the subject is too show to be seen. For example, the germination of sed and growth of a seedling.

(vii) Where the sub ject is non-visual. For example, sound-waves, electricity etc.

(viii) When the subject is complex to be understood in its natural from. For example, the working of steam-engine, proccess involved in the manufacture of ice etc.

1.Chalk-Board

Chalk-board is one of the necessary equipments of the class and is the commonest and the most indispensable aid for the teacher. If used properly, it becomes the most valuable for making instruction concrete and comprehensive. There are different types of chalk boards which have been suggested from time to time e.g. hinged boards, fixed wall-boards, rollup boards etc. Of all these boards, the roller board is recommended, because of its adavantages over the others. Hinged boards can also be provided in science rooms for they can be used from both sides. As regards the colouring of the chalk boards, experiments were done with different coloured surfaces but all of them proved not very successful owing to the discolouration of the board by the chalk used. Nothing appears to be superior to the simple use of white chalk and a black surface, supplemented by the other coloured chalks for diagrams to make distinction. Green board and yellow chalk are recommended .

Value of Chalk-board

1. it has astonishing power of attracting and holding the attention of the pupils.

2. Some vague statements drawn on the board become clear by sketches and diagrams etc. The pupils also watch the techniques of drawing a particular diagram.

3. It affords variety in teaching and breaks the monotony of narration.

4. It connects the aural and visual sensations which is helpful in learning.

5. This aid is economical both in time and money. The teacher has to devote very little time in writing the important points or drawing a sketch as compared to drawing on the chart. Secondly, it costs nothing. The only cost incurred is on preparing the board and on the chalk. As compared to charts and models, in hich we require chart paper, inks etc., every time while the board can be used for endless number of times.

How to use it?

While using the chalk-board should, it is very essential that the teacher takes into consideration the following points :

1. The writing on the chalk-board should be neat and bold so that it can be read easily by the students sitting on the last bench. The writing should be uniform and in a straight line. It is advisable that the teacher starts writing from the top left-hand corner across the board and then continues on the lower line from the left. The uniformity of writing captures the attraction of the pupils. A bad an d illegible writing on the board mars the interest of the students and it proves as a hindrance for learning instead of an aid.
2. The representation on the chalk-board should be correct and realistic. The teacher should write those statements or words or draw those diagrams on the chalk-board which he is quite confident that they are correct. It is always better not to write at all then to write wrong.
3. Lengthy and laboured drawings and writings should be avoided because in that way the teacher is all the time talking to the chalk-board with his back towards the students. This will also create chances for indiscipline.
4. Chalk-board should be well-cleaned before starting and after finishing the lesson. White chalk on black-board should ordinarily by used and coloured chalk may be used to show some distinction.
5. The teacher should guard against indisipline in the class while writing. He should occasionally look behind his back and also see to it that the students are also witing.
6. The teacher should not obstruct the view of the students while writing and should use only that part of chalk-board which he can conveniently reach and is visible to the whole class, the part of the board which reflects light should be omitted. It is always better that the teachers stands at an angle with the chalk-boar. In this way he will not cover the chalk-board with his body and at the same time can have an eye on the students who may otherwise enter into mischief.
7. The chalk-board summary should be brief and a continuous whole. The teacher should practise to write an draw rapidly. He should be an expert. This will economize time and at the same time, the students will not get any changce to do any short of indiscipline.

2. Charts, Diagrams, Pictures etc.

These aids also play a significant role in making the ideas clear and comprehensive. It is, however, desirable that these aids should be the result of active participation of of both of teacher and the pupils.

Values

1. These aids help in elucidating an argument or statement and in clearing up difficulties of comprehension. For example, the process involved in the manufacture of sugar can be very easily and effectively illustrated with the help of charts and diagrams.

2. They stimulate interest and excite curiosity in things which could otherwise be dull and dry. For example, the electronic structure of atom.

3. They help to secuire better attention and process 'fixing power'. As a result of this, the acts learnt are retained for a much longer time.

4. They cultivate the power of observation of the actual object and correct judgement for the accurate and truthful representation of the facts.

5. They give vividness and simplipy the explanation and narration, which could otherwise be too complex and dull for the students to understand.

Using these aids

While using charts, diagrams, pictures etc., the teacher should keep in view the following few points :

1. It should be interesting i.e., it should be according to the interests of the students. Bright colors, simple design and possibility or suggestion of action appeal to children. But care should be taken that the exactness and accuracy of the represented thin id not sacrificed in bringing brightness and simpilicity in the chart or picture.
2. It should be simple and comprehensible. The students should understand the purpose of the aid without any explanation or comment. The teacher should guard against crowding of observations. It it no using grouping all the fact in a simple chart. There should be proper spacing and the diagrams drawn should
3. It should be subordinate to the points illustrated. The diagram or picture used for elucidating certain points should not become a problem itself for the studends.
4. The picture or the diagram should be relevant, accurate, exact and realistic. There should be no exaggeration of the facts.
5. It should be properly exhibited. The place where it is displayed should be well-illuminated and visible to all the studends in the class. Sufficient time be given for display.

Aids to science teaching

3.Flannel Graph

This is also a useful aid which can be applied in teaching science. The chief value of this is that the prepared diagrams are ready without loss time at the movement thayare needed and can be used again and again over a period of years. Sometimes it is difficult to build up a complicated diagrams, say of a gas-plant, on the chalk-board. Though many of the charts, etc., are available in the market but most of them are produced as advertising matter and secondly they cost much. In such a case the teacher, with the help of the studends, can make the desire diagram on the flannel graph for no cost. We require a wooden board which is fixed to the wall. The background material is usually a pieceof flannel, etc., which is preferably white. Pieces of other material, flannel, thin felt, rough paper etc., are placed on the background of the flannel. The most cheap and convenient material to use with flannel is blotting-paper for it can be easily cut in any shape and can be brightly coloured with different colours. These bright colours attract the young pupils. For example, the whole process of pollination and fertilization can be easily depicted. Similarly, the preparation of a gas can be shown by making flask, beaker, cylinder, through etc. of blotting paper.

4. Bulletin Board

The bulletin board is one of the effective aids of teaching and so there should be a bulletin board near the science room. Asides from providing vitalized material, which supplement other soures of information, and as an effective motivational device, it provides opportunity for developing creativeness, responsibility and other abilities in the pupils.

The bulletin board should be made a project for the pupils and the material for display should be the result of active participation of pupils and the teacher. Maximum educational value is derived if the pupils are made incharge of it and the teacher acts as a guide. The pupils take keen interest in displaying some attractive material and thus their creative ability is developed. Some change is necessaryeveryday to make to make room for contributions. The studends should be encouraged to give regular contributions in order to keep the bulletin board dynamic.

The material exhibited should be of some scientific interest. Interesting and important science news should be published. Newspapers and magazine cutting of scientific interestshould be exhibited. The school, and the pupils who distinguished themselves in various activities in science should be notified.

B. Auditory Aids

These aids involve the use of the sense of hearing and include :

(i) Radio. (ii) Gramophones
(ii) Tape-reorder etc.

1. Radio

It is an instructional aid which is now coming into limelight. The existence of electromagnetic waves was predisted by maxwall in 1865 and their production and detection by Hartoz in 1888. G. Marconi, an Italian Engineer, was the first to demonstrate the actual transmission and reception of messages.

Program for school children is now a regular feature of A.I.R and B.B.C. frequently talks on scientific topics are broadcast which are of immanse value to the children as well as to the teacher. B.B.C. London gives extensive range and variety of program in whichgood lectures, dramas and discussions of scientific value are presented. These are being specially planned and written by teachers, professors and experts. Both B.B.C. and A.I.R. issue pamphlets in which the program foe the whole month is given in advance. The teacher can very easily select the topics which he thinks of great educational value and suit the interest and curriculum of the studends. It is, however, important that the radio should supplement the class teaching and not supplant it.

George Watsonsay :"Radio is not an addition to education. Radio is not something to be placed on top of education".

Reynolds, R.G., Write : " Radio is the most significant medium for education in its broadest sense that has been introduced since the beginning of the 20th century. As a supplement toclass teaching possibities are not confinefedtofive or six hous of the school day. It is available from earlymorning till long at night. By utilizing the rich ducatinal offerings of radio, children and adults in communities, however remote have acess to the best of the worlds store of knowledge and art. Some day its use as a educational instrument will be as common-place as textbooks and black-boards.

Values

1. Radio ives us the current news of the whole world. We can hear the talks of great scientist in different parts of the world. It establishes a relationship ad makes the countries as neighbours to one aother by eliminating the distance. We can know what is happening in America or Russia just in a few seconds sitting in our homes.
2. It brings a sense of participation on the part of the pupils. By listening to the stirring address or vivid description one feels like member of audience or participat.
3. It a adds variety to the calss room technique and removes the monotony. The ppils feel interestedwhentey hear of something pleasant and valuable. The programme appeals to the emotions of children when they listen to some dramatic act. This powers of judgemetand discrimination are also exercised.
4. It is a means of supplementing, vitalizing, correlating and moderning the material of textbooks. It can recreate historic events through dramtic re-Aids to science teaching.

   Enactments of important past events. There can be some features, such as the dramatization of cincident in scientists lives, wich cannot be presented in the clss room or laboratory can be successfully presented on radio.

Limitations and Difficulties

1. There is lack of sufficet radio sets.
2. The timingofradiio broadcast with the class schedule is also a problem. There is no provision in the time table for listening to the radio talks.

Some suggetions for utilizing radio broadcast

Science is predomnatly a visual study and science broadcast cannot really compete with individual laboratory work and class demonstration. However insome class in can suppelemnts the work of the teacher and it is here that the teacher should keep the following points in view wen making use of the raido broadcast:

1. The teacher should select the programe carefully according to the age experience and intelligence of the children.
2. The pupils should be prepared for the broadcast. It is always useful that teacher may give a brief description of teprogramme beforehand. He should also make the pupils conscious of ertain points which they should listen attentively. After the broadcast is over, ther should be reviewing and discussions.The pupils should consider it asa type of assignment for further study.
3. The tacher should not consider it as a substitute to teaching but as a supplement.
4. The programme selected should be correlated and integrated with class room work. It should be within the purview of the subject under discussion in the class room.
5. Wherever desirable and possible the broadcast should be supplemented wit other aids also.

Tape-recorder

This is another aid which can also be profitably used by the teaher, especially for introducing a lesson. The talk by some scientist on a certain scientific topic can be tape-recorded and then reproduced in the class when need be. The main advantage of this is that the speech of aoersib can be tape recorded at any time and the same speech can be sed for a number of times. It has the advantages of broadcastin addition to its own. But as with broadcast the visual stimulus is missing.

Its possibilities in the teacing of sound are considerable. For examplepianos etc. may be difficult to introduced into the laboratory. Here the tape recorder can efficiently serve the purpose. With the help of this the teaching can illustrate.

(i) Such instrumental tones or harmonics as he wishes to use.
(ii) The sympathetic vibrations of piano strings.
(iii) The changes in vocal tones caused by mechanical reproduction as in telephone etc.
(iv) The difference between noise and music can be shown by feeding the output from a recorder with an oscilloscope sothat the waves could be noted.

Simlarly, it can be sed to record the songs of different birds ect. If the recorder is portable it can be used on an educational visit to record explanations given by the guide and distinctive background noises.

C. Audio-Visual Aids

These aids involve the use of the sense of gearing and seeing. These include:

(a) Films (sound motion pictures)
(b) Televisions
(c) Video
(d) Cds

1. Films

No other scientific invention can claim to have rendered more service to education that the cinematograph, but the schools in Indian cannot make use of this privilege because of financial difficulties and lack of technical personnel. The films make the concept clear, kurable and realistic. It has now been realized to manufacture films for children only having lot of colour, music, action and simple realistic plot which can appeal and have a constructive desirable influence on the emotion of the children.

The importance and the guiding principles for ghe selection and use audio-visual aids have been dealt, hitherto, in this chapter.

The scope of educational sound-motion picture
Educational films can be divided into the followingtpes:

(i) Classroom Films
(ii) School made films
(iii) News-reels
(iv) Industrial films
(v) Docmentary films

(i) Classroom Films

The films are directlyconcerned with the classroom teaching and can be divided into the following categories:

(a) Process films. These films explain the different stages involved in a process e.g.,There are many films showing the natural phenomenon formation of rain, snow, change of seasion etc. again there are films which show the irculatin of blood, respiration and many other processes in nature,in industry nd other fields. A film may be used as the basis of ta lesson but for this the teacher should have full knowledge of the content of the film and shold plan the lesson around it.
(b) For general information. There are certain films which are not directly concerned with the curriculum by which form a basis for an integrated and correlated study. A short film showing wide applications of scientific principle may be used for giving general information.
(c) For demonstrating a skill. There are certain experiments which are beyond the scope of school science department. Such experiments can be successfully demonstrated in the film. Secondly the technique and the steps involved in

demonstrating certain experiments can be very easily observed by all the students in the class.

(d) Revision films. There are some films in which a wide range of materials is assembled in one short film. In this way a number of lessons can be reviewed in ten to twenty minutes with economy and efficiency.

(e) Films dramatizing an event, episode or life of the individual. Films can also be used in depicting the life histores of scientists, the history of some discovery or invention, and other scientific topics. Such film appeal to the emotions of children and have a desirable influence upon the students.

(ii) Industrial films

These films show the mechanicof different types of machinsi.e., the diferent part of a macine and the function of each part.

(iii)School made films

These films are preapared by the school showing diferentactivies of the school e.g., the film shoing the activities of the science clubs or the science fair etc. can bedisplayed to the students. This creatsa very healthy impression on the students.They areenourged to work more and show their worth in every activity.

(iv) Doc**umentary Films**

These films are produced by the goerent of india in quite large numer and cover a very wide ariety of subjects. Mucof real value in teaching of science can be achieved through the preservation of wll planned and carefully chosen programs of documentary films on industrial and soial themes. These films provide a background to scientific studies.

(V) **News-reels**

These are also produced by the government of india and deal with the current events.

Methods of using a film

More important than the film itself is the method of showing it. The teacher should

Make all necessary arrangements for projector,room, operator etc. well in advance. He should notify the day,date and time of showing the filmi with little details about the film regarding the time, whether silent or sound, the name of the film etc. New films which have not previously been seen by the teacher should be viewed or previewed before they are presented to the class. This should b done at least one day before the fil show. A thorough background of the subject-mtter covered in the film should be given to the students beforehand inorder to secure the greatest benefit form it. After the filmas been shown, there soldbe questioning, comments and discussions to clear up the fiffeculties, if the situation demands and the time premits. The film can be shown a second time to tome. Discussion should alwysfolloweither in the same perios or at the next meeting of the class.

2. Television

This is the latest addition to the lit of a nuber of audiovisual aids. It combines the best elements of the radio and the potentialities of the film. Its amazine impact upon the spectators led the educationists to realize it for the educational purposes. It has now become a powerful means of communication of ideas all over the world. The selected scientist can demonstrate a certain experiment at one place and this can be seen at any corner of the world.

Keeping in view the scarcity of qualified personnel and lack of well-equippedlaboratories, te television is made use of in teaching the class-room syllabus. This type of programme is called 'Instructional Television' . In such programmes the teacher designated as TV teacher or studioteacher performs the experiment or delivers the lecture before the TV- Camaera in the studio and this is received on television sets fitted in each classroom. This system of imparting instruction has been started n many schools in delhi and other cities. In delhi, the TV teacher and te class teacher workin collaboration.Our of 40 minutes period the first five minutes are reserved for tasting of previous knowledge of the students by the class teacher in order to prepare them for the lesson in the next 20minutes, the TV lesson is given an the remaining 15 minute left fer follow-up work. On the following day, the class room teacher gets one full period of minutes for explaining certain difficult points in the TV lesson, removing some misconseptions of the students. He also assesses the pupil's progress and also of the TV lesson. He inculcates among the pupils good viewing habits, attentive and critical listening. The main function of the class teacher is to psychologically prepare the students to receive the information and secondly to do the follow up work after the lesson.forthis is the class teacher is given a 'Guide sheet' for each TV lesson. He can, however, deviate from the sheet provided if he thinks so.

Merits

1. In some respect the television has the similar advantages as the film but it has a psychological advantage of being 'live'. The demonstration etc., made by the teacher on the television are as effective as done by the teacher in the class room. Experiments were conducted in America to find out the merit of class room teaching over the TV-teaching and vice versa. It was found out that TV-group and regularlyinstructed groups by the teacher generally learn and retain equaly well.

2. To some extent, it has solved the problem of the lack of good and qualified teachers. One good teacher can teach the same lesson to hundratesodf students at a time.

3. TV lesson is always better then the class room teaching. The teacher prepares the lesson by spending a lot of time and after consulting the recent informations on the topic. He makes use of such apparatus and audio-visual aids which are not available for class room teaching.This is also simplifies the work of the teachers for he has to demonstrate the experiment only once which would have been impossible by class-room demonstration.

4. The important advantage of it is that the teacher can listen to his own lesson which is pre-recorded. In this way the teacher gets a chance for criticism and improvement. He also

receive the reactions, criticism and suggestions of class room teacher. In this way, it helps the TV teacher to improve upon his previous performances. What is more the class-teacher gets a sort of 'Refresher course in teaching' by keenly observing and criticizing the TV-lesson.

Limitations

As in the case of films, the use of television deprives the students or seeing the actual apparatus and handling them. In a way they are possive observers and take no part in demonstration. For this the TV-teacher and the class room teacher should join hands to improve the teaching.

Some critics of educational television in America feel strongly that the purpose of educational television is not all that of improving education, but rather of cutting education costs by downgrading teachers financially through creating a kind of second class teachers. It is a risky think to lead to public to believe that simply by installing television sets you might increase the number of teachers, thereby automatically bringing about better instruction at less expense.

Adjustment to individual differences among pupils is limited television teaching. Often it is argued that television can extend the influence of great teacher from a few students to many hundreds or even thousands. Wat is overlooked is the extent to which the teachers are great because of their direct, personal influence on students.
Another difficulty faced by individual schools is to its their time tabe to the programmes schedules of television station.

The place of television in education is though conditioned by present limitations in facilities and fuly qualified teaching staff yet this is by this no means the imit of significance in school education. Its contribution is unique when outstanding scientists, or poet speak directly to the children.

Television is not merely a substitute for traditional ways of teaching. It is a medium with its own psychological and emotional appeal, able to transcend barriers of time and pace of disciplines and personalities. But the successful exploration of these contributions is hampered as long as there is conflict between immediate need and long range objectives.

Some studies in the united states have shown that children spent most of their time in front of television set which lead to less interest in reading, and more chances of obesity and higher incidences of violence and aggressiveness. The proliferation of television chennals have further affected the socialization process of children.

Some difficulties and suggestions in the use of audio visual aids

1. **Financial.**

Our India is a poor country and it will be over ambitious for us to demand the costly apparatus like projectors, televisions etc., from the government. The problem can, however, be solved to extent if :

(i) The teacher with the teacher with the help of pupils prepare the home mae projectors etc.,

(ii) The schools ofa locality purchase the various aids and jointly and make use of them by turn.

(iii)The municipalities and direct-boards should purchase a projector of their own and this should be made available to the schools.

(iv)Emphasis should be given to the use of cheaper aids like charts, pictures chalk-board etc.,

(v) Projectors and other aids can be borrowed from the ministry of education, American Embassy or the British Council.

2. Absence of good film libraries, museums of audio-visual education in the regional and central audio-visual education centres.

The central government as well as the state government should set up good audio-visual libraries at important places and should give active co-operation and guidance to teachers for the use of these aids.

3. Absence of electricity. This is again a hurdle in the effective use of the audio-visual aids. A majority of schools are situated at such places as are deprived of the boons of electricity. At such places, the petromex should bee made use of.

4. Improper selections of films. The film selected by the teachers are not in co-ordination with class room teaching nor the teachers care to integrate them. They have a wrong view that the films are meant for recreational and entertainment purposes.

5. Lack of facilities for training teachers. Teachers trained in the use of the audio-visual aids are not available nor is there the provision for training them. Provision should be made to train teachers in the use of commen audio-visual aids in training colleges.

6. Films are not prepared according to the needs and conditions of our country. The system prevailing in some other countries may not at all be suited for ours. Again most of the educational films have English commentary which is difficult for Indian children to understand.

7. Indifference of the teachers. Due to the improper planning, Lethargy of teachers, and absence of proper preparation, appropriate application and discussion and essential follow up work, the aids have not proved their full usefulness. There is a misconception in the minds teachers that audio-visual education is a new type of education that will to away with the teachers and books. They hav developed some crave or fad for it. The touch-me-not attitude regarding the aids adopted by teachers puts a wet blanket on the enthusiasm of the children.

Unit III

METHODS AND TECHNIQUES OF TEACHING

Different approaches of Teaching

Lecture method

Lecture method is one of the oldest and most common teaching methods. A lecture is an exposition of knowledge, facts, principles and information a teacher wishes to provide to the students. According to the **Carter Good's dictionary: "**an instructional procedure by which the lecturer seeks to create interest, to influence, stimulate, or mould opinion, to promote activity, to impart information, or to develop critical thinking, largely by the use if the verbal message, with a minimum of class participation, illustration, maps, charts, or other visual aids may be employed to supplement the oral technique is defined as lecture method".

A lecture conveys information, to be presented to a large group of students in a short period of time. This method is liked the most by the teachers. The teacher presents the material in such a way that it generates understanding and stimulates interest in the students. Lecture method is commonly sought when the number of students is large and teaching resources are scarce or limited. But this method is not based on psychological parameters and does not fulfil the real aims of teaching. Hence lecture method is most commonly used and is most widely criticized method.

Planning a lecture

A teacher has to plan he lecture in a systematic way for its effective delivery. The planning should be based on the following factors:

- **The audience:** The students are the audience for a teacher. The abilities, the needs and the level of knowledge of the students should be taken into consideration. The teacher can discuss or use a question answer session to acquaint with the students.
- **The purpose:** The teacher has to identify the purpose of the lecture. It should be based on the objectives of the lesson. It should
    - Provide an overview of the subject
    - Introduce a new topic
    - Bring changes in the student attitude
    - Provide detailed information
    - Teach a particular skill
- **Time period:** The teacher should plan her lecture for a given time. Appropriate examples, interesting questions, discussions could be included to make the lecture interesting.
- **Subject matter:** The teacher should possess an extensive knowledge of the subject matter. She should have a command over the topic. Poor knowledge of the subject may lead to failure of the lecture and confusion among the students.

Components of a Lecture

The lecture contains three main components. They are

1. The Introduction
2. The Body
3. The Conclusion

The Introduction

The introduction includes the first three to five minutes of the lecture. It gives a brief outline of the objectives and the central idea of the lecture it generates the interest and curiosity among the students. The main purpose of the introduction is to provide a framework for students' learning and a structure for the content. It helps to gain the students attention. Attention will not be sustained if interest is not developed during the introduction of the lesson.

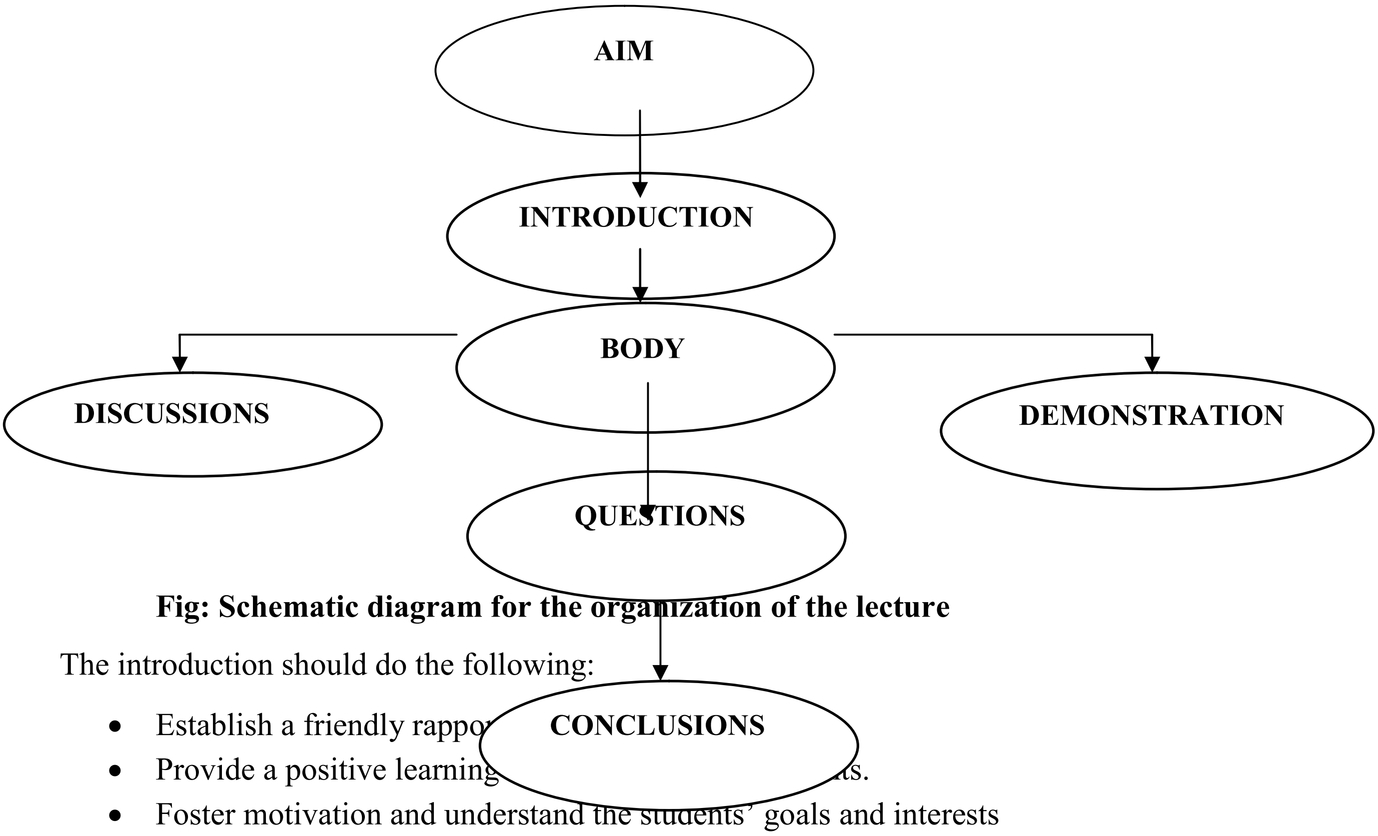


Fig: Schematic diagram for the organization of the lecture

The introduction should do the following:

- Establish a friendly rappo
- Provide a positive learning s.
- Foster motivation and understand the students' goals and interests
- Relate new information to the previous knowledge
- Explain the purpose of the lecture and its organization.

The Body of the Lecture

The body of the lecture includes the arrangement of the content in an organized way.

Lecture material is a combination of facts, concepts, principles and generalizations. In a lecture the important points are highlighted in logical succession. New concepts are introduced, linking them together into principles, and then into generalizations, each time adding concrete examples to develop these relationships. The body of the lecture should include audiovisual aids like charts, models, specimens, transparencies, or even the chalkboard to strengthen the presentation of ideas and to enhance the students learning. Providing motivational clues following active learning, changing the mode of presentation demonstrating enthusiasm can sustain the students' interest in the lecture. Asking students to respond to the questions can conclude the lecture.

The Conclusion:

The conclusion should be used to reinforce students' learning of the information as well as to clarify any misconceptions regarding their understanding of the concepts presented. Conclusions should cover all the objectives of the lecture.

- Repeat and emphasize main points
- Encourage questions from students
- Relate content to previous and subsequent topics

Presenting a Lecture

The lecture becomes effective when it is properly presented

The important criteria for a good presentation of a lecture are:

Posture: The way a teacher maintains himself is very important. It is preferable for the teacher to stand and teach in the class it creates a formal environment. She/he should be visible to every student in the class.

Appearance: The teacher should be appropriately dressed. He should appear decent and dignified. He should be confident and appear friendly to the students.

Mannerism: The teacher should possess good manners. He should be courteous a.d maintain poise.

Gestures: The teacher should maintain proper body movements. The teacher should avoid unwanted and unnatural body movements

Voice: The teachers' voice should be clear and audible to all the students. It should reflect the confidence of the teacher. The teacher should modulate his voice. The tone, the pitch and the volume should be modified to overcome monotony.

Language: The teacher should use simple language and avoid heavy loaded sentences. The vocabulary should be simple and easiy understandable to the students.

Usage of appropriate aids: The teacher should use the blackboard and other audiovisual aids regularly in a lecture. This will help in improving the value of the lecture. It will sustain the interest of the students in the lecture.

Time management: The teacher should organize his lecture effectively in the given time. To reduce monotony the teacher should include question answer sessions and discussions and involve active student participation.

Advantages

Some advantages of lecture method are:

- It is an efficient method of delivering a large amount of content to a large group of students.
- A single teacher can handle the entire class without using any other aid.
- An easy method of teaching where teacher can use his own style
- It helps in maintaining a logical sequence of contents
- A lot of information can be provided without any overlapping
- Abstract concepts can be taught with ease
- Introducing and summarizing a lesson becomes very easy
- Syllabus can be completed in time
- A well-presented lecture creates interest in a subject
- Good lecture motivate and inspire the learners and develop their critical thinking
- A lecture can complement the text material

Disadvantages

Lecture method is a primitive method of teaching and is not psychologically sound. Hence it has many disadvantages. Some of them are:

- Students are passive recipients of information and their participation is negligible
- It does not cater to the needs and individual differences of the students
- Only theoretical knowledge is given importance
- This method is not based on the principles of learning by doing
- It doesn't promote learning strategies like questioning and problem-solving techniques
- It does not consider the previous knowledge of the students
- It does not inculcate the scientific attitude and methods
- There is no provision for the feedback and remedial measures
- This method does not provide the opportunity for students to interact with the teachers
- It does not promote independent learning in the students
- Communication is one way and the students may be overloaded with the content
- The attention and the interest of the students are not considered
- Poorly delivered lectures may cause disinterest and demotivation among the students
- It is an authoritarian method where entire teaching process depends on the teacher. This checks the overall development of the learner

Role of the Teacher

The teacher plays a central role in this method. He is an active participant in the teaching process. Nearly 30-50% of teaching time is spent on lecturing. In this method the teacher teaches the subject according to his own style. It may be writing in the blackboard or providing the notes to the students to prevent monotony in the lecture method the teacher has to plan the lecture systematically and interestingly to make it communicative and effective. The lecture should be interspersed with the aids and other visuals to make it effective. The teacher has to interact with the students and follow the techniques of questioning and problem solving in the class. The basic purpose of lecturing is the dissemination of information. The teacher has to identify the important points in the content and deliver them in an interesting way through the lecture. A lecture is an effective method for communicating theories, ideas and facts to the students. The teacher has to provide concrete examples and apply them to the real life situations to motivate the students.

Lecture-cum- demonstration Method

This method includes the lecture and the demonstration. The teacher not only gives the lecture but also simultaneously demonstrates the required steps in the lesson. This method substitutes the lecture method which is relatively ineffective as it does not provide any interaction. In a lecture method the teacher speaks and the students listen and this leads to a passive learning situation. This is the major drawback of lecture method. The lecture-cum-demonstration method involves the active participation of both the teacher and the taught.

The science teachers in the class generally follow the lecture-cum-demonstration method. This method emphasizes on both theoretical learning skills and practical work. This method includes the merits of lecture and the demonstration. It tries to combine their advantages while removing their disadvantages. The teacher explains the theoretical concepts and demonstrates the experiments and the students observe the demonstrations and take the notes. This method helps in making the concepts of the subjects clear.

Active student participation is an important feature of this method. The students assist the teacher in organizing and conducting the demonstration. The teacher demonstrates the experiment simultaneously explaining the theoretical principles of its working. He students observe the demonstration carefully. The teacher asks question and elicits the relevant answers. Students describe the procedure accurately and give inferences. This develops active participation of the students in the teaching learning process. This method also helps in sustaining the interest of the students. Students draw conclusions when they observe the demonstrations. The students develop the skills of observation and analysis. They also develop reasoning and problem solving skills. Lecture-cum-demonstration method makes the abstract concepts easy to understand. This method employs teaching the concepts from "concrete to abstract".

Purpose of a lecture demonstration:

A lecture-cum-demonstration method is used in the following situations:

Provide a problem: Providing a problem will develop reflective thinking skills in the students. They develop interest and actively participate in the teaching learning process.

Explanation of the concepts: The teacher can explain the concept in a better way by demonstration. Eg: concepts relating to pollution

Problem solving: The students use the scientific skills of reasoning and analysis and come up with solutions to the problems relating to the content. Eg: experiments on osmosis, transpiration

Verify the facts: The demonstration helps in verifying the principles and concepts taught in the class. For eg: circulation of blood by using working models

Demonstrate the physiological processes: The processes like photosynthesis and respiration can be shown clearly to the students. Eg: Importance of sunlight and CO_2 to the plants.

Develop the scientific skills: Demonstrations will develop the skills of observation, skills of drawing, skill of explaining, analyzing and critical thinking in the students.

Apply to general situations: Demonstrations will help the students to identify a number of examples and apply a principle or concept to general situations.

Economize the time: It is not always possible for the teacher to follow the pupil-centred approaches. This method provides the required practical skills to the students even by following a teacher-centred method. This ensures active participation of the students in classroom teaching

Demonstrations are used to

- Introduce a lesson
- Explain the concepts
- Demonstrates the processes
- Solve the problems
- Apply the principles
- Summarize the topic

Steps in a Lecture-cum-Demonstration Method

Lecture-cum-demonstration method is a common method employed in teaching biological science. This method is very effective for illustrating concepts in class. It induces the students to think for themselves and is helpful in explaining an otherwise abstract concept or mechanism. The major steps of this method are:

- **Planning:** The teacher formulates the objective of teaching, identifies the concepts to be explained and the questions to be asked. Then she plans the lesson accordingly. The teacher prepares for the demonstration before conducting it successfully in the classroom.
- **Introduction of the lesson:** The teacher introduces the lesson by motivating the students. She motivates the students by giving a small problem or relating a real life situation to create interest in the new topic. Then the lesson is taught by lecture-cum-demonstration method. She may employ the usage of teaching aids to sustain the interest of the students.
- **Presentation of the Content:** The dissemination of the knowledge mainly depends on the presentation of the subject matter. The teacher has to present the content effectively. To make it interesting she should use some common examples or apply the concepts to real life situations. She may also correlate with other subjects. e.g while teaching the factors required for preparation of food by green plants, the teacher may bring two potted plants kept in the dark and in sunlight respectively and show the difference between them. This will give a concrete understanding of abstract

principles. The teacher should substantiate the teaching with different teaching aids like charts, models, diagrams, slides and posters. The teacher should ask questions and elicit the answers from the students and develop their reflective thinking. The questions and answers should be in such a way that they form a logical completion for the teaching unit. The teacher provides the answer to the questions which are not answered by the students. The teacher should use appropriate vocabulary and proper pronunciation while delivering the presentation. She should speak in a clear and slow voice and without ambiguity. Continuous talk may lead to monotony; hence it should be properly spaced with the demonstration.

- **Performing the experiments:** The demonstration should be performed in an organized and systematic manner. It should satisfy the objectives of the lesson. It should be simple and easy to understand. The teacher should explain the important points on the blackboard. She should summarize the information. The students should observe and understand the demonstration. They should relate with the theoretical content. They should give conclusions and generalizations with the help of the teacher. They should apply to real situations.

  Points to be considered while conducting a demonstration
    - The experiment should be simple and speedy
    - The experiment apparatus should be properly arranged
    - The experiment should be successful and give appropriate results.
    - The experiments should be properly spaced throughout the lesson.
- **Blackboard summary:** The teacher can use the blackboard for explaining the facts, concepts and principles. She may use it to draw the diagram of the experiment, give the formula, or the readings of the experiment. The student notes down these diagrams and reading and understands the concepts better. The black board is a teaching aid when effectively used along with other teaching aids enhances the teacher's effectiveness.
- **Supervision:** Though the teacher plays a major role in lecture-cum-demonstration method she can make the class interactive by involving the students in the demonstration. The students should not be passive learners. The students should observe the demonstration, listen to the explanation, note down the readings, draw the diagrams and relate the formulae and equations. The teacher should supervise their participation. She should ask the questions and elicit the answers from the students. She should oversee their active participation in the lecture-cum-demonstration.

Requisites for a good demonstration

- The demonstration should be planned and rehearsed in advance.
- The objectives of the demonstration should be formulated
- The behavioural outcomes of students should be identified.
- The purpose of the demonstration should be clearly defined.
- The teacher and the students should actively participate in the demonstration.
- The apparatus and the demonstration should be visible to the entire class.
- Basic facilities like adequate lighting and ventilation should be provided in the demonstration room

- ➢ There should be a relation between the lessons and the demonstrations. The demonstration should be supplemented with other teaching aids to make it more interesting.
- ➢ Demonstrations should be designed in such a way as to develop the power of observation, analysis, reasoning, explanation and verification. Reflective type of questioning will help in their development.
- ➢ The teacher should emphasize the major points and summarize them on the blackboard.
- ➢ The teacher should utilize the students support wherever necessary. The students active participation can be used to fix the apparatus, note the readings and summarize on the blackboard.

Common mistakes while conducting demonstrations

Some common mistakes that occur during the demonstrations are

- The demonstration and the lesson may not be related to each other.
- The apparatus may not be properly arranged leading to problems during experimentation
- Explanation may be clear. The teacher may not use other aids like blackboard for summarization.
- The teacher in a hurry to complete experiment may not give sufficient time resulting in improper data recording and conclusion.

Advantages

- This method is economical in saving the time and money
- This method caters to the needs of individual students
- The teacher uses this method when the apparatus is costly and dangerous to handle individually.
- The teacher provides more information in less time. It helps in illustrating and verifying the facts.
- It helps the teacher in channelizing the students learning in the desired direction
- It involves active students' participation in the teaching-learning process.
- The students develop enthusiasm and interest in the science. They develop practical skills in science.
- This method is useful in developing manual and manipulative skills among the students. They learn through hand and eye.

Disadvantages

- The concept of learning by doing has no place in this method.
- The students only observe the demonstrations. They do not conduct them individually.
- The teacher may follow his or her own pace while demonstrating. It may not cater to the individual differences of the students.

- It does not give training in laboratory skills to the students. They do not handle the apparatus or perform the experiments themselves.
- It fails to impart training in the scientific attitudes among the students

Role of a Teacher

The teacher has an important role in this method. The lecture-cum-demonstration method exposes the students to practical science teaching. The teacher should possess knowledge of both the theoretical and practical skills in science. She should be enthusiastic and motivating. She should relate the theoretical principles with the practical demonstrations. She should make the students participate in the session by conducting question answer sessions on the demonstrations. Though this method is a teacher-centred method, an effective teacher can make it highly interactive by involving the participation of the students.

Heuristic Method

The Heuristic Method is a discovery method. The prominent personality who advocated this method was Professor H.E.Armstrong. This method is mainly based on the principles of imparting practical learning in science. Science can be learnt not by studying it but by doing it. Earlier this emphasis was not given on this aspect but in the last past of the nineteenth century more importance was given to the practical work**.** It has become increasingly important that students should possess the practical skills to identify and solve the problems on their own.

Heuristic method is a step-by-step method to solve the problems. 'Heuristic Method' of teaching fosters the habits of self-activity and self-dependence. Here the pupils think and work for themselves.

The word 'Heuristic is derived from the Greek word 'Huriskein' which means to discover. The method places the student in the position of a discoverer. The heuristic method provides the students an opportunity to discover the things based on their own observations and experimentations. This gives the students more knowledge than that they gain through mere teaching in the classroom. This method is mainly based on the principle of "Learning by Doing".

According to **H.E.Armstrong**, "Heuristic method is a method of teaching which involves our placing the students as far as possible in the attitude of a discoverer."

According to **W.M.Ryburn,** "This method as the name implies is a method by which the pupil discovers things for himself. The pupil is put in the position of a pioneer and he finds his way along the path of knowledge as did those who first discovered the facts, principles and laws which are now known to all".

Heuristic method basically trains in scientific methodology. It provides opportunities to the students to acquire knowledge based on learning by self-experimentation.

The teacher provides activities and problems to the student. The teacher gives no help or guidance. The students are encouraged to solve the problems experimentally. They are made to collect data, analyze the data, interpret the data and arrive at the solutions.

The essential aspects of heuristic learning are:

- It provides the freedom of action
- It provides a responsive environment
- It provides an encouragement to learn
- It provides teachers' guidance whenever required

Principles of Heuristic Method

The Heuristic Method is based on the following principles:

- Principle of learning by doing
- Principle of freedom of activity
- Principle of logical thinking
- Principle of experience
- Principle of individual work

Procedure of the Heuristic Method

In this method the teacher assigns a problem to the class and the students are given equal scope to work out the problem and obtain the solutions. They try to solve the problem in a scientific manner. They use different sources of information such as books and journals for additional information. They conduct the experiments, collect the data, analyze the data, interpret the result and arrive at a conclusion. They do it individually but may also discuss with the teacher and other classmates. The teacher plays the role of a guide and facilitator. The teacher follows inductive method and provides a number of questions on the problem. The students search the answers and arrive at the conclusion. In this way students develop the skills of observation, experimentation and reasoning. They learn to solve problems, gather the information and interpret the data to arrive at the conclusions.

The Heuristic method can be fully utilized when the teacher

- Encourages the process of searching
- Respects creative thinking
- Welcomes the new ideas
- Corrects and checks the mistakes

Advantages

- Emphasis is on individual practical work. It makes the child self-reliant.
- Develops the scientific attitudes and scientific methodology
- The method develops self-learning and self-direction

- It develops in the student the habits of enquiry and investigation
- The method is based on the important principle of "learning by doing"
- Direct experiences of the students make them retain the knowledge for a longer period
- Develops the power of critical thinking and logical reasoning in the students
- It provides the scope of interaction between the teachers and the students
- This method caters to individual differences among the students. They work at their own pace.
- It encourages the attitude of research in the students

Disadvantages

- It is a time consuming method
- The syllabus cannot be completed in the prescribed time schedule as practical problems like planning of time table may arise
- This method is applicable only to enthusiastic teachers. It is too technical and scientific for an ordinary teacher
- The method requires hard word, efficiency, technical and problem-solving skills in the teacher.
- This method can be applied only to small classes with limited students
- More emphasis may be laid on the topics related to heuristic learning and other topics may be ignored
- This method is quite demanding and may put lot of pressure on the students as it emphasizes on individual learning and problem solving
- The emphasis is more on the practical scientific skills rather than theoretical knowledge. This leads to imbalance in learning
- Ordinary schools cannot afford this method as it demands a lot of time, money and infrastructure
- The method could not be used in all the classes and not many students can cope with this method
- Evaluation of learning by this method is very lengthy.

Though this method has a number of disadvantages, it is an important teaching method, which tries to develop a scientific attitude among the students and makes them more exact, truthful, observant and thoughtful future citizens.

Role of a Teacher

The teacher plays a major role in the heuristic method. The success or failure of heuristic method rests on the teacher. The teacher should be enthusiastic and interested in the subject. The teacher should guide the students through the problem and arrive at the solution.

The teacher should be sympathetic and courteous towards the students

The teacher in a heuristic method is essentially concerned with the following:

The teacher searches the problem suitable for the age, abilities and interests of the students, along with the available resources

The teacher is a guide to the students. She provides sufficient information and resources about the problem and help in solving them

The teacher helps in developing scientific attitudes and values in the students.

The teacher supplements the knowledge by organizing field trips, study tours, visits to places of natural interest etc.

The teacher facilitates the learning by drawing conclusions, arriving at generalizations and relating it to the existing knowledge

The teacher inculcates the skills of self-expression, self-development, self-confidence and self-expression in the students.

The teacher possesses the technique of asking questions and also encourages the students to ask questions. Questioning is very important in heuristic method as it helps in determination of the level of understanding in the students.

Project Method

According to Oxford learners dictionary “A project is defined as a plan of action”. It involves taking up a problem and providing a solution through constructive thought and action of the student. Other definitions of project are:

According to **Kilpatrick**, “A project is a wholehearted purposeful activity in a social environment”.

According to Ballard, “A project is a bit of real life that has been imparted in a school”.

According to Parker, “A project is a unit of activity in which pupils are made responsible for planning and purposing”.

According to Thomas and Lang, “A project is a voluntary undertaking which involves constructive effort or thought and eventuates into subjective results”.

According to Stevenson “A project is a unit of activity in which pupils are made responsible for planning and purposing”.

A Project involves an extended, in-depth investigation of a topic, worthy of the students’ attention and interest. In other words projects involve students in conducting research on phenomena and events worth learning about in their own environments.

In the process of investigating the project the students develop a chance to pose questions, develop a hypothesis, interview experts and obtain the relevant information and engage in activities involved in collecting the data.

The project method was first developed by Sir John Dewey an American philosopher and psychologist. The project method is a approach to teaching and is based on the principles of “learning by doing” and “learning by living”. It is an important method of teaching method of teaching science. It emphasizes on inquiry and investigation. It develops creativity and problem-solving abilities in the students. The students learn in a better way by association, cooperation and activity. The project method provides a practical approach to learning. It helps in application of theoretical principles to solve practical problems. The usage of the project method enables to develop technical skills and creative potentialities.

Projects provide a live experience to the students by bringing them face to face with real life situations. Projects can also involve students in close examination of the natural world around them what natural world objects consist of and teach them to observe closely how things grow and change over time. Projects provide contexts for students to argue, cooperate, collaborate, and share the responsibility of data gathering, check findings and many other research strategies.

Principles of the project method

- The principle of freedom
- The principle of reality
- The principle of purpose
- The principle of activity
- The principle of experience
- The principle of social experience
- The principle of utility
- The principle of correlation
- The principle of interest

The types of project

W.H.Kilpatrick classified the projects in to four types. They are:

- **Producer projects:** The major emphasis is on the actual construction of a material object or article.
- **Consumer project:** The main objective is to obtain either direct or indirect experience, such as reading and learning the material and listening to the music.
- **Problem projects:** The main purpose is to solve the given problem involving intellectual processes.
- **Drill projects:** The aim is to learn certain degree of skill.

The characteristics of a good project

- The project should fulfill a purpose. It should possess practical application
- A good project should facilitate proper learning experiences.
- The project should follow the problem-solving approach
- The project work should be challenging. The project should neither be simple nor complex. It should be feasible.
- The project work should take the monetary and material resources into consideration.
- The project should be properly planned. The activities should be meaningful and purposeful.
- The project should be based on the individual needs and abilities of the students.

- The project work should provide the full freedom for the students to carry their work. There should not be any scheduling and no timetable or curriculum should be framed. The students should decide how they should proceed in their work.

The steps in project method

- Identifying a problem
- Providing a purpose
- Planning the project work
- Executing the project
- Evaluating the project work
- Recording the data

These major steps may be elaborated as follows:

- **Identification of a problem:** The teacher should provide the problem situation to the students. They identify the problem and start working on it. The teacher provides information on the source like libraries, laboratories, journals, field trips etc.
- **Providing a purpose:** The teacher should clearly define the nature and goals of the problem. The problem should be acceptable to all the students in a group. The selection of the topic of the problem should be decided based on the needs and interests of the students. The period of time allotted and the available material also determines the nature of the problem to be taken.
- **Planning the project work:** A good plan is the prerequisite for the success of any project. The students plan the action under the guidance of the teacher. Each and every student in the group is encouraged to actively participate in the discussion on planning. The most appropriate and feasible plan is accepted. It is noted by all the students and the work is begun.
- **Executing the project work:** The teacher distributes the work to the students in the group according to their interests and abilities. Each student should actively participate in the execution of the plan. The different activities included are collection of information, field trips and experimentation. The teacher guides, gives instructions and encourages the students in their work.
- **Evaluating the result:** Once the project is completed the students are asked to evaluate their projects themselves. Self-evaluation gives the students scope to know their mistakes and also to rectify them. The teacher also evaluates the performance of the students and whether the project is completed according to the set norms and whether the objectives of the project are achieved or not.
- **Recording the observations:** The students note down all the steps including the name of the project, the planning methodology, the discussions held, duties assigned, observations and results. Suggested references and books studied for the project are also given.

Organization of a project Report

A Project report is written after completing the project work. It includes compilation of the entire work along with the analysis and inference of the data collected. Based on the inferences the conclusions are drawn. The Performa of a project report includes the following:

- The title of the project
- Abstract: A brief summary of the project
- Introduction: Gives a description of the topic, outline of purpose, scope and methodology to be followed.
- Material and methods: Provides a description of all the materials, instruments, chemicals and techniques utilized.
- Observation: Denotes a systematic record of the data observed.
- Results: Includes the data analysis and conclusions. Also includes the interpretations and comparison of different data.
- Appendix: Gives the additional information
- Bibliography: Gives the suggested list of references

Advantages

- The method is based on psychological principles of learning by doing and learning by living
- This method develops the skills of reasoning, analysis and critical thinking.
- This method helps in developing scientific attitudes and methods
- It promotes the cooperation and interaction among students
- The students develop the power of observation, the skills of interpretation and logical conclusion
- This method caters to the individual differences. The students work at their own pace, according to their own needs and abilities.
- It enhances the scientific knowledge of the students as they collect a lot of information during their project.

Disadvantages

- The teacher has to be gifted, enthusiastic and possess lot of scientific knowledge
- She should be motivated and flexible in her attitude to guide the students
- Projects require extra hours of work. The teachers and pupils should be able to spend the needed time.
- Very few books and other resources may be available in the school. The teacher and students should depend on the external sources.
- The project work may hamper regular classroom instruction. It may hinder the completion of syllabus in time.

Role of a Teacher

The project method encompasses the active involvement of the teacher in every stage of execution of the project. The teacher acts as a guide and a facilitator in this method. The teacher's role is indispensable as she plans, implements and evaluates the project. The teacher helps the students in:

- Selecting the projects

- Planning the activities for implementing the project
- Identifying the limitations and feasibilities for carrying out the project work
- Guiding the students in their work. Advising them on the appropriate methodology to be followed.
- Providing the advanced information regarding the project work
- Evaluating the performance of the students regarding their project work
- Helping the students to develop the scientific attitudes and methods

Laboratory Method

The laboratory work plays a central and significant role in science education. Laboratory method is an important of teaching science. Since the beginning of 19^{th} century, science educators have believed that the laboratory is an important means of instruction in science. Laboratory instruction is considered essential because it provides training in practical skills, helps in developing critical thinking and creates interest in science. The laboratory method is pupil-centred method. It is based on the principles of "learning by doing".

Laboratory is a starting place for the systematic development of students' own ideas and a testing ground for the predictive power of their reasoning abilities. Laboratory work helps the students to develop understanding about the abstract and complex ideas in an easy way. Students generate the appreciation for practical work through this method.

Laboratory instruction increases students' problem-solving ability. It provides the students a hands-on experience by making them participates in various scientific experimentations.

The class management is an important criterion in laboratory method. The teacher has to systematically structurize the various lab activities so that the students observe the experiments and record the data in a smooth manner. The teacher may provide well-written instructional cards, which contain the list of apparatus, chemicals and the details of the method to be followed for making the process of experimentation an easy task.

The laboratory method helps in achieving the following objectives:

- Skills - manipulative, inquiry, investigate, organizational and communicative skills
- Cognitive abilities - reasoning, critical thinking, problem solving, analysis, synthesis and application
- Understanding the scientific nature - scientific methodology, scientific enterprise, interrelation between science and technology and correlation between the different disciplines of science.
- Attitudes - development of scientific attitudes like curiosity, interest, creativity, objectivity, precision, perseverance, responsibility, consensus, collaboration and application

Laboratory activities develop the following skills in the students:

- Measurement with appropriate accuracy
- Observation with clarity
- Clear descriptions of their observations and measurements

- Representation of information in verbal, pictorial, graphical and mathematical terms
- Reasoning and analysis of the observed data
- Providing inference from the data
- Develop rational conclusions and predictions
- Participate and interact with peers and teachers in scientific experimentation
- Appropriate reporting of the observations, predictions and conclusions
- Discussion of the laboratory report
- Identify the problems. Plan, carry out, evaluate and report the solutions to the problems.

Important principles of the laboratory method

- The teacher and the students should be motivated to conduct the experiments with interest
- The teacher may modify some procedures to bring innovation and creativity into the process of experimentation.
- The aims and objectives of the experiments should be clearly defined.
- The teacher should perform the experiments in an organized and systematic manner. The arrangement and working of the apparatus should be explained.
- The data should be recorded systematically and evaluated by the teacher.

Some of the common laboratory approaches used in the schools:

- **Verification and deduction:** it is the most common approach employed in Indian schools. It can be performed simultaneously by a large number of students with minimal involvement of the instructor. The main purpose of this approach is to illustrate scientific concepts, principles and laws.
- **Induction method:** This method provides the students an opportunity to know the concepts, principles and laws by themselves.
- **Inquiry learning:** This method is based on individual inquiry and requires the students to generate their own procedures. The inquiry learning increases the involvement of students' in laboratory activities and develops positive attitudes towards science. Laboratory inquiry will make the students to engage themselves in higher order thinking and develop the skills of hypothesizing, explaining, criticizing and analyzing, judging evidence, inventing and evaluating arguments.
- **Discovery learning:** it is meant to personalize the information students acquire, making it more meaningful and thus better retained. In a discovery learning environment the instructor guides the student toward discovering the desired outcome which is accomplished by giving the students directions for what they are expected to do.
- **Problem based learning:** The instructor adopts an active role by posing questions or problems to the students providing the necessary materials and asking the students to develop the solution to the problem. It encourages students to apply their understanding of a concept to solve the problem.

- **Science process oriented:** Developing the skills of observing, classifying, measuring, inferring, predicting, interpreting data and experimenting are all stressed under this approach.
- **Technical process oriented:** In this approach the major emphasis is laid on acquisition of the laboratory techniques and manipulative skills.

Methods of conducting the practical laboratory work

For making the task of experimentation easy the teacher organizes the students into small groups. The students can be divided into groups depending upon the type of the experiment conducted and the strength of the class. Some common methods of grouping are:

- Class front method: This method is followed when the experiment is simple, the required materials and apparatus are of low-cost and the students can carry out the experiment individually. E.g. section cutting and animal dissections. In this method all the students can perform an experiment and understand the concepts together and it is easy for the teacher to give instructions simultaneously to all the students.
- Group method or rotation method: In this method the class is divided into small groups to carry out the experiments. This method is followed when the apparatus are less in number and the number of students is more. The students are divided into smaller batches and the experiments are performed in rotation by the different batches.
- Division or the part method: This method is used when the experiment is very lengthy and is not possible to be conducted at a stretch. Hence it is divided into small parts and is given to an individual or a batch of students. After completion of the experiment the data from all sources is pooled and a final recording is done. This data is discussed in the class and a final conclusion is arrived at. The division or part method of laboratory work helps the students to develop cooperation and interaction among themselves. The students discuss the various hypotheses and gather more information and develop better awareness of the concepts. They share the responsibility and work in unison for the success of the experiment.

Advantages

The laboratory method helps in the development of:

- Manipulative skills in the students
- Attitudes toward science
- Critical thinking
- Understanding the scientific processes
- Learning by doing
- Cooperation and correlation among the students

Disadvantages

The major limitations of this method are:

- A well-established laboratory is needed
- Requires more time than the other methods of teaching

- The number of students should be limited
- The teachers should be trained in laboratory techniques
- The laboratory manuals and teachers handbooks are required
- Framing separate periods for laboratory becomes difficult

Role of a teacher

The teacher has an important role in this method. The teacher identifies the important areas of practical work and organizes the laboratory work. The teacher is responsible for the smooth conduct of practical work in the laboratory. She/he is in charge of apparatus, materials, and instruments and oversees their maintenance and working. They plan, organize, explain and carry out the practical experiments. They develop the practical skills and scientific attitudes in the students. They teach the students relation between the theory and practice.

Evaluation

1. Differentiate between an approach and a method of teaching.
2. What are teacher-centred and pupil-centred approaches? Which approach is best suited for teaching science?
3. What is the educational significance of Heuristic Method?
4. Enumerate the demerits of lecture method?
5. Explain the role of a teacher in a project method.
6. What objectives are achieved by following the laboratory method of teaching science?

Discussion method:

According to Lee “Discussion is a group education work. In this the students discuss a problem together”. In this method a topic is taken and the teacher encourages the students to discuss it. He (the teacher) develops the lesson with the help of the answers and reactions of the students. In this method there is ample space for interaction among the teacher and the students. For the success of this method it is important that the students be given freedom of expression. All students should be encouraged to express their views but there should be control over the situation/circumstances by the teacher.

Group discussion:

There is no comprehensive definition of ‘group discussion’ but it is considered as a democratic teaching strategy. The pupils are more active in it. Teachers’ job is to supervise and to provide guidance to pupils’ activities. It is child-centred teaching strategy. It may be of two types (1) By the teacher (2) By the students

By the teacher:

This type of discussion is more autocratic in style.

By the students:

In this situation, discussion is more permissive or democratic in style.

Objectives:

The affective objectives and higher order cognitive objectives may be achieved.

Structure:

The group discussion is organized in two forms: Formally and informally. In formal group discussion, proper schedule is prepared and certain rules are absence of a teacher, pupils have to select a student to act as a leader of the group. The leader of the group prepares a plan for discussion. In the group discussion, due weightage is given to the answers and questions of the pupils.

Principles: This strategy is based upon the following principles of teaching:

(1) Principle of active participation
(2) Principle of freedom of work
(3) Principle of group work and equal opportunities to ask questions and to answer them

Advantages: The following are the main advantages of this strategy:

(1) It has the greater scope of criticism for incorrect approaches, ideas and concepts.
(2) It develops the feeling of group work and group participation
(3) It helps in developing the creative-ability and thinking among pupils.
(4) It develops the problem solving attitude and the tolerance to hear one is own criticism.
(5) It helps in developing the feeling of cooperation.
(6) The higher orders of cognitive mid affective objectives of teaching are achieved.

Limitations: It has the following limitations:

(1) It has chances for deviation from the main topic
(2) In the discussion, only few students dominate and to discuss more and large number of students do not participate in the discussion
(3) Generally groups are formed in this strategy and they are critical to one another.
(4) It involves more criticism rather than relevant discussion.

Suggestions:

It may be improved and can be effectively employed by observing the following precautions:

(1) Every student should be provided an opportunity to participate in the discussion
(2) Students should be encouraged and motivated to participate in the discussions
(3) Irrelevant criticism should not be encouraged

Approaches to science teaching inductive and deductive

The word method means – 'Mode' in Latin language. The methods of teaching can be defined as – a manner in which the teachers impart knowledge and skill by their teaching and students acquire it by learning. Method of teaching can be understood as a way of teaching. It implies the style of content delivery in the classroom.

According to Kothari Commission Report (1964 -1966): "If science is poorly taught and badly learnt, it is little more than burdening the mind with dead information, and it could degenerate even into a new superstition

The main aim of teaching is to bring about desirable behavioral changes in the students. Teachers who can create interest among the students and motivate them are considered as effecctive in this profession. Those teachers who do not possess these inherent skills can develop these skills through practice and experience. Teaching is not only considered as a science but it is also an art in itself. There are different methods and approaches which a teacher can employ to make classroom teaching nteresting. A teacher should familiar with all the methods in teaching and should also know the utilization of the right method at the right time. The teacher should be flexible in adopting a variety of methods in her instruction since a method adopted at a particular time for particular students may not be suitable for another group at anotherr time. Also a method considered best for one teacher may be a total failure for another teacher. The selection and utilization of the correct method of teaching in a given situation depends on the efficiency of the teachers.

Relation between Approach, Method and Technique of Teaching

A teacher uses various methods, approaches and techniques to make the process of teaching effective and the process of learning easy. Therefore, it is essential to understand specifically the meaning and scope of the terms-Approach, Method and Technique in the teaching-learning process.

An Approach is a set of assumptions concerning with the nature of the subject and the process involved in the teaching and learning of the subject. These assumptions are normally accepted as valid which deal with philosophy and psychology of learning and are considered as essential for the scientific knowledge acquisition.

A Method originates from an approach. It deals with the important aspects involved in the process of teaching and possesses technical characteristics. For different educationists the meaning of the method is different. A method may be considered as a set of teaching actions or strategies for effective teaching. Methods could be distinguished from one another by the content they include.

A technique is mainly concerned with the classroom activities. If a technique is not found to be effective, the teacher may adopt another technique to achieve the desired objectives. So, the techniques are relatively flexible and easy to implement. But the technique a teacher uses should substantiate the procedural details of the particular employed method.

Different Approaches to Teaching

Approaches involved in Science teaching: a number of approaches are used in science for effective classroom teaching. They are

1. Teacher-centered approach
2. Pupil-centered approach
3. Inductive approach
4. Deductive approach

Teacher-centered approach

This is the traditional and most commonly followed approach. Here the teacher's role is dominant. The teacher occupies a central position. He is regarded as the authority in the subject. He is the main source of information. He is the center of all classroom activity. The teacher selects the content to be taught and the activities to be carried out in the classroom. The teaching environment is very formal. There is no flexibility in the activities of the class. It is a restricted atmosphere where the teacher is considered as a taskmaster. The student is the passive recipient of knowledge. The student participation is restricted only to accept information provided by the teacher. The focus of instruction is on telling the facts, memorization and recalling the information. Teacher-centred approaches emphasize on discipline, respect for the institution and the authority of the teacher. There is no room for student autonomy. Eg.:- lecture method and lecture-demonstration method

Pupil-centered approach

This is a modern approach, which is based on psychological aspects of learning. The teaching learning is geared to meet the needs, requirements and interest of the pupils. It focuses mainly on the overall development of the student. Development of the learners' skills and abilities, independent learning and problem solving are stressed. The teaching learning is based on psychological principles. The teaching atmosphere is highly flexible. The teacher and student together participate in the learning. The teacher's role is as a facilitator of learning. She develops activities to suit the needs and requirements of the learner. All the classroom activities and assignments are based on student participation. Students develop the skills of analysis, reasoning and critical thinking. The content, teaching style, and methods are all devised to enhance the cognitive and intellectual abilities of students. The classroom atmosphere is informal. More emphasis is laid on group participation and group discussions.

Eg: Heuristic method, project method, discussion method and assignment method

Inductive Approach

Inductive approach is a method of teaching, which leads pupils from particular situations to generalizations. It proceeds from concrete to abstract principles. In this approach, the teacher provides concrete examples (either physical, pictorial or textual) from which inferences are made and a definition of concept or generalization is given. Principles from the observed phenomenon and rules from instances are also arrived at. This approach provides a learning situation in which discovery of a concept carried out by suggesting concrete examples. The solutions and conclusions are drawn taking these concrete examples. The child is made to learn and discover by himself. It is a suitable method of teaching sciences.

Steps in inductive approach

- Sense the problem
- Analyze the problem
- Organize the information
- Arrive at a suitable solution
- Verify the solution

The inductive approach enables students to

- Recognize the importance of science
- Develop interest in science
- Enhance scientific knowledge and skills

Use of inductive method

- The teacher provides suitable examples, having same concept and concept rule. The students identify the commonality in them.
- The teacher, through questioning elicits the attributes and characteristics of the concept. Then the students understand the common concept, which is found in all of the examples.
- The teacher shows examples and non-examples of the same concept to students.
- Students categorize the examples by explaining whether they fit or not in the concept rule they are discovering.
- The students either state the relationship or differences they observed in the concepts.
- Inductive approach involves a method of teaching, which leads pupils from particular situations to generalizations

Merits

- Develops scientific attitude
- Develops scientific thinking among the students
- Develops the skills of observation and critical thinking among the students
- Develops self-confidence and self dependence
- Makes classroom instructions interesting
- A logical method based on – “learning by doing”
- Generates the habit of intelligent thinking among the students

Demerits

- A slow and lengthy method
- It is time consuming

- It cannot be applied to all the topics of science
- Insufficient data leads to hasty and wrong conclusions
- Conclusions need to be verified by deductive method

Deductive approach

A deductive approach is used when a teaching material is very complex and cannot be illustrated. This is a widely used approach in science teaching. It is a reverse of the inductive approach. In this method the teacher proceeds from general to particular situations or from abstract principles to concrete examples. This method provides rules, generalizations and examples. The teacher relates new learning to previous learning she/he demonstrates or illustrates the new material; the student practices learning and then demonstrates their mastery of it. The deductive approach is an effective way of teaching difficult topics

Uses of deductive approach

Today there is an increased emphasis on application of science knowledge; this calls for a change in usage of teaching methods in the science classroom. The ability to apply knowledge of science to real-life situations and solve the problems in a scientific way is more important than accumulating an exhaustive theoretical knowledge of science.

The students of science still lack the application skills not because they are deficient in scientific knowledge, but, more importantly, in the skills to use the knowledge in a problem-solving manner. To be able to apply knowledge to real-life situations, students must possess good deductive reasoning and critical thinking skills. These skills are to be taught in the class. The teacher needs to provide the learning experiences that sharpen scientific skills of the learner. The focus of science learning should be on inquiry and problem solving rather than on theoretical memorization.

Steps in Deductive approach

  - Understanding the problem
  - Collecting information
  - Reviewing the principles and generalizations
  - Drawing conclusions
  - Verifying the solutions

Merits

- It is suitable for primary class
- It provides a get ready material
- It saves the time
- It simplifies teachers' work
- Makes the completion of the syllabus easy
- It supplements induction
- It is very effective if used as an inductive-deductive approach.

Demerits

- It is an unnatural method. The pupils don't use any method to find out the facts and concepts themselves.
- It does not impart any training in scientific methodology or develop scientific attitude
- It does not develop thinking skills, self-confidence or initiative in the student.
- It only encourages memorization of facts.

A teacher cannot use only a single method in her teaching. For effective classroom instruction the teacher should use different methods. The combination of the methods is highly effective in classroom teaching. The approach of teaching should be both inductive and deductive. Appropriate combination of the methods would be highly effective for teaching mathematics and sciences.

Unit IV

LEARNER CENTERED TEACHING METHOD

Individualized instruction

Concept

The conventional classroom teaching is group instruction. The teacher gives instruction to all students at a time following the same method. All the students learn the same content in the same length of time. In individualized instruction every student is considered separately. Instructional materials are prepared for the specific needs of the individuals. Study packages and remedial materials are prepared giving importance to individuals. The individualized instruction is planned considering the following aspects of the learners.

- The learners in any class wildly in their intelligence which determines their academic success.
- The learners differ wildly in their attitude towards education.
- All students will not have the same amount of motivation because their needs and interest differ.
- The student will not be interested in education if the curriculum is not useful to them.

According to Walter A.Wittich and F. Schutter individualized instruction consists of learning experiences specifically designed for individuals students on the basis of diagnostic procedure employed it determine individuals interests and needs. Once and within the broad limits an self scheduled according to the interest and convenience of the learners.

In individualized instruction the learns plays a major role in the selection of objectives, sequence of study, choice of materials and procedures. The time spent by the learner for a given subject area is determined by the performance rather than by clock. The progress of each student is measured by comparing his performance with the specific objective rather than with the performance of other students.

Individualized instruction has brought a breakthrough in our educational system. Educational technology plays a major role in individualized instruction. The machines have started handling pupils effectively. The talents of the teachers have to concentrate on the development and preparations of the software like filmstrips, transparencies, modules and programmed instructional materials etc

Instructional process

That topic is broken down into small units which can be finished in a week or two.

Specific performance objectives are formulated for these units. Students' activities for realising these objectives are identified.

These objectives are sequentially arranged in a logical manner and arranged in a chart.

Mastery level expected is determined.

Pretest is constructed to find out the previous knowledge and skills of the student.

An outline of study guide is prepared including the following aspects:

Title of the module

Performance objectives

Sequence of activities

Some definitions and references

Some basic instructions

Some exercises for self evaluation and indicators for teachers.

Instruction is prepared.

The module is tried out with a few students.

It is refined based on the observation and comments of students in the tryout.

Characteristics of individualised instruction

In individualised instruction the instructional objectives are written for students

- All students are not expected to achieve the same objectives
- All students need not use the same instructional materials
- All students need not use the same method or procedure
- Students can take their own time to complete the learning
- Student decide the type of instructional materials and procedures to be used.

Approaches to individualised instruction

Thereare many approaches to individualised instruction. Some of them are:

(i) Individually diagnosed and prescribed programmes

Individualised instructional materials have clearly specified behavioural objectives. The materials and methods of presentation will match with the objectives specified.

(ii) Self directed materials

In this type of individualised materials the students and teachers cooperate in formulating the learning outcomes. The students arc free to select the materials and melted to achieve the goals. This type of approach is useful with above average learner.

(iii) Personalized Programmes

In this type of programmes, the student selects his own objectives and afterwards follows the directed programme with specialized materials. This act is useful with high school students.

(iv) Independent Study

In this approach the learner selects his own objectives and the topic. He also decides onhis own, the method of achieving the objectives. This is good for above average learners.

Preparation of individualised instructional Material

Individualised instructional material could be in the form of printed material, films, machines, laboratory sets etc. Generally they are developed from a material for small unit called module. This could be in the form of a package. The learner can complete in a short time. Bearing these factors in mind individualised instructional material is prepared adopting the following steps.

Individualised instruction

The learning process of children differs from one to another. There are some who follow a step, just after reading about it, others need a model demonstration to follow its working. Teacher's explanation helpsafew students in their understanding. Others follow better from a picture or a film. There are some who need a lot of supplementary reading material while others learn after own handling, or experimentation. The only safe method to work with pupil is to give them, lots of chances, to approach learning, through a number of ways and activities.

All need not do all the action in the same way.Teacher s guidance and planning with his pupils is the secret of the organization of learning situations in which pupils act in the best manner required for learning.

No two students are the same either physically or intellectually. Their past learning, cognitive domain, psychomotor activities, successes and failures in learning perception of the self and similar other capacities differ from one to the other. As there is this individual aloofness in experiences, so is then difference in their requirements to learn, and in what they have already learnt, '['he best way, therefore, is to give them individualized instruction.

This method is not the same as independent study- programmed instruction or auto-study though these may be the steps. In this each child's study is self-directed and self- started. A chi Id takes his own responsibility to learn freely and independently.

Features of Individualized Instruction

1. The objectives of the programme are written on paper.
2. The students are given the content objectives.
3. All pupils are not expected to reach the same heights.
4. They do not use the same instructional materials
5. Same procedures are not followed by all pupils.
6. They do not study the same subjects for the same time.
7. In class-rooms the same activities are not carried out.
8. Students decide about their own aims of education.
9. Materials and procedures are also selected by them.

10. The time to be given to an activity is also fixed by them.

Approaches to the Programme

(i) Prescribed Programmes diagnosed for individuals have specific behavioural

aims to be met. 1 he materials, and methods are suited to the requirements 01 the situations

(ii) Self-selected material is used by students in cooperation with the teachers for the desired results. Pupils use discretion in selecting material and the techniques for their aims to be realized. Above average students' aims can be realized. Above average students are more benefited in this process.

(iii) Individual schemes are selected by the pupil for their own set objectives and later on an approved plan is followed with special material . Higher students can be benefited more under this plan.

(iv) Free study enables students to select his own method as well as target and topic. How he reaches the goal is also his own decision. Above average students get better results under this plan.

Merits

- Each child gets a chance to experience and investigate.
- He can proceed at his own speed.
- A child learns according to his interest, ability and method of learning.
- Learning atmosphere, motivation and encouragement are provided toa student thistechnique.
- It passes on novelty and innovations to the learner.
- Individuals needs of a student arc best served under this method
- Personality development takes place efficiently.
- Good teachers get recognition for hard work.

Demerits

- The provisions and facilities for this process are not available.
- It can be undertaken in a small class, while in our schools classes are mostly large.
- Well equipped laboratories are required and allied facilities like water, electricity gas and light arrangement are needed.
- A teacher needs more time for preparation and collection of material for this technique
- Teachers with sufficient background and interest arc not available.
- Individualised instruction is a novelty in schools.

Modern Methods and Techniques for preparing Materials for Individualised Instruction

Printed material films, tapes, laboratory kit, machines and even books and articles can be used as learning units or 'modules'. These modules are self-sufficient, self-instructional and are at times multi-media in approach.

Time is saved by these approaches. The method of preparing a "module" is given below:

- Select a topic and divide it into units for a week or so.
- Find out the aims and objectives for a learning "module".
- Decide activities to meet these objectives. These should be logical and may be shown on a chart.
- The mastery or competence for students to start a module should be decided. A test may help in finding this out
- The module may be tried out with a small sample,
- Detailed instruction-sheet for pupil should be made.
- Improve the teaching-modules after observations, comments and criticisms from teacher and pupil.
- Make a Guide for study. The title, the aim, the techniques, definitions of terms, reference - material, instruction for students, exercises, evaluation process, and checks to find out mistakes and to get corrections by the teacher should be provided in the Guide.
- An atmosphere of free and fair study should be provided to all the pupils.
- And finally, the teacher should be available to guide and remove difficulties of the pupils when they get stuck up in some wrong techniques.

Programmed learning

Meaning

Programmed learning is a new innovation and is the result of the experimental study of the learning process in the psychological laboratory. In the words of an American psychologist, "It is the first application of laboratory technique utilized in the study of the learning process to the practical problems of education." That is why it is claimed that the origin of modern programmed instruction, arises from the psychology of learning and not from technology. As a result of the extensive as well as intensive work undertaken in the area, programmed instruction has come to stay and is being increasing used in most countries of world.

The origin and background ofprogrammed learning-

Early Work

The term programmed learning is new but the practice is old. The traces of programmed instructional work can be found in the work of *Socrtites*"who developed a programme in Geometry." It also owes something to psychologists like *Freud* who studied behaviour. But, more recently, programmed learning is claimed to have begun in. America where the system is known as "*programiiied-mstructwn.*""The English term 'programmed learning' is, nevertheless, probably more accurate, as this is a learner oriented system with emphasis on the method by which material can be presented so as to be auto-instructional."

Pressy's Work

The origin of programmed learning is generally linked with *Sydney L. Pretsy,* an American psychologist of Ohio State University. In the 1920s, Pressy devised practical machines that could tell the learner at once when he made a mistake. Pressytried to market his device but failed. Being disappointed, he gave up work on his automatic teaching device in 1932.

Skinner's Work

The next major break in this direction came as a result of experiments carried by *Dr. B. F. Skinner,* a Professor of Psychology of Harvard. Dr. Skinner presented his famous paper, entitled *"The Science of Learning and the Art of Teaching."* Skinner gave an immediate reinforcing teaching device. He experimented with pigeons. He was convinced that once a desired behaviour is reinforced/ it is more likely to re-occur. As the action is mastered, reinforcement is given with less frequency. Skinner gave it the name *operent conditioning,*

Skinner's device differed distinctly from other similar devices in one important way. Skinner programmed his material in an organized sequence. The increment of learning in each step of sequence is very small. The pupil, having solved one problem, finds little difficulty in solving subsequent ones. Thus he is reinforced frequently. He is led step by step through the material to be studied. There is minimum of error and maximum reinforcement.

Work Done after Skinner

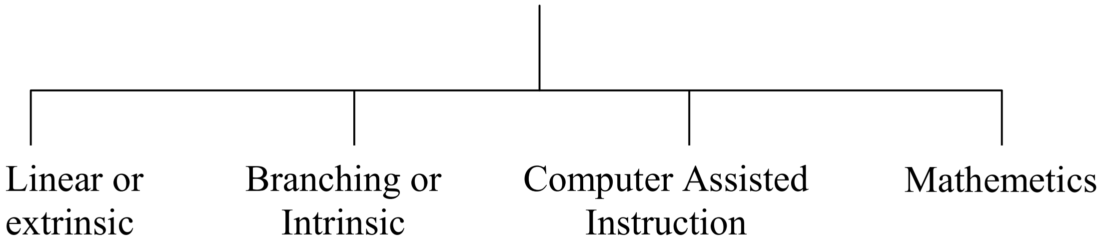
Since Skinner's presentation, much work has been done on programmed instruction/learning. During the last few years, a flood of literature on automated teaching has been made available in both America and Great Britain. Day after day, teachers, psychologists,, publishers and commercial firms interested in teaching machines are moving ahead with making this, device most sophisticated. No wonder, machines at present in use will probably appear crude in a short span of time and many new developments will take place in programming.

The exponents of his technique were *B. F. Skinner* and *Norman A. Croivder,* In this method the topic is to be taught in small steps and then their own response is to be written. The student receives new knowledge through medium of response and simultaneously tests the correctness of his answers. The correct responses are reinforced.

According to a scholar, "It is a process of organizing material to be learned in a series of small steps designed to lead a learner through self instruction from what he knows to the unknown of new and more complex knowledge and principles."

The various forms of programmed learning are shown below:

Forms of Programmed Learning



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answers."

*2. Dr. Susan Mankle's View. Dr. Susan Mankle*has defined programmed learning as a "method of designing a reproducible sequence of instructional events to produce a measurable and consistent effect of behaviour of each and every acceptable student."

3. *Michael J. Apter'sViewv.* In the world of *MichaelJ. Apter,* "Programmed instruction is a method of instruction in which the information to be taught is broken down into small units which are to be presented to the student (usually in written form) in a carefully planned sequence. Each unit or "frame" contains not only information but is also terminated with a question.

4. *Integrated Instructional System.* Recent advances in programmed learning have widened its concept. It is now "an integrated instructional *system* which may employ programmed books, teaching machines, films in various forms, audio-visual devices, stimulators and actual apparatus. The instructor himself, trained of formulating objectives and in diagnosticanalysis of his teaching results, is an important part of this system." This system also

implies a strategy in which various kinds of intellectual, emotional and motor experiences are provided to the learner in a controlled situation through the above mentioned devices, which ultimately result in behavioural modifications.

The new technology *has four important components,* these are:

1. *Instructional goals*—the system of objectives.
2. *The enteringbehaviour*—the system of input or assumptions of the programming.
3. *The instructional procedure*—the system of operation or sequence of content.
4. *Performance assessment*—the system of terminal behaviour or output monitor.

Thus, programmed learning is a complex system of systems wherein programmer, though physically absent, is as much a part of the whole process as any medium of auto-instruction.

Salient features of programmed learning

Some of the salient features of programmed learning and programmed material are as follows:

1. *Individualized System.* Programmed learning is an individualized system; one person learns at a time.
2. *Auto-Instructional System.* The learner learns through an auto-instructional device. The device teaches, corrects and reinforces without the presence of the teacher. However, the teacher is a part of the system: he is absently present.
3. *Logical Order of the Material.* The instructional material is nearly perfectly programmed. It is presented in a logical sequence. Each new step in the learning process follows naturally and logically each preceding step.
4. *Material Presented in Minimal Increments.* The material is programmed in minimum increments. Each increment is only a small step in the learning process and thus reduces the possibility of error to the minimum.
5. *Learner's Own Pace of Progress.* In a traditional class room procedure, an average student sets the pace for the whole class. In programmed system, each learner learns at his individual pace—the average moving

slowly, the brighter student learning quickly. The rate of accomplishment is established by each student's individual performance.

6. *Instant Check of the Learner's Answer.* The student's answer is almost instantly checked against the correct answer which appears by the side of the next question or frame. If his answer is correct, he receives encouragement. The very fact that it is correct, reinforces his learning. If his answer is incorrect, he is helped to locate the reason for his incorrect answer. In this latter case, the learner may be sent to a further teaching item which will clarify any misunderstanding.

7. *Intensive 'Validation' before the Release of a Programme.* All reputable programmes are the subject of 'validation' before publication. This consists in testing the draft programme on a sample of 'student population' of a similar background and intelligence to that of the target population.

Basic principles of programmed learning

Although the principles on which programmed leaning was originally founded have undergone a number of modifications in view of recent researches, they basically consist of the following six fundamentals:

1. Principle of behavioural analysis.
2. Principal of small steps.
3. Principal of continuous active responding
4. Principal of immediate confirmation
5. Principal of self pacing
6. Principal of validation.

Below, the above principles have been explained in brief.

1. *Principal of Behavioural Analysis.* One of the most important aspects of programming is an exact behavioural or task analysis. This is made up of "defining and breaking down the task to be performed into separate components so that the programme objectives can be formulated." It has been said that programmes are not written just for the sake of writing them. Programmes must bring about learning which can be defined as a *change* of *behaviour*that is:

(a) observable, and

(b) measurable.

2. *Principle of Small Steps.* Since programmed learning is a self-instructional device, step-size is very important. Instructional material must essentially be programmed through small steps. This will enable the learner master each step before proceeding to the next. Small steps have a number of advantages such as accuracy of response,, minimum errors, mastery of subject matter, easy evaluation of programmesequence, etc.

3. *Principle of Continuous Active Responding.* Most programmed learning is based on the principle of continuous active responding or, to use the technical term, on cmer *responding.* By overt responding we mean that at very stage of learning, the student is prompted to give an active response, either by writing an answer or by carrying out some action. *Mr. G. O. M. Leith*of National Centre for Programmed Learning, University of Birmingham, has confirmed on the basis of considerable research that children learn and retain material when they are called upon to make a continuous active response (overt response).

4. *Principle of Immediate Confirmation.* Psychological experiments (of *Thorndike* in particular) have proved that learning becomes permanent when accompanied by success and satisfaction. Programmed learning make use of this important finding in the psychological laboratory. In programmed learning the correct response is immediately confirmed. This becomes a sort of reinforcement for the learner to work further on the programme. However, care must be taken "to reinforce only those parts of the behaviour which are compatible with the objectives of the programme."

5. Principle of Self-Pacing. Programmed learning is an individualized process. This means each student—bright, average or dull—moves with the programme at his own individual pace. This is the principle of self-pacing.

6. *Principle of Validation.* Validation is a test procedure adopted by the programmer in order to make a definite statement on the terminal behaviour. *Terminal behairiour*is a statement of what the learner will be able to do on completion of the programme. For this purpose, it is essential to test the programme on as large a sample of target population as possible. This will enable the programmer to verify the claims made in favour of the programme. This will also enable the programmer to revise the programme and improve it.

These *are,* then, six important principles which can be regarded as the guide lines for programmed instructional materials.

Types/styles of programming

The following types/styles of programming are currently in vogue:

(a) Linear or Extrinsic Programming.

(b) Branching or Intrinsic Programming.

(c) Mathematics.

(d) Computer Assisted Learning.

Linear Programming

Linear Programming is based on programming ideas put forth by *B. F. Skinner.* In a linear programme, the subject matter is divided into quite small pieces of knowledge, known as *frames.* Each learner is taken through these frames, in small steps, and in the same sequence, along a *single path or line.* Student's response to the first frame is immediately confirmed before he goes to the second frame. 'The correct response to the previous frame apperas alongside the forthcoming frame.The programme is so structured that the probability of correct response become sufficiently high (nearly 95 percent). Linear Programmes can be produced in book form for use on a linear teaching machine.

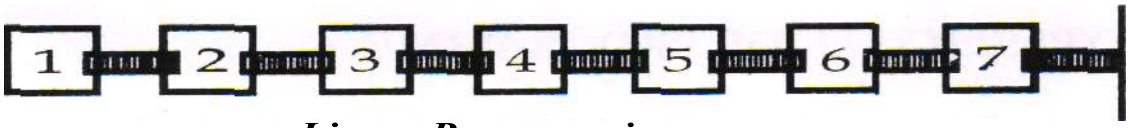
The following format for a Linear Programme makes the concept clear:

Format for a Linearprogramme

	1 - - - -
	Response 1
Correct	2 -
Answer 1	Response 2
Correct	3 -
Answer 2	Response 3
Correct	4 -
Answer 3	Response 4
Correct	5 -

Answer 4	Response 5

The following is the diagrammatic representation of a linear Programme:

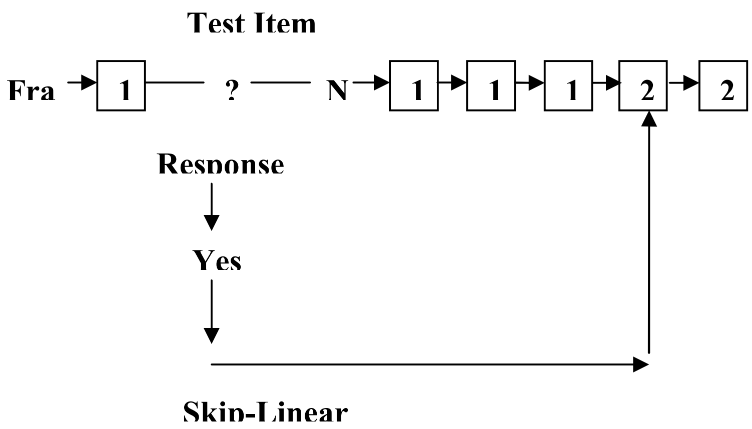


Linear Programming

(Note The chaining. The items are linked by a certain amount of common content material, shown in the diagram by shaded portion.)

Skip Linear

Basically, the Skip linear type of programming resembles Linear Programming. But, the former differs from the latter in this way. When the learner is going through the programmeat certain points he is given a test question or questions. If his response to the test question is correct, he is made to skip over a few frames and is advanced to a part ahead in the programme. (See diagram below.)



But if his response is incorrect, he is made to go through the normal sequence in order to obtain further practice. In the given diagram, the learner is given a test item after the sixteenth frame. If his response is correct, he is advanced to Frame 20, otherwise, he proceeds in the sequential order.

Test Your Grasp of Linear Programme

1. The proponent of linear programming is ....

2. The linear programme is..............................called/not called) a straight line programme.
3. The reinforcement ....(decreases/ increases) the tendency to give a response.
4. The linear programme is also called ...(intrinsic/ extrinsic) programming.
5. In a linear programme the learner learns by (making/avoiding) the errors.
6. According to Garner the emphasis in a linear programme is on............(stimulus/ response).
7. In a linear programme discrimination........................... (is/is not) more important.
8. In a linear programme the learner .... (can/cannot) skip over come frames.
9. In a linear programme the reinforcement............................(is/is not) quick.
10. The printed linear programmes ....(do not involve/ involve) logistic problems.
11. Towards the end, in a linear programme, the prompts are.............. (provided/withdrawn) gradually.
12. Cheating is discouraged by............ (revealing /not revealing) the answer.
13. 13..Basically, Skip Linear (is not/is) the same as the model.
14. In Skip Linear the learner ....(is given/is not given) test at certain points.
15. The correct response in a Skip Linear (leads/does not lead) to other part of the programme.

(For answers, see below)

Check your Answers

1.	B. F. Skinner	2.	Called
3.	increases	4.	extrinsic
5.	avoiding	6.	response
7.	is	8.	can
9.	is	10.	involve
11.	withdrawn	12.	not revealing
13.	is not	14.	is given
15.	leads		

Example of Linear Programming in Biology

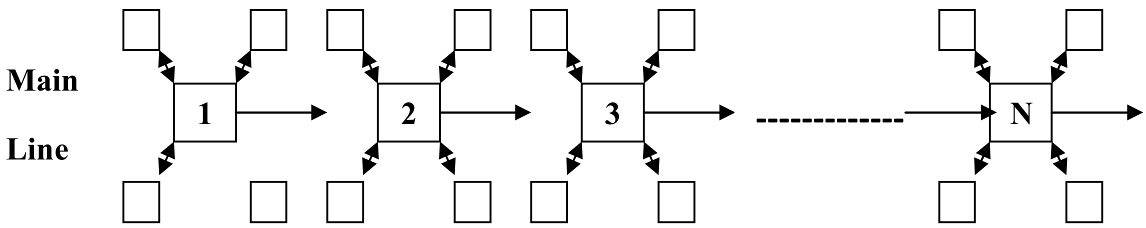
1. If we have Female Bb x Male BB (B stands for black and *b* for blue B dominant over b), their children will have............eyes. (Black)
2. If we have Female BB x Male B, their children will have.............eyes. (Black)
3. If we have Female Bb x Male Bb, some of the children will have...............eyes and some will have........................eyes.

   (Black, Blue)

Branching Programming

The branching or intrinsic approach to programming was devised by *Norman A. Crowder* of the Educational Science Division of U. S. Industries, Santa Barbara. He has defined branching Programming as a programme which adapts to the need of the students without the medium of an extrinsic device such as computer. The intrinsic approach to programming works like this.

The student is given the material to be learnt in logical units. The units are much larger than those used in linear programming. Each material unit is followed by multiple-choice answers, out of which the student is required to choose the answer which appears correct to him. According to the item which he has chosen, he is directed to different parts of the programme to check his answer. If his answer is correct, the student is put on the main line of the programme the same way as it happens in a linear programme. If he fails to choose the correct answer, the preceding unit of information is reviewed, the nature and cause of his error explained and he is either returned to the original unit of information, or *branched along a sub sequence* which gives him additional information to correct himself. He is then put to a retest before he is made to return to the main line. A diagrammatic representation of branching approach appear on below:



Branching Programming

on any one step would lead to a sub-sequence via certain branch, and then after additional information, back to the main line for another trial),

Test your Grasp of Branching Programming

1. The branching method was originated by ....
2. In branching programming the frame size is much ....(smaller/ larger) than that of linear programming.
3. In a scrambled text of branching programming the pages..................(follow/do not follow) in normal sequence.
4. In a branching programme the learner (can/cannot) skip over the frames.
5. In a branching programme .... (discrimination/ generalization) is over important.
6. The branching programming is also called .... (intrinsic/extrinsic) programming.
7. In a branching programme the assumption is that the learners learn by ....(making/avoiding) the errors.
8. The branching method ....(can/cannot) provide infinite branching to take care of all individuals.

Mathetics

What is Mathetics? The credit for formulating the basic precepts of Mathetics goes to Thomas F. Gilbert. He gave these precepts in his article *Mathetic,.the Technology of Education* which appeared in "Journal Mathematics" Vol. I, No. 1 (Now discontinued). The term itself has been derived from the Greek meaning "to learn." According to *K. P. Pandey,* "Mathetics is defined as the systematic application of reinforcement theory to the analysis and construction of complex repertoires which represent mastery of subject-matter." The whole system is rather technical. Although mathetical programming may be applied to any subject, the emphasis on task stimulation makes it a particularly suitable vehicle for teaching skills where "transfer of training" forms an essential part of instruction.

The unit for a matheticalprogramme sequence is called "exercise." There are no restrictions on its size or extent. The main consideration in his case, however, is to have as big an exercise as the student can reasonably take at a moment.

Retrogressive Chaining

The sequence of Mathetic model is *retrogressive* or *backward chaining*. The sequence can be explained like this. In a programmebased on the mode of mathetic, the learner performs all the operations that will be required by him, learning by Going. Sequence or chains in which response sets up a unique stimulus state of affairs are taught back-wards. It is because of this that the sequence in mathetics is often called "retrogressive chaining." The technique involved in retrogressive chaining is to start with the most motivating task or start with the mastery step. This step is the one that completes the task or procedure to be learned. Normally, not always, this is the final step in the sequence. All the steps involved in the process are displayed to the learner. The learner then completes the last task in the serial, the last but one and so on *regressing through the chain.* According to *K. P. Pandey,* "The programmer continues in this manner, each time allowing the student to performs one additional step until he has worked his way back to the first step in the procedure and can perform the entire task."

The steps involved in regressive chaining are:

1. Demonstrate
2. Prompt
3. Release.

1. The programmer *.demonstrates* in introductory frame which is the mastery frame.
2. *Prompts* are used in teaching frames to help the learner to give the desired response.
3. The testing frame, the last in the sequence, is the *release* frame where no prompts are given.

Comparison of programming methods

The three programming methods can be seen to vary from one another as shown in the following table as given by *Patricia Callender*in "Programmed Learning, its Development and Structure."

	Linear	**Branching**	**Mathetics**
Unit of Presen-tation	The frame	The frame	The operant (exercise)
Step size	Small	Larger	As big as possible

Number of steps in programm	Large	Smaller	As few as possible
Error rate permitted	Normal about 5 percent	Usually about 20 percentage	Some deliberate errors written into programme to sharpen discrimination and concentration.
Response	Constructed no choice	Multiple choice	Written or by performing task on stimulator, or both
Reinforcement	Correctness of Responses	Ultimate correctness of response Where broader concepts or larger pieces of information can be given scrambled text	Task completion.
Subject-matter suitability	Where subject is made up o0f many small pieces of information	Where broader concepts or larger pieces of information can be given scrambled text	Particularly suited to discrimination skills
Paper proramme	Liner book		Programmed instruction package
Machine	Simple linear which reveals one frame at a time	Programme on film which is seen by learner on screen of	Stimulation device

		machine.	
Cost: Machine	Cheapest machine	Considerably more than linear	Varies according to the typo of stimulator
Cost: Progamme	Printed on paper, quite cheap	More expensive. Produced on film, durable.	High because of detailed analysis which precedes programming.

Dynamics of programme preparation

Papee Pipe has observed that/four *general thoughts about preparation of programme*must be given due consideration before setting down to work out the details. These are:

(a) Preparation is just 100 percent *"technique";* art has very little to do with it. This technique needs 'hard work.'

(b) Note that preparation accounts for at least 25 percent of your total time. To give it less than it is to deny it justice.

(c) Do not bother about attained perfection in one step before you begin the next one. It is always fine to insert fine changes, but be sure that you write down any change you make.

(d) Any discussion on programming, and for that reason the discussion that follows is of necessity, in general terms, Do it the way that suits you—may emphasize one step more, another less.

With the above four ideas in mind, the following steps may be suggested in the programme preparation:

*Step 1.*Selection of a subject area or a unit to be programmed.

*Step 2.*Writing assumptions about the learners (the target population) for whom the programme is intended.

Step 3. Define instructional objectives in behavioural terms.

*Step 4.*Defining pre-requisite knowledge and skills in behavioural terms.

*Step 5.*Writing criterion test based on programmeobjectives.

*Step 6.*Deciding the order in which instructional matter is to be presented.

*Step 7.*Developing the content list, including frame waiting.

Steps Explained

*Step 1.Selection of a Subject Area or a Unit.*The expert advice regarding the selection of a subject area or a unit to be programmed is that the programmer should begin with a small unit He should not be ambitious to select a very wide and general topic. This will avoid much of frustration and failure for a programmer. The unit selected must emerge directly from the programmer's own field of study. There should be "ease" in the handling of the material. Moreover, the whole subject may be brought on the wheel of programming. Certain subject units may be taught conventionally with profit. Notorious stumbling blocks to learners must be selected to be programmed. Logical order of material is an important criterion in matters of selection. And, above all, special student, needs must be given proper consideration.

*Step 2.Writing Assumptions about Learners.*An important factor to be considered is the body of pupils for whom the programme is intended. The programmer must know fully well, as accurately as possible the major characteristics of the learners-the target population. He must therefore, list basic assumptions about them-their age, sex, skills, interest, abilities, their background etc. A pilot knowledge of these assumptions about the learners will matter much in deciding the scope of the programme and its actual writing.

*Step 3.Defining Instructional Objectives.*Preparing a statements of appropriate, instructional objectives in terms of behavioural changes is an important aspect of programmepreparation. According to *B. S. Bloom,* by instructional objectives, we mean "explicit formulations of the ways in which students are expected to be changed by the educative process, that is, the way in which they will change in their thinking, their feelings, and their actions."

*Robert Mager*has suggested how objectives of instruction can be rendered in specific behavioural terms.

"As statement of instructional objectives is a collection of words on symbols describing one or more of your educational intents."

An objective will communicate your intent to the degree you have described what that learner will be doing when demonstrating his achievement and how vou will know he is doing it.

Any statement on instructional objectives will take into consideration:

- *Terminal behaviour*of the learner after lie has completed the programme.
- *Conditions* under which the learner is to carry out the programme restrictions and limitations.
- *Tolerance* or acceptable standard of performance, that is, error rate permitted etc.

*Step 4.Defining P re-requisite Knowledge and Skills.*Defining pre-requisite knowledge and skills in behavioural terms does not fundamentally differ from defining instructional objectives. This, in fact, is a statement on what should be in the repertoire of the pupil at the end of the programme. The list of prerequisite knowledge and skills, a provisional, "arm chair" list, may be arrived at after giving an objective test to a sample of target population. By 'considering the errors committed by the students, a thorough list of pre-requisite skills to be covered by given programme may be developed.

Step 5.Writing a Criterion Test. Writing a criterion test based on programme objectives is to test the entire range of terminal behaviour or criterion behaviour, or instructional goals set by the programmer. This is meant to determine the success or failure of the entire programme. The result of the criterion test will help the programmer to modify his statements on instructional objectives and pre-requisite skills. A criterion test should preferably by made up of objective type test items.

While constructing a criterion test, the correct choice of words, the clarity of language and the relevance of each test item should be maintained. "A good criterion test is one which reflects representative elements of the universe of behaviour.

*Step 6.Deciding the Order.*Deciding the order in which instructional matter is to be presented can be compared to an essay plan where the writer first prepares a list of the points that he wishes to develop and then arranges them in the order which is likely to create the greater impact. After the programmer lias determined the key concept which are to be presented to the learners, he arranges them in the most logical order, ensuring that they are interlinked within the sequence. Most Programme writers go on analysing, breaking down the concepts into sub-concepts until the skeleton of the programmes is clear.

*Step 7.Developing the Content List.*Developing the content list comes last. Here the programmer should write the complete information relating to each concept to be presented. He must mention all the relevant examples, illustrations, diagrams, maps, charts etc, which would form an integral part of the content of a specific programme.

Characteristics of programmed learning

1. Students remain active.
2. The correct response of the student is reinforced.
3. It helps the students to learn in a psychological background.It is very important to bring about change in behaviour of students.
4. The need of the teacher is very little.
5. The students make few mistakes while learning.
6. The students come to know their mistakes immediately.
7. The method has fixed objectives and principles.
8. The students studies according to his speed.

10. These programmes have steps in a logical sequence, 11. In this technique stimulation is given to the student right from the beginning.

12. In this method stimulation discrimination is important.

Limitations of programmed -learning

1. A lot of money is spent right fromthe preparing-to publishing of programme.
2. Not useful for all subjects.
3. Specialized training is required for the programmer.
4. The achievement of expression and application objectives is not possible by his method.
5. The students have to write and check their responses which at times becomes uninteresting.
6. It loses its usefulness if the curriculum has a lot of facts.

Suggestions for programmed learning

1. It is an important technique for correspondence courses and open universities.
2. It may be used at Secondary/Higher secondary levels.
3. This method should be used for teaching concepts, principles and laws.

Computer assisted instructions (CAI)

Computer has contributed a lot in each and every sector of life. Computer assisted instruction (CAI) has emerged as an effective and efficient media of instruction m the advanced countries of the world. In fact, CAI is being used in formal and non-formal education at all the levels. In India too, computer has been introduced in most of the areas such as data processing, decision making. It has also impact on the working methods of research and development in the fields of science and technology. The computers are being used in almost all areas of life *i.e.,* transportation, communication, national defense, scientific research and education.

History

CAI is a natural outgrowth of the application of the principles of programmed instruction or learning. The main objective of programmed instruction is to provide individualized instruction Just to fulfillment the special needs of the individual pupil. In order to achieve this objective, some efficient device is required. This device should be flexible and it can store huge amounts of organized information. The device may enable a person to use some selected part of the stored information. A computer fulfils all these requirements. It can store the organized information, it can process the information suiting lo the needs of individual learner. In short, CAI covers the entire educational system by proving itself an useful tool in leaching various subjects.

Origin

If we see the origin of a computer, we shall find that some technicians attempted if a machine could be programmed to interact with a man. The first commercial computer was operative in 1951 in Census Bureau. First CAI attempt was made around 1961 when the University of Illinois produced Programmed Logic for Automatic Teaching Operation (PLATO). Hence, the use of computer in general education started from early sixties.

Use of Computers in General Education

There are two contradictory views, regarding the use of computers in general education:

1. CAI provides opportunities for systematically organized maximum learning for all learners. It provides complete individualising instructions. The increasing amount of information and lack of qualified teachers make (he use of CAI very essential.

2. Second viewpoint is its criticism. The critics see computer as an agent of destruction of human qualities. According to them, no computer can match a person's versatility and the emotional aspect. CAI mechanises human brain. In other words, human beings are converted into machines.

There are many educationists and psychologists who have been trying to find out ways in which electronic information processing may help the teacher in individual instruction. One of the important and prominent approaches is to use computer as a teaching machine. This approach is referred to as computer aided instruction or computer assisted instruction -abbreviated as CAI.

Computer aided instruction is a substantial innovation. A computer is a high speed data processing machine. The first large mechanical computer called as an analytical engine was designed during the nineteenth century by Charles Bubbage, a British Mathematician for computing astronomical and mathematical tables. The equipment was not of much success.

During the later part of the nineteenth century Herman Hollerith developed a machine for processing cards on which information was stored by means of punched holes. This machine was used to speed the tabulation of census results in U.S.A.

One of the early computers operating on the basis of electric pulses rather than mechanical switching was placed in operation at University of Pennsylvania in 1946. This machine was named as Electronic Numerical Integrator and Computer (ENIAC).

Basic Assumptions

1. CAI can be arranged for 4000 students simultaneously, it-can cope with the problem of quality and quantity in education.

2. One can learn at his own pace, receives immediate and personalized feedback, i.e., completely individualized instruction.

3.In CAI, each learner's performance during the course and on the test is automatically recorded and can be feedback to the teacher so that he may promptly evaluate the learner's performance and use the data in designing the best leaching strategy for the learner in future.

4. It can be used in all types of teaching-learning programmes. Any lesson in any subject can be programmed for CA1 provided that the lesson material can be represented in words, pictures andexperiments to be presented to the students. Operations in CAI

CAI system has been used at all levels of education ranging from elementary school to post-graduate study and on job training at almost all subjects. Atkinson (1968) designed a programmer for teaching reading to infants. The child .first must learn to identify letters. This task of identifying letters is done in three stages of the programme.

1. **First stage**. A model letter appears on the projector connected with a computer, while three letters are presented on the screen. Then the recorded voice instructs the child to look at the letter on the projector. Different letters are shown on the projector. Training is imparted to the child in identifying the letters.

2. **Second Stage**. At this stage, the child masters the identification of single letter. During this phase the child learns to discriminate pairs of letters.

3. **Third Stage**. During this stage, two-three letters combinations

are presented on the screen. The child is asked to touch or/e symbol out of the two combinations which are identical.

A recorded voice asks the child to touch and say the word that would be formed by combining the letters on the side and top of the screen. Errors made by child are automatically recorded in the computer. The child thus receives practice. The drills that various learners receive may be entirely different from each other. After mastery of simple reading skills, the child proceeds to acquire successively more complex skills. Computers have been designed to store and retrieve vast amount of information.

Various Instructional Modes

In the field of instructions, a computer plays a major role. In these computer assisted instructions, it interacts directly with the learners while presenting lessons. The computer delivers instructions directly to students and permits them to interact with the computer through the lessons programmed in the system. There are various

pupil's responses. On the basis of these responses it is further decided which information's are to be provided to the students. In case of incorrect response, the computer also hints at correct response. **In** this way, each pupil is cared and feedback to each and every pupil is provided.

Uses of CAI

1. It is the main sources of receiving facts and informations for the teachers and pupils.
2. Drill and practice opportunities are provided to the pupils.
3. It is useful in the form of learning laboratory.
4. It is important in solving administrative problems,
5. It is helpful in evaluation process.
6. It is useful in framing tune-table.
7. It is useful in preparing pay-bills.
8. It is used in developing various skills.

Advantages dl CAI

The main advantages of a CAI system arc related to the degree to which n permits the individual of education of education, particularly instruct ions :

1. The capability of individualizing both the means and ends of instruction.
2. The capability of doing research :

(i) On leaching under controlled conditions.

(ii) Under conditions which individualize instructions in a particular way.

(iii) On various modes of teaching.

(iv) Ability to collect detailed records of student performance.

(v) Permits evaluation of effectiveness of the teaching procedures as well as teaching materials.

(vi) The capability of developing ways of assisting teachers and authors in the development of instructional materials.

(vii) The capability of evaluating alternative media used to implement and support instruction.

Computer aided instruction (CAI) means using computers to teach people, it does not mean leaching people to use computer or teaching people about computer technology.

Computer can be used in education in two different ways ;

(i) To reinforce present educational system.

(ii) To revolutionize the present educational system.

(iii) To lay the foundations for future systems of education to come.

Role of Teacher in CAI

It is feared that the use of CAI in teaching-learning will relegate the place of (he teacher. To some extent its use may eliminate teachers from leaching scene. But this fear is false and baseless.

CAI has proved powerful tool for the teacher in the instructional process. Of course, there is some change in teacher's role.

CAI directly interacts with the students individually and with the teacher. Teachers are to play their role in CAI. Human teachers cannot be eliminated from teaching-learning process. We can highlight the role of a teacher in CAI in the following manner :

1.Use of New Tools. CAI provides the teacher some chance to use new tools. This use will enhance the person's satisfaction. Also it will increase the individual's efficiency. The CAL can compute accurately and rapidly huge amounts of data. It can produce elaborate graphs and drawings.

2.Compatible with Like Teaching. CAI is compatible with line teaching. It can be used side by side. CAI is a flexible system of instructions. It can very promptly evaluate the performance of individual student. The teacher can devote his time for more creative activities.

Experts Needed in CAI

Computer aided instructions need the help of the following experts

1. **Computer Engineer**. A computer engineer is a technical person and knows about basic principles and techniques of programming,
2. **Lesson Writer**. The lesson writer is an expert who is *familiar* with lesson writing. Lesson writers may be experienced teachers *or* an experienced teacher may be a lesson writer. He knows theories of learning.

3. **System Operator**. He knows the system thoroughly and *can* cope with all commonly occuring failures of software and hardware in the system.

Limitations of CAI

1.The computer fails to appreciate the emotions of students. The emotional climate created by teacher in direct class-room interaction will) die students is absent in CAI.

2. CAIprogrammes do not in themselves solve psychological or educational problems. Computer programmes of conventional type do not work like human beings at all.

3. CAI fails to develop essential features of language competency where (he ability to generate or construct meaningful sentences is essential.

4. It was pointed out that some students got more tired than conventional study or fell like quitting the study.

5. CAl cannot appreciate the student's artistic Endeavour and cannot strengthen his friendship and deepen his perception of those around him.

6. The peripheral equipment puts constraints in the ways on which a student can interact with the computer.

TEAM TEACHING

Introduction

Team teaching is comparatively a new idea in the field of education. It was a pattern which emerged in American education in 1954. It has assumed many dimensions and is now a big movement. Almost all the countries are now busy in making new experiments in this field. According to Shaplin, "A number of major universities are participating actively in the development of team teaching and there is a high level of professional interest, both pros and cons, expressed in meetings organized for the description and analysis of team-teaching." This professional interest in team teaching is growing day by day. By and large, team teaching is becoming the subject of discussion and its literature is constantly growing.

What is team teaching?

Team teaching is a comprehensive term. It is a term with many faces. The sphere of team teaching is very wide. It is not limited to any one level of education. In the most general and most widely applied sense, it means giving two or more teachers joint responsibility for education of group of pupils larger than what is generally considered a normal size class.

Shaplinhas defined team teaching in the following words:

"Team teaching is a type of *instructional organization,* involving teaching personnel and the students, assigned to them, in which *two or more teachers* are given responsibility, working together, for all or a significant part of *the .instruction* of some *group of students."*

Team teaching may also be defined to include not only organizational structure but also a highly complex philosophy of education.

According to M. B. *Naik,* "In a team teaching method, two or more teachers make a plan of the subject or subjects cooperatively, carry it out, and always evaluate its effect on the students periodically."

This is actually a very simple version of team teaching. Team teaching is a technique of teaching the students in a collective form which makes teaching more effective and a joint venture.

Professor *Michael]. Apter*has aptly remarked, '"Team involves bringing together a number of classes whose teaching is then the joint responsibility of the teachers of these classes who now constitute a team."

In brief, team teaching refers to the following *factors* or *components:*

1. It involves more than one teacher *i.e.,* there is a group of teachers.

2. Teaching becomes a joint responsibility. This includes instructional planning and other aspects of teaching. Team teaching is essentially co-operative teaching.

3. It is an organization of instructional material or courses of studies at all educational levels such as elementary, secondary or college levels.

4. The number of teachers depends upon nature and objectives of the course, the size of the class and the facilities to be used.

Main ingredients of team teaching

Team teaching refers to:

(a) Scheduling.

(b) Grouping of students.

(c) Assigning specific teaching responsibilities to the teachers.

(d) New building arrangements.

(e) Independent study time for pupils.

(f) Use of para professionals known as teacher-aids or persons who assist the teachers and students.

(g) Replacement of the centralised library with resource centres.

This describes the team. The way the team operates is team teaching.

Characteristics of team teaching

- ❖ It is a teaching method.
- ❖ Two or more teachers participate in the teaching.-
- ❖ It is based on cooperation. All the teachers participating in team teaching apply their resources, abilities and experiences.
- ❖ All the teachers involved in the team teaching plan teaching [cooperatively and execute it cooperatively. Inspite of this, evaluation isalso done on cooperative basis]
- ❖ The needs of the pupils, and schools and existing resoures are also considered.
- ❖ Various aspects of any topic of one subject is taught by two [or more teachers turn by turn]
- ❖ The main objective is to make the teaching-learning more effective.
- ❖ Isolation among the teachers is removed.
- ❖ Entire responsibility does not fall on one teacher only but it is shared by others too. Hence, this method is based on collective responsibility.
- ❖ The teachers decide their .activities themselves.
- ❖ It is a technique of creating instructional conditions.
- ❖ Its plan is flexible.

Objectives of team teaching

1. To make best use of attractive 'abilities, their interests and expertise in teachers' community.
2. To make the class-room teaching effective according to the rests and capacities of the pupils.
3. To encourage flexibility in grouping the pupils. In this, the grouping of the pupils in a subject is done according to the interests aptitudes of the pupils.
4. To increase the quality of the instruction

Principles of team teaching

1. Time factor. The duration should on decided on the basis

subject's importance. To allot much lime lo an unimportant subject makes the team teaching ineffective.

2. Level of Instruction, Before imparting instruction to the the initial behaviour of the learners must lie observed and the level of the instructions .should *be* according lo (he pupils.

3. **Supervision**. The type and the method of supervision depend upon the objective of the group. .Therefore, the objectives of the group must be kept m mind at the time of supervision.

4. **Size and Composition**. The fixed size of class is an, story now. In the present times the .size of the group changes according to the objective of the team-teaching. Therefore, the size composition of the group of the pupils should be appropriate according to the objectives of the group and learning experiences,

5. **Appropriate Duties Assigned to Teachers.** The division

duties and responsibilities of the teachers should be appropriate. These duties should be assigned to them according 10 their academic interests and their personality traits. Hence, the team members should be selected very carefully.

6. Provision of Learning Environment, The team teaching successful only if a proper learning environment is provided, was provision of library, laboratory, workshop etc.

Types of team teaching

1.A Team of Teachers from a Single-Department. In classification, teachers come from a single department. This arrangement is made for secondary and higher secondary classes. It is possible if there are more than one teacher for one subject.

2.A team of Teachers from various departments of Single Institution. In this classification, a team of teachers of different subject is formed such as teachers in Psychology, Philosophy and Sociologies etc. Now the leaching task is organized very easily. Thus, team teaching encourages interdisciplinary teaching.

3. A Team of Teachers from a Single Department of Various Institutions. In such team leaching, specialists from various instructions are invited at every level and for every topic. This provision process much useful where there is only one subject teacher, Such team-leaching encourages cooperative teaching. The effective use of this team-teaching &• becomes more possible in a city where there are more than one institutions.

Procedure of team teaching

The team-teaching is organized according to objectives in the teaching-learning process. A systematic procedure is followed through bowing steps or phases:

1. **Planning Objectives**. In order to prepare a plan of team-thing, the following objectives are remembered.
    - To determine the objective of team leaching.
    - To write the objectives of team teaching in behaviouralterms.
    - To identify entering behaviours of pupils.
    - To decide the topics for leaching.
    - To prepare an outline for leaching a topic.
    - To assign duties lo the teachers looking at the interests of pupils and their skills.
    - To determine the level of the instructions.
    - To decide the evaluation techniques.
    - To create learning environment and teaching material.
    - A comprehensive plan of team teaching is prepared keeping in and the above activities.
2. **Organization Besides these objectives**, the difficulties of the ills and their needs arc also kept in mind. Following activities are formed while organizing cam teaching.
    - Teacher asks some initial questions to decide the level of the instruction. Only then he can set the level of the instruction.
    - Keeping in view the pupils' knowledge of the language, the communication technique is selected.
    - The teacher delivers lead lecture while the other member tiers of the team listen to it. They note down the important points prolifically those which are difficult for the pupils to understand.
    - Then other teachers of the team also deliver lectures and clarify various elements.
    - Pupils' activities arc reinforced. The teacher encourages the peoples.
    - The pupils are asked to perform certain tasks in the class during these lectures.
3. **Evaluation of the Results**. In this step, the evaluation occurs with the reference to the achievement of objectives on the basis of performai.ccs of the pupils. It is examined whether the objectives have been achieved or not. The following activities are performed in this step:
    - Decision is taken regarding the achievement of objectives and performances by the pupils.
    - Necessary modifications are introduced in the planning and organization phase on the basis of evaluation.
    - For evaluation, oral and written questions and practical methods are followed. Each question evaluates some objective.
    - The shortcomingsand problems of the pupils are diagnosed and remedied.

The results of the evaluation phase function as reinforcement in the pupils and the teachers. Various institutions adopt the process of team-leaching according to their own resources and objectives.

Advantages of team teaching

i. **Better Quality of Instruction.** The main utility of team teaching is the improvement in the quality of instruction.

ii. **Economical**. Team teaching is economical in (terms of time and energy.

iii. **Discipline.** It also helps in maintaining the discipline in t] class.

iv. **Exposure of Group to more specialists**. The pupils can maximum opportunities of facing maximum specialists. Hence, theygain the advantage of specific knowledge of the different teachers.

v. **Development of the professional status of the teacher**. Tea teaching also develops the professional status of the teachers because provides them the opportunity of reading new literature. The teacher himself labours hard.

vi. **Development of Human relations**. Human relations are very essential for social ,adjustment. Traditional teaching lack human rclations-1 Team-teaching provides opportunities of developing human relations.)

vii. **Opportunity for free discussion.** Team teaching Team-teaching provides many opportunities to the member-students for participating in the discussion. It provides stimulus to the ideas of the pupils' and teachers.

viii. **Will and Responsibility**. It develops strong will and responsibility of participating among the pupils and teachers.

ix. **Flexibility**. The school building school staff and other resources of the school can be used very flexibly, team teaching helps in getting id off traditional time-table.

x. **Evaluation**. Team-teaching can be best utilized in evaluation the teachers get opportunity of evaluating the task of every teacher. Essential suggestions can be provided so that the necessary modifications n be applied. In the traditional teaching system, no teacher bothers out the task of the other teacher. By team teaching all the teachers an be assembled and they can be told about their teaching.

Limitations of team teaching

i. **Costly Method**. Team learning is costlier than the traditional teacching. Its cost per head is more than that of the traditional teaching.

ii. **Requires more Accommodation**. More rooms and furniture are required in team teaching in comparison to the traditional teaching.The rooms should be spacious too. Traditional teaching lacks sufficient and spacious rooms. Hence, due to the scarcity of space and building, the effectiveness of the team-teaching becomes doubtful.

iii. **Luck of Cooperation**. The basis of the team leaching is cooperation. Bui sometimes teachers hesitate to cooperate with otherteachers. Hence, in team teaching cooperation from all (he teachers cannot be expected.

iv. **Necessary Delegation of Power and Respo**nsibilities. Team-teaching needs the division of powers and responsibilities which are in the present school management because no manager will to delegate his powers.

v. **Disregard to the Dynamics of small Group**. No specific type guidance of can be imparted in team-teach ing because school staffcannot function like a football team.**Lack of Research Work**. Being a 'new concept, team-teaching research .work. .It is being used on the basis of trial and error-method.

vi. **Variations in the Roles of Teachers. If** the different teachers have different roles it increases the load of team-teaching members, One teacher considers the other's role as a hurdle. In such conditions The teacher face tough time to maintain the balance and coordination.

Team teaching in the Indian context

Team teaching is just a new innovation and is at the experimental stage in our country. Experience shows that Indian education is still traditional and stereotyped. It has not been possible to bring forth any reform. Various commissions have emphasized new experiments and given so many recommendations regarding teaching techniques and science of pedagogy. But no sincere and serious efforts have been made to implement them.

Indian education needs drastic change to give way to team-teaching. The trend **is** going towards specialization and team teaching can prove useful in some of the teaching subjects. We can give the benefit of expert knowledge of different subject-experts to our students. It will be a sort of enterprise and a new movementwill begin to make the learning process interesting and effective.

What is needed is comprehensivetraining and proper orientation to the teaching personnel, administrators and the institutions. A proper tone should be established in the schools and possibly, the present structure, pattern of organization , and scheme of studies in education shall have to be changed.

Let us hope that the idea of team teaching will be accepted whole-lieartedly by the teachers and others. The entire system of teacher-training and classroom teaching should be geared towards new innovations brought forth by Teaching Technology. Team teaching is certainly a valid technique and must be given a fair trial.

E-learning

Meaning

The meaning of e-learning is electronic learning which means learning through electronic equipments. Radio, television. tape recorder, teaching machines and computers are the most important e-learning equipments. These are the new and modern equipments which the students use in their learning becomes interesting to the students and as a result the learnt materials remain in the students memory for a longer period.

The teachers should come out of their traditional methods of teaching. When the teachers use any one of these electronic media, the teaching as well as easy as well as interesting. The teachers and students should be able as to use computers in education because computers will occupy the human life in the near future. Use of computers will be inevitable in the in our life and become part and parcel of our life computers and learning through computers is a must for both teachers and students. Any subject and topic can be learnt thought e-learning and internet.

E-learning is an abbreviation of the term electronic learning. It is a flexible term used to describing a means of teaching through technology. It is an all-encompassing term generally used to refer to computer enhanced learning, although it is often extended to include the use of mobile technologies such as PDAs and MP3 players. It may include the use of web-based teaching materials and hypermedia in general, multimedia CD-ROMs or web sites, discussion boards, collaborative software, e-mail, blogs, wifis, text chat, computer aided assessment, educational animation, simulations, games, learning management software, with possibly a combination of different methods being used.(Kumar&Kumar,2010).

E-Learning is an online education that is delivered in a synchronous or asynchronous format. Synchronous format is a condition where lessons are carried out in real-time and led by instructor, while asynchronous format is self-paced whereby each individual progresses according to one's pace. E-Learning requires the use of a network environment, also known as "cyberspace".

Traditional learning

Traditional teaching is concerned with the teacher being the controller of the learning environment. Power and responsibility are held by the teacher and they play the role of instructor (in the form of lectures) and decision maker (in regards to curriculum content and specific outcomes). They regard students as having 'knowledge holes' that need to be filled with information. In short, the traditional teacher views that it is the teacher that causes learning to occur (Novak, 1998)

Learning is chiefly associated within the classroom and is often competitive. The lesson's content and delivery are considered to be most important and students master knowledge through drill and practice (such as rote learning).Content need not be learned in context.The most common seating arrangement used by the traditionalists is rows.

Benefits of e-learning

1.Convenience and Flexibility

2.Offers Individualized Instruction

3.Self-paced

4.Broader Range of Opinions

5.Greater Range of Feedback

6.More Direct Control

7.High Level of Interaction

8.High Levels of Participation, Engagement and Concentration

Drawbacks of e-learning

1. Technology Issue

   There are uncertainties in this subject. For instance, it is unsure that the existing technology infrastructure can accomplish the learning or training goals.

2. Inappropriate Content

   Though limited, there are possibilities that certain E-Learning materials might contain inappropriate content. Such contents might be materials that include sensitive issues or materials that are not suitable for students.

3. Cultural Acceptance

   There might be possibilities that student demographics and psychographics may predispose them against using computers. Therefore E-Learning will not be a suitable medium of education for them.(Kamsin,2005).

Scientific method and scientific attitude

"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 modification in the light of further empirical observations. Science is both a body of knowledge and the process of acquiring and refining knowledge."

-Fit Partick

What is 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 method of solving a problem scientifically. This is one of the important contributions of Science and the students should be taught and well-trained in the method of attacking a problem, for training in method is more important than the acquisition of a fund of information. Once the students are trained in method they will approach all the problems in the same way, even if they are put in a situation which they are quite ignorant of.

Definitions of Scientific Method

Scientific method consists of systematic observation, classification and interpretation of data. -**Lundberg**

Though many teachers accept scientific method as an important objective of science teaching yet nothing was provided of teaching it because teachers commonly tend to assume that scientific method is just as outcome of Science teaching and, therefore, no deliberate effort was done in this respect. On the contrary much emphasis was given to cover an arbitrary range of content. Along with a number of laboratory exercises. The problems given in the text books are read by teachers as such without inviting any reflective thinking on the part of the students. There was a lack of understanding of the ways of teaching science which would have encouraged boys and girls to become scientific in their thought and action.

Scientific method involves reflective thinking, reasoning and results from the achievement of certain abilities, skills and attitudes, present evidence indicates that it needs a continuous training and is the outgrowth of day –to-day work with problems concerning the students in an atmosphere of careful and persistent investigation. For this continuous appraisal of Scientific method, the teacher should provide such situations and activities as are conducive to its development and training.

1. Problems concerning the whole class in general should be set for study such as sanitation of school. The whole class will thus be organized as research team.
2. Such is posed as a questions should be created in which a fact well-known to the students is posed as a question e.g. The students know that ‘evaporation causes cooling’. They can be asked the question, “How can you prove the truth of this statement”? This will devise and demonstrate the experiments and judge its adequacy.
3. Individual laboratory experiments which involve some aspects of Scientific method may be assigned by the teachers e.g. growing bean seeds in the laboratory under controlled conditions and finding out the conditions necessary for growth and factors which promote growth. This will provide an opportunity to the students to develop an insight into the Scientific method.
4. An historical event in science or its applications may be analysed to find out the phases of Scientific method e.g. Mendel’s endeavour to find out the Laws of Inheritance or the efficiency of Newton’s Laws of Motion etc.

The teacher should have democratic attitude and join the students in exploring problems, find out the solutions and proposing ways of testing data. Students have questions and problems and the teacher should listen to their problems. He should suggest such activities and provide situations in which the students can find out the solutions of the problems. The Science laboratory should be a place to experiment and such an atmosphere should be created in the laboratory should be a place to experiment and such an atmosphere should be created in the laboratory as may prove conducive to the students for finding out the method of solving their own problems.

Steps Involved in Scientific Method

Any method of solving a problem scientifically following some logical steps may be called as ***Scientific Method***. For example, ***Boeck***compared the achievements of two groups of high school Chemistry students, one taught by inductive –deductive approach and other by deductive approach. He found out that both groups fared equally well in the attainment of knowledge of basic and principles of Chemistry but the first group was significantly superior to the latter groups in so far as the ability to use the Scientific Method with an accompanying of Scientific attitude was concerned. So, in view of the fact he came to the conclusion that inductive-deductive method is best suited for teaching Chemistry to high school students. Similarly, other effective methods of teaching can be found out which can contribute potentially on the attainment of Scientific method. However, the Scientific method consists of the following steps :

(i) Sensing the problem.

(ii) Defining the problem.

(iii) Analysing the problem,

(iv) Collecting the data.

(v) Interpreting the data.

(vI) Formulation of tentative solutions or hypotheses.

(vii) Selecting and testing the most likely hypotheses.

(viii) Drawing conclusions and making generalisations.

(ix) Application of generalisation to new situations.

1. Sensing the problem

The teacher should provide such situations in which the students feel the need of asking some questions. The teacher may also put such questions which require reflective thinking and reasoning on the part of his students and this may become a problem for the students to solve. This setting up of a problem may be a cooperative approach of the teacher and the students. The teacher opens up a field for investigation and asks the students to suggest places where problem might exist. It is, however, important that the teacher should accept that problem, suggested by the students which he feels that it is up to the needs, capabilities and intelligence of the students. He should also take into consideration the interest of the students, the availability of the material on the problem, and its utility to the students in promoting reflective thinking and training in the method. The problem set should fit in the curriculum and should appeal to the majority of the students in the class; this will foster group work which makes for greater reflective thinking. *For example :*

The teacher demonstrates an experiment to the students to show that water boils at low temperature under low pressure. He takes a flask and fills it half with water. Boils water over a flame. Removes the flame.Corks the flask.Inverts it and pours-cold water on the flask. The students observe the process carefully and see that water has begun to boil again when cold water is poured on the bottom of the inverted flask. They at once sense a problem for themselves of finding out the reason and explanation of what they have seen.

2. Defining the problem (To win half the battle)

The students now define their problem in a concise, definite and clear language. There should be some key-words in the statement of the problem, which may help in better understanding the problem. The teacher should help the student in stating the problem. The student may be asked to write down the statement of the problem in the light of above criteria and then read it in the class criticism and discussion. The most appropriate statements should be accepted,*e.g.*

The students can give different statements such as :

- Why is water boiling ?
- Why did water boil first ?
- W hy was the flask corked and then inverted ?
- Why was cold water poured over the bottom of the inverted flask ?
- Why did water boil in the flask when cold water is poured over the inverted f ask ?

Of all these statements, the last one is in fact the problem which should be solved and at this same time it is in accordance with the criteria of stating the problem. So, this is accepted and the students start analysing it.

3. Analysis of the problem

The students now find out the key-words and phrases in the problem which furnish clue to the further study of the problem. The key-words help in finding out the required information. It is, however, important that the students should know the meaning of all the key-words and understand the. wholeproblem. And when the students have grasped the problem, half of the work is done. In our selected problem ***'water boil*** or the ***'boiling of water'*** are the key-words which gives us clue to find information regarding the boiling of water under different conditions.

4. Collecting the data

The teacher suggests references on the problem. The students consult the references and collect evidence bearing upon their problem. It is a good opportunity for the teacher to guide the students in developing a variety of skills and techniques. The teacher calls upon the students to use devices such as models, pictures, field trips, experiments, text-books etc. which require special techniques and skill. The students should be given practice in locating information and to devise means to obtain it.

5. Interpreting the data

It is an important and at the same time a difficult step, for it involves reflective thinking, and is complex of skills and abilities. The students require a lot of practice in interpreting data. It is, however, wise to break the larger area with simpler abilities and then, to find out the ways and means of setting different situations for developing these. The students organise the data by similarity and difference, and plan experiments to answer questions and test ideas. The superfluous data is discarded.

6. Formulation of tentative solutions or hypotheses

After the data is interpreted and organised, the students may be asked to write down the inferences based on the given evidence and to propose ways of testing out these inferences. The students can suggest the hypothesis like :

Water will also boil,

(a) When flask is not inverted.

(b) When water is not boiled but only warmed.

(c) When hot water is poured over the inverted flask containing cold water.

(d) When hot water is poured over the inverted flask containing boiled water.

(e) When cold water is poured over the flask containing cold water.

(f) When cold water is poured over an inverted flask containing boiled water.

These may be some of the hypotheses that students can suggest. They will also propose means or experiments to test these hypotheses.

7. Selecting and testing of most likely hypotheses

Selecting the most likely hypothesis out of a number of hyotheses requires special skill and involves analyzing, selecting and interpreting the relevant data, judging pertinence or significance of the data for immediate problem. The students can select the most tenable hypothesis by rejecting the others through discussions and experimentations. The selected hypothesis is again tested experimentally to find out its truth. *For example :*

The students have found out that water begins to boil again in an inverted flask when cold water is poured over it. In no other condition this was possible and so all other hypotheses were rejected.

8. Drawing conclusions and making generalisation

In fact the tested hypothesis **is** the conclusion to be reached at. However, such class-room situations may be provided as may help in drawing conclusion. Some demonstrations can be arranged to arrive at the conclusion.

The generalisation can be made by arranging a set of experiments which also show the same conclusion already reached at. *For example,* the effect of varying pressure on boiling point of water can be found out by conducting experiments. From these conditions, one can generalise that pressure has a direct effect on the boiling point of water i.*e.,* the increase in pressure raises the boiling point of water and *vice-versa.*

9. Application of generalisation to new situations

The students should apply the generalisation to their daily life. This will bridge the gap between the class-room situation and real life situation. As it is important to start the cycle reflective thinking with a problem which is interesting and useful to the students, so it is important to close the cycle with application of the generalization to new life situations. *For example,* the students will apply the generalization that increase in pressure increase the boiling point of water and *vice-versa,* to explain the reason of “Why is it difficult to cook meat a and pulses at higher altitudes?” “Why do the pulses etc, take lesser time for cooking in pressure cooker?”In this way the students will apply the generalization to other life situations.

Moreover, the application of the principle will help in verifying the principle itself. This is a ***deductive approach*** in which the students can predict and explain different phenomena on the basis of the principle.

So it is quite clear from the above discussion that Scientific Method involves a definite and set procedure of attacking the problem, finding out its solution inductively and lastly testing the adequacy of the generalization by deductive approach. It is, however, a wrong notion of the teacher that by mastering the concepts, principles and facts the abilities invested in solving the problem will develop automatically. On the other hand, there should be direct teaching in such ability and training in method. This, however, does not mean that the content should be given less emphasis but it should not become an end itself. It is obvious that the content learnt in the solution of the problem is much more durable than the content mastered as such for its own sake.

Some implications of using Scientific or Problem – Solving Method

Although scientific method is more effective in stimulating critical thinking and developing skills in problem-solving, its wide use and success depends upon the following factors:

1. *Competence of the teacher*: The effective use of the scientific or discovery or inquiry method depends to a large extent on the competence of the teacher –his mastery of knowledge in science and his skill in teaching or his

ability to use this method. The present programmes of training in-service as well as pre-service teachers do not prepare them to use this method.

2. *Student competence:* Another factor which determines the effective use of this method is student's competence-his general mental ability, motivation, and prior knowledge of the subject.

Some research studies show that students with lower mental ability can make some discoveries but at a slower rate than the brighter ones, and that student's performance improved with each grade.

3. *Availability of time* : This method requires that schedules be flexible to allow students sufficicent time for inquiry tasks.

Teaching by this method also requires that students conduct more different types of class work, homework, research studies, and other activities which require a lot more time from them.

All of these activities arerather difficult to carry out within the rather inflexible time-table, the limited financial resources and heavy teaching load of the school. Whether teachers are able to conduct all these activities will depend to a large extent on how much support they get from their supervisors, principles and administrators.

4. Support from administrators: Some administrators do not support the use of this method. The method requires that teachers organize activities such as field trips, visits to the library, surveys, etc, but they are not encouraged to organize such activities by the school administration. Some administrators are reluctant to allow field trips and other outdoor activities as they are apparently afraid to take responsibility for any unto ward incidents that may occur during these activities. The teachers have to take the risk themselves. However, in doing so, the teachers have a tendency to control the movements and the discovery activities of the students.

There are also limitations on the use of the school library, laboratory equipment, and other facilities of the school which are necessary for using this method.

The above limitations make it difficult for the teacher to use scientific method to the teaching of science. However, it should be possible to overcome most of these problems by making specific provision in the use of this method in the in-service and pre-service training of teachers, orientation of administrators and to seek their co-operation in encouraging teachers to use this method in schools. It should, therefore, be possible to teach some topics using inquiry or scientific method.

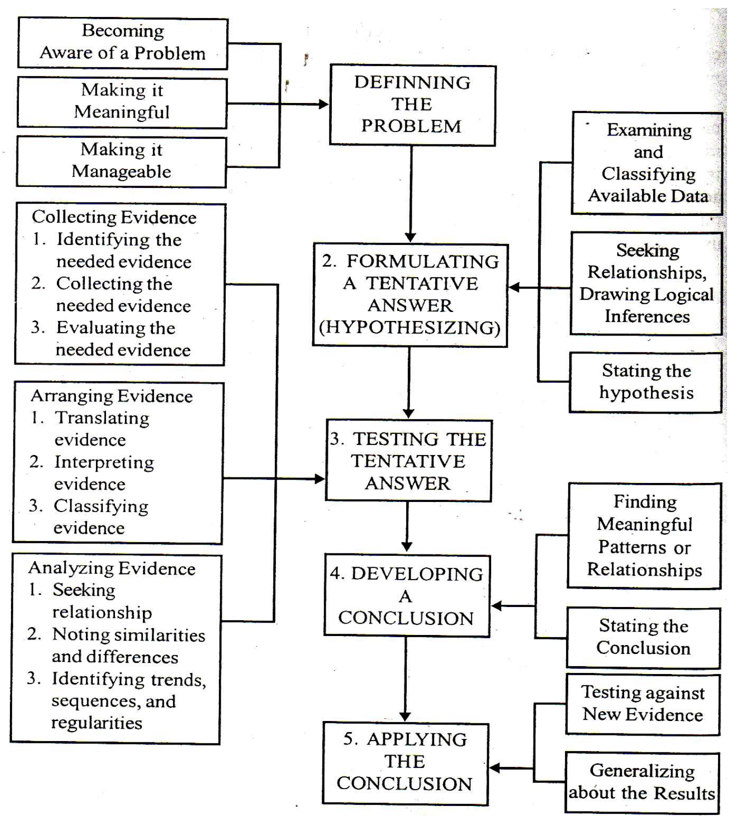
Process Skills involved in Scientific Method

A number of process skills are involved in the use of problem-solving or scientific method. They illustrated in the following figure.

The following is the list of process skills.

1. *Observing*
   - Using the senses (as many as safe and appropriate) to gather information.
   - Identifying differences between similar objects or events.
   - Identifying similarities between different objects or events.
   - Noticing fine details that are relevant to an investigation.
   - Recognizing the order in which sequenced events take place.
   - Distinguishing from any observations those which are relevant to the problem in hand.

The Process of Scientific Method



2. *Raising Questions*
    - Asking questions which lead to inquiry.
    - Asking questions based on hypotheses.
    - Identifying questions which they can answer by their which has to be carried out.
    - Putting questions into a form which indicates the investigation which has to be carried out.
    - Recognizing that some questions cannot be answered by inquiry.
3. *Hypothesizing*
    - Attempting to explain observations or relationships in terms of some principle or concept.
    - Applying concepts or knowledge gained in one situation to help understanding or solve a problem in another.
    - Recognizing that there can be more than one possible explanation of an event.
    - Recognizing the need to test explanations by gathering more evidence.
    - Suggesting explanations which are testable even if unlikely.
4. *Predicting*
    - Making use of evidence to make a prediction 9as opposed to a guess which takes no account of evidence).
    - Explicitly using patterns or relationships to make a prediction.
    - Justifying how a prediction was made in terms of present evidence or past experience.
    - Making use of patterns to extrapolate to cases where no information has been gathered.

Scientific Attitude

The characteristics of scientific attitude have already been mentioned in the chapter on instructional objectives. It can be defined as:

"Open mindedness, a desire for accurate knowledge, confidence in procedures for seeking knowledge and the expectation that the solution of the problem will come through the use of verified knowledge."

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Indicators of attitudes

Attitudes are more generalized aspects of behaviour than are process skills. The indications of their presence a range or situations.

cannot consider any one activity and say whether or not this or that attitude was .

However, we can still identify indicators of attitudes which can be used in much the same way as the indicators of process skills, except that they have to be applied across a range of activities rather than for any individual activity.

The following are some indicators of scientific attitude:

Willingness to collect and use evidence

- Reporting what actually happened, even if this was in conflict with expectations.
- Querying and checking parts of the evidence which do not fit into the pattern of other findings.
- Querying an interpretation or conclusion for which there is insufficient evidence.
- Setting out to collect further evidence before accepting a conclusion.
- Treating every conclusion as being open to challenge by further evidence.

Willingness to changes ideas in the light of evidence

(flexibility combined with open-mindedness)

- Being prepared to change an existing idea when there is convincing evidence against it.
- Considering alternative ideas to their own.
- Spontaneously seeking alternative ideas rather than accepting the first one which fits the evidence.
- Relinquishing an existing idea after considering evidence.
- Realizing that it is necessary to change ideas when different ones make better sense of the evidence.

Willingness to review procedures (Critical reflection)

- Willingness to review what they have done in order to consider how it might have been improved.
- Considering alternative procedures to those used.
- Considering the points in favour and against the way in which an investigation was carried out.
- Spontaneously reflecting on how the procedures might have been improved.
- Considering alternative procedures at the planning stage and reviewing those chosen during an investigation, not just at the end.

How to Develop the Scientific Attitude?

The sole responsibility of developing scientific attitude among the students lies on the teacher who can manipulate all the situations to instill in pupils the characteristic features of scientific attitude and at the same time present himself as an example to the students for his intellectual honesty, respect for other point of views, unbiased and impartial behaviour in his dealings and the like. This will create a favourable and permanent impression on the students to adopt the same attitude which their teacher has.

However, the teacher can develop scientific attitude among the students in the context of:

(i) Curriculum.

(ii) Physical facilities.

(iii) Opportunity for practical work.

A large majority of the schools are of the view that an enthusiastic teacher can help in developing the scientific attitude through the curriculum. The teacher should suggest projects which give the pupils training in problem solving. ***Curtis***is of the opinion that pupils who engage in wide reading in science develop scientific attitude more that those who read only one text book.

Democratic atmosphere in the classroom also helps in developing certain desirable attitude in the students. Such an atmosphere will infuse a spirit of healthy criticism. There will be no wishful or biased thinking on the part of the students. They are free to question and discuss and get to the prejudices and difficulties removed. For removing the superstitions and false beliefs from the minds of the students, the teacher should usually put such type of questions as "What evidence or proof have you got for this belief? This will also develop in them ***open-mindedness*** **and** ***critical thinking***. They should be taught not to take the things for granted because they appear in print or are spoken by some big man. But too much of stress on this point may prove harmful.

Opportunities for practising work should be provided in schools. This helps in forming and practising good attitudes. The students should perform the experiments themselves and find out truth of what they learnt in their theory. They should be taught to suspend judgement until sufficient evidence is secured. They should be instructed to observe critically and accurately and to report only what they see. Their habit of concocting and copying things should be discouraged. It is quite obvious that most of the attitudes can be developed through practical work and at the same time the students get the chance of practising the attitudes they have already acquired.

But it is not easy to assess the scientific attitude. We are not aware of any satisfactory test calculated to measure scientific attitude of pupils. However, there is enough evidence to show the active desire of teachers to cultivate habits of thought and action that gradually lead to the acquistion of scientific attitude.

Highlights-Scientific Method

The method or procedure which the scientists use in the pursuit of science may be termed as 'Scientific Method.' It involves reflective thinking and reasoning and needs a continuous training. Therefore, the teacher should provide such situations and activities which are conducive to its development and training.

Steps involved in the Scientific Method:

(i) Sensing the problem.

(ii) Defining the problem.

(iii) Analysing the problem,

(iv) Collecting the data,

(v) Interpreting the data.

(vi) Formulation of tentative solutions or hypotheses.

(vii) Selecting and testing the most likely hypothesis.

(VIM) Drawing conclusions and making generalisation.

(ix) Application of generalisation.

Scientific Attitude

"Open-mindedness, a desire for accurate knowledge, confidence in procedures for seeking knowledge and the expectation that the solution of the problem will come through the use of verified knowledge, these are among the scientific attitudes."**Rethinking Science Education.**

Indicators of Scientific Attitude

(i) Willingness to collect and use evidence.

(ii) Willingness to change ideas in the light of evidence. (iii)
Willingness to review procedures.

How to develop Scientific Attitude?

Science teacher is, perhaps, mainly responsible for developing **Scientific attitudes** among the pupils. He should provide opportunities for independent extra-reading, laboratory work, improvisation of apparatus, problem solving etc.

Activity based learning (abl)

Meaning of Activity Based Learning

We are familiar with learning through Activities propounded by John Dewey and Basic Education advocated by Mahatma Gandhi in which a productive craft formed the basis for correlated teaching.

In most of the primary schools, only rote learning is emphasized and children are expected to learn from the teaching in the classroom. On the other hand, in 'Activity Based Learning', children learn first hand experience by engaging in a series of activities. An activity is described below:

For students of Std V to make them understand that through the circumference remain the same, the circle may contain more surface than other shapes, a learning activity may be given. 'Several cardboard pieces which all have the same circumference will be given. Students are provided with pieces of twisted yarn of same lengths and pins. They are asked to fix the pins at small but regular distances along the edge of the cardboards and connect them with the twisted yarn pieces. Next, they are instructed to fill each cardboard with glass beads. After the task is completed, they are asked to count the glass beads contained in each cardboard shape. On counting, they will understand that the circular type contains more glass beads than any other type. This activity enables self-learning.

Origin of ABL

Activity Based Learning took shape in Rishi Valley School, maaged by Philosopher J. Krishnamurthy Foundation, which experimented in rural education centres opened by it. Later it was adopted by Chennai Corporation. M.P. Vijayakumar I.A.S. was keenly interested in popularizing this approach. Now, Village School teachers are given training in Activity Based Learning.

Activity Based Learning gets financial support from England and is lauded by several educationists from the west.

Characteristics of activity-based learning

The key feature of the ABL method is that it uses child-friendly educational aids to foster self-learning and allows a child to study according to his/her aptitude and skill. Under the system, the curriculum is divided into small units, each a group of Self Learning Materials (SLM) comprising attractively designed study cards for English, Tamil, maths, science and Social Science. When a child finishes a group of cards, he completes one "milestone". Activities in each milestone include games, rhymes, drawing, and songs to teach a letter or a word, form a sentence, do maths and science, or understand a concept. The child takes up an Exam Card only after completing all the milestones in a subject. If a child is absent one day, he/she continues from where he/she left unlike in the old system where the children had to learn on their own what they missed out on

Growth and Development of Activity Based Learning

In the year 2003-2004 twenty six teachers from Chennai Corporation were sent to Rishi Velley School for training in Activity Based Learning.

In 2003, Activity Based Learning was experimented in 13 selected schools from ten zones in Chennai.

In 2004, Activity Based Learning was implemented in 264 Corporation Schools. Learning cards were supplied to all children studying in standards I and II for all the four subjects. Teachers were provided with manuals giving guidelines regarding how to use the learning materials.

In 2004-2005 the training programme was extended many Block ResourseCentres(B.R.C)

In 1005, 'Activity Based Learning' was extended to std. III also.

In 2006, work books were supplied to pupils std. I to III

Four Stages of Activity Based Learning

i) Preparation
ii) Testing the materials
iii) Extension
iv) Evaluation

Advantages of Activity Based Learning

- Children learn at their own pace
- More time is devoted to self learning and the time taken by the teachers for instruction gets reduced
- Group learning, self-learning and learning from each other are promoted.
- Time taken by the teacher for instruction is evenly distributed among all pupils(i.e) more individual attention is made possible.
- Pupils progress could be evaluated without their knowledge.
- Rote learning is avoided.
- 'Activity Based Learning' has helped to solve two major problems facing primary schools.
    - ♦ Multiple class teaching (two teachers teaching five standards) which necessitates one teacher burdened with more than one class. Naturally, the teacher is more stressed and learning records poor progress.
    - ♦ Shortage of qualified teachers.
- The success of Activity Based Learning depends upon three factors noted below:
    i) Teachers, guide teachers and observers should have an open mind and willing to accept welcome changes
    ii) Involvement by the officials of the education department.
    iii) Financial support and backup by the people in authority.

Active learning method (ALM)

The term ACTIVE LEARNING is not new. Teachers, schools and institutions of higher learning have searched for ACTIVE LEARNING METHODOLOGIES. It was gratifying to discover that University departments, Colleges of Medicine and Veterinary science, Institutes of Geological sciences and a host of others have also generated much documentation on the subject. The difficulties of a largely lecture oriented learning environment, the principles and strategies for an active learning environment have been explored in different ways. The classroom and the given content are taken. This may be considered faulty by many. But the steps into tomorrow have to lead from what exists now. We cannot imagine schools in entirely new circumstances - different building, teachers, books etc. Whatever methodologies we choose have to be viable in the present circumstances. Thus the approaches suggested here are those that may find applicability in many circumstances. Not fighting with what exists, but searching for creative possibilities within the circumstances, yields many interesting insights and possibilities. This chapter attempts to answer some basic questions. The information here has been obtained from various sources on the internet and published material and is meant to give an overview of the prevailing understanding, if not in detail, in broad directional terms. Let's not confuse the delivery of content with its reaching the student. Or good explaining with good learning. It is not surprising that students get good at doing something – by doing it!

Active learning

to say that it is impossible to learn anything passively

doesn't take us far in understanding 'active learning'

or how it can be applied in the classroom.

Elements of active learning methodologies 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:

- Students are involved in more than listening,
- less emphasis is placed on transmitting information and
- greater emphasis on developing students' skills,
- students are involved in higher-order thinking (analysis, synthesis, evaluation),
- students are engaged in activities (e.g., reading discussing, writing), and
- greater emphasis is placed on students' exploration of their own attitudes andvalues.

"Active learning shifts the focus from the teacher to the student and from delivery of subject content by teacher to active engagement with the material by the student. Through appropriate inputs from the teacher, students learn and practice how to apprehend knowledge and use them meaningfully." Concerned about the explosion of information available in medical texts and the perceived need by lecturers that they must cover even more material in the limited time available, the authors studied the effect of information density on student retention. They prepared three different lectures on the same subject matter. The lectures were presented to a total of 123 students randomly distributed into three groups, which showed no significant difference in cumulative GPA's. Finally students were given a pretest that showed no significant difference in their knowledge base,

(1) a test immediately after the lecture, and
(2) an unannounced test
(3) 15 days later.

Statistical results clearly showed that students in this study learned and retained lecture information better when the density of new material was low. The implication is that the amount of new information that students can learn in a given time is limited and that the purpose is defeated when the limit is exceeded. [Who among us has not gone over the allotted class time by a minute or two to provide "just one more thing"?] This study suggests, however, that we would be better off presenting only the basic material necessary to achieve our learning objectives: approximately only 50 percent of the material presented in any lecture should be new. The rest of class time should be devoted to material or activities designed to reinforce the material in students' minds. This study is significant since one of the chief barriers always presented by faculty to the acceptance of active learning is that "there is simply too much content to cover." Apparently less new content and more time reinforcing the facts and concepts presented [which could include active learning] will lead to greater student learning.

- Lessons are divided into several segments and each segment id formulated as a competency to be mastered
- Each segment / unit is named as a milestone – and every step forward is in the ascending order. Each step is termed as 'logo'.
- Milestones are sequenced from easy to difficult order and suitable activities are identified for each one of them.
- Every group has separate identification cards / colours, for easy assembling.
- As evaluation is a part of ALM, no separate summative assessment is necessary. The individual progress cards and performance of activities which are recorded on the spot serve as reliable records for evaluation.
- Every pupil gets reinforcements through the work books / work sheets in which the teacher records his remarks.
- An assessment chart is maintained to show the progress of the student throughout the year.
- Each 'milestone' has different activities in which introduction, reinforcement, practicing, assessment, remedial measures, activities for improvement are some of the logos(steps).
- It has been found that children evince interest in the following activities.
    - Gardening
    - Rural songs
    - Skits (small plays)

- Games
- Puppet shows
- Learning by using the globe atlas and dictionary.

Cooperative learning

Our on-going classroom teaching is totally teacher dominated and content centered. Here ,the teachers are regarded as the repositories of subject knowledge and their role in simply to pour into the open, empty and willing(or-non willing) minds of students their vast reservoir of knowledge. They do not trust their students to learn. They think that they must tell them what to learn and provide all the structure for the learning to take the place. This learning structure is highly individualistic. It encourages individual and competitive learning in place of group and cooperative learning. Here the students and tempted to learn more and more in order to gain good grades divisions, certificates and appreciations, by excelling their own peers. Cooperative learning saysno to such practices. It advocates cooperative and group learning in place of the competitive and a individualistic approach prevalent in our educational system by redefining the roles of the teacher and the learners in a particular teaching- learning set- up.

Characteristics of cooperative learning

- Uses small groups of four or five students
- Focuses on tasks accomplished
- Requires group co-operation in interaction
- Mandates individual responsibility to learn
- Support division

Basic assumptions and features

- The cooperative learning ideology rests in making the teaching- learning process as leaner centered rather than being content or teacher centered.
- It advocates constructivist ideology for the better teaching- learning outcomes by encouraging the students to formulate their own constructs and ways of understanding the content material.
- It believes in redefining the role of a teacher from lecturer, expert or repository of subject knowledge to capable facilitator for helping his students in their cooperative learning task
- It advocates proper teaching-learning environment instead of mere lecturing and demonstration on the part of the teachers. Here the responsibility for learning is thus, shifted to the students from the teachers, for making them to learn by resorting to various tactics.
- It emphasizes social learning by assuming that learning takes place better in a social situation and group environment rather than in isolation.
- It believes in group efforts and cooperation among the learners in place of individual efforts and competition.

- It is of the view that children learn better in a cooperative way from each other on account of the proximity, equality, interdependence and rapport existing among them instead of the learning thrust them by some outside agency, includingteacher.
- It believes that students achievements and performances may be evaluated better in term of group achievements in the less threatening group situation rather than the competitive more threatening individualistic situations.
- It believes that students learn best when they are totally involved in the learning process by cooperating each other for attaining the maximum benefit.
- It advocates that the two necessary elements group goals and individual accountability should be used together for the evaluation of group achievements in cooperative learning.
- It believe in providing the students the opportunity to learn and work cooperatively in a group in order to develop them into a cooperative and responsible social being on the very assumption that students who cooperate with each other in learning learn to like each other in real life.

How to proceed with cooperative learning

To replace the traditional classroom learning and setting into a cooperative learning set-up is not an easy task. One may have to face so much opposition and resistance from the fellow teachers, students, authorities and parents in doing so. Moreover, the present circumstances and educational system are not at all favorable for the introduction of such innovative but useful practice in our schools and colleges. However, much depends upon the teacher who is himself convinced about the fruitful outcomes of the cooperative learning. For this purpose, be must learn the art and skill of employing it as a useful strategy of teaching-learning. Then he must get his students, authorities and parents of the students convinced about the utility of employing this noble practice. With such background and initiation, he should settle down for devising and employing variety of ways and means for the adoption of cooperative learning as a teaching strategy. In doing so, he may try for a number of typical cooperative learning set-up as mentioned here.

- A unit of the course in a subject may be broken down into certain meaningful subunits. These subunits may, then be assigned to the different teams (each having 5 to 8 students) of a class or grade for cooperative learning. The team members may collect relevant materials and go through learning experiences, activities etc. for gaining the required knowledge and understanding about assigned subunit in a quite cooperative way mutually helping and complementing each other's efforts. After sometime the members of the different teams may sit together for discussing their learning outcomes with respect to the subunits. In fact , they may teach each other the content material or learning experiences acquired by them after grasping the knowledge and understanding of the whole unit. They may again be asked to work in their respected groups/teams for gaining more insight and understanding of their striving to all the students of the class.
- Students of a class in any subject /grade may be asked to work on a group project. It may give extensive opportunities to them for cooperative learning and working in the group. Such group projects or investigations may be

highly structured to emphasize higher order thinking ,analyzing and evaluating skills. They may also provide a proper platform for the demonstration of practical and working abilities on the part of the working cooperatively.

- In another cooperative learning set-up the students with varying academic abilities may be assigned to 4-5 member teams for studding what had been initially taught by the teacher and to help each other reach his or her highest level of achievement. After doing such cooperative efforts, all the students are then tested individually. Then,the different teams may be awarded certificates or other recognition on the basis of their progress over their past records.
- In another cooperative learning set-up, a particular topic or unit of the subject is assigned to five or six groups or teams of a class. Each group or team may have a small number of students of varying interests and abilities. In a team, each team member is responsible for learning a specific part or subunit of a topic. He himself strives has the learning of this assigned sub-part in close collaboration with his or her counterparts in other teams. In fact, they work closely in a quite cooperative spirit for acquiring the necessary knowledge, experience and application related to that sub-topic. Then, all members of the team sit together for discussing the fruits of their striving and acquire complete picture of the knowledge and understanding of the sub-topic or sub-units. They may go for its deep understanding and advanced study by repeating their cooperation exercise in the process of learning.

Small group discussions

A major tenet of the constructivist philosophy is the importance of an active learning environment .Active learning can be implemented by organizing the class into small groups of students who can work harmoniously-foster their own learning strategies and get an atmosphere in which information sharing can take place.

A discussion is a teaching technique that involves an exchange of ideas with active learning and participation by all concerned. Discussion is an active process of student-teacher involvement in the classroom environment. Discussion allows a student to discover and state a personal opinion perspective, not merely repeat what the teacher on text has already presented. Besides promoting meaningful personal interaction, discussion promotes a variety of learning, including content, skills attitudes and processes . It is an appropriate way to improve both thinking and the speaking skill of students. Four basic concepts are tobe considered for initiating small group discussion. Providing co-operative learning opportunities is not simply a matter of placing students in groups and assigning tasks. Teacher must carefully selected structured groups plan co-operative learning activities , set both academic and social goals for group work and monitor individual student progress and group learning and social processes. The success of co-operative learning depends on the following:

- Teacher planning is critical
- Student engagement is mandatory
- Quality work is essential
- Constant student monitoring is required

- Assessment is vital
- Time requirements must be established
- Trust cohesiveness and responsibility must be promoted.

Learner benefits from discussion

i. Increased depth of understanding and grasp the course content.
ii. Enhanced motivation and greater involvement with the course
iii. Positive attitudes towards later use of material presented in the course
iv. Problem- solving skills specific to the contents of the course
v. Practice in the application of concepts and information to practical problems Basic small group discussion types

There are six basic types of small-group discussion

Brain storming, Tutorials, Task- directed discussion , Role playing. Simulations and Inquiry centered discussion discussion have been viewed along a continuum from greater teacher control to lesser teacher control.

1. **Brain storming:** Brainstorming is a simple and effective skills building technique to use as a high level of creativity is desired. The leader begins the brainstorming session by briefly stating the problem under consideration. Brain stroming gives everyone an opportunity to participate. The leader should express the group that all ideas need to be expressed. One or two students can, serve as recorders. All the students should be oriented to the rules ahead of time and the leader should enforce them.
    - All ideas, expect for obvious jokes should be acknowledged.
    - No criticism is to be made of any suggestions
    - Members should build on one another's ideas. In the final analysis ideas belongs to any individual.
    - The leader should solicit ideas or opinions from silent members, then give them positive reinforcement.
    - Quality is less important than quality, but this does not relieve group members of the need to think creatively and intelligently.

Brainstorming is an initiating process; it must be followed by some activity. The group must use the basis for another type of activity. Evaluation of the generated ideas should be short and nonthreatening the participants.

2.Tutorials: The tutorial discussion group is most frequently used to help students who difficulties learning or processing information at a satisfactory rate. The groups very small and focuses on a narrow range of materials. The tutorial group is used to help students grasp a concept again with a purpose of remedying a learning difficulty. The tutorial leader performs three major functions questioning students to pinpoint the exact problem that has blocked learning , providing feedback or skills to facilitate learning and encouraging the students to ask questions and to seek answers among themselves. Tutors can be peers, older students or even computers.

3.Task – Directed Discussion: Each student in a task group can make significant contributions to the discussion. A task group has clearly defined goals and clearly identified individual assignments and roles for example, recorder, library researcher, artist, leader and evaluator. Task groups tend to begin as teacher – dominated groups , in so for as the teacher usually selects the tasks and assigns each group member to accomplish a specific role. In task groups, tasks are assigned to each participant so that no one feels left out.

4. **Role playing**: Role playing is a process – oriented group technique in which students out a real life situation. Role-playing allows for some drama in the classroom. Role-playing can be used with students at all grade levels and all academic achievement. Each role-playing group discussion is a unique experience. Elements of role playing are the following:

- Briefing students – explaining the topic and establishing the scene in understandable terms for each student.
- Conducting the drama – behaving as an actor in the dramatic situation.
- Debriefing - analyzing how the roles were played and identifying what concepts were learned.
- Simulation: Simulation is a representation or recreation of a real object, event or situation. Simulation can be used to stimulate interest in a topic. It mirrors reality. It enhances skill development, changes attitudes and assesses performance by measuring it against an already established standard.

Distinction between collaborative learning and cooperative learning

COLLABORATIVE LEARNING	COOPERATIVE LEARNING
1.Collaborative learning reflects the philosophy of working together with less or no control of a supervisor /teacher	Cooperative learning is the technique or strategy with a well structured from the purpose of a particular objective product.
2. Collaboration refers to the process of learning where students teach each other, students teach the teacher by asking doubts and the teacher teaches the students too	Cooperation is a technique helpful to finish a certain product oriented task by working together in a faster and more effective way.
3. In collaborative learning more responsibility is shared among the learners and the teacher has only less control over the learning of the students	In cooperative learning, the teacher maintains control of the group/class ,even though the students will be working together to accomplish a goal.
4.Collabrative learning has a wider scope compared to cooperative learning	Cooperative learning has only a narrow scope related a specific task.
5. In Collaborative learning time allowed to complete the work / task is decided by the learners themselves	A fixed time schedule is given by the teacher/ supervisor

Benefits of cooperative learning

Cooperative learning may prove quite fruitful advantages on account of various benefits derived through its use

Academic benefits

- It involves students actively participating in the teaching- learning process
- It makes the students responsible for their learning
- It makes the teaching-learning process learner centered rather than content and teacher centered
- It helps the students in developing higher-order thinking and oral communications skills.
- It helps the students in learning so many tasks requiring manipulation, demonstrative and practical skills simply on the basis of learning through imitation and observation of the behavior of their peers.
- It helps the weaker students in improving their performance when grouped with higher achieving students.
- It gives opportunity for deeper understanding and insight into the subject matter as a result of discussing and teaching the material by them to their peers.
- It provides interactive model for the classroom teaching in place of one-sided teacher dominated lecture or demonstration method.
- It improves classroom results by making the students more involved ,motivated and determined to learn and achieve the learning targets providing an anxiety-free noncompetitive stimulating environment.
- It helps in improving the learning environment of a classroom by re-scheduling the roles of the teachers and the learners. Here the teacher now acts as a facilitator in the task of learning totally planned and implemented by themselves.
- It makes the teacher more free and capable of guiding and supervising the learning activities of his students, as groups are easier to supervise than the individual students.

Psychological benefits

- The students learn better in a cooperative environment that keeps them away from the unnecessary anxiety of being excelled by others.
- Cooperative learning encourages students to seek help and accept tutoring from the pears. It provides a sense of security that is almost endangered in a competitive traditional classroom environment.
- Cooperative learning helps in building the students self-confidence and self-esteem in a better way than the traditional classroom teaching.

- Cooperative and team sprit help the students reducing their classroom learning and test anxiety.
- Cooperative teaching helps in developing healthy interaction among the students and between teacher and students. Students acquire a quite healthy and positive attitudes towards each other and to their teachers who are always ready for helping them in their learning tasks.

Social benefits

- Cooperative learning is helpful in the development of many social qualities and virtues among the students for becoming an adjusted social being.
- It helps in promoting leadership skills among students.
- Through cooperative learning the students get along with the people of diverse opinion, background, socio-economic status, religion, caste, color, creed- etc. This is helpful to live and adjust in a democratic society.
- In cooperative learning, the students get a healthy positive atmosphere for modeling and practicing cooperation and consequently they are of getting and giving proper cooperation can be properly learnt through the practice of cooperative learning.

Role of teacher in cooperative learning

The teacher in cooperative learning becomes a guide a stimulator, and one who encourages, but not one who lectures not dispenses information. He/she is a resource person who has much knowledge of keeping pupil on task. The teacher as resource person has numerous materials and necessary information from which pupils in cooperative learning may gather what is needed to achieve objectives. As a helper and facilitator, the teacher is motivated to assist pupils to be creative, to engage in critical thought and to identify and solve problems. Higher levels of cognition on the pupils part in teaching and learning is in evidence.

Role of team member in cooperative learning

The team member of cooperative learning (C.L) develops the following roles:

- Develop and share a common goal.
- Contribute
- Contribute the understanding of the problem, questions, insights and solutions.
- Respond and work to others questions, insights and solutions. Each member empowers the others to speak and contribute, and to consider their contributions.
- Accountable to others
- Dependent on others.

Collaborative learning

Collaborative learning is a personal philosophy, not just a classroom technique. In learning situations where students come together in groups, it suggests a way of dealing with pupils which respects and highlights individual group member's abilities and contributions. The underlying premise of Collaborative learning is based on consensus building through co-operation by group members, in contrast to competition among group members. Collaborative learning involves the development of Collaborative communities, where groups or pairs of learners interact to learn and solve authentic problems and fosters constructive learning (Sivarajan&Faziluddin, 2008).

Collaborative learning advocates distrust structure and allow students more in forming friendship and interest groups. Student talk is stressed as a means for working things out. Interaction with peers and teachers supports question refinement and reflection, promotes a shared discourse, and established a learner culture, which fosters co-operation and mutual interdependence (Sivarajan&Faziluddin, 2008).

Meanings of collaborative learning

Collaborative learning ties into the social constructivist movement, asserting that both knowledge and authority of knowledge have changed. In the ideal Collaborative environment, the authority for testing and determining the appropriateness of the group product rests with, first, the small group, second, the plenary group(the whole class) and finally the requisite knowledge community. In Collaborative learning, the teacher – once the task is set- transfers all authority to the group. This creates interactive environments where students take more responsibility for their own learning and that of their peers (Sivarajan&Faziluddin, 2008).

Collaborative learning puts students together to work in heterogeneous groups. All perspectives of all learners are utilized for enriching learning; all are seen as equal contributors, collaborating to achieve a mutual goal. Collaborative consultation encourages shared responsibility in planning and decision making.

Learners are generally autonomous learners who are relatively independent. They will learn to find their own answers and to construct their own knowledge. As they work collaboratively they will learn to see things from a variety of different view points. This Collaborative work will increase multicultural awareness. Collaborative groups will focus on discussion of their work and the students will take responsibility for it. There will be high level of group interaction. Students share various roles in learning such as team leader, encourager, reteller, recorder, spokesman, etc. The learners will be self motivated managers of both their time and their learning. Learners will share knowledge and skills as experts in the field. Teacher assumes the role of mediator (Sivarajan&Faziluddin, 2008).

Collaborative learning then, may encompass any number of group learning methods, emphasizing efforts between the students, teachers, researchers, parents, etc. both inside and outside the classroom setting. The group learning process should involve a common inquiry process, active participation in learning and the understanding that the creation of knowledge is inherently social. Actual group sizes vary and groups change in composition depending on the complexity of needs (Sivarajan&Faziluddin; 2008).

Definitions of collaborative learning

Collaborative Learning is an instruction method in which learners work in groups toward a common academic goal. Collaborative learning is an educational approach to teaching and learning that involves groups of learners working together to solve a problem, complete a task, or create a product. Collaborative learning is based on the idea that learning is a naturally social act in which the participants talk among themselves. It is through the talk that learning occurs.

Collaborative learning (CL) is instruction that involves students working in teams to accomplish a common goal, under conditions.

Principles of collaborative learning

i) Working together results in a greater understanding than would likely have occurred if one had worked independently

ii) Spoken and written interactions contribute to this increased understanding

iii) Opportunity exists to become aware, through classroom experiences, of relationships between social interactions and increased understanding

iv) Some elements of this increased understanding are unpredictable.

v) Participation is voluntary. (Sivarajan&Faziluddin; 2008).

Approaches in collaborative learning

The approaches of Collaborative Learning as follows:

- Learning is an active process whereby learners assimilate the information and relate this new knowledge to a framework of prior knowledge.
- Learning requires a challenge that opens the door for the learner to actively engage his/her peers, and to process and synthesize information rather than simply memorize it.
- Learners benefit when exposed to diverse viewpoints from people with varied backgrounds.
- Learning flourishes in a social environment where conversation between learners takes place. During this intellectual gymnastics, the learner creates a framework and meaning to the discourse.
- In the collaborative learning environment, the learners are challenged both socially and emotionally as they listen to different perspectives, and are required to articulate and defend their ideas. In doing so, the learners begin to create their own unique conceptual frameworks and not rely solely on an expert's or a text's framework[3].

Thus, in a collaborative learning setting, learners have the opportunity to converse with peers, present and defend ideas, exchange diverse beliefs, question other conceptual frameworks, and be actively engaged.

Benefits of collaborative learning

The benefits of Collaborative Learning as follows[5]:

- Develops higher level thinking skills
- Promotes student-faculty interaction and familiarity
- Increases student retention
- Builds self esteem in students
- Enhances student satisfaction with the learning experience
- Promotes a positive attitude toward the subject matter
- Develops oral communication skills
- Develops social interaction skills
- Promotes positive race relations
- Creates an environment of active, involved, exploratory learning
- Uses team approach to problem solving while maintaining individual accountability
- Encourages diversified understanding
- Encourages student responsibility for learning
- Involves students in developing curriculum and class procedures
- Stimulates critical thinking and helps students clarify ideas through discussion and debate
- Enhances self management skills
- Students develop responsibility for each other
- Builds more positive heterogeneous relationships
- Encourages alternate student assessment techniques
- Fosters and develops interpersonal relationships
- Students are taught how to criticize ideas, not people
- Sets high expectations for students and teachers
- Promotes higher achievement and class attendance.
- Students stay on task more and are less disruptive

- Greater ability of students to view situations from others' perspectives (development of empathy)
- Creates a stronger social support system
- Promotes innovation in teaching and classroom techniques
- Classroom anxiety is significantly reduced
- Test anxiety is significantly reduced
- Classroom resembles real life social and employment situations
- CL activities can be used to personalise large lecture classes
- CL processes create environments where students can practice building leadership skills.

UNIT V

SCIENCE CURRICULUM

Curriculum is a conceptual plan and dynamic entity to achieve the requirements of the people of a country. Science curriculum is designed as per the aspirations of the leaders and. die people of the society, organized by researchers in science education, guided by the administrators and implemented by the science teachers in schools. Curriculum needs review because the subject matter of science and the views of the people are not static. Education department is a part in the ministry, of human resources development. Science education is related the ministry of science and technology. In our country NCERT is the professional body, which enriches the science curriculum and reorganizes it every ten years. Resource utilization for any nation is feasible through the enhancement of professionalism in the field of science and technology. Science curriculum is designed to achieve the objectives of science.

Meaning and Definition

The word curriculum is derived from a Latin word 'currere' that means course to run. This means the course to study or training leading to reach a goal. Some of the definitions of curriculum given by specialists in this field are as follows:

Kearney and Cook: "Curriculum is a complex of more or less planned and controlled conditions under which students learn to behave and do behave in their various ways".

Cunningham: "it is a tool in the hands of an artist to mould his material according to his ideals in his studio.

K.G. Sayidain: "the curriculum is primarily an aid in the process of adjusting the child to the environment in which he functions form day to day and in the wide environment in which he will have to organize his activities later".

Secondary Education Commission: "curriculum, does not mean only academic subjects traditionally taught in the school, but it includes totality of experiences that a pupil receives through the numerous activities that go on in the school, classroom, library, laboratory, workshop, playground, and in the manifold informal contacts between the teachers and the pupils".

Alexander and Saylor: "curriculum is the total effort of the school to bring about desired outcomes in the school and out of school situations".

Curriculum doesn't limit itself to a syllabus or the formal methods through which the school prepares its students for examinations or for occupations. It has as its integral part the acquisition of aesthetic experience, the development of moral values, the development of the body, and informal contact with the society. It includes all the educational activities of the school in the widest possible sense.

SYLLABUS OF BIOLOGY IN SCHOOLS

Previously there existed only High schools throughout India but after the recommendations of Secondary Education Commission (1952-53), Higher Secondary came up, as this commission recommended| eleven years of secondary education. Central Board of Secondary Education implemented the recommendation and upgraded the schools to Higher Secondary Schools. Some states like Punjab implemented it partially and introduced pre-university class in the colleges. Some other States did not pay heed to the recommendations and there existed only High Schools followed by Intermediate college classes. Indian Education Commission (1964-66) recommended twelve years of secondary education and there have come up 10+2 Higher Secondary or Senior Secondary Schools but the recommendations of this commission are still in their way of implementation. Now in India, there exist three types of schools regarding duration of school education—

i) High Schools
ii) Higher Secondary Schools (11 year duration)
iii) Higher Secondary Schools (10+2 year duration).

Similar has been the position of teaching of school subjects. There exists a diverse pattern in number of subjects and the content that is taught in the schools.

Syllabus in High Schools

In High Schools there is no Life Sciences syllabus as such. It forms only a part of General Science Syllabus. The students learn little beyond gaining some familiarity with a few plants and animals. They only get an its elementary idea of digestion, respiration and photosynthesis. In most high schools there is either no laboratory work at all or it is limited to the description of just a few plants and animals with the help of specimens, models, charts and slides.

Syllabus in Higher Secondary Schools

In Higher Secondary Schools of eleven year duration Life Sciences form only a part of general science syllabus up to middle or 8tn class. In the books on general science from sixth to eighth class, topics included are reproduction in plants, Germination of seeds and seeds dispersal, Adaptation of animals to their surroundings and migration of animals. Vegetative propagation in plants, Pollination—types and agencies, fertilization, Structure of seeds, structures and functions in earth worm, fishes, frogs, birds and mammals, Modes of respiration and intake of food in animals and some knowledge about the Life of insects.

In Higher Secondary Schools, students taking science stream can "take life sciences as elective subject in ninth class and can continue this up to eleventh class. 'Biology'—A Text Book for higher secondary schools published by N.C.E.R.T. is being taught in these schools. This book contains 58 chapters which are divided under seven sections. The I sections of this book are as under.

1. Some Basic Facts About Life—Deals with historical aspects of biology, characteristics of living things, their classification and an introduction to major plant and animal groups.

2. The Diversity of Plant Life—Deals with the life of typical flowering plant and an elementary knowledge of various plant groups.

3. The Diversity of Animal Life—This section contains topics on all major animal groups and typical study of each group but frog and man have been dealt in somewhat more detail.

4. Plant and Animal Physiology—Deals with the physiological functions in plant and animal systems.

5. Self Perpetuation and reproduction—Deals with vegetative propagation in plants and sexual reproduction in plants and animals.

6. Evolution, Heredity and Adaptation—This section is devoted to evidences and mechanism of evolution, principles of heredity and inheritance, different environments and adaptation of organisms to different environments.

TRENDS IN SCIENCE EDUCATION

Science education is now a major concern in almost all the developing countries. High priority has been accorded to its quantitative expansion as well as qualitative improvement. The following are some of the trends which are emerging in the developing countries :-

1. Establishment of State Institutes of Science Education

Separate institutions of science education are being established in a number of countries. These institutes are responsible for curriculum development in science and in some cases for planning and implementing science education in schools. Some institutions also have the function of training teachers of science.

2. Development of Indigenous Curriculum

Until late 1960, the efforts in science curriculum development tended to be "adoption" or "adaptation" of science curriculum designed in the developed countries. There is now a progressive shift towards development of indigenous science curriculum based on the past experience of the country and suitable to the needs and requirements of the children and the country. In a few countries there is also a trend towards giving greater freedom to teachers to design teaching-learning sequences within certain general guidelines, to meet the individual and local needs of the students.

3. Emphasis on Conceptual Learning

Although the traditional approach to teaching science as a body of facts is still prevalent, there is a shift in some countries' from factual to conceptual understanding of science.

4. Development of De-centralised Curriculum

In the traditional way the science curriculum is developed centrally. This no doubt helps in utilizing science resources of expertise and ensuring qualitative standards, but it also creates a gap between those who develop the curricula and the classroom teachers who are responsible for carrying out the curricula. There is now a greater realization of the importance of decentralising the development and implementation of curriculum. In some countries attempts are being made to decentralize the development of curriculum materials relating to certain topics while retaining a core of other topics development at the central level. In some countries, the curriculum is centrally prepared but its implementation is decentralized at the regional or district levels.

5. Individualized or Pupil-Centered Teaching

Individualized instruction in science is widely supported. It includes the use of audio-tutorial instruction, slides, films, film-loops or video-tapes. The major advantages of the individualized instruction and the basic reasons why it has not been fully implemented even in developed countries are summarized below.

Individualization requires an organization which allows the student to engage in activities uniquely appropriate to his own style and rate of learning. In this type of organization, instruction promotes independence, provides opportunities for study beyond the regular curricula and permits maximum use of instructional resources. The curriculum must be designed to meet the individual requirements of each child at his particular level of ability, achievements and progression. In applying such a premise to the day-to-day operations of a typical school programme, it is not difficult to understand the resultant frustration expressed by administrators and teachers when it is considered that most conventional programmes have only accommodated group, not individual interaction and processes.

6. Interdisciplinary Approach

During the sixties various programmes and courses were developed in the United States on Uni-disciplinary approach, e.g. BSCS, PSSC Physics, Chemistry, ESCP etc. These programmes did much to improve the quality of laboratory instruction and teaching of science concepts and processes. But it has been realized recently that in these complex times and with the amount of Scientific information growing at a fantastic rate, students cannot continue to learn the sciences as compartmentalized disciplines, that have little relation to each other or to man's place in the natural world.

The current efforts to develop curricula in the areas of environmental or population education indicate a trend towards interdisciplinary approach to curriculum construction. These areas are challenging in the sense that they require consideration in the context of Biological, Sociological, Historical, Economic and Political realities. There are, however, some problems in implementing the interdisciplinary programmes. Curricula that was developed on a truly interdisciplinary approach are almost non-existent. What is more, this new order of instruction requires changes in the nature of teacher preparation. Experience in team teaching is rare for the per-service teacher either in micro-teaching in the science methods class or during the student teaching experience. Science and social science teachers do not have necessary competencies to handle such a task. The colleges and universities do not provide opportunities for cross disciplinary training in the Sciences and in the Social sciences. The learning experiences will call for some type of team teaching approach thus utilizing different areas of specialization to be involved if we are to live in harmony with our environment. In order to achieve this goal, we must provide the opportunity for scientists, social scientists, and the trainers of teachers to interact in the planning and implementation of approaches, techniques, and materials necessary for a total approach.

There is some empirical evidence which shows that students will benefit markedly from a more natural learning process one that has a greater applicability to life situations.

7. Social-issues-Oriented

There is an increasing trend in science teaching in some developed countries to emphasize the social implications of science. The reasons for this are varied. The media are filled with popular concerns about over population, pollution, mental health, genetic engineering, the neurobiology of the learning process, and the like. Of course, these problems cannot be understood by the students without having understanding in the basic scientific concepts, e.g. one cannot understand pollution without a knowledge of fundamental concepts of ecology; or over-population without a knowledge of population dynamics. But to have the understanding of the basic concepts of different subjects does not provide a complete answer of the problem situations. The total 'answer' must be multidimensional. It must be issue-centered and it must include sizeable input from students in the curriculum development.

PRINCIPLES OF CURRICULUM CONSTRUCTION

- The principle of child-centredness, i.e., according to the needs of the pupils at the particular age.
- The principle of co mm unity-centredness : It should determine the purpose of a society
- The principle of integration: It should integrate the child's activities and his needs, on the one hand, and the needs of the twentieth century democracy, on the other. It should be related to the social environments of the students.
- Conservation principle: It should help in preserving and transmitting the traditions, standards of conduct on which the culture and civilization depend.
- Creative principle: It should place the pupil in the place of discoverer and provision should be made for creative type of activities.
- Principle of activity-centredness : There should be emphasis on learning by doing. More provision should be made for individual laboratory work and other field experiences.
- Forward-looking principle: It should help the child in adjustment and prepare him for full and effective adult life.
- Principle of elasticity and variety: It should not be rigid but should be changed to suit the changing needs of the pupils and the society. It should be flexible and broad based.
- The totality of experiences: It should provide for total development of the child.

So, it should be well-balanced, properly graded, fairly broad based and approximately designed for meeting the needs of the society and the individual.

SELECTION OF ORGANIZATION OF SCIENCE CONTENT

The aims and objectives of science teaching cannot be achieved mechanically by merely selecting the content as per certain accepted principles. It depends largely on how the content materials are organized and presented in curriculum. The role of the teacher is also equally important. In our country teachers depend upon textbooks prepared or prescribed by the department of education for the selection and organization of the content for their science courses. They have no choice. They have to follow the courses of study to letter. However, even within such rigid confines as these, the teacher will have to select and organize to some extent.

Organization of content material should provide for the effective learning of facts, concepts and principles. Facts are learned by experiences, in a variety of ways. Order is important in planning the organization of materials that opportunity is provided for receiving experience with concepts and principles to provide for the enlargement of understanding. It should provide a natural method of learning that is psychologically sound. Materials should be so ordered, for purposes of instruction, that learning experiences lead naturally towards the objectives sought.

B.S.C.S. identified seven levels of Biological Organization, these are Molecular, Cellular, Organ and Tissue, Individual Organism, Population, Community and Biosphere. At every level of biological organization students learn some common as well as diverse phenomena about living things.

1. At molecular level they learn the structure and types of molecules in living systems and their role in metabolism.
2. At cellular level, they learn about the various constituents of cells, cell divisions and cell as unit of life.
3. At organ-tissue level, they study the organization of cells in the form of tissues and their special functions and further the various tissues in associations forming various organ systems as digestive, nervous and skeletal systems.
4. At organism level, the students learn about the functioning of organisms, their diversity in nature, reproduction, energy utilization and their behavioural interactions.
5. While undertaking studies at population level, they learn about growth maintenance, food requirements, competitions, population changes and population problems etc.
6. At community level, they come to know the structure of various communities, dominant species, community relationships, food chains and food webs, matter cycles, interaction of organisms with the physical environment etc.

7. At the world Biome or Biosphere level, they learn the biotic and abiotic relationships of ecosystems, relationship among various ecosystems of biosphere, changes along time and man's place in the biosphere.

8. The B.S.C.S. team was convinced that there should be nine themes in the preparation of reading materials for the students. Out of them the seven should relate to the content and the two with the organization of the matter.

9. B.S.C.S. considered six levels, along which the students can organize their learning products and these were Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. This B.S.C.S. team adopted a three dimensional model in developing and organizing the subjects matter.

10. The model can be shown as below :

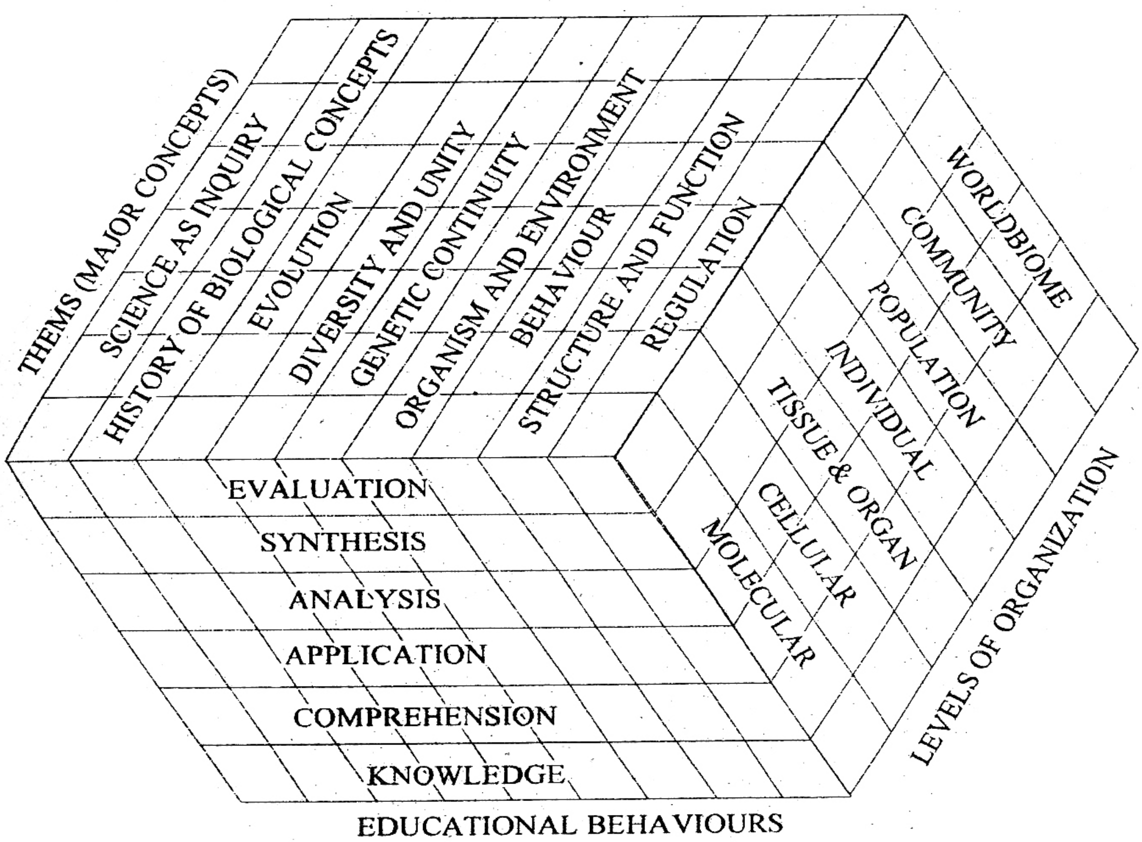


Fig. 1

Three dimensional model in developing and organizing the subject matter adopted by B.S.C.S. team

During the summer of 1960, the B.S.C.S. assembled three writing teams of high schools biology teachers and university research biologists, about equal in numbers, to prepare preliminary trial materials in terms of the new conceptual schemes. During 1960-61 school year B.S.C.S. materials were taught in 100 schools. Based on feedback, courses were rewritten during 1962 and tried in 500 schools. In 1963 the material was again written and tried in 950 schools. On the whole the B.S.C.S. materials had been tried and tested on over

1000 teachers and 1,50,000 students before the first edition (1963) of the B.S.C,S. three books came out.

The basic curriculum programme of B.S.C.S. consists of three distinct biology text books (written by each team) and related material for the use of 10th grade American High School. Originally the three versions were classified in terms of their approach to biology. These are also known by the colour of their covers.

- Molecules of Man (Blue Version).
- High School Biology (Green Version).
- Biological Science - An Inquiry into Life (Yellow Version).

NCERT CURRICULAM

After the inception of N.C.E.R.T. (India), a Text Book for Higher Secondary Schools was developed by Biology Panel. In this the approach in treating the material was modernized traditional. Regarding knowledge included the content was balanced. But treatment is according to groups of organisms or branches of biology. Preparation and testing of material on biology teaching by N.C.E.R.T. with the help of UNESCO and other agencies has been going on since 1968 and balanced curriculam have been developed.

Curriculum Reforms in Biology

In recent years curriculum reforms in Biology have taken place all over the world.

Work done in India (N.C.E.R.T.)

The work done in India towards improving life sciences programme, particularly after the inception of N.C.E.R.T. may be summarized under the following headings—

1. Development of a new curriculum and Text Books

The National Council of Educational Research and Training (N.C.E.R.T.) approached Professor P. Maheshwari to set up and guide a Biology- Panel consisting of 16 representatives, professors, teachers, and research workers from several universities and research institutions. The panel drew up a revised curriculum and prepared a new text book "A Text-Book of Biology for Higher Secondary Schools". While preparation of the text book was in process, the chairman was in close contact with the new developments and practices of other countries.

Modernized Traditional Approach

The members of the panel considered several ways of approaching the subject matter and discussed about their merits and demerits. Finally, they decided to adopt a modernized traditional approach suiting the prevailing standards and practices of teaching in Indian schools. The approach combines the pedagogical advantage of proceeding from known to unknown and also prevents the students from getting lost in the intricacies of more advanced aspects of biology. The members agreed that students should be introduced to different kinds of organisms, their activities, habits and their tissues and organs. This is essential and basic ta the understanding of concepts of evolution, ecology, heredity and cell physiology.

Contents

1. The panel discussed evolution separately into two chapters but an attempt was made to familiarise the student with this principle during his study of world of life.
2. Biological phenomena common to plants and animals are discussed together as far as possible but have not been carried too far, as several aspects of plants and animals deserve independent treatment.
3. Technical terms have been used only where they contribute to a easier communication and understanding.
4. Important biological discoveries have been dealt in a historical manner, to give an idea to students, of how science progresses.

Seven sections of the book

All the schools under Central Board of Secondary Education and schools in some states gave this book a fair trial. The book has been divided into seven sections.

- In the first section, the students are introduced to the subject matter of biology and the characteristics of living matter.
- An introduction to the variety of plant and animal life prepares the students for more detailed study of these forms in second and third sections.
- The fourth section deals with main physiological processes in plants and animals.
- The fifth section is devoted to modes of reproduction in plants and animals.
- Heredity, evolution and ecology are included in the sixth section.
- The seventh section includes interdependence of plants and animals and the role of biology in human welfare.

NEW CURRICULAR PROJECTS LIKE BSCS

The Biological Sciences Curriculum Study (B.S.C.S.) started it activities in January 1959. Financial support to this organization was given by National Science Foundation (N.S.F., U.S.A.).

Over 2000 biologists and specially competent persons had contributed to the development of various programmes of B.S.C.S., within ten years of its inception. The objectives of B.S.C.S.

- To produce modern biology courses (text-books) for the spectrum of students who take biology in high school.
- To develop special resource materials for the teaching of these courses as teacher help books, laboratory blocks, films-equipment and etc.,
- To formulate programmes and materials for in-service and pre- service education of the teachers.

The BSCS was mainly based on 9 major themes.

- Science as investigation and enquiry.
- History of biological concepts.
- Complementary of structure and function
- Diversity of type and unity of pattern.
- Change of organism through time as evolution.
- Genetic continuity.
- Organism and its environment.
- Regulation and homeostasis.
- Biological basis of behavior:

The BSCS has developed three textbooks, teacher's handbooks and laboratory .manuals as part of instructional materials. They selected three patterns of textbooks with different approaches, but all within the general framework of BSCS objectives. They are referred to as Blue, Green and Yellow versions.

- Blue version: Biological science - Molecule to Man (molecular approach). This book approaches the study of biological science from molecular level with emphasis on recent advances in physiology and biochemistry.
- Green version: High school biology textbook. The approach is through " study of ecology and behavioral aspects of biological science. Emphasis is on biological communities and biomes.

Yellow version: Bioscience textbook - called an enquiry into life, follows cellular approach. The book is organized, into four major concepts of Biological unity, Bio-diversity, Biological continuity and Biological interaction. Stresses given on cellular level of organization. In addition to all the textbooks, teacher guides and other laboratory manuals are also prepared. As part of the supplementary material teachers handbooks, evaluation aids, BSCS film programmes and BSCS research problems were also developed.

LOCAL NEEDS AND REQUIREMENTS BASED CURRICULUM & UTILITY OF LOCAL RESOURCE

National Council has also produced some Indian adaptations of B.S.C.S. books. The Directorate of Extension Programmes for Secondary- Education drafted a syllabus of General Science for class I to VIII with the help of specialists and teachers,

i) Biology Part I—In implementing the recommendations of Indian Education Commission (1964-66) that general science be taught compulsorily upto 10th class, N.C.E.R.T. produced syllabi and textbooks upto 10th class. Biology Part I for sixth class deals with life of typical flowering plants and an introduction to major plant groups.

ii) Biology Part II for seventh class deals with major animal groups with representative studies.

iii) Biology Part includes topics on human anatomy and physiology.

iv) The book of Life Sciences for class IX and X includes some major units like organization of life, life processes, genetics and evolution, agricultural practices and animal husbandry, human biology, health and nutrition, man and his environment.

v) Text books for +2 stage have also been prepared.

2. Provision for Laboratories and Equipment - The Government of India has been giving assistance to State Governments for the introduction of effective science courses in higher secondary schools. In two-first five year plan aid was given for construction of laboratories and purchase of apparatus. A panel was set up by Committee on Plan Projects of Planning Commission to draw up laboratory designs and lists of equipment for higher secondary schools.

3. Organizing In-Service Programmes - The Directorate of Extension Programmes for Secondary Education has been organizing a number of In-service Programmes for secondary school science teachers dealing with methods of teaching, preparation and use of teaching aids, co-curricular activities in science, lesson plans, evaluation etc. These have brought a keener awareness, among science teachers, about the new concepts and techniques of science teaching.

4. Exchange of Science Teachers - In 1958, forty science teachers were selected from training colleges and secondary schools from different states and were deputed to study modern methods of science teaching in U.K., U.S.A. and Canada by Govt, of India. On their return, their opinions were pooled in a seminar and a programme was drawn up for all levels. The suggestions were considered by All India Council for Secondary Education and were incorporated in the programme of science education for the third five year plan.

5. Television Lessons - A programme of television lesson in physics, chemistry and biology for higher secondary classes was introduced in Delhi in 1961—62. Each lesson, when started, was of 20 minutes duration and preceded by an introduction by the subject teacher. The scheme was started for IX class and has been increased.

6. Science Clubs - Science club activities in secondary schools were started during 1967-68, by All India Council for Secondary Education. Each school is given Rs. 1200 for the purchase of tools and apparatus. In addition to these, there are eight basic schools with established science clubs with a grant of Rs. 3001 for each. There are 60 central science clubs, established in training colleges, where extension services centres are located. These are given Rs. 2000 each per year. The programme aims at providing opportunities to young pupils to undertake activities of their interests and science teachers try to correlate the club-activities with classroom activities wherever possible.

7. Science Fairs - In 1960 All India Council for Secondaiy Education recommended a programme of All India Science Fairs to be organized on first December. These were followed by a science week in which exhibitions, lectures and symposia etc. could be held. In 1961, 54 extension services centres held science fairs with an aid of Rs. 500 given to each centre. Now the science fairs are held at district, regional and state levels.

8. National Science Talent Search - Govt, of India have formulated a programme of Science Talent Search under which promising science students of final year Hr. Sec. are selected and are given scholarships and ' certificates of merit.

Objectives of the Scheme

i) To identify students of marked scientific aptitude.
ii) To stimulate scientific talent through competition.
iii) To encourage schools to undertake scientific activities.
iv) To expose talented students to challenges of science.
v) To build up a body of future scientists who will contribute to scientific advancement in pure and applied fields.

Progress of the Scheme

The scheme was started in 1963. About 350 talented students are selected every year. The selection is based on an aptitude test, an essay competition, a project report and an interview by a committee of specialists. At schools and other institutes, the students are offered accelerated programme of science instruction so that they can acquire enough knowledge and motivation to pursue a career of research in science.

9. Summer Institutes for Schools Science Teachers - This in- service training of school teachers for a period of 4 to 6 weeks is jointly sponsored by the U.G.C. and U.S.A.I.D. Summer institutes are designed to improve the school science teaching and inspire the teachers to continue learning in their fields. The teachers attending these institutes learn new ways of teaching science especially with methods that would enable the students to learn science by discovery rather than studying descriptive science.

10. Participation of Foreign Organizations - The U.S.A.I.D. India sought the cooperation of U.S. National Science Foundation to implement a large scale year round programme of academic support in modernizing curriculum, laboratories and teaching aids. Indo-American conference on Scientific and Technical Education was held in New Delhi in May 1966. Here it was resolved that N.S.F.A.I.D. will co-operate Govt, of India in the follow up activities to organize summer institutes, preparation of text-books, teacher guides, curriculum material and strengthening of libraries and laboratories. U.N.E.S.C.O. Pilot Project has helped in curriculum renewal. C.F.D.O. and British Council also help Indian educational institutes.

UNIT VI

SCIENCE LABORATORY

Leaving the space occupied by worktables and almirahs in the laboratory there must be at least 1.5 sq. m. of space for each student to do the experiments. For a total of 20 students the laboratory must be of 20 m. x 10 m. size.

Worktables must be arranged in the following manner

1. The chairs and tables must be placed in such a way that the students face teacher in the laboratory. It is advisable to have worktables that allow the students to do the experiment from one side only, which will make the supervision of the teacher easier.
2. The arrangement should be in such a way that it is easy for both teacher and student to contact each other.
3. The upper part of the table must be made of teakwood.
4. The sinks must be attached to work.
5. A large demonstration table with water, gas and electricity facilities must be placed in the laboratory.
6. Drawers need not be placed in students' worktables.

Ventilation and Light

There must be at least two doors for the laboratory in order to make it convenient for the students to go out at the time of emergency. They can be either on one side or on the opposite sides and they must open outside. In order to get free air and light the windows must be placed at a height of 1 meter from the ground level. Tube light or mercury lamp is preferable than the ordinary lamp since they give uniform intensity of light without shadow and consume less electricity. Lamps that are connected to the pulleys are preferable for the biology laboratory.

Sinks

The biology laboratory is to contain two common sinks and one in demonstration table. There must be canals to take out the water that comes out of the sinks. Soap with soapbox must be kept in each sink. The holes in the sink can be closed with a plug that contains many small holes so that water can pass through the holes in the plug and the hard materials like paper, cork and pieces of glass can remain in the sink itself. There must be two bins made of either wood or iron in the laboratory to collect the waste materials.

Water facility

A tank can be constructed on the topmost part of the laboratory in order to supply water for the laboratory. The capacity of the tank must be at least 1000 litres. There must be a motor to lift water to the tank. Water must be taken to the sinks through the PVC pipes. There must be wheel valves for each tap to control the flow. The water coming out of the sinks must be taken out by separate canals and these canals must be closed with wooden planks.

Gas

Petrol gas is more convenient than coal gas. The equipment that prepares the gas can be set up separately outside the laboratory or in a corner of the laboratory. This must be enclosed by asbestos sheets. The gas coming out from this equipment must be taken to the worktables through pipes. Each pipe must contain a valve to control the flow. The Bunsen burners used for the coal gas cannot be used for the petrol gas. A separate type of Bunsen burner is required for petrol gas. Now a days liquid petrol gas is used in the laboratory.

Flooring

The cemented floor is more convenient for the hot countries. Cold countries have a floor of wooden pieces. If the cement flooring is sloping towards one direction it will be easy for cleaning. Round Corners are preferred than straight corners.

Black Board

A large wall blackboard of the size of the demonstration table should be behind the table.

Notice Board

This can be placed in the verandha outside the laboratory where there is no window. It must be made of teak wood and provided with glass doors and lock and key. This can be used to exhibit, photos, scientific informatii n and instructions and rules for the students.

Preparation Room

This room is used for the teacher to do the experiment before actually conducting it in the classroom, to keep the often-required apparatus and to keep apparatus of the incomplete experiments. So this room must be adjacent to the laboratory. This must contain a long worktable with sink and water facility. It is better to have the storeroom adjacent to this room. There must be a way from the laboratory to the science teacher room and to the preparation room.

Storeroom

All apparatus and materials can be stored in this room. Important acids can be kept in a separate almirah inside this room itself because the poisonous gas and material coming out of chemicals may spoil the sophisticated equipments in the room. The required amount of the chemicals can be taken to the laboratory or class whenever needed.

Poisonous materials and chemicals should be kept in a separate cupboard with lock and key. The key must be always with the teacher. A slip written as "poisonous substances" can be pasted on the cupboard.

Darkroom

In biology, to conduct experiments on photosynthesis it is necessary to remove starch from the leaves by keeping the plant in the darkroom: The room is useful for various activities conducted by science club. This room is useful to give training to the students in different branches of photography like developing, printing and enlarging. This room should be always supplied with safe lights, free air and water. There should be a cupboard setup in such a way that it will not allow the lights to pass through it.

Science Teachers Staff Room

This room helps the teachers to spend their leisure time usefully. The science or biology library can be in this room itself.

Special Room

To teach biology effectively there should be separate rooms like museum room, aquarium room and animal room.

Museum Room

This room can be used to arrange separately, with necessary description the rare apparatus prepared by the students stuffed specimens, wet specimens, and dry specimens.

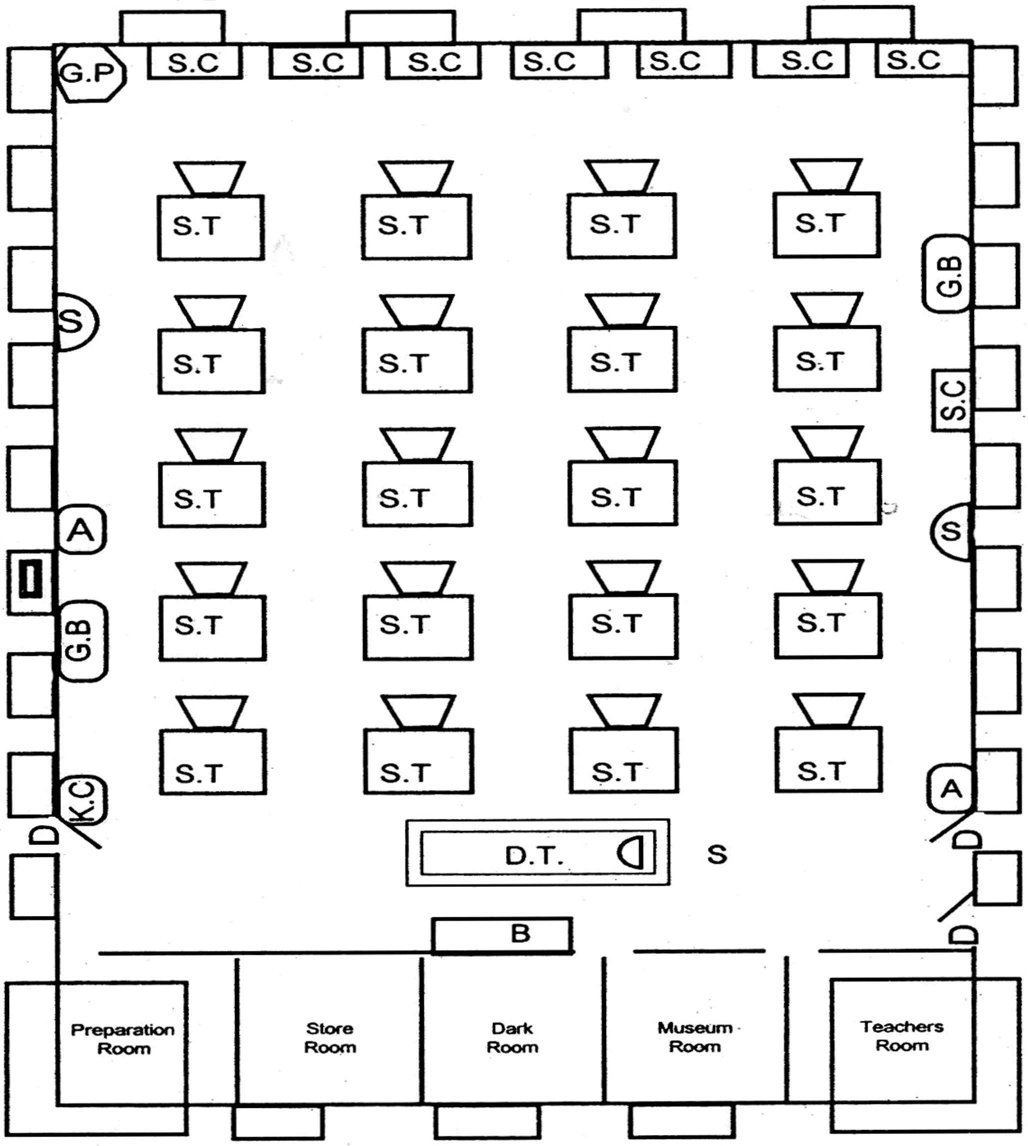
Animal Room

Biology is the study of living beings. The teacher should help the students to dissect and understand the internal parts of plants and animals. But it is not possible to get all plants and animals in all seasons. So when they are available in plenty the teacher must purchase and keep them alive in this room. Then they can be used when the need arises.

Projection Room

This is useful for screening slides, filmstrips and films. If there is no separate room like this then the laboratory can be made use of. Since majority of projections are done only during daytime there must be window curtains in order to make the room dark and exhaust fans in order to get free ventilation.

A laboratory plan for 20 students is given below:



Biology Laboratory for 20 Students (20 M × 10 M)

K.C.	-	Key Case	D.	-	Doors
G.B.	-	Germination Bed	D.T.	-	Demonstration Table
A.	-	Aquarium	B.	-	Black Board
S.	-	Sink	S.T.	-	Student's Table
G.P.	-	Gas Plant	N.B.	-	Notice Board
S.C.	-	Storage Cases			

II. EQUIPPING MAINTENANCE

Before purchasing various articles for the laboratory the teacher should make adequate arrangement to buy shelves or almirahs to arrange those articles. If they are glass almirahs the articles arranged in them can be seen from outside. The inner space of the almirahs should be large so that the articles can be taken out easily. In a general science laboratory the articles should be arranged according to the subjects and in a biology or subject laboratory they should be arranged according to topics.

All the articles in the laboratory should be cleaned daily. The teacher should check all the articles in the laboratory once in a week. He must have a knowledge about the method of cleaning certain articles.

Iron Articles

To avoid rusting, these articles should be cleaned often with oil for example stand, pinch cocks, bone cutters, hammer etc., may be cleaned in this way.

Wooden Articles

These should be polished often to avoid termites entering them. The upper portion of these articles may be coated with wax so that accidentally falling acid will not spoil them.

Stainless steel Articles

The articles like scissors, knife, and needles in the dissection set have to he wiped and cleaned with cotton and with oil after use.

Glass Articles

These can be cleaned by using potassium dichromate or soap powder. Lens of the microscope and magnifying glass can be cleaned with chamois leather.

In order to avoid missing of articles like stoppers, stop cocks etc, from their respective equipments they may be tied to them with a string. Sometimes it will not be possible to remove the lids of bottles and the stoppers of burette. Ta prevent this, Vaseline should be applied to them after use and before putting them in the respective apparatus.

Rubber Tubes

These should be kept in a ventilated dark room after applying French chalk on them.

Microscope

These should be purchased along with microscope cases so that they can be kept in the cases safely. The objective and eyepiece lenses should be cleaned regularly. The teacher should check all the parts of the microscope while giving it to the students as well as taking it back from the students.

The balances should also be bought along with the boxes for use.

Chemical Substances

These should be filled in the bottles. Generally narrow mouthed bottles are used for liquids and wide mouthed for solids. For experiments and preparing microscopic slides dropping bottles can be used.

As said before poisonous substances, inflammable substances and chemicals should be placed in one almirah. It is better to place the poisonous substances alone in a separate almirah, which can be kept under lock and key. Acids can be placed in almirahs, which are not tall. If they are kept in short almirahs it will be easy to take them out.

All chemicals should be placed in bottles only. These bottles should bear the name of the substance. The name should be either typed or written in bold letters in a paper or card and then pasted on the bottles. The living being preserved in wet media should also bear this name slip. Dry mounts can also bear this slip. Sometimes the materials in the bottle would have been changed without completely tearing the slip on the bottle. It should not be done so. The new slip should be pasted on it after completely removing the old one.

The broken articles should not be kept in a corner of the laboratory. All the used and broken materials should be completely removed then and there.

So far in this lesson, you have learnt about the planning of a Biology Laboratory. You have also learnt the organisation and maintenance of Biology Laboratory?)

III. PREPARATION OF INDENT

Living plants, animals and other equipments are important for the teaching of biology. Indent gives a clear idea about the number of equipments and the name of the equipments. The teacher has to prepare the indent. Preparation of indent needs some basic ideas. If the laboratory is a new one importance should be given to equipments, which are daily needed like, beaker, test tubes, microscope, dissection box, measuring jar, chemical etc. The quantity of these items should be greater than other materials. The next priority should be given to the occasionally used costly equipments.

The indent can be prepared easily by the teacher after studying all the biology lessons of different classes in school. When he studies the book he can understand the different experiments to be conducted and the different plants and animals to be studied. From this knowledge he can prepare the indent. He should also mention the quantity of the materials required. When a laboratory is started in a school a number of equipments have to be purchased for it. So a large amount of grant will be granted by the government. In addition to this every school will be getting additional grants for every year from the Government to meet the recurring expenditure.

The annual grant should be used for purchasing essential materials for the laboratory. The indent for this should not be prepared all of a sudden in one day. Instead the teacher should note down in a separate notebook the requirements of the students for the experiments as and when they do the experiments and based on that list only he should prepare the indent.

Procedure for the Purchase of Equipments

The prepared indent should be sent to more than three scientific companies with required particulars asking them to give their lowest price list for the articles in the indent. The illustrated catalogues prepared by the scientific companies will help in preparing the indent with full particulars.

When quotations from at least three companies reach the teacher he can start preparing the comparative statement. The comparative statements should be in the following pattern:

S.No.	Name of the articles	Quantity	Price by the I company	Price by the II Company	Price by the III Company	Remarks

The company, which has given the lowest price for the articles, will be accepted. This does not mean that quality should not be considered. He should select better equipment at cheaper rates but care should be taken that quality should not suffer at the cost of money. If the material cost is much it should possess some qualities. The material like dissection set made up of stainless steel will be costlier than that made up of ordinary iron. But the stainless steel equipment will not rust and will serve for a number of years. That is more beneficial than that made of Iron.

Regarding glass articles like test tubes etc, Pyrex or corning are more qualitative than the ordinary glass apparatus. The glass apparatus made up of Pyrex or corning can be heated to a high temperature, that too directly. But the price will be four times that of the price of ordinary glass apparatus. But considering its quality and service for a longer period this is preferred more than the ordinary one. Instead of buying three- dozen ordinary glass test tubes, it is enough to buy one dozen Pyrex glass test tubes. The chemicals made up of BDH are superior to that of other companies. The teacher should give instruction to the company to send the chemicals after properly sealing them in the bottles.

Materials like rubber tubes, rubber cork etc, are often required for the laboratory. They can be of assorted size instead of a single size. All the materials bought for the laboratory should be of better quality. The teacher is empowered to buy the quality materials even if they are costly.

After considering the above requirements the teacher should send orders for the respective companies to supply the articles. When he receives the articles along with the price list he should compare the price list with that of the quotation given previously to find out whether the price is the same. He should also check the quantity of the materials and breakage of glass apparatus and chemical bottles. If there is any deficiency or damage it should be immediately communicated to the respective companies and arrangement should be made to return the equipment in order to get a new one or to reduce the price. These articles should be entered in the concerned stock registers.

In some cases it proves beneficial to purchase the apparatus from the local firms or from one firm only. If possible the teacher should go personally to the firm and get materials packed in his presence. This will save time as well as money, which is otherwise wasted in postage etc.

IV. LABORATORY REGISTERS

The materials received should be properly checked and entered in the stock registers the same day. A correct and properly maintained record of articles is important to check any article at any time. The following registers are to be maintained in every laboratory.

1. Accession Register
2. Non-Consumable Register
3. Consumable Register
4. Register of Breakages
5. Issue Register

Accession Register

The materials received from the companies should be entered in this register in the following pattern then and there. This register will give an idea whether the amount allotted for the year has been spent, about the amount spent for buying the equipments and the amount paid to a particular company.

Date	The name of the article	Name of the Company	Particulars about nvoice Price of each	Quantity	Total Price	Name of register in which ntered with page no.

Non-consumable Register

Articles of metal, wood or any other thing of permanent nature, which are not liable to be broken or consumed should be entered in this register. Apparatus that are used daily or occasionally but can be retained after the experiment and the cost should be entered in this register. Breakable articles made up of glass need not be entered in this register, but articles like the thermometer, lens etc., should be written in this register since they have specific measurements. Microscopes, dissection sets, razor, bone cutter, twig cutter, charts and other apparatus should be entered in this register. This register contains the following columns.

Name of the Article:

Date	Number and date of Invoice	Name of the company	Receipts	Issues	Balance	Remarks

All the articles should be entered in the alphabetical order in this register. Each article should be allotted a separate page. When new articles are bought they can be entered continuously. If any article becomes unserviceable due to break or wear and tear the teacher himself cannot remove it from the stock register. He should get permission from the Headmaster for such removal. He should condemn and remove any article from the stock register only after getting the Headmaster's permission.

Consumable Register

Articles that are liable to break, chemicals and other materials that are consumable should be entered in this register. Test tubes, beaker, pipette etc, and other chemicals can be entered. Chemicals can be written in the first portion of the register and other materials can be written after that. Articles should be entered in the alphabetical order. One page should be allotted for each kind of article. If the articles entered in this register are broken or consumed the teacher himself can remove them from the stock register. He doesn't need to get the permission of the Headmaster for this. At the end of the year he should calculate the quantity of chemicals used and deduct this quantity from the total quantity.

Regarding some articles the teacher cannot decide whether it is a non-consumable article or consumable article. If he cannot find out this, he should enter the name of the article in any one of the registers. All the articles received from scientific company should be entered in one register or the other.

In addition to this the teacher may be entrusted with the responsibility of taking care of some other materials. For example the equipment belonging to audio visual department can be given to the physics teacher. Otherwise the biology teacher who is in charge of the laboratory will also be in charge of the audiovisual apparatus. Two registers should be maintained for this apparatus, non-consumable and consumable. A separate register should be maintained for museum specimens and garden tools.

Name of the Article:

Date	Number and date of Invoice	Name of the company	Receipts	Issues	Balance	Remarks

Breakages Register

Apparatus are liable to break accidentally while arranging for the practical class or while doing the practical. The apparatus broken during such occasions should be entered in a separate register, which may contain the following columns. At the end of the year all such items should be seen by the Headmaster. He must give order to auction such equipment and to condemn and remove the other equipments from the concerned stock registers. If the broken article is a non- consumable one, then the teacher should not remove it from the stock register without getting the permission from the Headmaster. Consumable items can be removed by the teacher himself at the end of the year. So the register maintained for the purpose is called register of breakages.

Date	Details of the broken article	The nature of breakage	Name of the stock register	Signature of the person who broke it	Signature of biology teacher	Headmaster's remarks

Issue Register

There may be four or five science teachers in a High School. But only one teacher will be in charge of the laboratory. If there are separate/laboratories for different subjects, the senior most teacher of the subject will be in-charge of it. Other teachers may require some articles from the laboratory for their classes. At that time the laboratory in- charge should enter the articles given to the teachers in this register and get their signatures. When the articles are returned he should make a note of its return. By doing like this some unnecessary troubles are avoided and the number of articles used by a teacher can also be found out.

SAFETY RULES

In order to minimize the accidents some safety rules should be followed both by the teacher as well as by the students. You study them one after the other.

Guidelines for the Teacher to follow in the laboratory

1. Students should not be allowed in the laboratory unless a Science Teacher is present.
2. The Teacher should maintain discipline among the students. Discipline is required in laboratory than in classroom.
3. The Principles to be followed by the students in a laboratory should be neatly typed and exhibited in a place where all students can see it.
4. Laboratory should be neat and clean and all the articles should be in the respective places.
5. The apparatus and materials required for the students' practical work should be placed on the tables much before the students' arrival.
6. The procedure for handling new apparatus should be informed to the students and the precautions to be taken while doing experiments should also be told to them.
7. The experiments, which involve some danger and require some skill, should be explained to the students.
8. The students must know the technique of handling gas and electricity during emergency situations.
9. Fire extinguishers should be provided and the teacher and students must know how to operate them.
10. Each laboratory should possess a First Aid Box filled with required First Aid materials. The teacher must know the basic principles of First Aid.

Rules to be Followed by the Students

There are rules for the students as there are for the teachers in order to maintain discipline in the laboratory. The movement of the students in the laboratory is more frequent and possible than the classroom. So it requires more discipline from the students. Some rules are given below in order to make the students maintain discipline in the laboratory and these can be exhibited in the notice board outside the laboratory.

1. Students should not take the laboratory materials out of the laboratory.
2. The apparatus should be used by the student to conduct the experiment told by the teacher. He should not use it to do in a different manner or different experiment.
3. Breakages or accidents must be reported immediately to the teacher.
4. When the students find incomplete or unclear names on the chemical bottles they should report it to the teacher.
5. They should not lift the bottles by the neck or cork.
6. The stopper of particular bottle should be replaced on that particular bottle.

7. Only small quantities of chemicals should be used.
8. Chemicals should not be tasted and smelled without care.
9. If any chemical has been put into the mouth, that should be removed and the mouth should be washed with much water.
10. When acid or alkali is poured on the body or cloth accidentally that part should be washed with water thoroughly.
11. Solids should not be put in sinks.
12. After use, all apparatus must be cleaned and replaced and the bench left clean.
13. Water and gas must not be wasted and should be turned off before leaving the laboratory

VI. SAFETY MEASURES

The following articles should be kept in a place in the laboratory, which could be easily taken by anybody. These ^articles should be checked in the beginning of every term of the academic year.

1. A carpet or rug should be kept in order to put out fire on the dress.
2. A bucket full of sand.
3. A fire extinguisher.
4. A first-aid box. A handbook regarding the procedure for the first-aid.
5. An asbestos sheet to prevent fire in the inflammable articles.
6. The doors of the laboratory should not be locked when the students are inside the laboratory.
7. The students should not enter and remain inside the laboratory without the permission of the teacher.
8. Concentrated acids, alcoholic, highly inflammable things should be kept in a separate storeroom.
9. All poisonous substances should be kept in a separate almirah, locked and the key should be with the teacher.

It is the important responsibility of the biology teacher to avoid accident in the biology laboratory.

VII. TYPES OF LABORATORIES

A science laboratory should be located preferably on the ground floor and on the extreme side of the school building if possible so that there is no disturbance to the laboratory. The open space outside the laboratory will be of much use to conduct some experiments outside in sun light. Biology and general science laboratory should have North - South orientation to provide adequate sun light exposure.

There are three important plans of science laboratory

1. Lecture room - cum - laboratory as suggested by Dr. R. H. Whitehouse.
2. Lecture - cum - laboratory types as suggested by the panel for Science Education in Secondary Schools, 1964.

These two plaits "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 the other half as a laboratory to arrange practicals for one or more subjects. (Physical Science, Biological Science).

3. All purpose laboratory

The whole laboratory is used for all purposes namely for lecture and laboratory work.

COMMUNITY RESOURCES

Live Specimens

Living plants and animals are necessary for the teaching of biology. Plants can be brought to the classroom from the school garden. Animals can be collected and kept in animal .room.

School Garden

Nature study is one of the important aspects at the elementary stage and is only possible if the school has a garden of its own. In the Secondary School where gardening is one of the subjects the teaching of plant life and animal life becomes easy. The students learn, by observation from nature and environments. They see the concrete things and understand the wonders of the plant world. The students get comprehensive ideas of plant life that is the medicinal value, the food value and the aesthetic value of plants. The utilitarian value of plant life can be well impressed upon the young minds through the garden and their learning becomes more effective, concrete and visual. The teacher should encourage the students to take interest in the maintenance of the garden.

Animal House

Animals are also required for the study of biology. Animals are of different types according to the habitat they live. Some animals live in water. They are called as aquatic animals. Some live on land and called as terrestrial animals. Some animals live in deep sea and called as marine animals. Some birds fly in air. These animals can be collected and kept in a separate room called as "animal room". In this room separate habitat is provided for the animals. Whenever the teacher needs them he can take it to theory class or to the practical class and make his teaching effective.

Aquarium

Aquatic animals like fishes can be kept in the aquarium. Every school should have a 'live corner' where the animals and plants are grown and reared. Such activities in the school open new avenues of enjoyment and interest.

Unit VII

RESOURSES FOR TEACHING BIOLOGICAL SCIENCE

Text books and journals of biology

On the basis of the conduction of various experiments in the United States of America, the text-books are an important means in the process of teaching. Thus, the text-books should not be used as an instrument. In the lower classes, there is not much need of text-books but in higher classes the knowledge is attained through books, “Text-book is an obtainable means which is used in schools to accomplish the teaching programmers”. The text-books of biology are subdivided. The text-books provide printed information.

The text-books should not be learned by heart. Using the books carelessly and learning by heart hinders the mental development of the students and makes them dull. Thus, they should be used with utmost care. In reference to this, in a report by the central advisory educational board, it has been said that, “As it is difficult to imagine ‘Hamlet’ without the king of Denmark. Similarly in the modern educational system, it is difficult to imagine the deficiency of boos.”

While expressing its views on the importance of text-books, Mudaliar Commission has also stated that, “It is not important for the students to depend on some prescribed text-books. Thus, it is necessary to bring improvements in this total dependence and we recommend that text-books should not be prescribed for all subjects. It is proper to recommend fixed text-books for languages in each class but for other subject Text-book-committee’ should ascertain a list of good-books and the students should select books according to their capabilities.”

Needs of text-books

1. Biology is a mixed subject. Due to the scientific form, this was not as easy as it was earlier. The scientific discoveries have made it more intricate than before. Due to this complexity and the need to acquire knowledge, the fixation of text-books and their study has become a must.
2. The condition of the books of biology is deplorable in the libraries of the schools. You can go to any school/college; the number of books of biology will be very low as compared to other subjects. In the absence of the books, how will the students be able to study completely? They will not know the extent of knowledge of the subject, the quality of knowledge, is weaknesses and how the improvements can be brought about?
3. The text-books are written in fixed sequence. The child acquires knowledge in a sequencial and organized manner.
4. The teacher imparts knowledge to the students according to his capabilities. After all he is a human being. He is liable to forget some points. The text-books help the students to gain knowledge of these left out points.
5. Through the medium of books, high criterion can be set and uniformity can be formulated.

6. It eradicates the faults of other methods e.g., in the lecture methods everything cannot be explained in detail and in a systematic manner, but with the help of text-books this drawback can be removed.
7. The text-books help the teacher to know the number of topics to be taught in each class.
8. The text-books are generally, the essence of the experiences of specialized or experienced teachers. Thus, the teachers benefit of this experience through the medium of books.
9. In good text-books all information is in a proper sequence, so the teacher does not have to search for information.
10. By the help of text-books, home-work can be given easily.

Good points of text-books

Only those books should be selected by the teachers which give a thorough investigation of the facts. Those which can enhance the thinking power of the students should be modern and complete. Those which enter new facts yearly and are written in easy language.

1. The author of the book should be experienced and efficient.
2. The book should be written in a psychological and beautiful style.
3. The book should be able to arouse the interest of the level of students for whom it is written. It should be able to satisfy their curiosity, help in the development of their natural inherent tendencies. The subject matter should be clear, well-organized and it should be written in an interesting manner.
4. Good books are those which help in repetition of the subjects matter taught by teacher in the class by use of experiments, demonstration and practical methods, unimportant lessons should not be given place in the book. The described matter should be true and accurate.

While compiling the subject-matter of the book, the following things of students.

a) The subject-matter should be according to the age, level and growth of students.
b) The subject-matter should be related to life.
c) The subject-matter should be inter-related. There should be a co-ordination between different lessons.
d) The subject-matter should be able to make the students mentally disciplined.
e) The subject-matter should be able to make the students mentally disciplined.
f) The subject-matter should be described aesthetically and should be inspirational.
g) The subject-matter should be complete in itself.

5. The book should have ample pictures, diagrams, graphs, maps, example and these should be according to the level of the students. These should be clear and pleasing. The book should have some coloured pictures also.
6. The printing of the book should necessarily be clear and beautiful. Any printing-mistakes should be avoided as far as possible. The heading, sub-headings and the subject-matter should be printed in appropriate type as per the requirement.

7. The books should look beautiful and attractive. The paper sued should be of good quality and the binding should be strong. It should be hand bound. The shape should also be appropriate.
8. The book should be cost effective.
9. The book should have a table of contents in the beginning and bibliography and appendix/index at the end.
10. The questions should be scientifically true and technically accurate.
11. The book must have the complete curriculum/syllabus.
12. In the end of the book, test papers and suggestions for practical work must be given.
13. The outlook and inner setting should be appropriate
14. In the text-book, thorough investigation of all parts of the syllabus should be done.
15. The text-book should be in accordance with stipulated objectives, inventions and changes.
16. In the text-book, the arrangement of matter should be psychological and in logical sequence.
17. The lessons should be based on the principle of 'easy to difficult'
18. The text-book should be based on the modern and practical methods of teaching biology.
19. The text-book should be based on the modern and practical methods of teaching biology.
20. There should be proper arrangement for repetition of previous work.
21. There should be enough questions for practice and review exercises.
22. Those formulae, symbols, definitions and nomenclature should be used which are accepted at the National and International level.
23. New type of objective questions should be given at the end of the lesson.
24. There should be symbols for various subject related actions.
25. There ought to be different books for teachers and students. The book of the teacher should have innovative methods of teaching and the books of students should have ample exercises.
26. The text-book should have suggestions for plans, collections, home-work, class-work and other biological practical work.
27. The text-book should be readily available.
28. The text-book should be revised from time to time and necessary changes should be made.

On the basis of the above mentioned qualities, the books can be evaluated, after evaluation proper books can be selected.

DEFECTS OF TEXT-BOOKS

1. The books of Biology cannot be used by students of all classes. The books are more useful for students of higher classes as compared to those of lower classes.
2. These test-books do not have the matter in an interesting and easy way. Most of the books are written by inexperienced authors, who do not have enough knowledge and experience of the subject-matter. The books start selling by obtaining the name of some famous writers along with.
3. The text-books remain silent about new changes and discoveries.

4. There is deficiency of practice-exercises as per the level of the students.
5. They do not have indications for practical work and experiments.
6. The cost of the text-books is high.
7. The arrangement of subject-matter is in psychological and logical sequence or not in the text-book is not taken into consideration.
8. Relevant figures, pictures and graphs are deficient.
9. The book is seldom revised after being written once.
10. There are a number of printing errors in the books.

Despite these types of defects, the books are very famous in the educational sphere. The books are a boon for education and care should be observed in their use. If the teacher uses the books carefully then "good text-books" are means of attainment of 'basic knowledge'. For scientific thinking, the text-books act as a guide.

The books of teaching of Biology have not even reached the first stage. There is need to pay attention towards it. The publication of interesting literature related to this subject should be encouraged. Those portions and literature from the foreign books should be translated, which has relevance in the Indian setting. From the total work done in the field of science, if 1/10the of it had been done in India to improve the text-books of Biology, then the students of graduation in Biology would not have felt so helpless and restless.

In reference to this, the National Education Institute's (National Educational Research and Training Board) text-book section's efforts towards text-book production are praiseworthy.

BIOLOGY JOURNALS AND INSTRUCTIONAL MATERIAL

Biology teacher should contribute to some journals and periodicals. He should be acquainted with some important literature related to his field and some sources of instructional material. Given ahead are some suggested journals, periodicals, books and instructional material; at may help the teacher in his class-room instruction and professional growth.

I. JOURNALS

Indian

1. Every day Science.
2. Junior Scientist.
3. Science Reporter.
4. Science Today.
5. Vigyan Lok.
6. Vigyan Pragati
7. World Science News.
8. Journal of Indian Education (N.C.E.R.T.)
9. Indian Educational Review (N.C.E.R.T.)
10. School Science (N.C.E.R.T.)
11. Vigyan Shikshak (A.I.S.T.A.)
12. Primary Teacher (N.C.E.R.T.).

Foreign

1. Bio-Science
2. Nature.
3. Natural History
4. Scientific American
5. American Biology Teacher.
6. Biology Teacher.
7. Journal of Research in Science Education.
8. The Science Teacher.
9. Journal of Biological Education
10. Science Education.

II. BOOKS

1. Biological Science – Molecules to Man, B.S.C.S. (Blue version). Houghton Mifflin, Boston, 1968.
2. High School Biology, B.S.C.S.
   Rand Mc Nally & Co. Chicago, 1968.
3. Biological Science – An Inquiry into Life, B.S.C.S. (Yellow version).
   Harcourt Brace Jovanovich Inc. New York, 1968.
4. Biological Science, Interaction of Experiments and Ideas – Prentice-Hall Inc. Englewood Cliff, New Jersey.
5. Biological Science – Patterns and Processes.
   Holt Rinehart and Winston Inc. New York.
6. B.S.C.S., Biology Teacher's Hand Book (Second Edition).
   John Wiley & Sons, New York, 1970.
7. B.S.C.S., Biology Teacher's Hand Book (Third Edition).
   John Wiley & Sons, New York, 1978.
8. Biology, A Text Book for Higher Secondary Schools,
   N.C.E.R.T., New Delhi.
9. Elements of Biology, Paul B. Weiss.
   Mc Graw-Hill book Co. New York, 1965.
10. Inquiry Techniques for Teaching Science.
    William D. Romey Prentice-Hall, Inc. Englewood Cliffs, New Jersey, 1968.
11. Methods and Materials for Teaching Biological Sciences.
    David F. Miller and Glenn W. Blayeds, (Second Edition)
    Tata McGraw-Hill Publishing Co. Ltd., Bombay, 1977.
12. New Trends in Biology Teaching, Vol. II U.N.E.S.C.O., 1969.
13. Biology Teaching Methods. Doris F. Falk.
    John Wiley & Sons Inc. New York, 1971.
14. A Hand Book of Biology Teaching Methods.
    Mollie Pullan, Oxford University Press, 1973.
15. Preparation and Evaluation of Text-books in Biology.

N.C.E.R.T., 1972.

INSTRUCTIONAL MATERIAL

Instruments, chemicals and teaching aids can be had from different scientific suppliers. Several films and film strips that can be integrated in class-room teaching are of value for general information and can be obtained from the following sources –

1. British Council, Old Mill Road, New Delhi.
2. Central Films Library, Department of Audio-Visual Education 10-B Inderprasath Estate, New Delhi.
3. Communication Media Centre, U.S.A.I.D., Faridkot House, New Delhi.
4. State Institutes of Education.
5. Foreign Embassies.

SCIENCE CLUBS

Mckown, (Mcknown, H .C., "School Clubs" Macmillan Co., New York) states the advantages of clubs over usual classroom learning as follows.

"The club offers the pupils an opportunity for specialization which he does not have in the class-room. In the class room his work is formal, in the club it is informal; in the classroom he is told what to do, in the club he chooses; in the classroom method of dealing with a topic is clearly outlined by teacher imposed restrictions, in the club program the method is of his own devising; in a class room he tries to please the teacher, in the club he works for his own and his club's interests and for joy of doing this work; in the classroom he conforms to a system, in the club he suits his own convenience. In short the club 'presents' freedom and expression, where as the classroom represents conformity and repression." Thus science club provides for learning by doing and learning by living.

The Science Club Movement is very popular in the U.S.A. and the U.S.S.R. In India the NCERT is responsible for the formation of science clubs in schools.

Organizing a Science Club

The proper organization of the club is a must for its successful functioning. It should have a constitution. Meister has suggested that the following questions are to be answered during the farming of the constitution of a Science Club.

1. "What shall be the aim and purpose of our Science Club?
2. What shall be its name?
3. (Membership) (a) Who can become a member? (b) What must a boy or girl do to become a member?
4. Meetings (a) When and where shall they be held? (b) How often shall they be held? (c) Who shall call for special meetings?
5. Money (a) Shall we pay due? (b) For what reason or reasons?
6. Expelling members: (a) for what reason or reasons?
7. The business program (a) How long shall it be? (b) What shall be the procedure?
8. The Program: (a) How many different activities shall the club have? (b) Who shall decide upon and arrange these programs?

9. Officers (a) When shall elections take place? (b) How often? (c) What officers shall we have? (d) What shall be the duties of each officer? (e) How can an officer be impeached? (f) How can an officer resign? (g) Shall officers filling positions left vacant be appointed or elected? And how?
10. Any other regulations you think important to put into the constitution. The questions listed above perhaps would have given you some idea of the problems involved in running a science club. Science clubs usually have the following office-bearers elected by the members: President, Vice-President, Secretary, Joint- Secretary, Treasurer, Librarian, and Stock – Keeper. The science teachers are usually the Sponsors of the club.

Activities of a Science Club

Heins et al suggest the following activities to be undertaken by a science club:

1. Visual programmers- film shows or slide shows.
2. School journey-utilizing community resources
3. Discussion on current topics in science
4. Individual projects
5. Special lectures by experts
6. Science almanac. This programme consists of reports on famous scientists born in a particular month.
7. Science debates
8. Science Plays
9. Science games: spelling match – "Spelling Bee in which only science words are used".
10. Science question box or quiz programme. Besides science clubs can train pupils in applied science, like the preparation of soap, ink, cosmetics, tooth powder, and paper and so on. But Club activities should be science oriented and not sale oriented. There is no harm in learning tp produce consumer goods, but it should not be the only aim.

FIELD TRIPS

The need for utilizing community resources in science teaching is very much emphasized now. It is to make science teaching meaningful and community – centered and life centered. For this a teacher has to take his pupils out for a field trip or a school journey. "The school journey is any school exercise designed to provide complete sensory experience with things and phenomena, which cannot be brought into the classroom." It represents the instructional work done outside the classroom and laboratories. In a school journey the pupils are active participants and the teachers are advisers and guides. There are some advantages of the school journey, which are presented below:

Advantages of Field Trips

1. It provides first hand experiences- 'natural phenomena in their proper settings'.
2. It enables the pupils to come into intimate contact with the environment.
3. It develops keen power of observation and skill in exploration.

4. It helps in the correlation of school subjects.
5. It makes pupils active participants.
6. It effects a real socialization of school work – school and community come close together.
7. It develops problem – solving skill in pupils.
8. It paves way for the collection of specimens to organize a school museum or exhibition.

Specific Purposes for conducting Field Trips

1. "They serve as a preview of a lesson and for gathering instructional materials.
2. To crate teaching situations for cultivating observations, keenness, discovery-to encourage children to see and know the things about them.
3. To serve as a means of arousing specific interest as in birds, trees, animals, the heavens and industrial processes.
4. To supplement classroom instruction; to secure definite information for a specific lesson and
5. To verify previous information, class discussions and conclusions or individual experiments." The effectiveness of a school journey or filed trip depends on how systematically it is organized and conducted.

Using Field Trip as an Aid to Teaching

The following points have to be borne in mind in using field trip as an aid to science teaching:

1. The teacher must preview the place, after determining the purpose of the field – trip.
2. He must make necessary arrangements with school authorities and the authorities concerned with the places to be visited.
3. He must prepare the pupils physically and mentally for the trip. The pupils must feel the trip essential and interesting. They should be very clear about what they are to look for.
4. Throughout the trip the teacher should function as a prudent guide. He must allow the pupils to observe for themselves, take notes, draw sketches, and collect materials and so on.
5. Follow-up-work reinforces learning. After the field trip, the teacher may initiate discussions on the trip. Pupils may read out their recorded observations, ask questions, arrange for an exhibition or conduct an experiment in the laboratory to verify same phenomenon observed during the trip and so on.
6. The teacher must evaluate the field-trip in terms of specific educational gains.

SCIENCE GARDEN

Nature study is one of the important aspects at the elementary stage and is only possible if the school has a garden of its own. In the Secondary School where gardening is one of the subjects the teaching of plant life and animal life becomes easy. The students learn, by observation from nature and environments. They see the concrete things and understand the wonders of the plant world. The students get comprehensive ideas of plant life that is the medicinal value, the food value and the aesthetic value of plants. The utilitarian value of plant life can be well impressed upon the young minds through the garden and their learning becomes more effective, concrete and visual. The teacher should encourage the students to take interest in the maintenance of the garden.

Animal House

Animals are also required for the study of biology. Animals are of different types according to the habitat they live. Some animals live in water. They are called as aquatic animals. Some live on land and called as terrestrial animals. Some animals live in deep sea and called as marine animals. Some birds fly in air. These animals can be collected and kept in a separate room called as “animal room”. In this room separate habitat is provided for the animals. Whenever the teacher needs them he can take it to theory class or to the practical class and make his teaching effective.

Aquarium

Aquatic animals like fishes can be kept in the aquarium. Every school should have a ‘live corner’ where the animals and plants are grown and reared. Such activities in the school open new avenues of enjoyment and interest. The students observe the interdependence of animals and plants. As aquarium is a small pond arranged in the classroom, which provides opportunities for unlimited amount of spontaneous undirected observation and enjoyment. In addition it may be used in many planned activities. It is very essential that the conditions provided in the aquarium should be more or less the same as those of the pond where we obtain the plants and animals. Stream animals are adapted to well created water and do not thrive in the aquarium unless water is constantly changed. On the other hand the pond animals, which are conditioned to live in stagnant water, can survive very well in the aquarium.

It is desirable that the aquarium is small in size as preferably rectangular so that it is easily portable when desired. Keep up a small amount of rich soil at the bottom of the aquarium. Cover this soil with plenty of sand. Put some pieces of stones in aquarium in order to provide a place for the animals to hide. Water for the aquarium can be obtained from a pond. Tap water is also satisfactory but is better to allow it to stand for a day in order to let the chlorine present in it escape before using it. Fill the aquarium with water without exposing the soil. Now root the water plants collected from the ponds in the soil in the aquarium. This is easily done by thrusting the tip of the forefinger along with the tip of the stem through the layer of sand in the aquarium. Too many plants should be avoided. Small mass of threads should also be put. Now the animals can be introduced into the aquarium but care should be taken that there is no over-crowding of the animals. All kinds of animals should not be put in one aquarium. Let each group of students select one or more animals for their aquarium. There is no need for elaborate aerating arrangement if plenty of waterweeds are present. A few snails may also be introduced to keep the glass clean. Very little feeding is required. The fishes eat the snail’s egg and other water organisms. They may be fed once a week but the unconsumed food should be removed immediately otherwise fungus will grow on it and will infect the fish.

Green House

This is maintained in temperate regions in order to keep foreign plants by providing suitable temperature, water and moisture. The same is also used in hot countries in order to present plants from drying up because of hot sun and dry air. This is made up of wooden planks in the top and sides are made up of glass. The size of the green house depends on the requirements and the availability of funds. This house is provided with single door and the top with closing and opening facility. A number of wooden planks of breadth 30 inches can be fixed on the sides in tiers. Small plants in flowerpots can be placed on these wooden planks. Flowerpots can also be hung from the ceiling and plants can be kept in them. The inner-side of the top glass portion can be painted in green or white colour. This will reduce heat inside the house.

Biology is a subject that deals with living plants and animals. When the teacher has to teach about plant or animals he should use the actual living organism. In case, the living organism is not available and it is beyond the reach of the teacher, then only the teacher has to use models and other aids. Use of living organism is more preferable in the teaching of biology than any other teaching aids. So the teacher should collect the required living organisms, keep and maintain them in their appropriate environments. Whenever they are wanted for the theory or practical class he can use them. This gives the students firsthand experience and this will result in effective learning. The structure and function of different organisms can be best learnt only when the teacher teaches them with the help of real organisms. He cannot talk about them without the real organisms. So, for this purpose, the preparation and maintenance of living specimen is more important.

Terrarium

This is like an aquarium tank in which the front part is made of glass. This is used to keep terrestrial animals like reptiles and also amphibians by providing the same conditions in which they live. The students can observe the external appearance, movement, food capturing mechanism, movement of eyelids and breathing mechanism. Students get direct experience about all these activities which is more important in the learning process. A small branch of a tree can be kept inside the terrarium so as to enable the reptiles to climb and take rest. Water can be kept in a small vessel for the reptiles to drink and for the amphibians to wet their body.

Plants can also be grown in a sealed transparent container which is also called a terrarium. This helps the students to learn about the growth of plants.

Vivarium

It is a place prepared for keeping animals in conditions similar to their natural environment for the purposes of study or as pets. Since biology is a subject that deals with plants and animals the habitat, external appearance, movement and food habits of the animals could be learnt when the students are taken to the places where animals live by arranging field trips. But field trip is not always possible. At that time teachers can make use of vivarium, in studying about animals habitat etc. Frogs or birds or any animal can be kept in vivarium for study. Some people keep this vivarium in their houses and keep the animals like birds as their pets. This is useful for the students in their study and for the people to spend their time joyfully in the company of the animals.

In this lesson you have learnt laboratory safety measures, rules to be followed by the teacher and students and about different types of accidents that may take place in biology laboratory and the first aid that could be given for them and also the method of preparing and maintaining live specimens.

SCIENCE MUSEUMS

One of the objectives of teaching biology is to make the students understand the things in the world and the relationship between human beings and environment. Students cannot learn about things only by learning about them from books. They should see, touch and feel the things. Students should obtain knowledge about the things in the natural environment. In the large classrooms it is not possible to take the students to the natural environment. So the things are brought to the classroom or the laboratory. The things required for biology are the plants and animals. These plants and animals are collected and preserved in a place called "museum". Each school should have a museum. The teacher should encourage students to collect and preserve the plants and animals.

The place and Importance of Museum

Museum is important for the development of students' knowledge and culture. This serves not only as an aid for teaching but also as a stimulant for developing students' research attitude. The living organisms required for museum should be collected by the students themselves. The organisms should be properly classified and preserved in order to be used by the teacher in his teaching.

Butterflies, some insects, fishes, frogs, snakes, turtles, birds and their nests, eggs, various types of mollusks, leaves of plants, stems, roots, fruits, flowers, algae, some mammals, skull, Skelton etc., are some of the materials that could be preserved in museum. It is very difficult to preserve these materials. If they are not preserved and maintained properly they will not be useful. Each material requires separate method to preserve it.

Preparation of Museum Materials

Flowers and plants can be dried and preserved. Using the preserved plants, details about structure of plants, flowers, fruits, stems and roots can be taught. Since it is not possible to collect all the parts of the plant at the same time, the parts, which are available, should be collected and preserved. Students can use vinculum, plant press, blotting paper, pads and mercuric chloride for collection. When fresh water and marine plants are collected a piece of cotton dipped in the particular water should also be put along with the plant to maintain moisture.

Plants should be collected in summer season so that fungus may not develop on the plant and the plants will dry quickly. The leaves of Vanda and Bryophyllurn are very thick.

Before preserving, these leaves should be put in hot water. Plants can be pressed between two fine sheets and then be transferred to plant press. After two or three days the plant should be kept between newspapers. For the first two weeks the papers should be changed daily. After the plants dried, they need not be changed daily.

The dried plants should not be affected by fungus. For that a mixture of ½ gram mercuric chloride in 100 ml. ethylated spirit is to be applied on the plants. Then the plants should be pasted or stitched on a thick paper. The right side lower corner of the paper should contain all details about the plant. The details regarding its name, species, genus, family, class, date of collection, place of collection and the name of student should be written.

The associated parts of the plant like fruits and other fleshly parts should be collected separately and preserved. If the seeds are small, they can be put in small polythene bags and attached to the sheet containing the plant. Different types of grains, seeds additional plants fruits, different types of seeds with different adoption or dispersal, cross section of big trees, different types of barks bamboo with flowers and grasses can be collected and preserved in dry condition.

Preservation of Insects

Insects can be collected and put into insect killing jars. Inside the jars the insects will be killed in one or two days. After that the insects should be transferred to the space in between two cork-sheets. A third cork sheet should be kept in the middle of these two sheets below. The body of the insect is kept in the groove in between the two cork sheets. A long pin should be pricked on the thorax region of the insect and fixed with the cork sheet. Creosote solution or a mixture of Naphthalene balls in chloroform should be applied on the insects. The wings, legs and feelers should be carefully spread on the cork sheets on the sides. The wings should be spread and a piece of paper should be kept on the well spread wings and two pins should be pricked on the papers without touching any part. After the insect has dried up the paper should be removed. This preserved insect can be now transferred to a box, which can be hung on a wall.

Preservation of other animals

Frogs, reptiles, birds and mammals can be killed by putting a piece of cotton dipped in chloroform into the bottles containing these animals. Mammals can be preserved in 70% alcohol or 4% formalin. It is better to preserve frogs, snakes, calottes, snail, octopus, crab, scorpion and centipede in alcohol. Before preserving mammals like squirrels, their stomach should be opened and the contents removed and then it should be stitched and kept in formalin.

Preservation of Skeleton and Skull

After removing big muscles, the skeletal system should be boiled in water and small muscles should be removed using iron brush. This is one method of preparing skeletal system. The other method is somewhat difficult but the best method. After removing the big muscles the skeletal system should be immersed in water in big tanks for 10 to 12 months. Then the skeleton should be washed in hot water using carbolic soap. Then it should be immersed in solution of bleaching power for 10 minutes. Now the skeleton will become white. Then it should be dried in sunlight and then combined to form a skeletal system. Skull can also be preserved in the same manner.

Preservation of Birds

The bird should be killed using chloroform. The inner contents should be removed by cutting on the lower side from neck to the tail. The legs, bone in the wings, eyes, esophagus, alimentary canal should be removed. The brain should be removed through a opening in the skull. Arsenic powder is a mixture of 500 gms arsenic, 100 gms camphor and six washing soap pieces. These fibres should be kept inside the body along with arsenic powder.

A long metal should be sent from head to tail along the fibres. Legs should also be provided with metal pieces. These two metal pieces are connected inside. Then the lower side should be stitched using thread and needle. These stitches should not be visible. The wings should be folded on the sides.

The marble stones or glass pieces should be fixed for eyes. This bird should be placed on a piece of wooden plank and the metal piece protruding from the legs should be drawn through the wooden plank and folded on the bottom. Now you can see a real bird sitting on the wooden plank.

Preservation of eggs of Birds

A small hole should be made on one side of the egg. The inner content should be drawn out using a syringe after thoroughly stirring the content with a stirrer. Then it should be cleaned with carbolic acid. The hole should be closed with plaster of paris. These eggs can be kept along with the birds and nests.

Preservation of eggs and worms of insects

The eggs of insects can be killed by using alcohol or by using light temperature. When they are killed using temperature the colour does not change. The temperature should not exceed 175ºF. Then these eggs should be kept in dilute glycerin or sodium chloride solution taken in specimen tubes whose mouths should be closed and made airtight. If they are not kept in liquids they will shrink after some time.

Small worms of the insects can be collected and preserved in glycerin before they start the first molting. Bigger worms are collected and preserved by pricking a pin on the posterior end and removing the inner contents little by little pressing near the hole. Hairs on the body should not be made to fall down. After completely removing the contents, using hay or capillary tube through the whole air should be blown into the body. The worm will regain its original shape. It should be dried in lamp heat and preserved.

Construction of Museum

The museum materials should be collected and preserved by the students. They should be kept in boxes or bottles according to their nature. The name should be clearly written on them. The preserved materials should not be kept in a corner. They should be properly exhibited.

Points to be noted in Museum

The materials collected should be classified on the basis of classification. Different sections should be allotted for different divisions of biology in museum. In the different sections the preserved organisms should be continuously and systematically arranged. Students should be able to take some small things and observe them keeping in the hands. Learning is not complete only by seeing and observing. Living organisms should be collected by both teachers and students. The teacher should avoid purchase of museum materials as far as possible. Inferior quality materials should not be kept in museum. The worn out materials and damaged materials should be replaced by new materials.

Animal Section

In these section different types of animals, invertebrates, vertebrates, skull, development of brain, embryo, fossils and the evolution of man can be kept. If possible this can be divided into some sections.

Plants Section

Types of plants, monocot and divot plants, structure of plant parts, dispersal of seeds, economically important plants, medicinal plants and fossils can be kept in this section.

Maintenance of Museum

Cotton dipped in a mixture of naphthalene balls; camphor and carbolic acid should be kept in almirahs thrice in a year. A mixture of Canada balsam and turpentine should be applied on selected parts and skull once in a year. Turpentine should be brushed on the body of preserved birds so that the features will not fall down. Turpentine mixed with Canada balsam should be applied to the beak and legs. The dried leaves, fruits, seeds and grains should be properly preserved.

Uses of Museum

The teacher can bring the real preserved specimens from museum for his teaching. Students can be motivated to collect organisms for museum. They can be asked to preserve them and they can be permitted to write their names on the sides, so that they will be motivated to collect more and more organisms. A well-maintained museum helps the people to spend their time usefully. At the same time they gain some knowledge from it. The school museum can be kept open for the public on some days. Aquarium, vivarium, terrarium and aviary can also be kept in museum. When the students collect organisms in groups they develop the group feeling and to work co-operatively.

IMPROVISATION OF APPARATUS

‘Necessity is the mother of invention; new emerging needs of science teaching, therefore, call for improvisation”.

- Unesco Source Book for Science Teaching.

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

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

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

Characteristics of Improvised Apparatus

The following are some characteristics of improvise apparatus:

(i) The raw materials are easily available either free of at low cost in the local environment.

(ii) The materials do not involve specialized skills and can be made by pupils, teachers or members of the community.

(iii) The materials can be easily and effectively used by the teachers and pupils in clarifying the set objects.

(iv) The process involved in the production of the materials is simple and inexpensive.

(v) The material is simple, accurate and appropriate to the age level of the users.

(vi) The material stimulates thinking, reacting, discussing, experimenting or further study.

(vii) The material is free from distractions, conflicts or bias.

(viii) The production of the materials is not time-consuming.

Process of Developing Improvised Apparatus

The flow chart given on following page shows the process of developing improvised apparatus. The different steps involved in are:

(i) ***Definition of objectives***: The objectives of the materials in terms of knowledge, skills and attitudes to be developed are defined in the light of the needs of the users.

(ii) ***Preparation of a design***: A design for the development of different materials is decided in terms of the type of the materials to be developed, its cost, relevance, and the resources available in the local environment.

(iii) ***Development of materials***: After having decided the design, the materials are developed by students, teachers, specialists or community in cooperation which each other.

(iv) ***Pilot testing of the materials***: The pilot testing of the materials is done by the teachers or researchers with selected sample users. On the basis of the results of pilot testing necessary improvements are made in the materials. This also provides a feedback for modifying objectives and design of the materials if necessary.

(v) ***Finalization of materials***: If the material is considered satisfactory after pilot-testing, it is finalized for production.

(vi) ***Production and distribution***: Adequate number of copies of the final materials is produced. It is distributed to different schools if it is considered valuable to users.

Importance of Improvisation

The following are some values of improvising low-cost science materials.

1. Economic Value

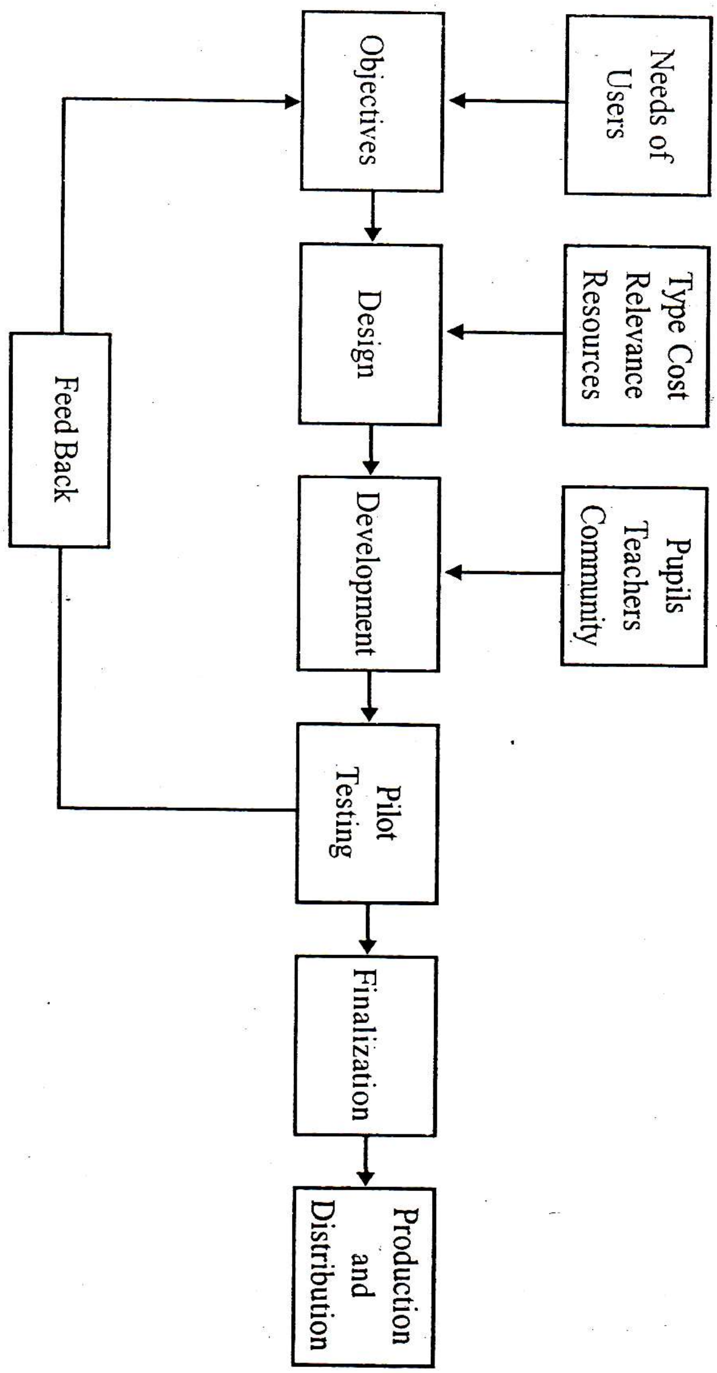
The economic value of home-made apparatus has already been discussed. It is in line with scientific traditions to use the minimum and the cheapest of the materials to the maximum advantage. We are getting the amenities of life at cheaper rate and the scientists are trying to give up cheaper than the cheapest radios, gramophones, means of transport etc. This improvisation of the apparatus also contributes a great deal in making the school self-sufficient.

2. Educational and Psychological Value

The educational and psychological researches have shown that in the case of young children, the understanding travels from hands to the head. For better understanding, the co-ordination of hands and head is important. This principle forms the basis of homemade apparatus. The pupils handle the apparatus, prepare models etc. and get a deeper and wider knowledge of the whole principle or working underlying a particular apparatus which would otherwise have been impossible to attain.

The co-ordination of hands and head and the overall confidence that pupils acquire be constructing some model or apparatus may lead to develop some creative hobbies. In this way the constructive and the creative instincts of pupils are also satisfied. The thrill and joy of having created something will give them a sense of achievement. This may enthuse children to utilize their energies in the exploration of some new things. Their energies find fruitful channels of sublimation at the adolescent stage.

The improvisation of apparatus provides opportunities for the exercise and development of ingenuity and resourcefulness. The pupils find a new media for the application of their knowledge. They learn to think critically and improve their work by criticism and auto-suggestion. The pupils from the habit of thinking scientifically and are instilled with the spirit of emulation find something new. In this way, the problems of leisure and indiscipline are solved to a great extent. While improvising the apparatus the pupils feel the difficulties that the scientists had faced in inventing some apparatus. This will encourage the students to face the problems boldly and which confidence and develop independence of thought and self-reliance. It also provides for individual differences and the students work with their own pace.



Flow Chart for the Improvisation of Low-Cost Educational Materials

3. Social Value

When the pupils work with their own hands, they develop love for labour. They love to work with their own hands. This removes the barrier between the mental and manual labour and thus contributes much in placing the pupils on socialistic pattern of society. Moreover, the habits and attitudes formed as a result of improvisation are applicable in the daily life of the child outside the school.

4. **Recreational Value**

Improvised apparatus has got its recreational value and thus helps to solve the problem of leisure.

5. **Scientific Value**

When the children work themselves, they develop interest in scientific activities; as a result they attain scientific knowledge. Thus improvisation helps to develop scientific attitude.

6. **Inspiration**

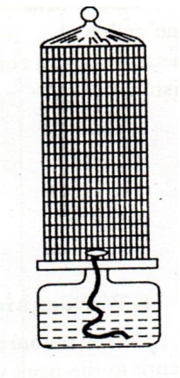
Improvisation can inspire young children to explore, discover and invent new things.

Some Improvised Experiments

It is difficult to discuss all the home-made apparatus in this book. The teachers are, however, suggested to consult "Unesco Source Book for Science Teaching'. A few examples of home-made apparatus are dealt with here.

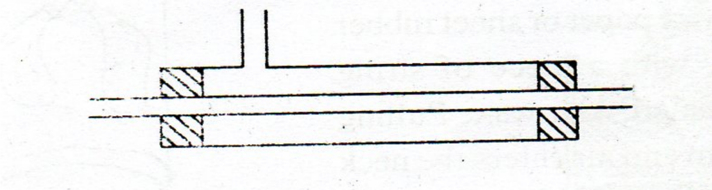
1. **Davy's Safety Lamp**

Take an ordinary spirit lamp or an empty ink-pot and surround the flame by wire-gauze preferably of copper.



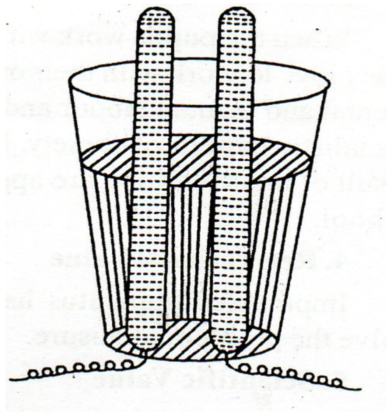
2. **Liebig's Condenser**

Take a metallic pipe of required length and diameter. Make two holes one on each end, one for inlet and other for outlet. Solder two small tubes one on each hole. Fix the cork at each end.

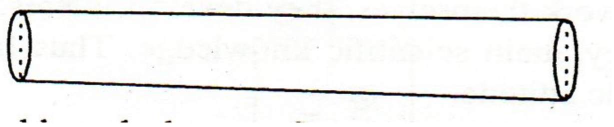


3. **Voltameter**

Take a plastic glass and pierce two holes at its bottom. Insert two copper wires one in each hole. Fill the glass with acidulated water and invert two test-tubes of water one on each wire. One connecting the wires to the two terminals of a battery, water will begin to decompose into Hydrogen Oxygen which get collected in the two test-tubes.



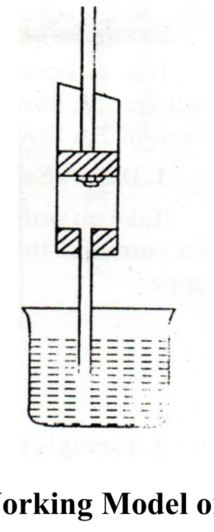
4. Astronomical Telescope



Take two card-board tubes one fitting in the other. Fix tow lenses of different focal lengths at the end of each tube. The lens of low focal length says 2 cm or 3 cm serve as the eye piece and of 15-30 cm as the object lens.

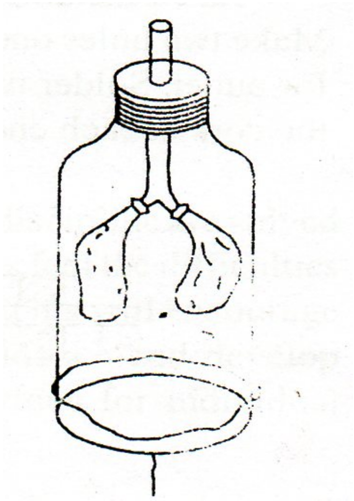
5. A simple Syringe Pump

Take a broken glass or metal tube and close its one end with a cork carrying a glass tube. A small metal rod and a cork wrapped with rag will serve as a piston.



6. Working Model or Lungs

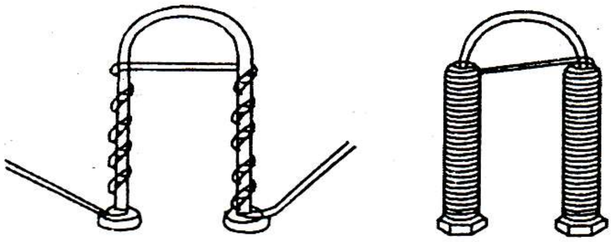
Cut the bottom off a large plastic or glass bottle. Fit a cork to the neck with a Y tube in it. On each of the lower limbs of the Y tube tie a rubber balloon or some small bladder Tie a sheet or brown paper or sheet rubber round the bottom of the jar, with a piece of string knotted though a hole and sealed with wax. Pulling this string lowers the diaphragm upwards has the opposite effect.



7. **Electromagnet**

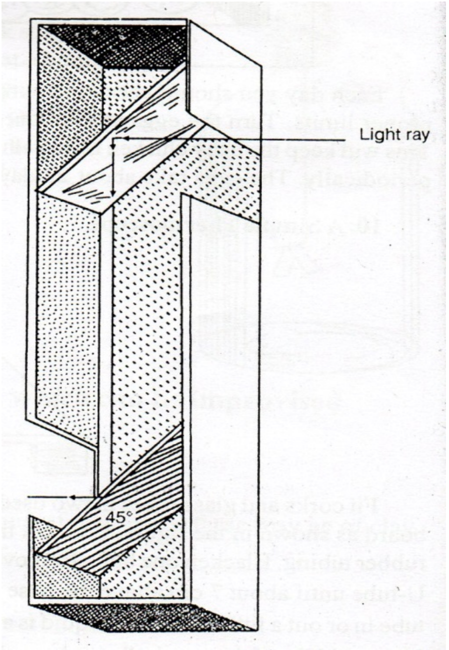
Obtain a U-shape piece of iron about 5mm in diameter. Wind a coil of several layers of bell wire on each arm of the magnet leaving the curving part free as shown. Begin at the end of one arm. Leave about 30 cm of wire sticking out for connections. Wind about three layers on this pole, then carry the wire across the top to the other end; be sure to wind this pole exactly as shown in the diagram.

Connect the open ends of the wire to a battery and test for polarity with a magnetic needle. One end should be North Pole and the other South Pole. If both ends have the same polarity, you have wound the second coil in the wrong direction. In that case unwind the coil and rewind it in the opposite direction.



8. **Periscope**

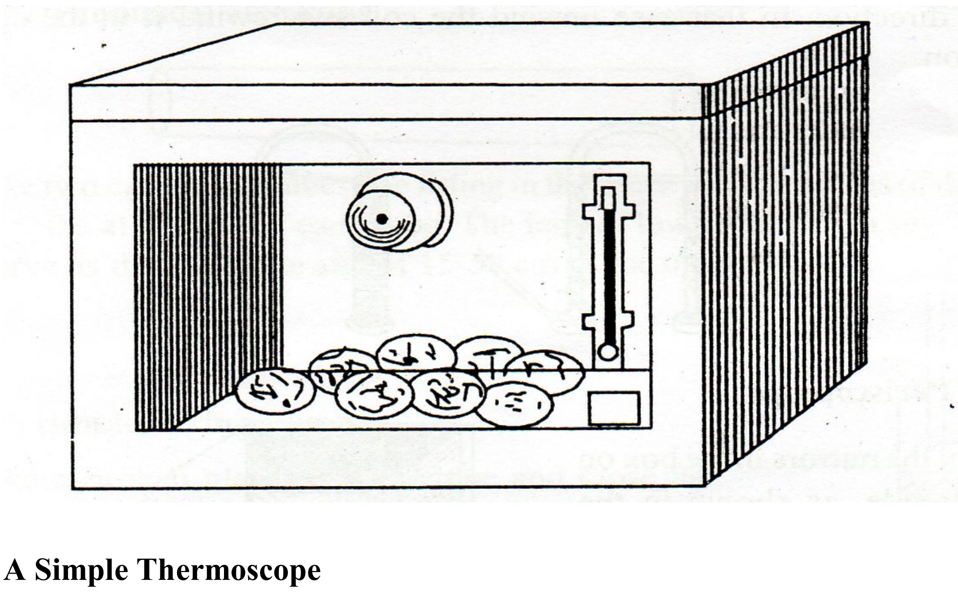
Fix the mirrors in the box on a 45° angle, as shown in the figure. Cut holes in the side of the box so that you can look into the mirrors. To demonstrate the use of periscope, shine a beam of light into one mirror in a darkened room and observe how the light has been bent.



9. Incubator

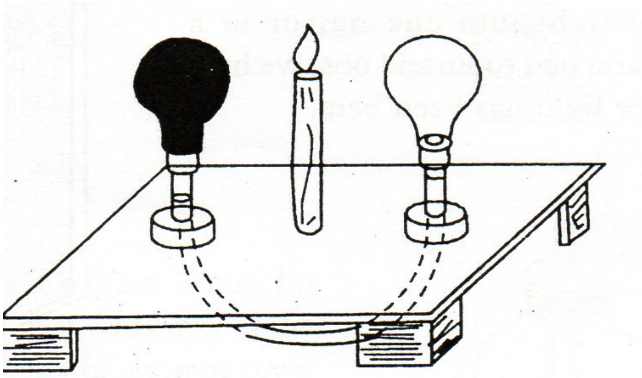
Cut a hole in the side of the cardboard box and tap a piece of glass in the box so that it covers the hole. The edges should be sealed airtight. Fix the bulb in the back of the box (opposite the window). Tape the holes so that the box is airtight. Affix a thermometer to the back so that it can be seen through the window. Place the eggs on the bottom of the box with a pan of water beside them to keep the air moist. Put a sixty-watt light bulb in the socket and plug the socket in. This will keep the temperature between 103º and 106º. Place the lid on the box. It should fit as tightly as possible, but don't seal it because you will have to get into the box every day.

Each day you should check the temperature to make sure it is within the proper limits. Turn the eggs at least once each day, but not more than twice. This will keep the baby chicken from being deformed. Sprinkle water over them periodically. The eggs take about 22 days to hatch.



10. A Simple Thermoscope

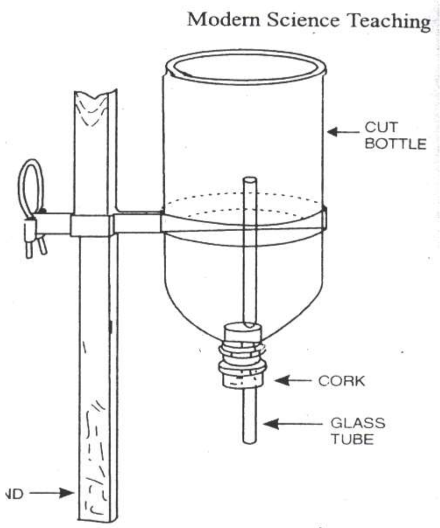
Fit corks and glass tubes in two used light bulbs and fix them on a wooden board as shown in the figure. Connect the open ends of the glass tubes with rubber tubing. Blacken one bulb. Remove one bulb and pour any liquid into the U-tube until about 7cm above the base board. Replace the bulb and slide the tube in or out a little so that the liquid is at the same level. Place a lighted candle in the middle of the two bulbs and see the effect on the level of the liquid.



11. Overflow Jar

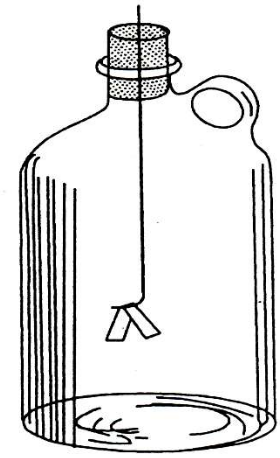
Cut off the bottom of the bottle. Bore a hole in the cork to one side, not at the centre. Fit the cork to the neck of the bottle. Introduce the glass tube in it. The end part of the tube that is inside the bottle should be at least ½" below the cut bottom.

This jar can be used to measure the volume of irregular bodies which don't fit into the graduated cylinder and to collect the water displaced by bodies in experiments concerning the laws of flotation or Archimedes' principle.



12. Electroscope

Push a thick wire through the cork stopper of a jug or bottle. Bend the wire so that a hook is formed and place a piece of aluminum foil over it. Lower the wire in jug until you can cork the jug. Any charged article brought near the open end of the wire will make the foil react.



List of some of the Items which can be improvised Biology

1. Auxonometer simple
2. Models of plants and animals and of their parts; these may be of clay, plaster of paris, card-board or soap etc.
3. Osmometer.
4. Potometer simple
5. Preparation of simple slides of plants and animals.
6. Preparing and maintain aquarium and vivarium etc.
7. Preservation of plants and animals.
8. Respirometer.

UNIT VIII

Educational Technology

In short educational technology, in its wide sense as understood today, includes the "development", application and evaluation of systems, techniques and aids in the field of learning's. As such its scope encompasses educational objectives, media and their characteristics, criteria for selection of media and resources, management of resources as well as their evaluation.

The various technological media are used to communicate the needed factual information to students and they are capable of doing this perhaps more accurately and efficiently than the teacher. So today "students acquire knowledge through the various media and behavioral change via the teacher".

Educational technology can be conceived as a science of techniques and methods by which educational goals can be realized. Educational technology also means the mechanization of educational process.

Definition

According to B.C. Mathis **"Educational technology refers to the development of a set of systematic methods, practical knowledge for designing, operating and testing in school"**.

Robert A. Cox has defined that the term educational technology is the application of scientific process to man's learning conditions to what has come recently to be called educational or instructional technology.

Hardware Approach

Educationists categorize the concept of educational technology in to two approaches viz. the hardware approach and the software approach.

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

Software Approach

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

Classification of A.V.aids

Sensory experience forms the foundation for intellectual activity and learning. For long, the common practice to communicate knowledge has been by means of written and oral language. But language has many limitations that may contribute to learning difficulty. The modern educators recognize such basic values as concreteness, enrichment, clarity and dynamic interest in audio-visual materials, The number of aids for teaching has become so numerous that even the most abstract can now be presented to the pupils in a concrete way by means of more than one aid. All the teaching aids that come under audio-visual aids can be broadly categorized under two heads namely projected and non-projected aids. They are further classified as follows.

Audio-Visual Aids

Projected Aids

Films

Filmstrips

Slides

Opaque-Projection

Overhead-Projection

Non-Projected Aids

Graphic Aids

Photographs

Pictures

Flash cards

Posters

Charts

Diagrams

Maps

Graphs

Cartoons

Audio-Aids

Radio and

Television

Recordings

Display Boards

Blackboards

Flannel Board

Bulletin Board

Peg Board

3-D Aids

Models

Objects

Specimens

Mock-ups

Dioramas

Puppets

Activity Aids

Experimentation

Field Trips

Demonstrations

Dramatics

Programmed Instruction

Teaching Machines

Computer Assisted Instruction

Projected Aids

When a projected aid is used an enlarged image of the material is projected on a screen kept at a distance from the projector. The room is either totally or partially darkened. A projected aid is bound to be more effective than a non-projected aid since a darkened room reduces distraction and the bright image on the screen secures the attention of the audience easily. Colour will make the aid more attractive; motion will make the aid more dynamic; and motion associated with sound will be more effective and attention-compelling than the non-projected aids.

A projected aid is suitable for large groups as well as small groups. The projected image could be made large and bright to enable every one in the large group perceive details. The following are some of the projected aids which can be used in teaching any subject especially biology.

Video Cassette Recorder and Player

The VCR or VCP is helping to enhance the educational and entertainment values of TV. The instruments and the software needed for them such as video cassettes are available cassettes on different school subjects are available now in the market at cheaper prices. The school possess a VCR or VCP and a TV. Then these recorded cassettes can be played for the students. The play in colour with associated sound makes viewing dynamic and its impact on the viewers considerable. The play can be done in one or more TVs simultaneousness facilitating large audience viewing in different classrooms. New projection TV systems with 6’ to 10 screens and facilities for front or back projection are available nowadays.

By using VCRs the teacher can record educational TV programmes telecast over networks of educational interest and value and replayed whenever necessary. Animal planet, National Geography, Discovery channel etc., are some of the channels which telecast life histories, adaptations, food habits, movement, reproduction, parental care and such other activities of plants and animals. UGC programmes on classroom teaching and learning are telecast by Doordharsan channels. These could not be seen by the students as they are telecast during school hours. The teacher can record these telecasts using VCR and replay them to the students whenever they have time.

Now **Compact Discs** (CD) have occupied the place of video cassettes. A number of educational programmes are available on CDs. For the use of CD the teacher requires VCD players and TV, VCD players and TV are very cheep now. Operating a VCD player is easy and it is more portable and versatile than any other projected aid. Educational CDs are now available an all the subjects in the market which are ready to help the teacher in his teaching.

OHP and transparencies

The name overhead projector (OHP) comes from the fact that the projected image is behind and over the head of the speaker or teacher. In overhead projection, a transparent visual is placed on a horizontal stage on top of light source. The light passes through this transparency and then is reflected at an angle on to the screen at the back of the speaker or teacher OHP is not a new one and it was used in World War II for teaching the recruits in armed services.

Overhead projectors are designed for direct or indirect projectors. The projectors designed for direct projection use either Halogen lamps, 'linear or pea (650w) or in some cases 30 volt locomotive head lamp, worked with a transformer.

The overhead projectors designed on the principle of indirect projection use the tubular projection lamps (750 or 1000w) as in a film projector.

OHP should not be kept on use continuously for long periods. The lamp should not be touched by hand while in use. The lamp can be put off after use but the fan should be allowed to work till the lamp container cools.

Advantages of OHP

It gives large image. The teacher can always face the students or audience. This can be used even in lighted room. Its weight is less and it can be used with flexibility and versatility. It can be used for personalized presentation. Home made and low cast transparencies can be used in OHP.

Transparencies or OHP sheets are prepared from tri-acetate film rolls of minimum thickness. The tri-acetate sheets are now available in required and suitable sizes. They can be suitably mounted on card board mounts. Poster boards make attractive mounts.

Matter can be permanently written on acetate sheets using quill or ruling pen or rapid mat pen with special Indian ink or acrylic markers with special inks. Temporary erasable impressions may be created with china graph pencils also called grass marking pencils and water colour markers with special inks. These impressions can be removed by wiping with a dry cloth or cotton waste. Acetate sheets may be cleaned with sponge dipped in detergent or soap solution.

Method of Preparing Transparencies

Hand-drawn Transparencies

The required visual is drawn or written on a white paper. The ace fate sheet is placed over the paper and kept in position by paper clips or pins. The sketch is carefully traced using ruling pen or marker pen or colour, chisel marker. If the transparency is required for permanent use, the impression carrying surface should be protected by either varnish spray or keeping another ace fate sheet over it.

Good line drawing and typewritten impression can be made on ace fate sheet using hector-carbon paper. The procedure is the same as that of using ordinary carbon paper over plain white sheet.

Photographic Transparencies

Employing reflex printing process, negatives on reflex printing paper can be made of complicated diagram or rare pictures printed on books or composed diagrams using Indian ink. With these negatives, positives can be printed on sensitized dia-positive ace fate which is available in rolls or as sheets of 10”X12”.

The Diazo Process

To make large number of copies of transparencies, diazo chemical coated acetate can be used along with master drawing on translucent paper. The two are kept together exposed to sunlight or ultra-violet source for 2 to 3 minutes. The image will develop on exposure to ammonia vapour. Beautiful coloured overlays can also be prepared by this process.

Copying Machines

These machines produce the positive and negative transparencies from the original material. In the infra-red copying machine, the transparency film is placed in contact with the original. In just 4 seconds a transparency can be obtained on black and white.

OHP can be used for the presentation of material in step-by-step fashion and sectional fashion using overlays. Small live aquatic animals may be kept in a flat glass dish and get projected. Leaf profiles, flower petals and details can be projected. Even dynamic demonstrations can also be shown.

Slide Projectors

Slides are projected by an instrument equipped with a powerful light source in a lamp house and carriers for holding slides of suitable sizes. It is a simple mechanism and the essential elements in it are the same as in filmstrip projector. Usually a double slide carrier is fitted in the projector so that when one slide is being projected on the screen, a second slide can be kept ready. When the class views the second slide, the first slide can be removed and another inserted in its place. There is a “thumb mark” or guide marker on the upper right hand corner of each slide.

Most 2”X2” slide projectors today use drums or cartridges in which may (100 or 200) slides can be loaded in proper sequence in advance. The projectors can be operated and focused by remote controls. It is also possible to record the narration in a tape recorder and the latter may be hooked up to the projector in such a way as to give the necessary commentary without the help of the teacher.

Film Projector

Film as an aid to teaching is inferior to direct experience. But in some cases film will be able to provide the expected learning outcome better then even direct experience. The bright image on the screen with the associated sound is more realistic if it is in colour. It provides a vivid, dynamic visual presentation.

Films can be classified as entertainment films and educational films. Educational films may be further subdivided into general educational films and classroom films. Classroom films are on curricular subjects produced for promoting learning in a specific curricular subject. Educational films are produced to provide general knowledge. Educational films should be devoid of antisocial activities and abnormal behavior.

The equipment used to project film is called as film projector. Educational institutions use 16 mm projectors. There are many different 16mm film projectors made by various manufacturers. Each has its own distinctive characteristics and advantages but all are similar in principle.

The principle involved in a film projector is this. An object kept in between 'f' and '2f' of the lens will produce a real image beyond '2f' of the lens on a screen. In the film projector the object is the transparent film. The film unwinds from the feed roll and goes through the picture head where it is illuminated by the light source and is then projected on the screen. Then the film passes through the sound head to give sound.

Advantages of Films in Teaching

The films present certain meanings involving action or motion. This compels attention which helps in permanent retention. Fast and slow motion can be shown to occur at normal speed, making analysis and appreciation possible. Events like crystal growing, plant growth, flower blossoming etc., which occur over days can be made to appear to occur in seconds. This presents materials that cannot be seen by the human eye and even by microscope and telescope.

Film are of different gauges. They are 35 mm, 16 mm, 8 mm, standard films, 8 mm super films and 70 mm films.

Closed circuit Television (CCTV)

In CCTV the signal is sent to the receiver using co-axial cable. Hence the range is limited to the length of the cable. CCTV can be used to a very great advantage in educational institutions. Its uses are as follows:

(a) Increases the range of instruction to one or more locations beyond the classroom.
(b) Magnifies exhibits and demonstrations which are normally difficult to see in a classroom situation.
(c) Provides opportunities for exchanging professors and courses between one institution and another linked to a circuit.
(d) Enables institutions to present televised instruction in accordance with their own schedules and needs.

In teacher training institutions CCTV with video tape recorder can be used to record performance of the student teachers during "Micro teaching sessions. Video tape provides the necessary feedback.

CCTV is used in many medical colleges in developed countries. When an operation is being performed, it is not possible and desirable to admit inside the theatre large number of persons. But the entire operation can be covered using a single television camera or a battery of cameras located at vantage points. The signal from the proper camera can be fed to the viewer by the monitor system.

In the same manner lectures, dissection of animals and sectioning of plant parts can be seen by many students using CCTV.

Non-Projected Aids

These aids are the form of visuals that cannot be projected using equipment. They convey meaning mainly through relatively conventionalized symbols that are nearer to reality, perceptually than verbal symbols. The following are some of the non-projected aids that could be used in the teaching of biology and other subjects.

Charts

Any visual information developed on the chalk board by the teacher in the presence of students is bound to be most effective. This will be more effective when the teacher uses colours to stress specific aspects. This is not always possible. The diagram may be a difficult one or it may involve more time to draw or the teacher may find it more difficulty to draw in the presence of the students. On such occasions a chart is of much help and handy to the teacher. The teacher can prepare the chart whenever he finds it convenient. He can make use of the artist or the student with drawing skill for this purpose. The diagram in the chart should be bigger in size with all components drawn in different and distinct colours. At present sketch pens in colour are available for drawing lines even 4-5 mm thick. The most commonly used types of charts include outline charts, tabular charts, flow charts and organization charts.

The suitable chart used by the teacher will result in considerable saving of time. The same chart could be used over a number of years. Tree chars, Time line charts, Technical diagrams and process diagrams are also commonly used in classrooms.

Readymade charts are available for use in teaching in almost all areas in all subjects. But it is not difficult for any teacher to prepare a chart. In fact a teacher would find a chart prepared by him incorporating his own ideas and lines of approach of the specific topic more useful to him.

The chart should be large; every detail depicted should be visible to every student in the class wherever he is sitting. The chart should not contain too minute details or too much written matter making it necessary for any observer to come near and see. Flip charts and flow charts are the two types of charts used for different purposes suitable for them.

Models (Static and Working)

The use of models for teaching purpose should definitely be highly effective Models are concrete objects, some considerably larger than the real object, some small replicas of objects which are too large to be seen as a whole, mostly three-dimensional, or sectional to explain clearly the structure or functions of the original. In many cases working scale models of the original are used where the specific action of the original is duplicated and could be explained easily. Models offer a kind of short-cut or substitute for the real things and sometimes models can be more effective than reality. An object is a real thing; but a model is just a recognizable three dimensional representation of it. **Specimens** are objects that are representative of a class or group of similar objects.

Any concrete object shown to students will enable them to have a correct concept of the object and since the model is a replica of the original they will have a clear concept of the structure and mode of working of the original.

It is possible to easily explain the structure, function and working of the original using the model.

Models may be static or working. Static models are the models which the teacher or the students can use but they cannot move by themselves.

Working model is one which functions and enables the students to learn by its working. A working model will secure immediate attention and will serve as motivation. Interest stimulated could be utilized to fullest advantage. Models should be used only if it is not possible to get the real objects to the classroom or when the real objects would not be helpful to give a better explanation.

Cardboard, plastic materials, plaster of paris, wood, metal PVC, Acrylic materials and thermocole are some of the materials used for the preparation of models.

Flash Cards

The flash cards are compact visual aids. Teaching can be made more meaningful and interesting with the help of flash cards. The flash cards are approximately 10X12 inches in size which are flashed before the students to get their attention and to emphasise important points in the lesson. They should contain brief and stimulating messages. The message should be presented in step by step manner for its easy understanding. The number of cards should be restricted to ten or twelve in a period.

The flash cards may be prepared buy just writing the contents on a card or thick plain paper. A large piece of cardboard to and can be purchased and cards of 10X12 inches or 4X4 inches shall be cut from it. The lettering on these cards may be written simply and legibly. Nowadays alphabet stencils of different sizes are available in the market which can be used to write letters on these cards. Cards of different colours can be made to attract the attention of the students. Colour letters can also be used on the cards for lettering purpose. Attractive figures, diagrams, illustrations, cutout pictures and cuttings from magazines can be made use of in the preparation of flash cards. These cards can be used in all subjects effectively.

Pictures

These may be hand-drawn or photographic reproductions which are self-explanatory. Good picture should have good quality, good composition, good contrast and sharpness, effective colour and should communicate the idea clearly. They are complete by themselves and do not require any lengthy explanation. There are still opaque representations of a scene or object or plant or animal. Such pictures cost less, are readily available and can easily be made and used; but often they are of small size, lack depth and motion. Worthwhile pictures can be preserved for future use by suitably mounting them on a backing surface. The usual way of fixing a picture is to make use of gum or rubber cement on the backing surface and placing the picture on it and pressing it uniformly. Dry mounting is another method of permanent mounting.

Chalk board

Even in the present day when the teacher can make use of visual aids like OHP, CCTV etc., the chalk board, also called as black board, remains the most commonly, teacher used visual aid in the classroom, lecture room and laboratory. The use of chalk board is highly essential particularly for the teaching of languages, science, mathematics, technology and to a smaller extent in teaching other subjects. The teacher can vitalise teaching through good, clear, well-proportioned illustrations developed in the presence of students, making good use of coloured chalk to emphasise or differentiate specific points, aspects or details. The modern chalk board is not black but made in different colours, mostly in pleasing green.

Chalk board provides a very convenient surface where the teacher can develop subject-matter visually in a manner and at a pace to suit the subject and the students.

The traditional blackboard is made with a large surface fabricated with wooden planks and coated with dull black paint. The board was supported with an easel. This type of board is being replaced by wall boards even in schools.

The wall boards consists of either the plank board fitted to wall surface or a rectangular portion coated with suitable paint. Chalk board surface should never be finished with glossy paint.

Modern chalk boards are made by of the following different types of writing surfaces.

1. Paint coated pressed wood,
2. Dull finished plastic surface,
3. Vitreous coated steel surface,
4. Ground glass board.

Ground glass board is the ideal board for the modern classroom. The construction is easy and very little effort is necessary to write on the same. It can be made in a variety of colours.

The chalk board should be so positioned that the surface is well lighted and the entire surface will be in full view of any student seated in the last row and any teacher of average height will be able to reach any portion of the board easily. A rectangular box is fitted at the bottom of the board to hold the chalk piece and duster.

The chalk board can be used to write assignments, spelling lists, definitions, outlines and summaries. Facts, ideas and processes can often be illustrated with the help of drawings, sketches and other visual symbols.

Flannel board

In the modern age flannel boards have special importance. These are prepared by mounting a flannel cloth very tightly on 18”X24” or 36”X48” piece of plywood or hard board. Then, on it, various pictures, maps, sketches and graphs etc., related to different subjects are displayed. In order to display on the flannel board, sand papers are pasted on the back of the pictures, maps etc,. This makes these pieces sticking to the flannel board. After using them, these can be removed easily or retained for future use. These flannel boards can be used very conveniently for teaching language especially foreign language and mathematics to the lower classes and history, geography, civics, economics, mathematics and science to the higher classes. Hence every teacher should use this instrument as the need arises.

Magnetic Boards

A magnetic board will be useful to show the relative movements between elements of visuals. A magnetic chalk board becomes more versatile due to the additional facility of visuals that could be made using chalk. A sheet of iron (G.I. or M.S.) that attracts a pieces of magnet can be used for magnetic board. Steel-backed chalk boards specially provide the added utility of a surface that can be used either for chalk board or magnetic board or both in combination can be installed. Small, ceramic magnets can be fixed to the back of the display cutouts by fevicol.

Pockets of thin sheets may be pasted at suitable locations on the back of the display.. Proper size ceramic magnets could be inserted in pockets, when display is to be used. This will enable use of several displays without purchasing large number of magnets.

Bulletin Boards

These are commonly called as **notice boards**. The modern term for these is **display boards**. In well designed modern school buildings, there are extensive bulletin board spaces in classrooms, display cases located at vantage points, teaching walls made up of folded sliding panels which can be extended to form a partition between one classroom and another and at the same time provide a lot of display space, etc., Varied and colourful displays which both communicate information and incite interest and involvement, impart to a school and its classrooms a vitality needed for motivated and purposeful learning.

The bulletin board should be near the laboratory or science room. Aside from providing vitalized material, which supplements other sources of information, and as an effective motivational device, it provides opportunity for developing creativity, responsibility and other abilities in the students.

The bulletin board should be fairly longer in size and made up to teak wood and provided with sliding glass doors which can be locked. The inner part of the board should be provided with dark colored cork like material, so that the exhibits can be fixed on it with pins without much effort. The dark coloured background will attract the attention of the students and make the exhibits appeal to the students.

Any information to the students can be put up in the bulletin board. Maximum educational value is derived if the students are made in-charge of it and the teacher acts as a guide.

Exhibits

The sterile appearance of the traditional classrooms, libraries', and corridors of schools is recently giving way to warm, attractive and flexible surroundings with a wealth of display materials or exhibits. The exhibits should be the result of active participation of students and the teacher. The students take keen interest in displaying some attractive material and thus their creative ability is developed. The students should be encouraged to give regular contributions in order to keep the bulletin board dynamic.

The exhibits should be of some scientific interest. Interesting and important science news should be published. News papers and magazine cuttings of scientific interest should be exhibited. The activities of the science club, the science magazine published by the school, and students who distinguished themselves in various activities should be notified. All informations and instructions to students, rules to be followed in the classrooms, laboratories, playground etc., can be the exhibits.

Study Exhibits

A study exhibit is an organized visual arrangement of learning materials and is usually designed to present significant information on a given topic. The exhibit may include a wide variety of materials such as diagrams, pictures, photographs, news clippings, three dimensional objects and specimens. It may be planned by teachers or students or both.

Exhibits may do motivational developmental and summarizing functions.

A successful commercial exhibit must command attention, arouse interest and involve the viewers in such a way as to buy the product. Similarly school exhibits must be so arranged as to "sell" the idea for a new unit of study.

Audio Players

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

The uses of the tape recorder in education are as follows

1. It can be used to record educational broad casts and for replay at suitable and convenient times.
2. It can be used to record music and sound effects for use during staging of dramas in schools and cultural programmes.
3. It can be used to record the talk of important visitor to the school and this can be effectively used later.
4. It can be used very largely in language laboratories for giving speech-training and for correction of pronunciation defects.
5. Recordings of model talks by teachers or experts in the languages can be frequently used.

6. Instructions for experiments or any activity can be recorded on cassette and the individual can listen to it by earphone and do the necessary operation without disturbing others.
7. Commentary to filmstrips or slides can be suitably recorded on a tape-recorder and the tape may be played back while the students view the filmstrip or slide pictures projected on the screen.
8. In teacher training institutions a tape-recorder can be very effectively used during the "Micro-teaching" sessions. This will provide necessary feed back for discussions to improve the lesson.

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

UNIT IX

SCIENCE TEACHER

"The status of the teacher reflects the socio-cultural ethos of a society; it is said that no people can rise above the level of its teachers."

— National Policy on Education (1986).

A poor teacher tells;

An average teacher explains;

A good teacher demonstrates;

And a great teacher inspires.

Science is now one of the compulsory subjects in the secondary schools, because of its multifarious values. In the present state of affairs when the rockets are booming overhead and man has reached to moon. India cannot spare to lag behind in the race. For this we need some extensive programme through which we can impart scientific knowledge to the people of the country in the background of our own culture so that we can increase the wealth of the nation and promote a healthy international outlook.

Swami Vivekanand wanted to combine western progress with India in its spiritual background. He said, "Make a European Society with India's Religion". "Be an occidental of occidentals in your spirit of equality, freedom, work and energy and at the same time a Hindu to the very back bone in your religious culture and instincts". The task of spreading scientific knowledge and building up habits of thought and action in consonance with what Swami Vivekanand has said, devolves upon the secondary schools science teacher more than anybody else.

For an effective and efficient teaching of science, we need well equipped science laboratories but more important than this we need well-qualified science teachers, for the quality of education depends mainly upon the quality of the teacher and not on the material facilities only. An efficient and resourceful science teacher can carry on his work quite efficiently even with inadequate science facilities. But it is rather a sad commentary that the continued failure 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 efficient and effective.

The Secondary Education Commission has very aptly remarked, "We are, however, convinced that the most important factor in the contemplated educational reconstruction is the teacher-his personal qualities, his educational qualifications, his professional training and the place that he occupies in the school as well as in the community. We were painfully impressed by the fact that social status, the salaries and the general service conditions of teachers are far from satisfactory. In fact, one general impression in that on the whole their position today is even worse that it was in the past. It compares unfavorably not only with persons of similar qualification and other professions but also, in many cases with less important and socially less significant duties. We are convinced that if the teacher's present mode of discontent and frustration is to be removed and education is to become genuine nation-building activity, it is absolutely necessary to improve their status and their conditions of service."

Of all the different factors which influence the quality of education and its contribution to national development, the quality, competence and character of teachers are undoubtedly the most significant. Nothing is more important that securing a sufficient supply of high quality recruits to the teaching profession providing them with the best possible professional preparation and creating satisfactory conditions of work in which they can be fully effective.

It is, therefore, very important that the status of the teachers be raised before long. It has been a pit that the teaching profession does not attract best brains because it does not offer attractive emoluments. Gifted and above average children feel attracted towards Engineering, Medicine, Business, Industry and Administration. It is, indeed, an irony that whereas we are trying to set up industrial plants in accordance with the latest techniques, in education we are content to follow out-moded and stereotyped practices. It is, therefore, desirable that social esteem and reasonable high status must be accorded to this "Nation Builder". Feeding him only on high sounding phrases and slogans would not do. Here, the observation of Prof. Whitechead is worth mentioning:"the waste in the teacher's workshop is the lives of men". This is the price that any country will have to pay for not giving sufficient attention to the need of the teachers. Education provides a good illustration of the " feed back” process. If we plough back into our schools year after year individuals with less than an average ability, standard of the nation would continue to go down as years roll by.

Qualifications of a Science Teacher

Besides possessing the personal qualities, that every teacher should possess, the science teacher should fulfill the following broad requirements:

1. Basic academic qualifications,
2. Trained in the modern methods and techniques,
3. Practical knowledge of child psychology and of the learning process.

1. **Basic academic qualifications:** The basic academic qualifications are laid down by the Education departments or the employer but in all cases the science teachers in high schools should be at least B.Sc., and in higher secondary schools M.Sc,. They should preferably be trained.
2. **Trained in modern methods and techniques:** New methods and techniques are being employed in the teaching of science. Science club, improvisation of apparatus, programmed instruction, teaching machines, and many other new concepts are coming in. It is, therefore, essential that the science teacher should be trained in:
   - (i) The class-teaching methods and planning of lessons.
   - (ii) Laboratory organization.
   - (iii) Museum arts and techniques necessary for vitalizing science teaching programme in schools. He should have knowledge of preserving specimens of plants and animals arranging science aquaria, vivaria etc.
   - (iv) The care and repair of apparatus. He should be able to improvise certain apparatus.
   - (v) Preparation of instructional material, etc.
3. **Practical knowledge of child psychology and of the process of learning:** The teacher should have knowledge of child psychology so that he may guide the students according to their interests, capabilities and help in educational, vocational and personal problems. He should also know the different laws of learning which can be applied to the teaching of science.

Some suggestions to science teachers

1. The first requisite for the science teacher is that he should have a thorough grasp of the subject-mater that he has to teach. Preferably be should plan his lesson before-hand.
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 that the teacher can be caught sooner or later.
3. The teaching should be pupil-centered rather than subject or teacher- centered, The approach should be inductive.
4. Adequate opportunities should be provided for the individual laboratory work by students.
5. He should keep himself in touch with the latest development in science.
6. Teaching-learning process should be a co-operative Endeavour of the teacher and the pupils. He should give knowledge to the students and at the same time learn with them.
7. He should make good use of teacher's manuals and laboratory guides, if available.

Professional Growth of Science Teachers

"***A teacher can never truly teach unless he is still learning himself. A lamp can never light another lamp unless it continues to burn its own flame. The teacher who has come to the end of his subjects, who has no living traffic with his knowledge, but merely repeats his lessons to his students, can only load their minds, he cannot quicken them. The greater part of our learning in the schools has been a waste because, for most of our teachers, their subjects are like dead specimens of once living things".***
—**Tagore**

In order that the teachers are kept alive to the new developments, concepts, problems in their areas, a number of opportunities are provided by the Government in the form of:

(i) Seminars, Workshops, Conferences.
(ii) Refresher Courses.
(iii) Summer Institutes etc.

The teachers can also add to their professional growth by participating in teachers organizations like the All India Science Teachers Association, Indian Association of Teacher

Educators (I.A.T.E.), All India Federation of Educational Associations (A.I.F.E.A.), Seminar Readings, celebration of teachers' day, National Foundation for Teachers' Welfare etc,.

Summer Institutes for Science Teachers

Various kinds of summer institutes have been started in India in order to refresh and up to date the knowledge of teachers of science and mathematics in secondary schools as well as for teacher educators in teacher training colleges. The different Types of summer institutes are:

1. **Unitary Institutes:** A number of summer institutes are organized every year in sciences. The purpose of these institutes is to orientate the teachers in the developments in different fields of science as well as in the newer approaches to teaching science.
2. **Sequential Institutes:** The sequential summer institutes are organized on an all India basis for the best five participants (teachers) of the unitary type of institutes. The purpose is to prepare a team of pioneer resource persons for state level summer institutes as well as to develop in them professional leadership qualities. The emphasis in these institutes is both on the understanding of modern concepts in content as well as of the new techniques of effective teaching. The programme includes lectures, group discussions, individual discussions, laboratory work, use of audio-visual material and project work.
3. **Special Institutes:** These institutes are organized on all India level for Method masters from teacher training colleges and institutes of education. The main emphasis at these institutes is on the development of improved textual material for the use of training colleges in the areas of science and mathematics and on the development of improved techniques of teaching and education technology.
4. **Project Technology Institutes:** These are special types of summer institutes for secondary school teachers organized on regional basis. The programme includes intensive laboratory work, workshop practice, individual and group discussions. Emphasis is laid on the development of indigenous resource materials and audiovisual materials, which could be used by them in teaching when they go back to their respective school.

Thousands of teachers of different subjects have been trained through the summer institutes.

Some Reactions about Summer Institutes

The importance of summer institutes for science teachers cannot be denied, especially when scientific knowledge is expanding at an enormous speed. The rate with which the knowledge is increasing, it is doubtful whether it will be at all possible for all school teachers to catch up with the new advances in the near future. It is, therefore, very essential that such institutes are organized on a much larger scale through the year. Though the summer institutes have made their own impact on the teachers who have attended them, yet much has to be done to make them a successful enterprise. Some doubts have been expressed by a number of teachers and other educators. Some of them are given here:

(i) The materials used in the summer institutes for high school teachers are unrelated to the real Indian class-room situation for science teachers in most of the States. It is, therefore, of great importance to develop a new and integrated course material.

(ii) There is no follow-up programme to keep alive the knowledge and attitudes stimulated during the summer institutes.

(iii) Much of the value of the summer courses is lost because of the dichotomy between what the teachers learn in the summer institutes and what they have to teach in the class. This obviously leads to frustration of enthusiastic teachers who want to make use of the concepts taught in summer institutes. The courses are prescribed by the Board or University and they have to be strictly followed.

(iv) The necessary books are not available.

(v) One of the biggest hurdles is the system of examination which leaves little scope for the teacher to deviate from the routine syllabus and the way of teacher to deviate from the routine syllabus and the way of teaching. As a result the teachers are liable to forget most of the things which they learn at summer institutes, in a year or two.

Some Suggestions

(i) There should be a vigorous follow-up programme with a view to help the teacher to continuously apply the new knowledge in the class-room.

(ii) The material to be used in summer institutes should be designed to meet the needs of teachers in schools under the present conditions.

(iii) There should be some agency to act as a clearing house for all new information and development in science and mathematics, which should be treated as a follow-up programme of the summer institutes.

(iv) Some kind of incentives should be given to teachers who attend sequential and project technology summer institutes by way of promotions, increments or privilege in admission in B.Ed. or M.Ed. courses.

(v) The teachers should be encouraged by the administration to use innovations of teaching that they learn in the summer institutes.

Biology Teacher

In the present set up, the teacher is the pilot in every scheme of work. The success or failure of a biology course depends on the teacher. He may be provided with an excellent laboratory best equipment well-stocked library, an ideal curriculum and very suitable timetable, but unless he himself put his heart in his work, loves his profession, knows his subject and understands the technique of teaching he is not likely to become a successful teacher. A devoted teacher, who is wedded to his profession, is sure to shine in spite of numerous obstacles and handicaps.

In the words of Kothari Commission –“Among all the different factors which influence the quality of education and its contribution to national development, the quality, competence and character of teacher are undoubtedly the most significant”.

In the words of Dr. S. Radhakrishnan, “The teacher’s place in society is of vital importance. He acts as the pivot for the transmission of intellectual traditions and technical skills from generation to generation and helps to keep the lamp of civilization burning”.

Qualifications of a Biology Teacher

It is considered under two heads:

1. Academic Qualifications and
2. Professional Training or Education

Academic Qualifications

Before learning "how to teach" biology, the teacher must be familiar with what to teach. Therefore, the basic academic qualification of the teacher is very important. The minimum basic qualification laid down by the education departments of different states is B.Sc., for middle and high schools and M.Sc., to teach electives in higher secondary schools. The biology teacher should possess adequate knowledge in both Botany and Zoology. At the degree level one subject should have been studied as main subject and the other as ancillary subject along with physics or chemistry.

Professional Training or Education

Along with basic academic qualifications, every biology teacher must have undergone teacher training course, that is, B.T., or B.Ed., It is all the more necessary when new techniques of teaching, methods of evaluation, improvisation of science apparatus, equipments, science kit and activities are being introduced. It is, therefore, most essential that biology teacher must equip himself with this useful training. This will help the teachers to get knowledge about psychology, which is most essential for teachers. This will enable the teachers to know about the interests. Physical and mental abilities of the students and give work according to them. The laws of learning will also help the teacher to use them in the teaching of biology. This training helps the teacher to prepare his lesson in advance and treat the student as the centre of education.

Special qualities of Biology Teacher

Biology teacher should possess some special qualities in addition to the requisite qualities of teachers in general. He should plan his lesson and teach. He should know the syllabus of each and every class and teach integrating the subjects of other classes. He should know different methods of teaching and use the appropriate method for each topic. He should plan and organize biology laboratory and practical work. He should demonstrate the experiments in an attractive manner. By using mobile laboratory he could eliminate the insufficiency of laboratory. He should be able to repair and improvise apparatus. He should be able to organize field trip, excursion and exhibition. He should develop keen observation and critical thinking in the students. He should know the method of preparing slides, using microscopes, photography, printing and enlarging. He should be able to operate tape recorders, filmstrip projectors, overhead projectors, LCD projectors etc. He should be able to organize museum and maintain it. He should know the method of preserving various types of plants and animals and the chemicals used for them. He should be able to construct and maintain aquarium, vivarium, terrarium, aviary and school garden. He should be able to organize science exhibition and library and maintain them.

Personal Qualities of Biology Teacher

The biology teacher should have a good appearance. He should wear neat and clean dress. He should be alert and active at all times. He should be kind and sympathetic towards students. He should allow the students to ask questions and raise doubts boldly and clear them then and there. He should allow the students to interact with him. He should be punctual and regular to the classes and in all other classroom and school relates works.

He should arrange the practical classes neatly with help of students. Practical classes should be regular.

He should talk loudly and with proper modulation. His voice should be clear and audible and with correct pronunciation and stress.

In-service Training

A biology teacher in order to keep himself informed about the latest methods of teaching should refresh his knowledge of biology, and should go through some of the latest books on biology and be familiar with apparatus concerning biology teaching, obtain practical training in the organization of science clubs and participate in district and state level science fairs etc. He must be ever willing to attend and participate in such seminars and refresher courses organized by the extension Service Departments. He must be willing to attend in-service training programmes, summer institutes, refresher courses, seminars, conferences and workshops. These are organized by National Council of Educational Research and Training, Regional Colleges of Education, State Institute of Science Education, State Council of Educational Research and Training and Professional Organisations. The NCERT has also established Centers of Continuing Education all over the country, which provides facilities for in-service education. The biology teacher should also become a member of a good science association like All India Science Teachers Association and also subscribe and contribute to good science journals.

Classroom Climate and Biology Teacher

Introduction

Teaching can be considered as interactive communication. Teacher in the classroom undertakes the task of influencing the minds of pupils so as to modify their behavior. This act of influence is essentially a two-way process. The teacher impresses upon the pupils both verbally and non-verbally. Pupils interpret these acts of the teacher, understand them and react. Based on the reactions of the pupils, the teacher either continues his activities further or modify suitably so as to make them more meaningful to pupils. Thus formal system of teaching in the classroom could be considered as a process of natural interactions taking place between the teacher and the pupils. These interactions are largely (about 80%) verbal in character. Educationists feel that an analysis of verbal interactions that take place between the teacher and pupils in the classroom will lead to a better understanding of the nature of instruction and will also reveal the teaching behavior or teaching style of the teacher.

Teacher – Pupil Interactions and the Classroom Climate

"Classroom Climate" deals with different patterns of classroom interactions and its significance. Teacher provides learning experience, to his students which involves many actions like lecturing, asking questions, praising, reprimanding, giving directions, clarifying pupils' doubts, accepting pupils' suggestions etc. on the part of the teacher. These actions of teachers put together go by the name **teaching-behaviour.** Every teacher has a unique pattern of teaching-behaviour which constitutes his/her **teaching style.**

The students, on observing the behavior of the teacher during the instructional process, adapt themselves to suit the teacher and respond appropriately through acts like careful observation, listening, answering questions put to them, copying from the blackboard or working out the solutions of problems in their notebook and carrying out the directions of the teacher. These actions of pupils, during classroom instruction constitute **'student behaviour'.**

The behaviours of the teacher and students set a typical atmosphere in the classroom which motivates the teacher to teach and the students to learn. This atmosphere is called climate and since this climate is created inside the classroom it is called " Classroom Climate".

Meaning of the term "Classroom Climate"

The term classroom climate may be defined as the generalized attitudes towards the teacher and the class that the students share in common inspite of individual differences. The development of these attitudes is an outgrowth of classroom social interactions. As a result of participation in classroom activities, students develop expectations about how the teacher will act, teach, reply to their questions, draw diagrams on the blackboard, conduct experiments/demonstrations, reprimand students etc. They form an idea about what kind of a person their teacher is. They also form general attitude towards the class as a whole. These expectations and attitudes colour all aspects of classroom behavior creating a social atmosphere or climate that appear to be fairly stable, once established.

Thus the term **'Classroom Climate' is merely a shortened reference to those qualities that consistently predominate in most teacher-student contacts and contacts between students in the presence or absence of the teacher.**

Climate of a class can be referred to as a way of life. When a group of people meet for an hour or more in a day in the same place and for some general purposes, they will come to know what to expect from each other, what statements will be appreciated or disregarded, what sort of norm will be respected, and what sort of ideas will be rejected. The habitual mode of behavior exhibited in the classroom by a set of students and their teacher, lending it individualistic atmosphere is called **'classroom climate'.**

Factors Affecting 'Classroom Climate'

The social climate that prevails in a classroom mainly centre's around the teacher and students. The behavior of the teacher is not the same in all classes and in all periods. The behavior of different teachers is also not the same. Teachers differ in their behaviors inside the classroom. In the same way the behavior of students is not the same in different subject periods and for different teachers. So we can conclude that though classroom climate is largely determined by the teacher, he is not the sole factor. No teacher is an island; he works in the midst of his students and with the subject. Therefore the factors affecting classroom climate could be listed as: (1) Teacher (2) Students (3) Subject that is taught in the class.

Assessing the Classroom Climate

The classroom climate can be assessed by measuring the interaction between the teacher and the students and the attitudes of the students. **Ned A. Flanders** has developed and interaction analysis system (FIAS) to measure the interaction between the teacher and students. There are ten categories in this system. Out of the ten categories in the system evolved by **Ned A. Flanders**, seven categories are assigned to teacher talk and two to student talk and the tenth category to pauses (short periods of silence) and talk that is confusing or noisy. The seven categories assigned to teacher talk are again divided into indirect and direct influence. Categories 1 to 4 represent indirect influence and categories 5 to 7 represent direct influence. Indirect influence encourages student participation and freedom of action. Direct influence increases the active control of the teacher and often aims at conformity and compliance. That is direct influence of the teacher could be felt in the teaching activities like lecturing, restraining students' responses and behavior, and giving advice to students.

The observer sits in the classroom in the best position to hear and see the participants. The observer allows 5 to 10 minutes to get acclimatized to the class situation and then begins to record at every 3 seconds or every 5 seconds, the type of interaction that takes place by writing the number of the category to which it belongs. For example when the teacher asks a question to a student it is noted down as '4', while appreciating a student's response as '2', lecturing as '5' etc. When there is no activity in the 3 second period or more than one student talks simultaneously, it is marked as '10'. The observer should decide carefully the nature of the interaction category. Live video recording facilitates objective reporting.

Flander's Interaction Analysis Categories (FIAC)

TEACHER TALK	**Indirect Influence of Teacher**	1. Accepts feelings of pupils (in an Unthreatening manner) 2. Praises or Encourages (Jokes to release Tension but not at someone else's Expense, nods head, says go on etc,) 3. Accepts or uses ideas of pupils (Clarifies, Builds, or develops student's ideas) 4. Asks questions (with the intent that the student answers)

	Direct Influence of Teacher	5. Lectures (gives facts, opinions about content or procedure, express his own ideas, asks rhetorical questions etc.) 6. Gives directions (directs, commands, orders and expects students to comply) 7. Criticizes or justifies authority (shouting at, extreme self-reference etc.)
	STUDENT TALK	8. Student talk-response (Pupil replies to teacher's questions and queries) 9. Student talk-initiation (Pupil himself initiates the talk) 10. Silence or confusion (pauses, short periods of silence, noisy behavior can not understand what the teacher is doing etc,)

Ground Rules for Recording Interaction Categories

Because of the complexity of the problems involved in categorization, several ground rules have been established. These rules of observation help in developing consistency in trying to categorize teacher behavior. They have been useful in working classroom with all subject areas and all grade levels.

Rule 1: When not certain to which of the two categories a statement belongs, choose the category that is numerically farther away form category 5.

Rule 2: If the primary tone of the teacher's behavior has been consistently direct or consistently indirect, do not shift into the opposite classification unless a clear indication of shift is given by the teacher.

Rule 3: The observer must not be overly concerned with his own biases or with the teacher's intent.

Rule 4: If more than one category occurs during the three-second interval, then all the categories involved in that interval are to be recorded. Therefore, record each change in category. If no change occurs within 3 seconds, repeat that category number.

Rule 5: If a silence is longer than three seconds. It is recorded as 10.

Transforming the Recorded Data into a Matrix

After recording the observed classroom activities sequentially in terms of their category number, the obtained raw data are transferred to a 10X10 interaction matrix consisting of 10 rows and 10 columns. To form the interaction matrix, the first step is to write down the number 10 at the beginning and end of the number series recorded (This is based on the assumption that silence prevails in the class before the start of instruction as well as after the completion of teaching). Each number in the data is transformed into a pair, by combining it with the previous number. The successive pairs of numbers are denoted in the matrix by putting a tick (√) in the appropriate cell of the matrix. In each pair, the first number denotes the row and the second number the column in the matrix. For example, if the recorded numbers are like those found in the first column of the following table, then the method of coveting them into pairs is illustrated as shown in the next page:

Series of numbers recorded	Sequence of Numbers taken For paring	Transforming the numbers into successive pairs
4	10	10 I Pair
8	4	4
2	8	II Pair 8 III Pair
5	2	2
5	5	IV Pair 5 V Pair
9	5	5
5	9	VI Pair 9 VII Pair
3	5	5
5	3	VIII Pair 3 IX Pair
5	5	5

6	5	X Pair	5	XI Pair
10	6		6	
4	10	XII Pair	10	XIII Pair
8	4		4	
1	8	XIV Pair	8	XV Pair
5	1		1	
4	5	XVI Pair	5	XVII Pair
10	4		4	
7	10	XVIII Pair	10	XIX Pair
5	7		7	
5	5	XX Pair	5	XXI Pair
	5		5	
	10	XXII Pair	10	

Thus for 'N' observations (I Column of the above table), there will be (N+2) numbers in the series (II Column) resulting in (N+2-1) i.e.(N+1) tallies in the matrix. While recording, for example for the first pair (10,4), the tally is placed in row ten and column 4 cell. For the second pair (4,8) the tally is placed in row four and column 8. In this way all the pairs are represented in the 10X10 matrix as tallies. The total number of tallies in each row and column are calculated. They represent the frequency of the respective row and column. As could be seen from the following sample interaction matrix, the frequency of a given column is equal to the frequency of the corresponding row of the same number. For example the frequency of the 6th row and 6th column will be equal. Similarly this is true of all other rows and columns.

Sample Interation Matrix

Category ↓ →	1	2	3	4	5	6	7	8	9	10	Total
1					/						1
2					/						1
3					/						1
4								//		/	3

5			/	/	///	/			/	/	8
6										/	1
7					/						1
8	/	/									2
9					/						1
10				//			/				3
Total	1	1	1	3	8	1	1	2	1	3	N=22

Quantitative Analysis of Teaching-Behaviour

Quantitative analysis of teacher-behaviour can be undertaken in three ways. They are:

(i) Calculating the percentages of frequencies for different interaction categories.
(ii) Computing the percentages of frequencies for different areas of interaction matrix.
(iii) Computing the various interaction behavior ratios.

The details about these three methods are given in the following sections:

Calculating the percentages of Frequencies for Different Interaction Categories

This method analyses various aspects of classroom interaction by converting the frequency of each interaction category into percentage and then comparing percentages of different categories to draw relevant inferences. From the data found in the sample interaction matrix, the following computations could be made to draw inferences.

Row/column	1	2	3	4	5	6	7	8	9	10	Total
Frequency	1	1	1	3	8	1	1	2	1	3	22
Percentage of Frequency	4.55	4.55	4.55	13.65	36.40	4.55	4.55	9.00	4.55	13.65	100

Computing the Percentages of Frequencies for the Different Areas of Interaction Matrix

The tabulated matrix is divided into special areas A, B, C, D, E, F, G, H, I and J for interpretation, as shown below:

S.No.	Special	Location of the Area and its percentage of	Indication

	Areas	Frequencies	
1.	A	Total of the frequencies of the first four Columns	Indirect influence of the teacher
2.	B	Total of the frequencies of the column 5,6 and 7	Direct influence of the teacher
3.	C	Total of the frequencies of columns 8 and 9	Measure of Student talk
4.	D	Frequencies in the 10th column	Silence or confusion
5.	E	Total frequencies of the 9 cells bounded by the first three column and rows	Level motivation in teaching behavior
6.	F	Total frequencies of the 4cells formed by the column and rows 6 and 7	Classroom discipline (Higher Value indicates indiscipline)
7.	G	Total frequencies of the cells formed by the rows 8 and 9 with columns 1,2 and 3	Encouragement given to pupils' participation
8.	H	Total frequencies of the 4 cells formed by rows 8 and 9 with columns 6 and 7	Measure of assignment given by the teacher to pupils
9.	I	Total frequencies of the 4 cells formed by the rows 8 and 9 with columns 8 and 9	Measure of students' participation in classroom discussion
10.	J	Total frequencies of the 4 cells formed by the rows 8 and 9 with columns 8 and 9	Measure of students' group discussion

The different areas of Interaction matrix taken up for analysis are shown in the following figure.

Areas of Matrix Analysis

<table>
<tr><th>Category</th><th>Classification</th><th>Category</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>Total</th></tr>
<tr><td>Accepts Feeling</td><td rowspan="4">Indirect Influence</td><td>1</td><td colspan="3" rowspan="3">Area E</td><td colspan="2" rowspan="7">Content Cross</td><td colspan="2" rowspan="3"></td><td colspan="2" rowspan="3"></td><td rowspan="10"></td><td></td></tr>
<tr><td>Praise</td><td>2</td><td></td></tr>
<tr><td>Accepts Student Idea</td><td>3</td><td></td></tr>
<tr><td>Asks Questions</td><td>4</td><td colspan="3" rowspan="2"></td><td colspan="2" rowspan="2"></td><td colspan="2" rowspan="2">Area I</td><td></td></tr>
<tr><td>Lectures</td><td rowspan="3">Direct Influence</td><td></td><td></td></tr>
<tr><td>Gives Directions</td><td>6</td><td colspan="3" rowspan="2"></td><td colspan="2" rowspan="2">Area F</td><td colspan="2" rowspan="2"></td><td></td></tr>
<tr><td>Criticism</td><td>7</td><td></td></tr>
<tr><td>Student Response</td><td rowspan="2">Student Talk</td><td>8</td><td colspan="3" rowspan="2">Area G</td><td rowspan="2"></td><td rowspan="2"></td><td colspan="2" rowspan="2">Area H</td><td colspan="2" rowspan="2">Area J</td><td></td></tr>
<tr><td>Student Initiation</td><td>9</td><td></td></tr>
<tr><td>Silence</td><td>Silence</td><td>10</td><td colspan="3"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td></td></tr>
<tr><td></td><td></td><td>Total</td><td colspan="4">Area A</td><td colspan="3">Area B</td><td colspan="2">Area C</td><td>Area D</td><td rowspan="2"></td></tr>
<tr><td></td><td></td><td></td><td colspan="4">Indirect Teacher Talk</td><td colspan="3">Direct Teacher Talk</td><td colspan="2">Student Talk</td><td>Silence</td></tr>
</table>

Computation of Behaviour-ratios

The following twelve behavior-ratios are computed and compared with the ‘norms’ to infer about the quality of classroom climate. Out of these twelve behavior ratios, the first five are very important.

1.Teacher – Talk Ratio (TTR)

This is related to teacher based activities and can be calculated with the formula given below:

$$\text{TTR} = \frac{\text{Sum of the frequencies in the first Seven rows/columns}}{N} \text{X}100$$

$$\text{TTR} = \frac{\sum f[col.\ 1,2,3,4,5,6\&7]}{N} \text{X}100$$

Where N = Total frequency of the interaction matrix . In the sample interaction matrix given TTR= $^{16}/_{22}$X100=72.72%

2. **Pupil-Talk Ratio (PTR)**

This refers to pupils' participation in interactions

$$\text{PTR} = \frac{\sum \text{f[8th and 9th coloumns]}}{\text{N}} \times 100$$

In our sample interaction matrix, PTR = $\frac{3}{22} \times 100 = 13.6\%$

3. Silence/Confusion Ration (SC Ratio)

$$\text{SCR} = \frac{\text{[Frequency in the 10th column/row]}}{\text{N}} \times 100$$

In our sample interaction matrix, SCR = $\frac{3}{22} \times 100 = 13.6\%$

4. Content cross Ratio (CCR)

$$\text{CCR} = \frac{\text{[Total frequency in the 4th and 5th rows and columns]}}{\text{N}} \times 100$$

In our sample interaction matrix, CCR = $\frac{2(11)-(1+3)}{22}\times 100$

$$\text{CCR} = \frac{22-4}{22}\times 100$$

$$= \frac{18}{22}\times 100 = 81.8\%$$

5. **Ratio between Teacher's Indirect and Direct Influence (I/D Radio)**

$$\text{I/D} = \frac{\sum \text{f[col.1,2,3 and 4]}}{\sum f[col.5,6 and 7]}\times 100$$

In our sample interaction matrix, I/D = $\frac{6}{10}\times 100 = 60\%$

6. **Teacher Response Ratio(TRR)**

This measures the teacher's attitude to accept students' feeling and ideas. The formula for this is

$$\text{TRR} = \frac{\sum \text{f[col.1,2 and 3]}}{\sum f[col.1,2,3,6 and 7]}\times 100$$

7. **Teacher Question Ratio (TQR)**

This refers to the style of the teacher asking questions while presenting the content in the class. The formula for this is

$$\text{TQR} = \frac{\text{frequency of the 4th column}}{\sum f[col.4 and 5]}\times 100$$

8. **Steady State Ratio (SSR)**

The so called steady state cells [(1,1),(2,2),(3,3),(4,4),(5,5),(6,6),(7,7),(8,8),(9,9).(10,10)]fall on the diagonal of the matrix. Tallies here indicate that the speaker persists in a particular communication category for longer than 3 seconds. Other cells are transition cells moving from one category to another.

$$\text{SSR} = \frac{\sum \text{f[steady state cells]}}{\text{N}} \times 100$$

High value of this ratio indicates monotony in the class as the same kind of activity is persisted for long duration of time.

9. Pupil steady State Ratio(PSSR)

This refers to pupils' participation persisting for more than 3 seconds at a time. The formula for this is

$$\text{PSSR} = \frac{\sum \text{f[cells(8,8) and (9,9)]}}{\sum f[col.8and9]} \times 100$$

10. Instantaneous Question Ratio (TQR$_{8,9}$)

This refers to questioning of teacher in response to pupil's talk. That is the teacher puts questions in a bid to clarify the student's doubts.

$$\text{TQR}_{8,9} = \frac{\sum \text{f[cells(8,4) and (9,4)]}}{\sum f[cells(8,4),(8,5),(9,4)and(9,5)]} \times 100$$

11. Instantaneous Teacher Response Ratio (TFF$_{8,9}$)

This refers to the tendency of the teacher to accept the feelings of the student or make use of the ideas expressed by him classroom discussion, once the student-talk terminates. The formula for this is

$$\text{TRR}_{8,9} = \frac{\sum \text{f[cells(8,1), (8,2), (8,3), (9,1), (9,2)and (9,3)]}}{\sum f[cells(8,1),(8,2),(8,3),(8,6),(8,7),(9,1),(9,2),(9,3),(9,6)and(9,7)]} \times 100$$

12. Pupil Initiation Ratio (PIR)

$$\text{PIR}_{8,9} = \frac{\text{frequency of the 9th column}}{\sum f[col.8and9]} \times 100$$

13. Vicious Circle Ratio (VCR)

This indicates the reprimanding/regulating when the pupil does not provide the desired response. The formula for this is

$$\text{VCR} = \frac{\sum f[\text{cells}(6,6),(6,7),(7,6) \text{ and } (7,7)]}{N} \times 100$$

Norms for Different Behavior Ratios

The obtained behavior ratios are compared to the norms {average performance noticed in a huge target population} to assess the quality the classroom climate, taken up for study. The following table provides the norms established for different behavior ratios, through experimental studies.

<table>
<tr><th>S.No.</th><th>Behaviour-Ratios</th><th>Symbol</th><th>‘Norm’ Established by Ned Flanders (in%)</th><th>Indian Norms (in%)</th></tr>
<tr><td>1.</td><td>Teacher Talk Ratio</td><td>TTR</td><td rowspan="3">$\left.\begin{array}{l}70\\19\end{array}\right\}100$
11</td><td rowspan="3">$\left.\begin{array}{l}67\\21\end{array}\right\}100$
12</td></tr>
<tr><td>2.</td><td>Pupil Talk Ratio</td><td>PTR</td></tr>
<tr><td>3.</td><td>Silence/confusion Ratio</td><td>SCR</td></tr>
<tr><td>4.</td><td>Content Cross Ratio</td><td>CCR</td><td>68</td><td>72</td></tr>
<tr><td>5.</td><td>Ratio between Indirect and Direct Influence</td><td>I/D</td><td>102</td><td>86</td></tr>
<tr><td>6.</td><td>Teacher Response Ratio</td><td>TRR</td><td>35</td><td>26</td></tr>
<tr><td>7.</td><td>Teacher Question Ratio</td><td>TQR</td><td>20</td><td>19</td></tr>
<tr><td>8.</td><td>Steady State Ratio</td><td>SSR</td><td>52</td><td>46</td></tr>
<tr><td>9.</td><td>Pupil Steady State Ratio</td><td>PSSR</td><td>26</td><td>17</td></tr>
<tr><td>10.</td><td>Instantaneous Question Ratio</td><td>$TQR_{8,9}$</td><td>39</td><td>42</td></tr>
<tr><td>11.</td><td>Instantaneous Teacher Response Ratio</td><td>$TRR_{8,9}$</td><td>67</td><td>48</td></tr>
<tr><td>12.</td><td>Pupil Initiation Ratio</td><td>$PIR_{8,9}$</td><td>15</td><td>12</td></tr>
<tr><td>13.</td><td>Vicious circle Ratio</td><td>VCR</td><td>5</td><td>7</td></tr>
</table>

Use of FIAS for Effective Teaching

- A teacher who frequently uses the categories 1,2,3 and 4 is said to be democratic teacher because he encourages more students' participation. Learning proficiency is high in such type of classes.
- A teacher who frequently uses the categories 5,6 and 7 is said to be an authoritative teacher because he gives more directions and curtails students' participation. This results in increased students' dependence. Such teachers are advised to change their teaching style.
- A teacher who gives room for frequent occurrence of category 10 is ineffective in verbal communication and classroom management.

Advantages of FIAS

i) It enables the observer to describe in considerable detail and in sequence, the on-going pattern of classroom events.

ii) It is a well tried and reliable technique to analyse the classroom climate. It has simple rules to codify the classroom events that could be easily mastered and applied.

iii) When properly used, it can serve as a means to develop self-insight on the part of the teacher with objective feed back about his teaching. Thus it enables him to make changes when and where be himself sees fit.

iv) This is used as an effective technique to analyse the patterns of interaction in in-service and pre-service education.

v) This supplements the technique of micro-teaching and team-teaching in teacher education.

Limitations of FIAS

1. This system gives importance to only verbal communication that takes place in the class i.e this system is not adequate to describe the totality of classroom activities. For example the demonstrations conducted in science class, drill and practice given in solving numerical problems in the mathematical class, map drawing skill practiced in social studies class, silent reading undertaken by pupils in language class, blackboard

writing of teachers etc. can not be codified in this system; all these activities will be marked as 10, meaning silence or confusion which is absurd.

2. This system heavily depends on the skills of the observer and his likes and dislikes.
3. Non-verbal communication like gestures, facial expressions, physical movements etc. are over-looked in this system.
4. This system permits no room for pupil discussion.
5. Forming the interaction matrix and undertaking the analysis to infer about the different aspects of teaching behavior are cumbersome, laborious and time-consuming.
6. FIAS could be attempted only by expert teachers who have been specially trained in this.
7. The quality of the subject matter or content can not be judged; only social skills involved in classroom management are taken care of.
8. FIAS is not suitable to study the classroom climate where more formal teaching, that too giving more emphasis for content=coverage is in progress.
9. Utility of FIAS is very much limited for educational researchers who have to study many kinds of problems encountered in education.
10. Both silence and confusion are placed in the same category in FIAS. But silence and confusion are not of same nature. Further no distinction is made between meaningful silence and silence without any reason.
11. Category number 4, does not clarify what type of questions (simple or probing questions) being asked.
12. FIAS does not give much importance for pupil related activities as it shows more concern for analyzing the teaching-behaviour.

Research Findings

H.H. Anderson, Helen and Joseph Brewer, Mary Francis Reed and Flanders have conducted systematic researches on classroom climate, teacher's direct influence and indirect influence. It is important to know about these climates in the classroom. A student beating another student indicates direct influence or domination whereas a student making friendship with another student indicates integration.

The findings of Anderson and others are based on the study of preschool, primary and elementary school classrooms involving several different teachers and extending over several years. Their imaginative research has produced a series of internally consistent and significant findings. First the dominative and integrative contacts of the teacher set a pattern of behavior that spreads throughout the classroom. The behavior of the teacher, more than any other individual, sets the climate of the class. The rule is that when either types of contact predominate, domination incites further domination and integration stimulates further integration. It is the teacher's tendency that spreads among the students even when the teacher is no longer in the classroom; furthermore, the pattern a teacher develops in one year is likely to persist in his classroom the following year with completely different set of students. Second, when a teacher has a higher proportion of integrative contacts, students show more spontaneity and initiative, voluntary social contributions and acts of problem solving. Third, when the teacher has a higher proportion of dominative contacts, the students are more easily distracted from schoolwork and show greater compliance to as well as rejection of, teacher domination.

Anderson and Flanders created laboratory situations in which contrasting patterns of teacher behavior were exposed to one student at a time. A sustained dominative pattern was consistently disliked by students, reduced their ability to recall, later on, the material studied and produced disruptive anxiety as indicated by galvanic skin response and changes in the heart beat rates; reverse trends were noted in student reactions to integrative contacts.

The research findings do not suggest any single pattern of teacher behavior that should be continually maintained in the classroom. Any one with teaching experience recognizes that there are situations in which our integrative teacher behavior pattern is less appropriate than a dominative pattern. Furthermore, it is possible that identical acts by the teacher may in one situation be perceived by students as dominative and in another situation as integrative. The results do show that over a period of time, more integrative than dominative teacher-student contacts will establish desirable student attitudes and superior patterns of work.

Teaching Behaviour Patterns

A pattern of dominance

In this pattern the teacher uses a particular method to solve the problems or to teach the concepts. The students are accustomed to that particular method and if a substitute teacher solves the problem in a different pattern, the students do not accept it though it may an easy method. What we can say is that they have become set in their ways of solving problems.

They are being forced to follow one routine, which is presented to them readymade. Instead of thinking through each new situation, they expect every problem to be like the last standard example. This is “stimulus-response” psychology. By demanding the practice of his routine, the teacher is reducing readiness to think, reducing readiness to reason. His students are discouraged, even prohibited from attempting to scale concepts through creative problem solving.

The tragedy here is that this kind of teachers think that they are “doing their job” but they never try to analyse what “their job is”. They have the knowledge, the intelligence and the inherent abilities to bring children to self-controlled learning, but this never seem important to them.

This kind of teacher operates on schedules and does not care for the slow nor hurry for the fast learners. He gives one example and asks the students to solve other problems in the same manner.

Laissez – Faire Pattern

Laissez – Faire means an idea of certain person that one should not make too many laws but allow things to go on in their own ways. This is a classroom-teaching pattern in which coordination and planning are absent in the teaching approach. In this the teacher gives undue importance to the students and asks them “what do you want to do this period?”. By this the teacher impresses them that they could do what they want; he is there only to help them; they could work in groups, individually or as a class; the examinations are to be made up by the students with his guidance.

The students select some topics. Everyday the groups meet to work in allotted corners and other spaces of the room. The teacher is ready there to help.

Advantages and Disadvantages

1. The students will learn to work together.
2. The best students will learn a great deal. But immature and slow learners idle away their time without any purposeful learning.
3. The students will learn to arrive at hypothesis.
4. They will learn to experiment.
5. They will learn to report and take keen interest in the subject.

6. Amount of student-learning in the classroom may not be substantial.

Democratically Planned Pattern

This is in between a pattern of dominance and one of laissez-faire. The latter does not give room for the kind of responsible guidance a teacher should give his students; the former does not encourage personal responsibility and growth in goal forming and concept seeking which should be a part of every person's education.

The teacher in this pattern asks the students what they like to learn? Based on the aims, students select the topics to be learnt, later each topic will be discussed by the entire class. It's advantages and disadvantages will be weighted in the light of the amount of class time available, its priority in helping to improve the quality of living, its usefulness in helping to pass the examination, its special interest to a few students.

In this pattern the teacher is a guide and friend, he is firm and demanding, but not coercive, he is permissive. There is an absence of threat in his class; there is freedom to proceed with the business of learning but no freedom to disrupt learning. In this pattern the poorer students and the science – shy students have much better opportunity to exert leadership.

So far three different types of classroom climate have been discussed. Among them, which is the most suitable climate?. What activities should be followed by the teacher in order to promote learning in students?. It is important to find answer for these questions.

Generally, when a teacher exercises domination at certain times and integration in appropriate times then it is the best climate suitable for learning. This may appear opposite to the research findings superficially. When we carefully analyse the data gathered from researches. We can find instances of domination of teachers in the classroom.

Some data have already been collected which suggest that younger students aged 5 through 7 do not react to direct influence in the same ways as older students. Data from school classes suggest that certain subjects such as mathematics and science are normally associated with a higher proportion of direct influence although, at the moment, this should be considered as no more than a commentary on current school practices.

Unit X

EVALUATION

The success of any educational system hinged on proper planning, efficient administration, adequate financing and effective evaluation. The evaluation aspect hinges on proper inspection and supervision of the educational programme right from the planning stage through to the final stage when assessment of the whole process and reasonable decisions will be made. Educational evaluation started off as a branch of psychology in the late 50s, as a result of curriculum innovations. It was then referred to as Educational Measurement, Measurement and Evaluation or Test and Measurement. Within the last few decades, educational evaluation has grown into a separate, independent discipline, though with some leanings on the ideas of psychologists, psychometricians and statisticians. In recent years, its development into a complex art and technology had taken place. Efforts of educational evaluators have been directed specifically towards using precision, objectivity and mathematical vigour of psychological measurement in ways directly related to educational institutions, educational processes and purposes.

Evaluation : Meaning

The definition of" evaluation" itself: "Value judgment for an object or its meaning." Education evaluation is analysis and judgment of the value of an educational input, process, and outcome.

Some Operational Definitions of Educational Evaluation

Various ideas and definitions of educational evaluation are given by different people/researchers.

Tyler (1950) defined evaluation as "the process of determining the degree to which goals of a programme have been achieved". He sees evaluation as a measure of the success of the outcome of a programme.

Crombach (1960) defined evaluation as "the collection and use of information to make decisions about an educational programme".

Wheeler (1967) defined evaluation as a more general judgement of the outcome of a programme, which involves the use of observations, various tests, questionnaires, interviews, etc. His emphasis was on the processes of educational evaluation.

Alkin (1970), like Wheeler, emphasized the processes of educational evaluation. He defined evaluation as the process of ascertaining the decision areas of concern; selecting appropriate information, collecting and analysing information, in order to report a summary of data useful for decision makers in selecting among alternatives.

Blooms et al (1971) gave two types of evaluation (formative and summative) and the respective definitions of each. Formative evaluation is defined as a system of quality control in which it may be determined at each step in the teaching-learning process, whether the process is effective or not, and if not, what changes must be made to ensure its effectiveness;

while summative evaluation is defined as an evaluation directed towards a much more general assessment of the degree to which the larger outcomes have been attained over the entire course.

Paul (1976) defined evaluation as both a judgement on the worth or impact of a programme, procedure or individual and the process whereby judgement is made.

Yoloye (1981) defined evaluation as the assigning of some values to an entity in relation to some criteria values or objectives.

Afolayan (1985) saw curriculum evaluation as subsuming both formative and summative assessment of the adequacy of any educational programme.

Tyler (1951):

"Education evaluation is the judgment process for the educational goal (behavioral objectives) realized through education and class activities."

Cronbach (1984):

"Education evaluation is the process of information gathering and treatment necessary to make a decision for an education program."

Stufflebeam (1971):

"Process of information defining, acquiring, and providing necessary for decision-making process."

FUNCTION OF EDUCATION EVALUATION

Education evaluation has confirmation and judgement functions concerning how well the educational goal is realized, based on the goal as originally defined. It also has information-gathering and application functions necessary for making decisions regarding learners, educational methods, and administrative assistance. In addition, it has formative functions for development, revision and supplementation, and alternatives research for new and better educational programs, as well as the strategic functions of advertisement, attention, and motivation.

PHASES OF EDUCATION EVALUATION

First Phase:

Create the Evaluatian Plan:

Because the contents and methods of evaluation differ by evaluation plan, confirm the evaluation goals or necessity, and set up the evaluation plan and design by arranging for phases such as setting education goals, stating methods, selecting the evaluation design, producing the evaluation tools, collecting evaluation data, analyzing evaluation results, and applying evaluation results.

Second Phase:

State the Evaluation Goal:

Decide on the evaluation goal, and select the best statement methods possible, based on the goals that the evaluation process is to achieve. Confirm the evaluation goal, state it, analyze and evaluate the stated goal, and create a dual classified table.

Third Phase:

Select an Evaluatian Design:

Create a specific design, according to the evaluation goal, to collect, analyze, and compare the data expected to be received during the evaluation. Set up tests, composition of sample space, evaluation time, number of evaluations, and the relative standards for evaluation results.

Fourth Phase:

Produce Evaluation Tails:

Decide on the evaluation methods or measuring tools that will be used to collect data or information, and produce the best evaluation tool possible.

Fifth Phase:

Collect the Evaluatian Data:

After selecting and producing the evaluation tools, collect the actual information and data by acquiring the necessary labor, facilities, and time; check and improve the given condition.

Sixth Phase: Analyze the Evaluation Results:

Arrange and grade the information and data collected during the fifth phase to obtain the mean, variance, and standard deviation. Analyze the collected data qualitatively and quantitatively, according to the evaluation goal.

Seventh Phase:

Report the evaluation results.

Eighth Phase:

Apply the Evaluation Results:

Based on the evaluation results, improve the education methods, induce motivation to learn, apply the various evaluation results according to the evaluation goals, and check the end result.

METHODS OF EDUCATION EVALUATION

Evaluation Types Based an Domain:

Bloom (1956) suggested a taxonomy of education objectives, setting standards on the content of education and behavior dimensions, and dividing into goals of cognitive, affective, and psychomotor domains.

Evaluation of the Cognitive Domain:

This evaluation measures the achievement of cognitive education goals that can be achieved by conceptual process such as memorizing, understanding, and reasoning on the educational contents specified in the educational goals.

Evaluation of Affective Domain:

This evaluation looks at changes or improvements in interest, merit, confidence, and attitude, or characteristics such as a spirit of cooperation, responsibility, law-abiding nature, sociality, and self-consciousness.

Evaluation of Psychomotor Domain:

This evaluation measures the achievement of education goals that can be achieved by using whole of parts of the body such as hands, feet, legs, and shoulders. Evaluatian **Types Based an Methods:**

According to the education process or program evaluation method, Scriven (1965) divided evaluation types into formative and summative evaluations.

Formative Evaluation:

This evaluation accumulates information to enhance methods and optimize education while the education is in progress.

Summative Evaluation:

This final, total evaluation, which takes place after fixing and repairing by Formative Evaluation, gives a diversified decision about a completed education process or the total result or effectiveness of program.

Types of Evaluation:

Three main types of evaluation are identified:

Diagnostic (initial) Evaluation –

The evaluation is done during the formation of educational objectives. It is used to decide the entry behaviours of the learner in a particular course or programme. It takes place before the commencement of the programme.

Formative Evaluation –

Evaluation within or during the development of a course or programme. It is used in improving the performance of both the teacher, the student and curriculum developer. It is used in determining the mastery level of the learner and the remedy to make. It is a quality control evaluation.

Summative (Final) Evaluation –

The evaluation is carried out at the end of a course or programme for grading, certification and placement. It is used in making decisions regarding the future of the students teaming or the programme being developed; whether it should be continued or terminated, replicated or disseminated.

Types of Evaluation

There are many different types of evaluations depending on the object being evaluated and the purpose of the evaluation. Perhaps the most important basic distinction in evaluation types is that between *formative* and *summative* evaluation. Formative evaluations strengthen or improve the object being evaluated -- they help form it by examining the delivery of the program or technology, the quality of its implementation, and the assessment of the organizational context, personnel, procedures, inputs, and so on. Summative evaluations, in contrast, examine the effects or outcomes of some object -- they summarize it by describing what happens subsequent to delivery of the program or technology; assessing whether the object can be said to have caused the outcome; determining the overall impact of the causal factor beyond only the immediate target outcomes; and, estimating the relative costs associated with the object.

***Formative evaluation* includes several evaluation types:**

1. *needs assessment* determines who needs the program, how great the need is, and what might work to meet the need
2. *evaluability assessment* determines whether an evaluation is feasible and how stakeholders can help shape its usefulness
3. *structured conceptualization* helps stakeholders define the program or technology, the target population, and the possible outcomes
4. *implementation evaluation* monitors the fidelity of the program or technology delivery
5. *process evaluation* investigates the process of delivering the program or technology, including alternative delivery procedures

***Summative evaluation* can also be subdivided:**

1. *outcome evaluations* investigate whether the program or technology caused demonstrable effects on specifically defined target outcomes
2. *impact evaluation* is broader and assesses the overall or net effects -- intended or unintended -- of the program or technology as a whole
3. *cost-effectiveness and cost-benefit analysis* address questions of efficiency by standardizing outcomes in terms of their dollar costs and values
4. *secondary analysis* reexamines existing data to address new questions or use methods not previously employed
5. *meta-analysis* integrates the outcome estimates from multiple studies to arrive at an overall or summary judgement on an evaluation question

Principles of Educational Evaluation

There are important factors to note which can serve as guides to educational evaluators in seeing to the effective planning and implementation of educational programmes, to yield the desired positive results. The classroom teacher or evaluator should always be perfectly clear in bis mind about what he is aiming to achieve i.e. what to evaluate and how to evaluate.

Evaluation of educational programmes should be comprehensive i.e. assess pupils' progress in all areas. Educational evaluation, apart from testing knowledge (Memorization), should also bring about pupils* originality and use of ideas, and their ability to think and apply the knowledge and skills already learnt. All evaluation devices/instruments should be valid and reliable. They are valid when they measure what they aim to measure, and they are reliable when they produce consistent results over time. The teacher as an evaluator should be impartial as much as possible. He should try to avoid personal prejudices. All evaluation instruments should take into account the practical problems of administering and marking of the responses i.e. the instruments should be convenient to administer and clear to the pupils. The pupils' responses should be easy to mark. Educational evaluation should be well planned in advance and should be carried out continuously, periodically and at least each term.

Types of Achievement Tests

- An achievement test is a systematic procedure for determining the amount a student has learned.
- According to the nature of content and various functions, achievement tests can be classified into four different types namely.
    1. Placement tests (to assess entry behavior)
    2. Formative tests (to monitor learning difficulties)
    3. Diagnostic tests (to diagnose learning difficulties)
    4. Summative tests (to certify mastery or assign grades at the end of instruction)
- Moreover, achievement tests can be divided into two types depending on the nature of interpretation of scores. They are,
    1. Norm-referenced tests (relative ranking of student)
    2. Criterion – referenced tests (learning tasks a student can and cannot perform
- Apart from above, achievement tests can be classified into three categories depending upon the types of methods applied. They are,
    1. Written tests (to obtain written records)
    2. Oral tests (to select professionals)
    3. Practical tests (to measure skill outcomes)
- Written test can also be divided into the types. They are,
    1. Essay tests
    2. Objective tests

Advantages of written tests

- More evidence could be obtained of the achievements of each pupil or teacher.
- A written record of those achievements would be produced.
- Each pupil would be asked the same questions ; thus all would be treated alike.
- There would be less possibility of favoritism for or bias against particular pupils or teachers.

Objective Tests

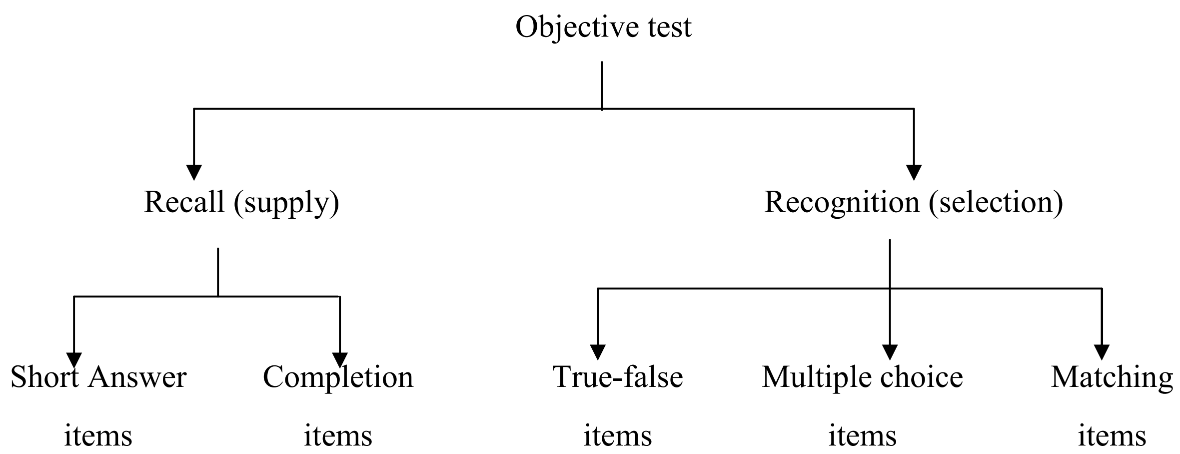
♦ The items which can be scored objectively are called objective items.

♦ Knowledge outcomes are typically measured by objective test items because these items types –

- can be adapted more easily to the specific learning outcomes to be measured.
- provide for more adequate sampling of student's behavior, and
- can be scored more quickly and objectively.

♦ Objective test item can be used to measure a variety of knowledge outcomes. Complex learning outcomes ranging from the lowest level of understanding to the highest levels of intellectual skill can be measured by objective test items.

♦ Various types of objective tests



Short Answer or Completion Items

♦ The short answer (or completion) item is the only objective item type that requires the examinee to supply, rather than select, the answer.

♦ It consists of a question or incomplete statement to which the examinee responds, by providing the appropriate words, numbers, or symbols.

e.g - What are the incorrect responses in a multiple choice item called?

- The incorrect responses in a multiple-choice item are called ____ .

Answer : Distracters

Weaknesses

- It is extremely difficult to phrase the question or incomplete statement so that only one answer is correct.

- spelling

It should be reserved for those special situations where supplying the answer is necessary part of the learning outcomes to be measured.

Rules for constructing short answer or completion item

- State the item so that only a single, brief answer is possible.
- Start with a direct question, and switch to an incomplete statement only when greater conciseness is possible by doing so. [The words to be supplied should relate to the main point of the statement].
- Place the blanks at the end of the statement.
- Avoid extraneous clues to the answer.
- For numerical answers, indicate the degree of precision expected and the units in which they are to be expressed.

True-False Items

- ♦ The true – false item is simply a declarative statement that the student must judge as true or false.
- ♦ This item type is characterised by the fact that only two responses are possible.

  e.g. True-false items are classified as a supply – type item. (T/F)

  (Answer : F)
- ♦ Since only two choices are possible, the uninformed students has a fifty-fifty chance of guessing the answer.
- ♦ Whenever there are only possible responses, the true-false item or some adaptation of it is likely to provide the most effective measure.
- ♦ When assembling the test, it is necessary to place true and false statement in a random fashion.

Rules of construction true – false items

- Include only one central, significant point in each statement.
- Word the statement so precisely that it can unequivocally be judged true or false.
- Keep the statements short and use simple language structure.

- Use negative statements sparingly, and avoid double negatives.
- Statements of opinion should be attributed to some source.
- Avoid extraneous clues to the answers.

Multiple-Choice Items

- The multiple-choice items, the modification of the true-false item are the most generally useful formats for measuring complex achievement.
- It consists of a stem, which presents a problem situation, and several alternatives, which provide possible solution to the problem.
- The stem may be a question or an incomplete statement. The alternatives include the correct answer and several plausible wrong answers, called distracters. The function of the latter is to distract those students who are uncertain of the answer.
- It typically includes either four or five choices.

e.g - Which one of the following item types is an example of a supply-type test item?

A. Multiple-choice item

B. True-false item

C. Matching item

D. Short answer item

An example of a supply-type test item is the _________ .

A. Multiple-choice item

B. True-false item

C. Matching item

D. Short answer item

Answer : D

Rules for constructing multiple-choice items

- Design each item to measure an important learning outcome.
- Present a single clearly formulated problem in the stem.
- State the stem of the items in simple, clear language.
- Put as much wording as possible in the stem of the item.
- State the stem of the item in positive form, whenever possible.
- Emphasize negative wording whenever it is used in the stem of the item.
- Make certain that the intended answer is correct or clearly best.

- Make all alternatives grammatically consistent with the stem of the item and parallel in form.
- Avoid verbal clues that might enable students to select the correct answer or to eliminate an incorrect alternative.
- Make the distracters plausible and attractive to the uninformed.
- Vary the relative position of the correct answer in a random manner.
- Control the difficulty of the item either by varying the problem in the stem or by changing the alternatives.
- Make certain each item is independent of the other items in the tests.
- Use an efficient item format.

Matching Items

♦ The matching item is simply a modification of the multiple-choice form. Instead of the possible responses being listed underneath each individual stem, a series of stems; called premises, is listed in one column and the responses are listed in another column.

e.g. - Direction : Column A contains a list of characteristics of objective test items. On the line at the left of each statement, write the letter of the test item in Column B that best fits the statement. Each response in Column B may be used once, more than once, or not at all.

		Column A	Column B
D	1.	Best for measuring computational skills.	A.. Matching item
C	2.	Least useful for educational diagnosis	B. Multiple-choice item
B	3.	Measures greatest variety of learning outcomes.	C. True-false item
D	4.	More difficult to score objectively	D. Short answer item
C	5.	Provide the highest score by guessing alone	
D	6.	Measures learning at the recall level	

Rules for constructing matching items

- Include only homogeneous material in each matching item.
- Keep the list of items short and place the brief responses on the right.
- Use a larger, or smaller, number of responses than premises.

- Specify in the direction the basis for matching and indicate that each response may be used once, more than once, or not at all.

Essay Tests

- The notable characteristic of the essay test is the freedom of response it provides.
- The essay question places a premium on the ability to produce, integrate, and express ideas.

Weaknesses

- limited sampling of achievement it provides.
- concerned with the student's response

  i.e. writing ability, poor expression, errors in punctuation, spelling and grammar typically lower the scores assigned to essay answers.

  subjective nature of the scoring. The scoring is not only difficult and time consuming but also tends to be inconsistent.

- A balanced testing program would include the use of both objective and essay questions.
- **Type of essay questions**
  1. Restricted – response questions (placed strict limits on the answer to be given)
  2. Extended – response questions (gave the student almost unlimited freedom to determine the form and scope of his response).

- **How can the reliability of essay tests be improved?**
  - By asking more questions that call for short answer than by asking fewer questions that call for long answers.
  - By attempting to write an ideal answer to it.
  - By grading them question by question, by concealing the name of the examinee, and by arranging for several independent gradings.
  - By making the questions specific enough so that all good answers must be clearly identical.
- **Rules for constructing essay questions**
  - Use questions to measure complex learning outcomes only.
  - Relate the questions as directly as possible to the learning outcomes being measured.
  - Formulate questions that present a clear task to the student.
  - Do not permit students a choice of questions unless the learning outcome requires it.

- Provide ample time for answering and suggest a time limit in each question.

Test Construction

Steps involved in constructing a test are : -

1. Determine the purpose of the test.
2. Identify the learning outcomes to be measured by the test.
3. Define the learning outcomes in terms of specific, observable behavior.
4. Outline the subject matter to be measured by the test.
5. Prepare a table of specifications.
6. Use the table of specifications as a basis for preparing tests.

Educational objectives were identified as three domains :

1. Cognitive domain
2. affective domain, and
3. psychomotor domain

The Cognitive domain is concerned with intellectual outcomes, the affective domains with interest and attitudes, and the psychomotor domains with motor skills.

♦ **Intellectual outcomes in the cognitive domain are**

- Knowledge (remembering previously learned materials)
- Comprehension (grasping the meaning of material)
- Application (using information in concrete situations)
- Analysis (breaking down material into its parts)
- Synthesis (putting parts together into a whole)
- Evaluation (judging the value of a thing for a given purpose using definite criteria)

♦ Table of specifications is a table that states outcomes to content and indicates the relative weight to be given to each of the various areas.

E.g. Table of specifications for an achievement test

CONTENT / **OUTCOMES**	The nature of achievement tests	Types of achievement test	Planning the test	Total number of items

Knowledge Comprehension Application Analysis Synthesis Evaluation	6 5 5	8 10 6	20 7 13	34 22 24
Total number of items	16	24	40	80

Thus, the key to effective achievement testing is careful planning.

Reliability and Validity

- To test and measure human achievement and ability systematically is not an easy task.
- To be table to make the nearest estimation of human ability, the test must possess two important characteristics :
  1. Reliability
  2. Validity
- **Reliability** is the estimation of the consistency of measurement attained by educational and psychological tests.
  - it answers the question "how consistency does a test measure?"
  - it refers to the positive degree of relationship between scores under varying testing conditions.
- **Three methods of finding reliability coefficient** are
  1. Test-retest method
  2. Parallel forms method
  3. Split-half method
- **Factors influencing the reliability coefficient** ae
  - test difficulty
  - length of test
  - range of individual differences
  - time limit
  - proper instruction
  - test anxiety

- item discrimination

- ♦ **Validity**
    - it refers to the degree of relationship between what the test measures and what is supposed to measure
    - it answers the question "Is the test actually measuring what it is designed . to measure?"

- ♦ **Basic types of validity**

Type	Question to be answered
Content Validity	How adequately does the test content sample the larger universe of situations it represents?
Criterion-related Validities	How well does test performance predict future performance, (predictive validity) or estimate present standing (concurrent validity) on some other valued measure called a criterion?
Construct Validity	How well can test performance be explained in terms of psychological attributes.

EDUCATIONAL STATISTICS

As much as teaching and testing go together, statistics and testing go hand in hand. Through tests, we can find out

(1) how much pupils learn from our teaching, i.e the achievement of our pupils, and

(2) whether our teaching is effective or not.

This can be done by treating and processing the test results.

Statistics, as we know, is the study of the collecting and analyzing of data to see what inference and conclusions can be drawn.

Statistics can be defined as the legal data, which describe, summarize, generalize the condition of a country or a school or a department or a student. It is essential and indispensable in important fields of specialization in education.

After a test has been given, it is essential to arrange the scores in some order and do some calculations to interpret the results. The basic knowledge of statistics is essential to enable us to process these test scores.

The aim of teaching statistics in this course is to enable the students to

(1) construct test systematically,

(2) compile and analyze data, and

(3) interpret the results scientifically.

Frequency Distribution

The score by itself is meaningless. They are only useful, if order can be put into the collected scores. It is the statistical methods that put orders into data.

One of the most fundamental techniques for putting order into a disarray of data is the frequency distribution. Basically, it is a systematic procedure for arranging individuals from least to most in relation to some quantifiable characteristics.

Frequency distributions are constructed primarily for two reasons. First, they put the data into order so that visual analysis can be made of the results of the measurements, and secondly, they provide a convenient structure for simple computations.

Frequency distributions mean the way the scores within a group are spread out. From the frequency distribution, we can know

(1) the number of scores above and below the Mean.

(2) whether me scores are all bunched up around the Mean or spread about quite far away form the Mean towards either end of the range.

The two types of Frequency distribution tables are as follows:

(1) Frequency distribution table where actual scores are used as groups, and

(2) Frequency distribution table where ordered data are grouped within the range of intervals.

Frequency distribution table can be set up by

(1) finding the range,

(2) dividing the difference by 15 or 10

(3) writing down the class intervals, and

(4) taking frequency counts.

An example using English test scores of 25 students will illustrate the procedure for setting up the two types of frequency distribution table.

English test scores of 25 students

75	72	77	68	71
80	78	63	87	72

67	70	66	70	72
82	83	76	76	70
62	65	84	68	62

Table 1 A Frequency Distribution of English Test Scores of 25 Students

Scores X	Number of Student (frequency)	Scores X	Number of Student (frequency)
87	1	74	0
86	0	73	0
85	0	72	3
84	1	71	1
83	1	70	3
82	1	69	0
81	0	68	2
80	1	67	1
79	0	66	1
78	1	65	1
77	1	64	0
76	2	63	1
75	1	62	2

Table 2 A Second Frequency Distribution of English Test Scores of 25 Students

Class Interval X	Frequency f
85-87	1
82-84	3
79-81	1
76-78	4
73-75	1
70-72	7
67-69	3
64-66	2
61-63	3
Total	25

From the above frequency distribution, we can calculate the followings:

(1) The Range

Range = Highest Score – Lowest Score

From Table 1, Range = 87 – 62 = 25

From Table 2, Range = 86 – 62 = 24

(2) Exact Limits of The Class Interval (85-87)

Exact Lower Limit = 84.5

Exact Upper Limit = 87.5

(3) Size of class interval (CI)

CI = U – L

CI for the interval (85-87) = 87.5 – 84.5 = 3

(4) Mid point of the class interval x = $\frac{(U+L)}{2}$

Mid point of the class interval (85-87) = $\frac{(84.5+87.5)}{2}$ = 86

$$\text{(5) CI} = \frac{\text{Range}}{\text{No. of Class Intervals}}$$

(i) If range is 60, and number of class intervals is 12, then CI equals 5.

(ii) If range is 80, and CI is 5, then the number of class interval equals 16

(iii) If the number of class intervals is 10 and CI is 3, then range equals 30

Exercises

(1) Find the exact limits, mid point and CI of the interval (56-60).

(2) Given the following IQ data, construct a frequency distribution according to prescribed procedures.

144, 116, 97, 111, 112, 85, 132, 128, 123, 106, 80, 93, 118, 113, 104, 121, 101, 117, 138, 122, 118, 112, 109, 114, 105, 125, 129, 133, 103, 92.

(3) Using the given data, construct two frequency distribution table assuming CI = 3, and CI = 5.

115, 108, 102, 106, 103, 97, 104, 105, 110, 97, 101, 103, 92, 92, 105, 104, 106, 93, 103, 95, 104, 98, 106, 91, 102, 99, 103, 96, 99, 102.

Graphic Representation of Data

Graphs are used in the practical handling of real set of data. It is also used as visual models in thinking about statistical problems.

The graphic representation of education of educational data takes various forms. They are:

(1) Pie Chart

(2) Bar Graph

(3) Pyramid

(4) Histogram

(5) Frequency Polygon

(6) Cumulative Frequency Curve

(7) Cumulative Percentage Curve or Ogive

(1) Pie Chart

The pie chart is a convenient way of indicating the various components of a whole. It is useful when one wishes of picture proportions of the total in a striking way.

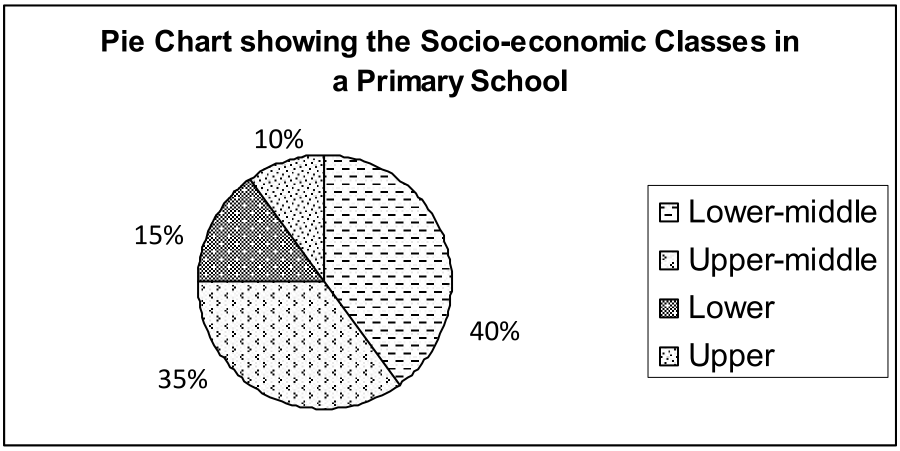


Fig 1 Pie Chart showing the socio-economic classes in a Primary School

(2) Bar Graph

Bar graphs are commonly used to represent the size of measures, scores, percentages etc. It is often used in Education and Psychology to compare the relative amounts of some traits (height. intelligence) possessed by two or more groups.

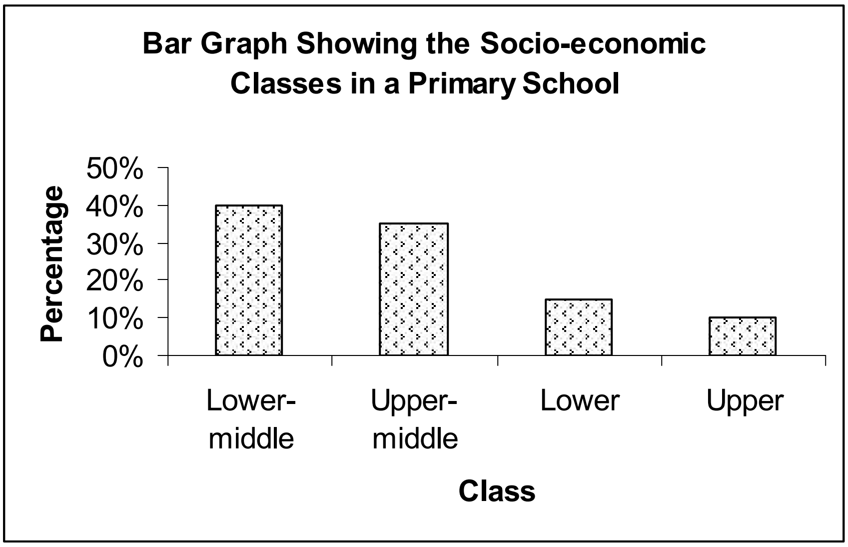


Fig 2 Bar graph showing the socio-economic classes in a Primary School

(3) Pyramid

Pyramids are used for the purpose of comparing the number of students enrolled by levels, by grades and by sex etc.

The data represented by the pyramid are very helpful for educational administrators and planners.

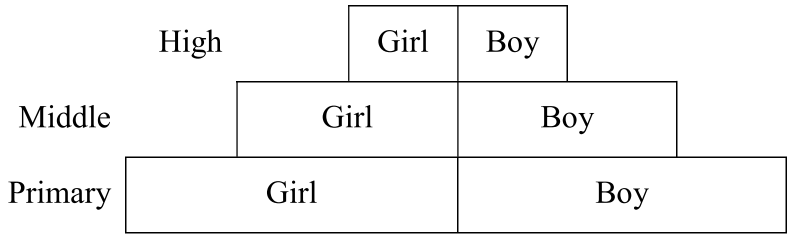


Fig 3 Pyramid showing the general feature of enrollment in a High School.

(4) Histogram

One way of presenting frequency distribution in a graphic form is a histogram. A histogram is a graph plotted by exact limits and their respective frequencies. In a histogram, the scores are assumed to be spread uniformly over the entire interval.

It shows how the scores in the group are distributed-whether they are piled up at the low or high end of the scale or are evenly distributed over the scales.

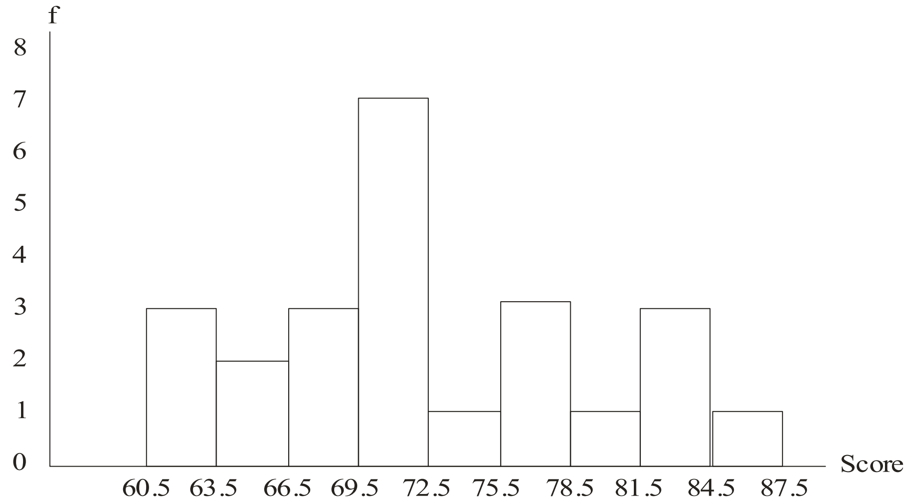


Fig 4 Histogram showing distribution of English test scores of 25 students.

(5) Frequency Polygon

Sometimes we wish to reflect the continuous nature of our data. By placing a point at the center of the top of each bar (class interval) and connecting these points and lines, we will get a frequency polygon. In a frequency polygon, we assume that all cases in each interval are concentrated at the mid-point of the interval. Thus, a frequency polygon is a graph plotted by actual scores or mid points and their respective frequencies. It is likely to be more useful in comparing two or more graphs plotted on the same axes.

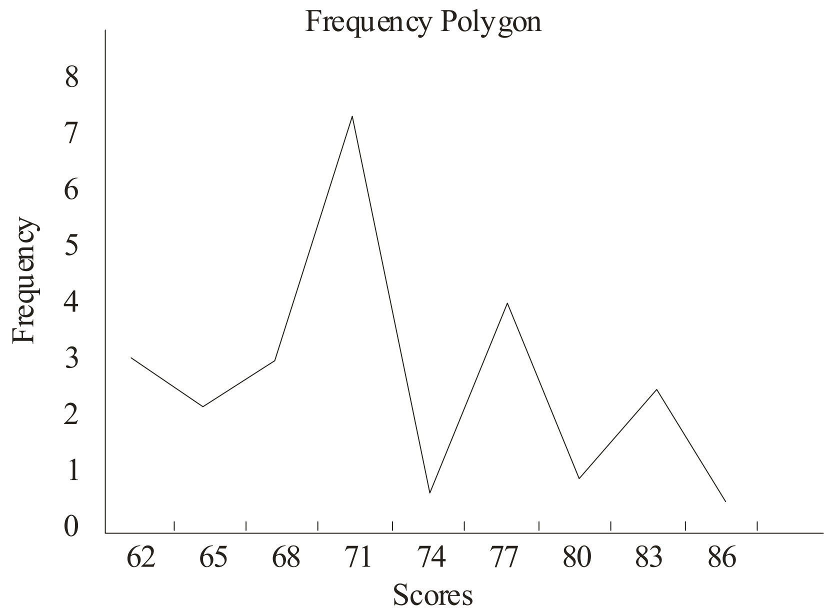


Fig 5 Frequency Polygon showing distribution of English Test Scores or 25 students.

Frequency distribution curve can generally be classified into two types, depending on the shape of the curve.

(1) Symmetrical Curve

(2) Skewed Curve

- Positively Skewed Curve
- Negatively Skewed Curve

(1) Symmetrical Curve

A curve is symmetrical when one half of the curve is a mirror image of the other half.

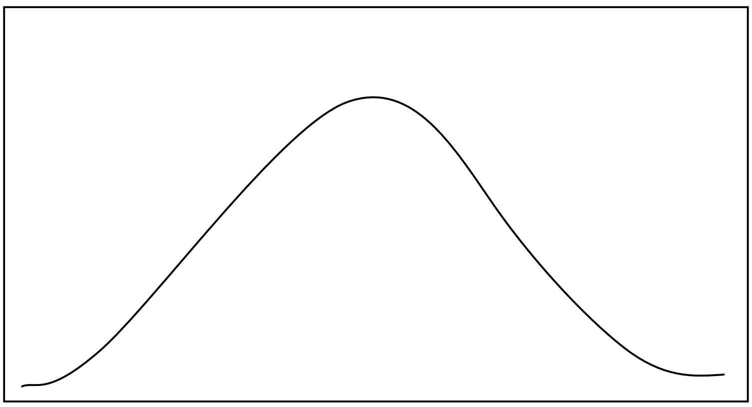


Fig 6 An example of a symmetrical curve

(2) Skewed Curve

A curve is skewed it is not symmetrical.

(i)Positively Skewed Curve

If the massing of the scores is at the left end of the curve with the tail extending to right end, then the curve is positively skewed.

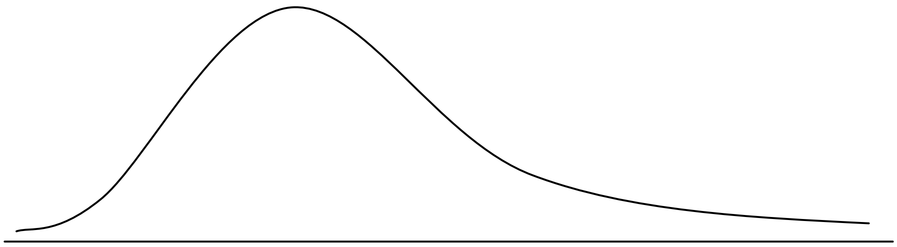


Fig 7 An example of positively skewed curve

(ii)Negatively Skewed Curve

If the massing of the scores is at the right end of the curve with tail extending to the left end, then the curve is negatively skewed.

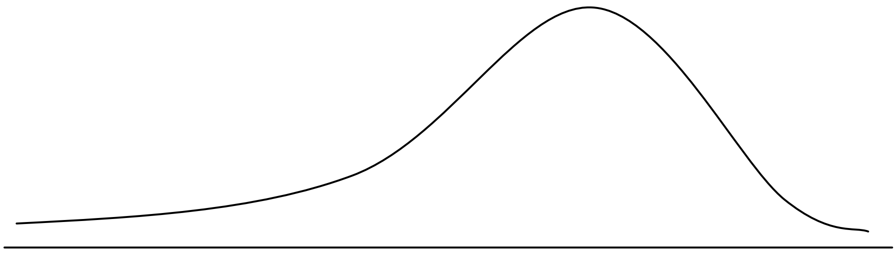


Fig 8 An example of negatively skewed curve

(6)Cumulative Frequency Curve

The cumulative frequency is used to determine the number of cases falling above or below particular values. In cumulative frequency curve, we plot points above the top of the exact limits of the interval.

X	f	F	F%
85-87	1	25	100

82-84	3	24	96
79-81	1	21	84
76-78	4	20	80
73-75	1	16	64
70-72	7	15	60
67-69	3	8	32
64-66	2	5	20
61-63	3	3	12

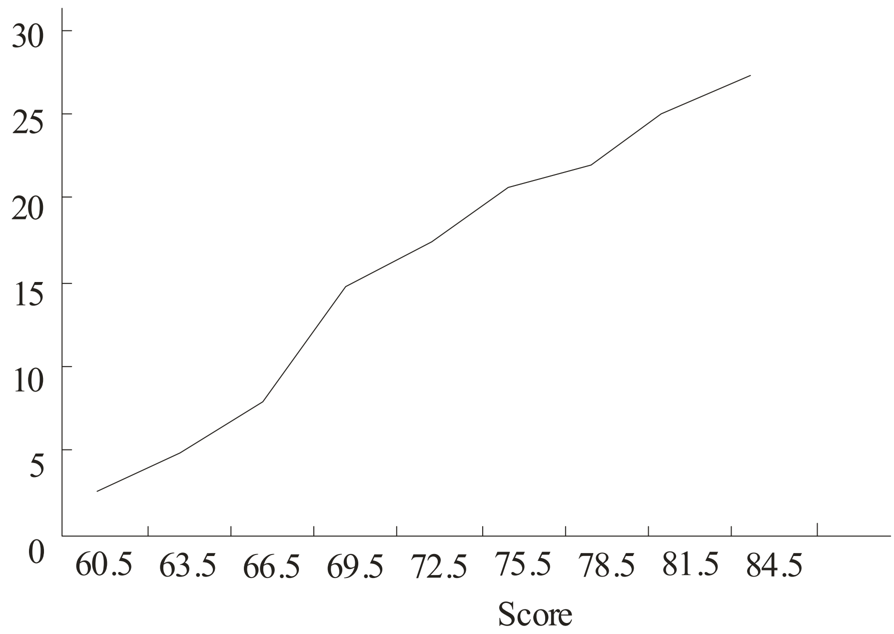


Fig 9 Cumulative frequency curve showing distribution of English test scores of 25 students

(7) Cumulative Percentage Curve or Ogive

We may determine the cumulative percentage frequencies by converting raw frequencies to percentage. A cumulative percentage or Ogive can be obtained by graphing these frequencies.

The advantage of this type of graph is that, from it, we can read off directly the percentage of observations less than any specified values. Percentiles and percentile rank can be determined quickly an fairly accurately from this Ogive.

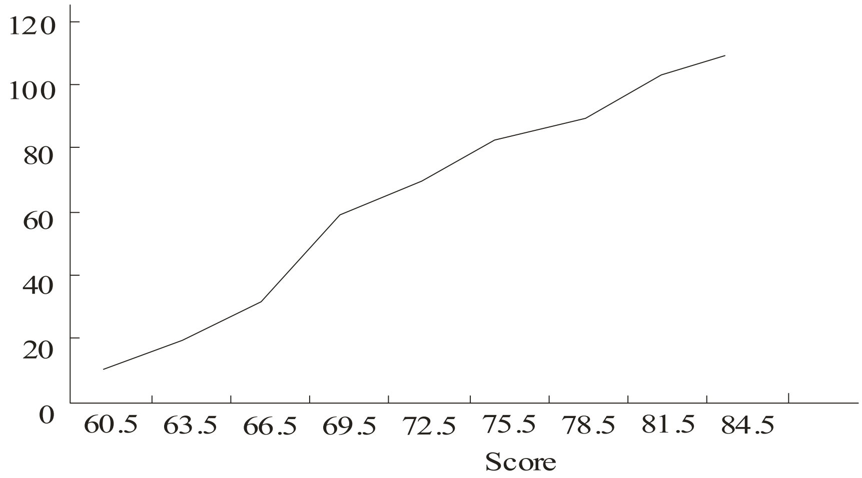


Fig 10 Cumulative Percentage Curve or Ogive showing distribution of English test scores of 25 students

Exercises

(1) Draw a (i) Pie Chart (ii) Bar Chart from the given percentages of students attending school in a township.

Primary Level	45%
Secondary Level	35%
High School Level	15%
Colleges Level	5%

(2) Plot a (i) Histogram (ii) Frequency Polygon (iii) Cumulative Frequency Curve (iv) Cumulative Percentage Curve or Ogive, from the given distribution of spelling test scores.

X	f
46-50	4
41-45	6
36-40	10
31-35	18
26-30	6
21-25	3
16-20	1
Total	50

Measures of Central Tendency

In the previous chapters, we are concerned with the organization of collections of numbers in the form a frequency distribution and how such frequency distribution could be presented in tabular or graphic form. Now we will proceed to a consideration of how a collection of numbers may be described in a single value.

Measures of central tendency is a value around which a distribution tends to center. It gives us a concise description of the typical performance of the group as a whole. It enables us to compare the performance of two or more groups. The indicators of central tendency are the mean, the median and the mode.

The Mean

The mean is the arithmetic average. Of the three statistics, it is the most stable from sample to sample.

The mean is simply the sum to series of measures divided by the number of measures. It is represented by the Symbol X.

The formula for mean is:

$$\overline{X} = \frac{\sum X}{N}$$

where $\overline{X}$ = mean

X = individual score

N = total number of measures

= summation

Example

(1) Find the mean of the following scores.

19, 20, 26, 18, 21, 8, 20, 24, 15, 18, 20

$\sum X = 209 \quad N = 11$

$$\therefore \overline{X} = \frac{\sum X}{N} = \frac{209}{11} = 19$$

$$\overline{X} = 19$$

The Median

By simple definition, the median is the mid-point in a set of ranked scores.

The median is not influenced by how far extreme scores may range in a given distribution because the range of these scores does not change the point that divides the distribution into two equal-sized groups.

Examples

(1) What is the median of the following set of scores?

22, 28, 19, 25, 8, 23, 20

First, arrange the scores in order of magnitude.

28, 25, 23, 22, 20, 19, 8

Here the middle score is 22.

$\therefore$ The median of this set of scores is 22. There is only one score in the center when working with odd number of scores.

When even number of scores are given, the arithmetic mean of two middle scores would be the median.

(2) What is the median of the following set of scores?

20, 19, 22, 17, 15, 25, 12, 18

First arrange the scores in order of magnitude.

25, 22, 20, 19, 18, 17, 15, 12

$\therefore$ **Median** = $\frac{18+19}{2}$ = 18.5

The Mode

The mode is simply the most frequently occurring score in a distribution. It is less frequently used measure of central tendency. It is used in preference to either the median or the mean, when a measure of the most characteristic of a group is desired.

Example

(1) Find the mode of the given set of scores.

2, 3, 3, 2, 4, 5, 2

Here the most frequently occurring score 2 is the mode.

Mode = 2

(2) Find the mode of the given set of scores.

3, 4, 5, 6, 7, 8

Since all the frequency of each score is equal, there is no mode.

Also if the given scores are 2, 2, 3, 3, 4, 4, 5, 5, there is no mode since the frequency of each score is equal.

(3) Find the mode of the given set of scores.

4, 4, 5, 5, 6, 6, 6, 7, 7, 7, 8, 9

Since the most frequently occurring scores 6 and 7 are consecutive,

$$\text{Mode} = \frac{6+7}{2} = 6.5$$

(4) Find the mode of the given set of scores.

4, 4, 4, 5, 5, 6, 6, 7, 7, 7

Here, there are two modes namely 4 and 7.

Calculation of Measures of Central Tendency from a Frequency Distribution Table

Calculation of the Mean

Example (1) Find the mean using the given frequency distribution table.

Table 1 : Table showing mathematics test scores of 50 students.

X	f	fX
10	2	20
9	4	36
8	9	72
7	15	105
6	8	48
5	7	35
4	5	20
Total	50	336

Here $\sum fX = 336$, $\sum f = 50$

Using the formula $\overline{X} = \dfrac{\sum fX}{\sum f}$

$$\overline{X} = \frac{336}{50} = 6.72$$

$$\therefore \text{Mean} = 6.72$$

Steps

1. Multiply each score by its respective frequency.
2. Add these products.
3. Divide the sum of the products by the sum of frequencies.

Example (2) Find the mean using the given frequency distribution table.

Table 2 Table showing English test scores of 50 students.

X	*f*	*X*	*fx*
65-69	2	67	134
60-64	10	62	620
55-59	11	57	627
50-54	12	52	624
45-49	9	47	423
40-44	5	42	210
35-39	1	37	37
Total	50		2675

Here $\sum fX = 2675$, $\sum f = 50$

Using the formula $\overline{X} = \dfrac{\sum fX}{\sum f}$

$$\overline{X} = \frac{2675}{50}$$

$$= 53.5$$

$$\therefore \text{Mean} = 53.5$$

Steps

1. Calculate the mid-point of all intervals.
2. Multiply each mid-point by the corresponding frequencies.

3. Sum the product of mid-point by frequencies.
4. Divide this by sum of frequencies, i.e., (*N*)

Calculation of the Mean by the short method

Example (1) Find the mean from the following distribution table.

X	f	d	fd
10	2	3	6
9	4	2	8
8	9	1	9
7	15	0	0
6	8	-1	-8
5	7	-2	-14
4	5	-3	-15
Total	50		-14

The formula for using the shorts method is

$$\bar{X} = AM + \frac{\sum fd}{\sum f} \times CI$$

where, AM = Assumed Mean

$$d = \frac{X - AM}{CI}$$

From the table

$AM = 7$

$\sum fd = -14$

$\sum f = 50$

$CI = 1$

$$\therefore \bar{X} = 7 + \frac{-14}{50} \times 1$$

$= 7 - 0.28$

$= 6.72$

Example (2) Find the mean from the following distribution table.

X	f	d	fd
65-69	2	3	6
60-64	10	2	20
55-59	11	1	11
50-54	12	0	0
45-49	9	-1	-9
40-44	5	-2	-10
35-39	1	-3	-3
Total	50		15

Here AM $= 52$

$\sum fd = 15$

$\sum f = 50$

CI $= 5$

$$\overline{X} = AM + \frac{\sum fd}{\sum f} \times CI$$

$$\overline{X} = 52 + \frac{15}{50} \times 5$$

$$= 52 + 1.5$$

$$= 53.5$$

Combined Mean

Sometimes we have means or several different samples and would like to know the mean for the total combined group.

The formula for computing a combined mean is

$$\overline{X} = \frac{N_1\overline{X}_1 + N_2\overline{X}_2 + ...+ N_K\overline{X}_K}{N_1 + N_2 + ...+ N_K}$$

Where $\overline{X}$ = mean or combined groups

$N_1, N_2, \ldots, N_K$ = numbers of cases in sample 1, 2 and k

$\overline{X}_1, \overline{X}_2, ..., \overline{X}_K$ = means of sample 1, 2, K

Example

The mean IQs for there sections of eight standard students are given. Find the combined means for the eighth standard.

	$\overline{X}$	N
Section 1	101	30
Section 2	107	35
Section 3	95	26

Using the formula

$$\text{Combined mean } \overline{X} = \frac{N_1\overline{X}_1 + N_2\overline{X}_2 + ... + N_K\overline{X}_K}{N_1 + N_2 + ... + N_K}$$

$$= \frac{30(101) + 35(107) + 26(95)}{30 + 35 + 26}$$

$$= 101.6$$

Calculation of the Median

Example : Calculate the median for the following distribution table.

X	f	F
65-69	2	50
60-64	10	48
55-59	11	38
50-54	12	27
45-49	9	15
40-44	5	6
35-39	1	1
Total	50	

In calculating the Median, we must first set up a cumulative frequency column. The formula for calculating the Median is

$$\text{Mdn} \quad = \quad L + \frac{\frac{N}{2} - F}{f} \text{ x CI}$$

where, L = exact lower limit of the interval containing the median

F = cumulative frequency below the class containing the median

CI = class interval

In this example $\frac{N}{2} = \frac{50}{2} = 25$, $L = 49.5$, $F = 15$, $f = 12$

$$\therefore \quad \text{Mdn} \quad = \quad L + \frac{\frac{N}{2} - F}{f} \text{ x CI}$$

$$= \quad 49.5 + \frac{25 - 15}{12} \text{ x } 5$$

$$= \quad 49.5 + 4.166$$

$$= \quad 53.666$$

$$\therefore \quad \text{Mdn} \quad = \quad 53.67$$

Calculation of the Mode

Example : Calculate the mode for the following distribution table.

X	f
65-69	2
60-64	10
55-59	11
50-54	12
45-49	9
40-44	5
35-39	1
Total	50

The formula for calculating the mode is

$$M_0 = L + \frac{\Delta_1}{\Delta_1 + \Delta_2} \times CI$$

where M_0 = Mode

L = exact lower limit containing mode

Δ_1 = $f_0 - f_{-1}$

Δ_2 = $f_0 - f_{+1}$

CI = Class Interval

In this example

L = 49.5

Δ_1 = 12 – 9 = 3

Δ_2 = 12 – 11 = 1

CI = 5

$$M_0 = 49.5 + \frac{3}{3+1} \times 5$$

$$= 49.5 + \frac{15}{4}$$

$$= 49.5 + 3.75$$

$$= 53.25$$

Comparison of the Mean, Median and Mode

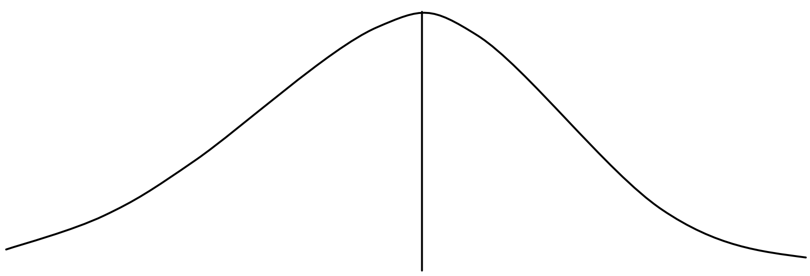
If the frequency distribution is Symmetrical, the mean, median and mode coincide.

If the frequency distribution is skewed, these three measures do not coincide. (Fig 1)

If the mean is greater than the median, then the distribution is positively skewed. (Fig 2)

If the mean is less than the median, then the distribution is negatively skewed. (Fig 3)

Thus just by knowing the values of mean, median and mode, the shape of the distribution can be easily calculated.



Mean = Median = Mode

Fig (1) A Symmetrical Curve

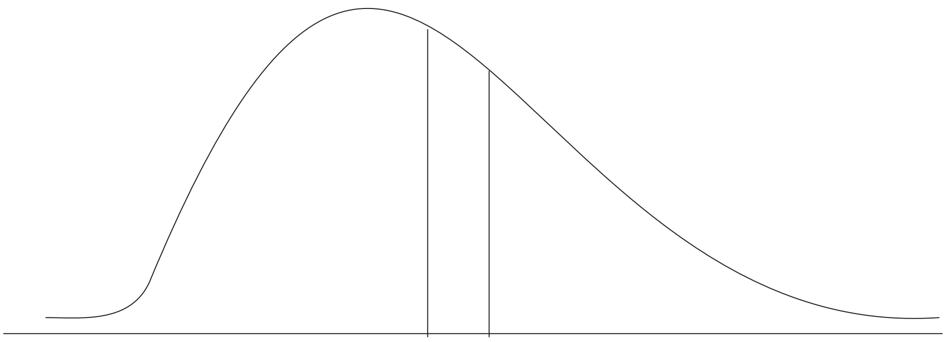


Fig (2) A Positively Skewed Curve

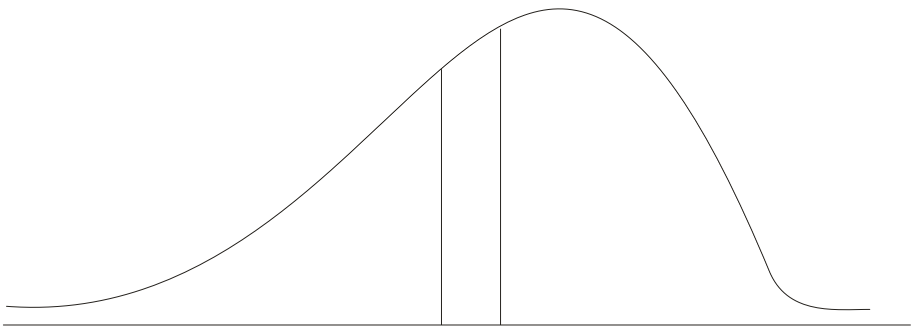


Fig (3) A Negatively Skewed Curve

Exercises

1. Compute means, medians and modes for the following data.

   (a) 3, 8, 18, 36, 54

(b) 11, 20, 19, 29, 29, 45

(c) 3, 3, 4, 6, 6, 6, 7, 7, 7, 9

2. Calculate the mean, median, and mode for the following distribution and trace the shape of it.

X	f
85-89	4
80-84	5
75-79	5
70-74	20
65-69	18
60-64	10
55-59	13
50-54	10
45-49	4
40-44	6
35-39	5
Total	100

Measures of Variability

Statisticians have taken advantage of two outstanding features of most frequency distributions:

(1) The tendency of the data, to cluster around some value lying between the smallest and largest data.

(2) The tendency of the data to be dispersed around this central value.

The first feature is **central tendency** and the second feature is dispersion or **variability.**

Although measures of central tendency are very useful statistics for describing a set of data, they do not tell us enough. Two sets of data, which are very different, can have identical means, or medians. As an example, consider the following sets of data.

Set A	59	59	59	60	61	61	61

Set B	30	40	50	60	70	80	90

The mean of both sets of score is 60 and the median of both is 60, but set A is very different from set B. In set A, the scores are very close together and clustered around the mean. In set B, the scores are much more spread out; that is, there is much more variation or variability in set B. Thus, there is a need for a measure that indicates how spreads out the scores are and how much variability there is.

Measures that indicate the amount of scatter in a distribution scores are referred to as measures of variability. In other words, measures which reflect the way in which data are spread in either direction from the center of a distribution are called measures of variability or dispersion or spread ness or scatter.

Five measures have been devised to indicate the variability or dispersion within a set of data. They are :

(1) The range

(2) The quartile deviation

(3) The mean deviation

(4) The standard deviation

(5) The variance

The Range

The range is defined either as the difference between the highest score and the lowest score (R = H – L) or as the difference Plus one (R = H – L + 1), the latter being more accurate. For example the range for the scores 59, 59, 59, 60, 61, 61, 61 is 3 where as the range for the scores 30, 40, 50, 60, 70, 80, 90 is 61. Thus, if the range is small, the scores are close together whereas the range is large, the scores are more spread out. Like the mode, the range not a very stable measure of variability and its chief advantage is that it gives a quick, rough estimate of variability.

The Quartile Deviation

The quartile deviation (also referred as the semi-inter quartile range) is one-half of the difference between the upper quartile and the lower quartile in a distribution. The upper quartile is the 75^{th} percentile that point below which are 75% of the scores, the lower quartile. Correspondingly, is the 25^{th} percentile, that point below which are 25% of the scores. By subtracting the lower quartile from the upper quartile then dividing the result by two, we get a measure of variability.

$$QD = \frac{Q_3 - Q_1}{2}$$

As an example, if there are 60 scores, Q_1 is the point below which are 15 of the scores (15 = 25% of 60), and Q_3 is the point below which are 45 of the score (45 = 75% of 60). If the quartile deviation is small, the scores are together whereas if the quartile deviation is large, the scores are more spread out. The quartile deviation is a more stable measure of variability than the range and is appropriate whenever the median is appropriate. Calculation of the quartile deviation involves a process very similar to that used to calculate the median, which just happens to be the second quartile Q_2.

The Mean Deviation

Unlike the range and the quartile deviation, the mean deviation takes into account every score in the distribution. The difference, or deviation, or each score from the mean of the distribution is determined without regard to the direction of the difference. These deviations are added and the sum is divided by the number of scores. The result is the mean of the deviations of the scores from their mean.

The mean deviation does not have a wide range of application, nor it is very useful for making comparisons among sets of data. The main reason is that the absolute values of the deviations of scores the mean are used in the computation. In other words, we ignore the signs of deviations.

The Standard Deviation

The standard deviation is appropriate when the data represent an interval or ratio scale and is by far the most frequently used index of variability. Like the mean, the measure of central tendency which is its counterpart, the standard deviation is the most stable measure of variability and takes into account each and every score. In fact, the first step in calculating the standard deviation involves finding out how far each score is from the mean, that is, subtracting the mean from each score. If we square each difference, add up all the squares, and divide by the number of scores, then we have a measure of variability called variance. The square root of that measure is called the standard deviation. A small standard deviation indicates that scores are close together and a large standard deviation indicates that the scores are more spread out.

If you know the mean and the standard deviation of a set of scores, you have a pretty good picture of what the distribution looks alike. If the distribution is relatively normal, then the mean plus 3 standard deviations and the mean minus 3 standard deviations encompasses just about all the scores over 99% of them.

For example, suppose that for a set of scores the mean ($\overline{X}$) is calculated to be 60 and the standard deviation (SD) to be 1. In this case, the mean plus three standard deviations, $\overline{X}$ + 3SD is equal to 60 + 3(1) = 60 + 3 = 63. The mean minus three standard deviations, $\overline{X}$ -

3SD is equal to 60 – 3 = 57. The scores fall between 57 and 63. This makes the scores to be close together or not to be very spread out.

As another example, suppose that for another set of scores the mean (X) is again calculated to be 60, but this time the standard deviation (SD) is calculated to be 5. In this case, the mean plus three standard deviations and the mean minus three standard deviations are 75 and 45 respectively. Thus, almost all the scores between 45 and 75. This almost makes sense since a larger standard deviation indicates that the scores are more spread out.

The Variance

The variance is nothing but the square of the standard deviation. Thus, in order to determine the variance of a distribution, each of the deviation scores is squared. These squared deviations are then added together and divided by the number of scores in the distribution. The mean of sum of these square deviations is called the variance of the distribution.

If the variance is small, the scores are close together, if the variance is large, the scores are more spread out. Both variance and standard deviation are most widely used statistical indices of variability and are fitted into further statistical analyses.

Calculation of Measures of Variability from Ungrouped Data.

Example (1) Find range, quartile deviation, standard deviation and variance of the following data.

10, 15, 13, 8, 10, 10, 15, 13, 11, 7, 4, 4

(1) Calculation of range.

Range = Highest Score Lowest Score

= 15 - 4 = 11

(2) Calculation of quartile deviation

X	*f*	*F*
15	2	12
13	2	10
11	1	8
10	3	7
8	1	4
7	1	3

$$Q_1 = L + \frac{\frac{N}{4} - F}{f} \text{x CI}$$

$$= 6.5 + \frac{\frac{12}{4} - 2}{1} \text{x } 1 = 6.5 + 1 = 7.5$$

$$Q_3 = L + \frac{\frac{3N}{4} - F}{f} \text{ x CI}$$

$$= 12.5 + \frac{\frac{3 \text{x} 12}{4} - 8}{2} \text{x } 1 = 12.5 + 0.5 = 13$$

$$QD = \frac{Q_3 - Q_1}{2} = \frac{13 - 7.5}{2} = \frac{5.5}{2} = 2.75$$

4	2	2
Total	12	

X	$X-\overline{X}$	$\lvert X-\overline{X}\rvert$	$(X-\overline{X})^2$
10	0	0	0
15	5	5	25
13	3	3	9
8	-2	2	4
10	0	0	0
10	0	0	0
15	5	5	25
13	3	3	9
11	1	1	1
7	-3	3	9
4	-6	6	36
4	-6	6	36
Total		34	154

(5) Calculation of variance

$$\text{Variance} = \frac{\sum(\mathrm{X}-\overline{\mathrm{X}})^2}{\mathrm{N}} \qquad = \frac{154}{12} = 12.83$$

Note : (1) Variance = SD^2 (2) SD = Square root of Variance

Calculation of Measures of Variability from Grouped Data

Example (2) Find range, quartile deviation, standard deviation and variance of the following frequency distribution table.

X	*f*
70-74	5
65-69	5
60-64	8
55-59	10
50-54	20
45-49	14
40-44	12
35-39	16
30-34	10
Total	100

For calculating such measures, we have to construct the given table adding with another four columns. (F, d, fd, fd^2) as follows:

X	*f*	F	*d*	*fd*	fd^2
70-74	5	100	4	20	80
65-69	5	95	3	15	45
60-64	8	90	2	16	32
55-59	10	82	1	10	10
50-54	20	72	0	0	0
45-49	14	52	-1	-14	14
40-44	12	38	-2	-24	48
35-39	16	26	-3	-48	144
30-34	10	10	-4	-40	160

Total	100				533

(1) Calculation of range

Range = Highest Score – Lowest Score = 72 – 32 = 40

(2) Calculation of quartile deviation

$$Q_1 = L + \frac{\frac{N}{4} - F}{f} \text{ x } CI = 34.5 + \frac{25-10}{16} \text{ x } 5 = 39.18$$

$$Q_3 = L + \frac{\frac{3N}{4} - F}{f} \text{ x } CI = 54.5 + \frac{75-72}{10} \text{ x } 5 = 56$$

$$Q = \frac{Q_3 - Q_1}{2} = \frac{56 - 39.18}{2} = 8.41$$

(3) Calculation of Standard Deviation

$$SD = CI \text{ x } \sqrt{\frac{\sum fd^2}{\sum f} - \left(\frac{\sum fd}{\sum f}\right)^2} = 5 \text{ x } \sqrt{\frac{533}{100} - \left(\frac{-65}{100}\right)^2}$$

$$= 5 \text{ x } 2.21 = 11.05$$

(4) Calculation of Variance

Variance $= (SD)^2 = (11.05)^2 = 122.1025$

Exercises

1. The data below represent raw scores on a test taken by a class of 15 students.

32	36	38	39	42
44	45	46	45	45
48	48	50	51	51

(a) Find the range of distribution.

(b) Compute mean deviation and standard deviation by using the ungrouped data method.

(c) Arrange the scores into frequency distribution with intervals three points wide (i.e. CI = 3) beginning with 30-32. Compute again the standard deviation and quartile deviation of the given distribution.

2. If $\sum\left(X-\overline{X}\right)^2 = 144$, N = 16, find the variance and standard deviation.

Percentile and Percentile Rank

The Nature of Percentile and Percentile Rank

A numerical value which summarizes the responses actually made on a test by an individual is called a raw score. Raw score alone is not enough to interpret a student's performance. Knowing a student's raw score merely is about how well he did on the test and it also means that how much a student about how well he did on the test and it also means that how much a student made his/her actual performance without comparing to either a criterion score or the performance of others who took the same test. Clearly there is a need for methods of transforming raw scores into values which facilitate the interpretation of scores on both an individual and group basis. Then it becomes the measures of relative position more meaningful in interpretation of scores and in comparison of student's performance as well.

Measures of relative position indicate where a score is in relation to all other scores in the distribution. In other words, measures of relative position permit a teacher to express how well an individual has performed as compared to all other individuals in same group who have been given the same test. Raw scores that have been transformed systematically into equivalent values which indicate relative position are referred to as derived scores. The most common types of derived scores are percentile and percentile ranks.

A percentile is a point which cuts off a given percentage of a distribution.

There are 99 percentiles that a distribution is divided into 100 equal parts. The first percentile symbolized as P_1 is the point below which are one percent of the scores. Similarly, P_{50} is the point below which 50% of the scores and P_{90} is the point below which are 90% of the scores.

A percentile rank (PR) indicates the percentage of scores that lie below a given value in the total distribution.

Thus, if a score of 48 corresponds to a percentile rank of 80 (symbolized PR80), this means that 80% of the score are below the score 48. In other words, if a student had a percentile rank of 98, this would mean that he/she did as well or better than 98% of the members of some group which took the same test.

The median of a set of scores corresponds to the 50^{th} percentile which makes sense since the median is the middle point and therefore the point below which are 50% of the scores. Similarly, the first quartile (Q1) corresponds to the 25^{th} percentile and second quartile (Q2) corresponds to the 50^{th} percentile and the third quartile (Q3) corresponds to the 75^{th} percentile. thus, percentile ranks basically allow us to determine how well an individual did in relative terms, as compared to others who took the same test. If percentile ranks are given for a number of subtests, they also provide a rough mean if comparing an individual's relative performance in a number of different areas.

One point to keep in mind when interpreting percentile ranks is that they are ordinal, not interval measures. Therefore, we do not have equal intervals between percentile points. An increase of a given number of percentile points corresponds to a different number of ranks score points depending upon where they are in the distribution. For example, the difference between the 45^{th} and 50^{th} percentile does not represent the same increase in raw scores as the difference between the 90^{th} and 95^{th} percentiles.

Uses of Percentile and Percentile Rank

The percentile rank is useful to compare not only the performance of two different tests. It can be used to set up tables that list the percentile equivalents of each raw score. Moreover, it can also to draw a profile of the student's performance (relative to a reference group) on a several different tasks.

Percentiles are also useful in determining the cutoff score. Cutoff scores are never predetermined in a relative system. Percentile ranks must be set up first according to the quota. After that percentiles must be computed to find the raw scores equivalent to the percentile ranks which have already been set up. For example, 20% of the candidates who sit for a competition examination is supposed to be selected. It means that 80% will be rejected. Thus, P_{80} must be computed to determine a raw score, below which 80% of total candidates lie. This calculated raw scores can be regarded as the cutoff score, because students who receive below this raw score will be rejected. It is obvious that percentile and percentile rank are interdependent.

The Computation of Percentiles and Percentile Ranks

The method of calculating percentiles is essentially the same as that employed in finding the median and quartiles. So, it can be calculated by using the following formula.

$$P_p = L + \frac{\frac{\mathrm{P\,x\,N}}{100} - \mathrm{F}}{\mathrm{f}} \text{ x } CI$$

Where, P = Percentage of the distribution wanted.

L = exact lower limit of class interval upon which P_p lies.

$\frac{\mathrm{P\,x\,N}}{100}$ = Part of N to be counted off in order to reach P_p.

F = Sum of all scores upon intervals below L. This is, the cumulative frequency below the class containing P_p.

CI = Length of the class interval.

N = number of cases.

Calculation of Percentiles from Ungrouped Data

Example (1)

Find P_{70} of English test scores of ten students given below.

70, 60, 55, 55, 50, 46, 46, 46, 40, 35

In order to make the computation easier, it is necessary to set up a frequency distribution table using the given data shown in the table.

X	f	F
70	1	10
60	1	9
55	2	8
50	1	6
46	3	5
40	1	2
35	1	1
Total	10	

The formula for P_{70} can be written as:

$$P_{70} \quad = \quad L + \frac{\frac{70N}{100} - F}{f} \text{ x } CI$$

$$\square \frac{70\,N}{100} = \frac{70 \times 10}{100} = 7$$

Therefore from the table, it can be observed that class interval in which P_{70} falls is 5.5.

$$\therefore L \quad = 54.5,\ F = 6,\ f = 2,\ CI = 1$$

$$\therefore P_{70} \quad = 54.5 + \frac{7-6}{2} \text{ x } 1$$

$\therefore P_{70} \quad = 54.5 + 0.5$

$\therefore P_{70} \quad = 55$

Calculation of Percentile from Grouped Data

Example (2)

Find P_{70} by using the following frequency distribution table. The table is showing the Mathematics test scores of 100 students of Standard Five.

X	f
70-74	5
65-69	8
60-64	7
55-59	10
50-54	30
45-49	15
40-44	18
35-39	4
30-34	3
Total	100

Before applying the formula, it is necessary to reconstruct the table with its cumulative frequencies as follows.

X	f	F
70-74	5	100
65-69	8	95
60-64	7	87
55-59	10	80
50-54	30	70
45-49	15	40
40-44	18	25

35-39	4	7
30-34	3	3
Total	100	

$$P_{70} = L + \frac{\frac{70N}{100} - F}{f} \times CI$$

$$\frac{70N}{100} = \frac{70 \times 100}{100} = 70$$

$\therefore L = 49.5, , F = 40, f = 30, CI = 5$

$$\therefore P_{70} = 49.5 + \frac{70-40}{30} \times 5$$

$\therefore P_{70} = 49.5 + 5$

$\therefore P_{70} = 54.5$

Calculation of Percentiles Ranks from Ungrouped Data

The formula for calculating percentile rank is

$$PR = \frac{\text{No. of cases below the score} + .5(\text{No. of cases at the score})}{N} \times 100$$

Example (3) Compute PR of the student with the test score of 50 in the distribution, 30, 32, 33, 38, 40, 48, 50, 58, 70, 75

By the problem,

Number of cases below the score 50 = 6

Number of cases at the score 50 = 1

Total number of students in the distribution = 10

$$PR = \frac{6 + 0.5 \times 1}{10} \times 100$$

$$= \frac{6.5}{10} \times 100$$

$= 65\%$

Therefore, percentile rank of score 50 is 65%

The Computation of Percentile rank from grouped data

If percentile ranks have to be computed from a frequency distribution, where the scores are grouped within the range of 2 intervals, we have to use the following formula.

$$PR = \left[(S-L)\frac{f}{CI}+F\right]\frac{100}{N}$$

where PR = percentile rank

S = the given score

L = the lower limit of the class interval in which the given score lies

f = frequency of the class interval in which the given score lies

F = cumulative frequency below the class containing the given score

CI = class interval

Example (4) Find PR of the score 67 in the following frequency distribution.

X	f
70-74	5
65-69	8
60-64	7
55-59	10
50-84	30
45-49	15
40-44	18
35-39	4
30-34	3
Total	100

The given table is reconstructed as follows and *L, f, F* and *CI* are calculated from that table.

X	f	F
70-74	5	100
65-69	8	95
60-64	7	87
55-59	10	80
50-54	30	70
45-49	15	40
40-44	18	25
35-39	4	7
30-34	3	3
Total	100	

Score 67 falls on the interval (65-69)

$L = 64.5$, $f = 8$, $F = 87$, $CI = 5$, $S = 67$, $N = 100$

$$PR = \left[(S-L)\frac{f}{CI} + F\right]\frac{100}{N}$$

$$= \left[(67-64.5)\frac{8}{5} + 87\right]\frac{100}{100}$$

$$= \left[2.5\times\frac{8}{5} + 87\right]\times 1$$

$$= [4 + 87] \times 1 = 91\%$$

Therefore, percentile rank of score 67 is 91%.

Exercise

(1) By using the data given in example (4), find P_{91}.

(2) By using the data given in example (4), find how many percentages of students who passed the examination when their

cutoff score is decided as 40 marks.

(3) By observing the given data also, find cutoff score so that 90% of students should pass the examination.

6.6 Correlation

So far we have been concerned only with a single variable and its frequency distribution. Now in this chapter, our concern will be on two variables or even more.

Many variables or events in nature are related to each other. As the sun rises, the day warms up, as children becomes matured, they think more completely and the persons bright in one area tend to be bright in certain areas too. Such relationships are called correlations. This relationship of one variable to another is known as correlation.

The correlation coefficient is a statistical measure that describes the degree of relationship between two or more variables. All correlation coefficients lie between – 1.00 and +1.00 passing through 0.00. One might more easily visualize possible coefficients as existing on a line as indicated below.

-1.00 0.00 +1.00

The sign of coefficient expresses the direction of the relationship, and the size of coefficient expresses the degree of relationship.

A scatter diagram is one of the clearest ways of showing the meaning of the correlation graphically. By using scatter diagrams the student can get the indication of the magnitudes of the correlation coefficient and also an indication of the signs of relationship.

Classification of Correlation

Correlation can be classified into five categories as follows:

(1) Perfect positive correlation.

(2) Positive correlation

(3) Perfect negative correlation

(4) Negative correlation

(5) Zero correlation

(1) Perfect positive correlation

As X increases a given amount, Y increases in a proportionate amount. The relationship is therefore a perfect positive one.

X: 20, 18, 16, 14, 12, 10, 8, 6, 4, 2

Y: 10, 9, 8, 7, 6, 5, 4, 3, 2, 1& was To

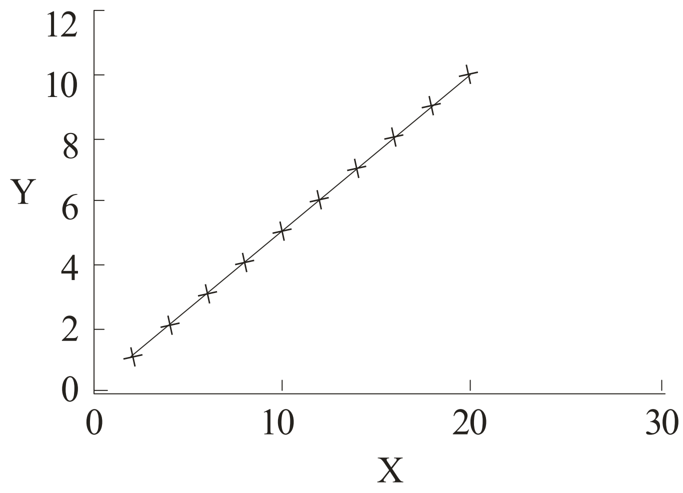


Fig (1)

When the pairs of these variables are plotted, the points will fall along a straight line. It runs upward from left to right as shown in Fig (1). The correlation coefficient r is equal to 1.00.

(2) Positive correlation

But if all pairs of variables do not progress together unit for unit, their relationship is positive but less than perfect.

X (Age): 43, 48, 56, 61, 67, 70

Y (Pressure): 128, 120, 135, 143, 141, 152

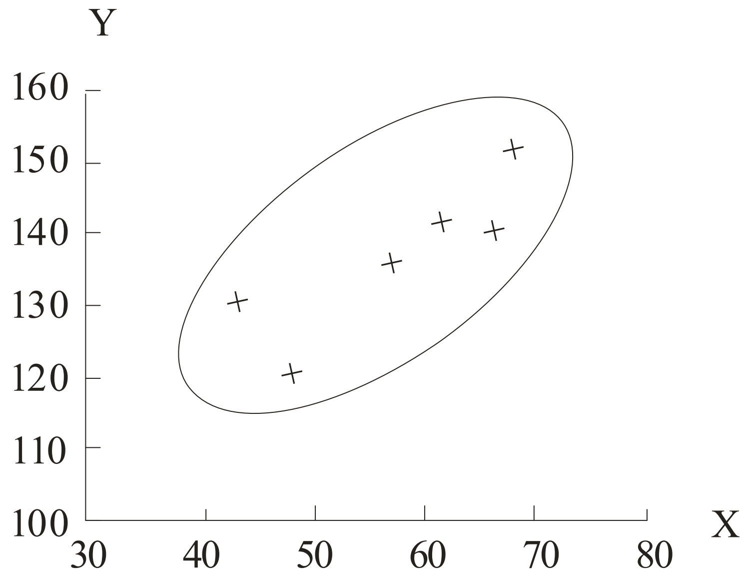


Fig (2)

Thus the plotted points fall near but not directly on the straight line as shown in Fig (2). The correlation coefficient would be less than 1.00.

Some example of positively correlated variables are intelligence and school success, high rainfall and high humidity.

(3) Perfect Negative Correlation

For every increase on the X, Y decreases a constant number of units, the relationship therefore is a perfect negative one. When the pairs of the variables are plotted, the points will fall along a straight line. It runs downward from left to right as shown in Fig (3). The correlation coefficient r equals to – 1.00.

X: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Y: 10, 9, 8, 7, 6, 5, 4, 3, 2, 1

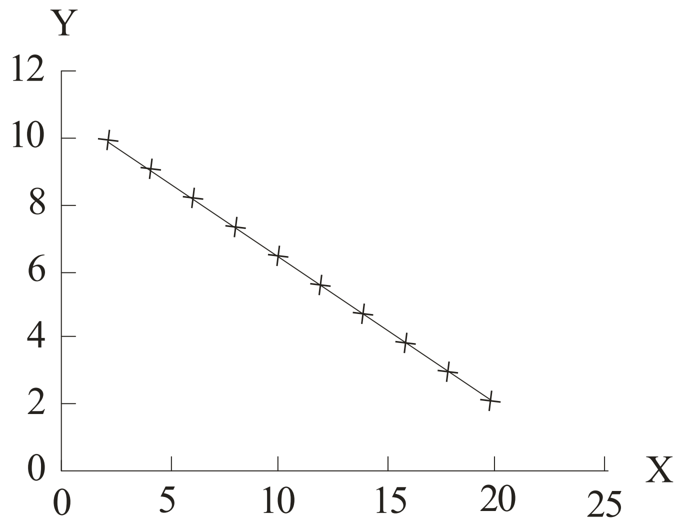


Fig (3)

(4) Negative Correlation

As X increases a unit, Y has a decreasing trend but not in a proportionate amount. The relationship therefore is negative but not perfect.

When the pairs of the variables are plotted, it will not fall along a straight line, as shown in Fig (4). The correlation coefficient r will be a negative number between 0.00 and – 1.00.

Some examples of negative correlation are fatigue and test performance, decrease in teaching quality and increase in number of failures.

X (No. of Absence) 6, 2, 15, 9, 12, 5, 8

Y (Final Grade) 82, 86, 43, 74, 58, 90, 78

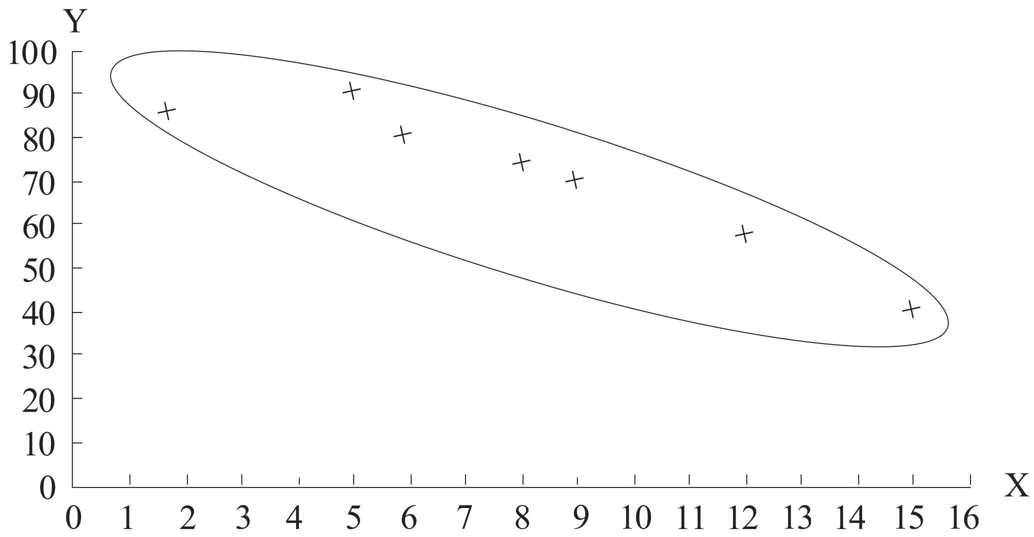


Fig (4)

(5) Zero Correlation

If an increase or decrease in one variable tells us nothing about the likely condition of the other variable, there is no relationship, and we may say that there is zero correlation.

When the pairs of the variables are plotted, we will have no definite direction as shown in Fig (5). The correlation r will be zero.

An example of zero correlation is adult height and intelligence.

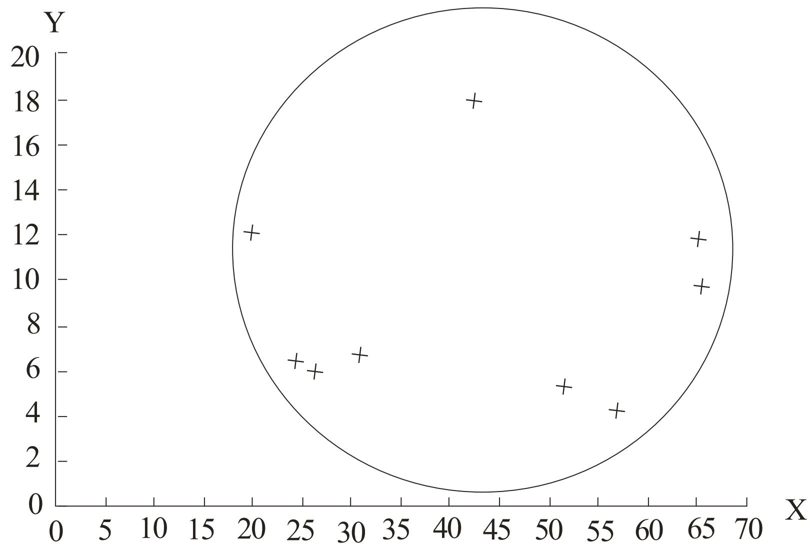


Fig (5)

The Strength of Correlation Coefficient

When statisticians refer to high and low correlation, they are usually using the absolute scale of 1.00 to 0.00 as their guide. 'High' or 'Strong' correlation coefficients therefore, should not necessarily be thought as 'important' nor should 'low' or 'weak' correlation coefficients necessarily be considered 'unimportant'.

Generally correlation coefficient r equal to or greater than 0.70 can be regarded as high, between 0.40 and 0.70 as fair and equal to or less than 0.40 as low correlation.

But it should be noted that for certain purposes r of 0.50 might be considered satisfactory whereas in other situations, an r of 0.90 or high would be required.

If two test forms are to be considered equivalent, we would expect a very high positive correlative between scores on the two forms, i.e. a correlation of somewhat about 90. Yet in other educational situations, for example, in relating academic achievement to a predictor test of achievement, such as IQ test, we are often satisfied with an r of between 0.40 and 0.50. An r of 0.70 in such situation would be exceptional indeed.

The Computation of the Pearson Product Moment Correlation Coefficient

Computing a Correlation Coefficient from Raw Scores

Formula:

$$r = \frac{\sum XY - \frac{\sum X \sum Y}{N}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{N}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{N}\right]}}$$

Examples

(1) Given the following scores on an arithmetic test and corresponding scores on a reading comprehension test, correlate the two set of scores.

X Arithmetic	Y Reading	X^2	Y^2	XY
3	6	9	36	18
2	4	4	16	8
4	4	16	16	16
6	7	36	49	42
5	5	25	25	25
1	3	1	9	3
$\sum X = 21$	$\sum Y = 29$	$\sum X^2 = 91$	$\sum Y^2 = 151$	$\sum XY = 112$

$$r = \frac{112 - \frac{21 \text{x} 29}{6}}{\sqrt{\left[91 - \frac{(21)^2}{6}\right]\left[151 - \frac{(29)^2}{6}\right]}}$$

$$= \frac{112 - \frac{609}{6}}{\sqrt{\left[91 - \frac{441}{6}\right]\left[151 - \frac{841}{6}\right]}}$$

$$= \frac{112 - 101.5}{\sqrt{[91 - 73.5][151 - 140.16]}}$$

$$= \frac{10.5}{\sqrt{17.5 \times 10.84}}$$

$$= \frac{10.5}{\sqrt{189.7}} \quad = \frac{10.5}{13.77} \quad = 0.76$$

Computer r using the following information.

$\sum X^2 = 8.5$ $\quad \sum X = 83$ $\quad \sum XY = 788$

$\sum Y^2 = 766$ $\quad \sum Y = 82$ $\quad N = 10$

$$r = \frac{\sum XY - \frac{\sum X \sum Y}{N}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{N}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{N}\right]}}$$

$$= \frac{788 - \frac{83 \text{x} 82}{10}}{\sqrt{\left[835 - \frac{(83)^2}{10}\right]\left[766 - \frac{(82)^2}{10}\right]}}$$

$$= \frac{788 - 680.6}{\sqrt{[835 - 688.9][766 - 672.4]}}$$

$$= \frac{107.4}{\sqrt{146.1 \times 688.9}}$$

$$= \frac{107.4}{\sqrt{13674.96}}$$

$$= \frac{107.4}{116.94}$$

$$= 0.918$$

$$= 0.92$$

Computing a Correlation Coefficient from Standard Sores or z Scores.

Formula: $r_{xy} = \frac{\sum Z_x Y_y}{N}$

where $Z_X = \frac{X - \overline{X}}{\sigma_x}$, $Z_Y = \frac{Y - \overline{Y}}{\sigma_y}$

N = number of pairs of X, Y scores.

Example

Given the following pairs of z scores repre seven children's position on the IQ scale an on a test, what is the reading comprehension?

IQ scale = x

Reading Comprehension = y

Z_x	Z_y	Z_xZ_y
1.4	1.0	1.40
1.0	1.4	1.40
.7	.7	.49
.0	.0	.00
-.6	-1.2	.72

$$r_{xy} = \frac{\sum Z_x Z_y}{N}$$

$$= \frac{6.35}{7}$$

$$= 0.91$$

Exercises

(1) Ten individuals made the following scores on two methods (X and Y) of spelling test. Compute r between their scores.

X	Y
14	13

12	15
10	8
9	10
8	7
7	5
6	4
3	2
2	4
2	5

(2) By using the following information, calculate r.

$\sum X^2 = 393$ $\sum X = 57$ $\sum XY = 431$

$\sum Y^2 = 514$ $\sum Y = 62$ $N = 10$

(3) Calculate r from the given pairs of Z scores.

Z_x	Z_y
1.50	0.50
2.00	1.00
0.90	-0.30
-0.35	2.00
-3.00	-0.25
0.50	0.10
0.30	0.20