ROLE OF BIOLOGICAL SCIENCE IN HUMAN WELFARE

The development of science and technology is directly related to the development of human race. The developing civilizations utilized the knowledge of science and technology for their growth. We can say that the better conditions of human living are all based on the scientific inventions. The knowledge of biological science has really benefited the mankind. Some of its effects are:

Food

Food is a major requirement for all human beings. Our country is a thickly populated country and growing and supplying adequate food for all citizens is a major problem faced by our governments. The knowledge of biology has helped the farmers as well as scientists to develop better quality seeds, healthy agricultural practices, resistant varieties, hybrids, pest control techniques, and obtain a better yield of food grains. Advanced techniques like tissue culture, production of synthetic seeds, and bio-control techniques can also be explained to the farmers to obtain better yields. The growth of poultry and aquaculture is the result of biological science, the knowledge of biology has helped in the Green Revolution and White Revolution in our country.

Health

The knowledge of biological science has revolutionized the field of medicine. It has improved the value Of human life and increased the human lifespan. The research in this field has resulted in developing vaccines and medicines for eradicating the dreadful diseases. Here we can quote the eradication of diseases like small pox and control of plague and others. We have recognized the importance of balanced diet and have developed methods to control malnutrition and mineral deficiencies by taking appropriate food. New inventions in pharmaceutical field led to production of new drugs in the areas of cancer, heart ailments, AIDS etc., bringing a ray of hope to the ailing. Development of microsurgery, laser surgery, and non-invasive surgical

techniques have made surgeries simple. Development of advanced diagnostic techniques have helped in the identification and cure of diseases. Advancement in life sciences has really helped in improving the standard of health in the human beings.

Population

Increase in population is the root cause of all problems in the world. The uncontrolled explosion of population results in scarcity of food, which causes a number of problems for the human beings. The knowledge of science helps in educating the people about problems of over population and importance of population control. The need for family planning and advantages of small family norms, maintaining the health of the family, importance of health of the mother and child etc are all understood by the knowledge of biological science.

Improvement of Domestic/Wild Animals

The growth and development related practices like poultry, dairy farming, aquaculture and pisciculture (fish farming) are all required for developing self-sufficiency by the people. The know• ledge of biology gives an insight into these practices and helps in development of cross-breeds for giving more yield of meat and milk, disease resistance and vaccines for diseases and developing artificial breeding methods for improvement of population.

Production of Bio-products

Today is the age of biotechnology. Every individual has focused his attention on producing something from biological organisms. The development of alternative sources of food the algal proteins from single cell cultures of chlorella, and spirulina have already taken place. Biological control of pests and diseases, production of bio-fertilizers in the place of conventional chemical fertilizers are the result of advancement of science and technology.

Conservation of Natural Resources

Conservation of environment is a major task of all the people today. Protection of our environment helps in protecting our human race. Forests are the natural sources which help in

maintaining and balancing our environment. But degradation of this wealth and misuse of it has created a lot of imbalance, which has a negative effect on all aspects of our environment. The increase in temperatures, reduction of rainfall, depletion of our forest resources, loss of the ozone cover, extinction of a number of plant and animal species is directly or indirectly related to the environmental degradation. To protect our mother nature it has become mandatory for every person to help in conservation of social forestry programmes and afforestation programmes and animal-protection programmes have become the need of the day.

New Innovations for Improvement of Living Beings

Great advancements have occurred in the field of genetics resulting in the development of many scientific techniques, which could open new vistas of knowledge relating to the basic chromosome structures and DNA and RNA. This resulted in a vast exploration of biological principles pertaining to plants, animals and man. The advanced concepts of DNA Fingerprinting, Eugenics, Preservation of the Gene Pool, Chromosome Mapping etc. are the result of this explosion of knowledge. These have resulted in identifying genetic disorders, improving plant and animal gene pool, and the mapping of human gene. The Human Genome Project is the culmination of the efforts of all scientists which when completed will bring an all-round development of human life.

Biology and Environment

Biology and environment are very closely related with each other. The study of biology develops knowledge and understanding of the environment. Most of the aspects of biology can be applied to the environment. It helps the individual to realize the importance of nature and appreciate the nature. It creates awareness about the interrelationships among the organism and the problems like environmental pollution, population explosion and maintaining the health and sanitation of people, the deforestation and depletion of natural

resources, and importance of maintaining ecological balance Today it has become important to relate the teaching of science to environment. It is called as Environmental Education. Environmental education can be defined as "an individual's awareness of environment". With the growing trade of destruction of forest areas due to increased population pressure and dependency on forest resources, there is an urgent need for creating an appropriate level of peoples participation in environmental protection and conservation. The chief goal of environmental education is to "prepare citizens capable of acting on behalf of the environment" by Integrating information from different disciplines like social ctences and natural sciences. Integration of mathematics, and physical science and biological science with the environment can be productively used in educational system. The goal of environmental education can be achieved by using concepts of environment as a tool to teach mathematics and science, there by infusing in the students the capability to tackle environmental problems successfully in their everyday life.

The National Policy on Education (1986) has recommended that it is essential to develop an awareness of the environment by combining the classroom teaching with the application of environmental principles.

The UNESCO, Tbilisi Declaration, 1978 has said that Environmental education is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters *attitudes, motivations, and commitments* to make informed decisions".

The Objectives of Environmental Education are:

a) to develop an awareness of environment, and the physical, social and aesthetic aspects of environment. To maintain a dynamic equilibrium between all the six elements that support living system i.e., air, water, land, flora, fauna and light.

b) to develop the knowledge and understanding of the environment and its related problems.

c) to develop an attitude of responsibility towards environment and its conservation.

d) to acquire critical thinking skill to identify and solve environmental problems.

e) to actively participate in environmental projects.

f) to plan the utilization of resources not only by present generation but also future generations without any exploitation.

Environmental education can be taught as part of topics in biological science or as a separate subject. The activities that form part of the learning experiences of the students to develop environmental awareness are:

Conducting discussions and debates on topics related to environment.

Organizing field trips to impart an understanding of the nature and its problems.

Developing simulated situations for environmental studies. Organizing project work on environmental problems.

Creating an interest in environment by developing reading habits.

Evaluation

1. Scientific knowledge is a combination of both a Process and a Product - Critically analyze the statement.
2. Explain the significance of a scientific theory.
3. Describe the nature of science in relation to its structure.
4. Discuss in detail the relation of Biological Sciences with the natural environment.

History of Science - An Overview

Around 600 B.C. Greeks began the age of theoretical science, a science based on logic and reasoning. As the records available in later periods indicate, the Hindus were already familiar with some of the sciences of the Greeks and probably of the Babylonians too. Atreya, Susruta and Charaka in medicine and surgery are the important names in the history of science in India. There were no further developments in science in India during the later periods till the twentieth century when we can now proudly refer to the great talents of Ramanujam, Raman, Bose, Bhaba, Khorana, Narlekar and many other scientists of international repute.

The Greeks looked into the events of the world with a new interest. They were a prosperous race with enough leisure to think. They considered the mysteries of nature from the philosophical point of view and tried to interpret their observations on the basis of reasoning and logic. They gave a new trend to thought process and scientific pursuits. The science, which was earlier pursued as a learned craftsmanship and from a utilitarian point of view, now received its theoretical and logical foundations. The Greeks were great theoreticians but hated practical experimentation in science. In the different areas of science they produced brilliant theories and thus theoretical science replaced practical arts of the past. They accepted slavery and this led to the separation between practical and intellectual aspects of science. Some historians even blame the Greeks for their inaccurate' observations and for erecting lofty theories on unsound foundations. Though the Greek science ultimately did not stand the test of time, whatever, scientific theories this wonderful civilization gave to the world, held sway for more than twenty centuries. This period has produced great thinkers whose contributions are responsible for changing the entire course of world civilization of later times. With the fall of Greek civilization and the death of the philosophers and the scientists of Greece, a dark period prevailed upon the earth. The progress of civilization, as it came to a temporary halt in Europe, almost nothing significant could be added to the practical science that existed and the theoretical scientific ideas of the Greeks during the long stretch of about a thousand years till the end of the middle ages. The Dark Age continued up to the twelfth and thirteenth centuries and there was almost complete intellectual stagnancy, especially in Europe. But the world was now ready for the transition of a new phase of regeneration eventually leading to the emergence of Renaissance in Europe. As the ancient science could no longer satisfy the physical and mental needs of the people, they began to rely only on what they actually found rather than what the ancients had written or told. Thus, we find that the fifteenth and the sixteenth centuries heralded the dawn of the new science-the experimental science. The development of printing techniques during the later part of the fifteenth century made all kinds of publications easier and the dissemination of ideas became wider. The scientist of the period began to

verify the scientific ideas handed down by the Greeks and other ancient civilizations. The Italian genius of the fifteenth century, Leonardo da Vinci (1452-1519) gave great Support to the new approaches to science through his drawings in anatomy and the biological and physical scientific objects.
By the sixteenth century, the world received an intelligible and useful picture of science and nature, and the world in the next three centuries was to see the marvelous advancements in science, shrinking the total knowledge and achievement of all earlier civilizations spread over several million years, into insignificance. l'hc study of science from the seventeenth century onwards is marked by the use of all components of scientific process. The scientists of this period observed facts, verified them, measured and repeated them before coming to any conclusion, and finally published results of investigations for discussion in the society. The research trend in science became established. There had been a rapid development in all aspects of human living such as agriculture, medicine, engineering, industry, trade and commerce and these in turn demanded still greater developments in science. The period from the fifteenth to the eighteenth century saw the development of scientific talent, which was instrumental in leading us to our present position of living as a member of a modern scientific society. The scientists of the twentieth century hardly need mentioning as they are too conspicuous in the scientific world and we remember them for our very existence in the modern world. Modern science, characterized by its speed and accuracy has now established its supremacy over all avenues of knowledge.

THE NATURE OF SCIENCE & SCIENCE TEACHING

Meaning and Definition of Science

What is Science?

The word science is taken from a Latin word ‘Scientia’, simply means knowledge' or to know'. Curiosity of man to know about himself and the surroundings has led to an accumulation of a vast body of knowledge which is called 'science'.

Science generally referred as an organized or body of knowledge. Science is known as a classified verifiable knowledge of facts. But science is not always about the collection of facts or development of new concepts or ideas. It’s all about the passion for the discovery that drives one to explore environment and the nature on the whole.

Science was basically founded to investigate the nature and processes Although there are a number of other methods that be utilized to acquire the knowledge about nature, science

is the only one that results in the acquisition of liable knowledge. Hence, Rene Descartes once said, "Science is method of investigating nature that discovers reliable knowledge about it."

Science also includes the investigation of new phenomena, previous theories, analyzing ideas etc. Science is both particular kind of activity and also the results of that activity which uses tools like observation, measurement and scientific and is entirely based on the truth.

Therefore Science is an amalgamation of observation, identification, description, experimentation, investigation and theoretical explanation of the phenomena that occur in nature.

In common terms, science can be described as the study, which attempts to depict and understand the nature of the universe in whole or part.

Definitions

During early times people perceived science, as what the scientist does. There are many definitions available but not a single one, which is universally accepted. Some of the widely used definitions are mentioned here:

According to Columbian Dictionary "science is an accumulated and systematized learning in general usage restricted to natural phenomena".

"Science is an attempt to make the chaotic diversity of our sense experience correspond to logically uniform system of thought"-*Einstein*

"Science is a cumulative and endless series of empirical observations, which results 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" *Fitzpatrick*.

"Science is the organization of our knowledge in such a way that it commands or makes possible the explanation of more of the hidden potentialities found in the environment"

- *J. Bronowski.*

"Science is a way of thinking, an attitude towards the solution of problems, a means of solving problems as well as products of the investigation of natural phenomena"-*Richardson*

"An inter-connected series of concepts and conceptual

schemes that have developed as a result of experimentation and observation and are fruitful of further experimentation and observation" - *Conant*

"Science is a human endeavor that seeks to describe with ever increasing accuracy of the events and circumstances which occur or exist within our natural environment".

-*J. Woodburn and E.O. Obourne*

A comprehensive definition of science would be "science is a body of knowledge, a way of thinking, and a way of investigation, a way of experimentation in the pursuit of exploring the nature".

Science = methods + knowledge

= process + product

= scientific method + scientific attitude + scientific knowledge

Nature of Science

Following are some of the important characteristics of science:

Science is a process as well as a product:

Science is a combination of process and product. The continuous processes that we observe in nature as well as in the laboratory give rise to development of scientific knowledge. The methods of inquiry play a major role in the process of science. The process of science gives rise to a number of products of knowledge like the facts, concepts, theories and generalizations. These products of science are of great utility to the human beings.

Scientific knowledge is durable:

Although scientists reject the idea of attaining absolute truth and accept some uncertainty as part of nature, most scientific knowledge is durable. The modification of ideas, rather than their outright rejection, is the norm in science, as powerful constructs tend to survive and grow more precise and to become widely accepted. The growing ability of scientists to make accurate predictions about natural phenomena provides convincing evidence that we really are gaining in our understanding of how the world works. Continuity and stability are as characteristic of science as change is, and confidence is as prevalent as tentativeness.

Scientific knowledge is based on inquiry: Fundamentally, the various scientific disciplines are alike in the irreliance on evidence, house of hypothesis and theories, the kinds of logic used, and much more. Nevertheless, scientists differ greatly from one another in what phenomena they investigate and in how they go about their work; in the reliance they place on historical data or one experimental findings and on qualitative or quantitative methods; in their recourse to fundamental principles; and in how much they draw on the findings of other sciences. Still, the exchange of techniques, information, and concepts goes on all the time among scientists, and there are common understandings among them about what constitutes an investigation that is scientifically valid.

Science is based on scientific methodology: The very nature of science involves a particular, methodical approach towards it. These methods are observations and inquiry. It is always essential to choose a right kind of approach for further investigation. The right approach also means a series of questions to be asked and answers to be found out by the scientist. All these teach us that we need to follow standard methods for experimentation, while at the same time not restricting ourselves.

Scientific knowledge is based on evidence:

The validity of scientific claims is settled by referring to observations of phenomena. Hence, scientists concentrate on getting 'accurate data'. Such evidence is obtained by observations and measurements taken in situations that range from natural settings (such as fields)to completely artificial ones (such as the laboratory). To make their observations, scientists use their own senses, instruments (such as microscopes) that enhance those senses, and instruments that tap characteristics quite different from what humans can sense (such as magnetic fields). Because of this reliance on evidence, great value is placed on the development of better instruments and techniques of observation Scientists observe passively(earthquakes, bird migrations),make collections (rocks, fossils, shells),and also actively probe the world to collect the valuable data.

Science is a blend of logic and imagination:

Although all sorts of imagination and thought may be used in coming up with hypotheses and theories, sooner or later scientific arguments must conform to the principles of logical reasoning—that is, to testing the validity of arguments by applying certain criteria of inference, demonstration, and commonsense. Scientists do not work only with data and well-developed theories. Often, they have only tentative hypotheses about the way things maybe. Such hypotheses are widely used in science for choosing what data to pay attention to and what additional data to seek, and for guiding the interpretation of data. In fact, the process of formulating and testing hypotheses is one of the core activities of scientists. To be useful, a hypothesis should suggest what evidence would support it and what evidence would refute it. A hypothesis that cannot in principle be put to the test of evidence may be interesting, but it is not likely to be scientifically useful.

Science explains and also predicts:

The essence of science is validation by observation. But it is not enough for scientific theories to fit only the observations that are already known. Theories should also fit additional

observations that were not used in formulating the theories in the first place; that is, theories should have predictive power. Demonstrating the predictive power of a theory does not necessarily require the prediction of events in the future. The predictions may be about evidence from the past that has not yet been found or studied. A theory about the origins of human beings, for example, can be tested by new discoveries of human-like fossil remains.

Science is **an enterprise**:

Science as an enterprise has individual, social, and institutional dimensions. Scientific activity is one of the main features of the contemporary world and, perhaps more than any other, distinguishes present times from earlier centuries. As an endeavor for learning how the world works, it provides a living for a very large number of people. It is important for students to understand how science is organized because, as adults in a democracy, they will be in a position to influence what public support will be provided for basic and applied science. Other important aspects of the scientific enterprise are its social structure, its discipline and institutional identification, its· ethics and the role of scientists in public affairs.

There are an indefinite number of characteristics of science a part from the above-mentioned ones. Some of them are:

- Science is empirical
- Observations - Process Concepts
- Science knowledge is replicable
- Scientific knowledge is dynamic and tentative in nature.
- Scientific knowledge is holistic and humanistic
- Scientific knowledge is based on values of objectivity, rationality and neutrality.
- Science is based on critical discrimination -that is, it is objective, impartial and unbiased.

- Science is a body of knowledge accumulated through reasoning and reflection. It is self corrective.
- Science makes predictions, descriptions and explanations of various phenomena
- Science is universal, that is facts, and concepts, generalizations, theories and laws have universal acceptance and applications.
- Scientific knowledge is based on assumptions accumulated over years of experience.

Scientific Knowledge (Nature of Science)

Scientific knowledge is based on:

- Observations of the universe.
- Belief in universal uniformity of knowledge.
- Belief in probabilities but not in certainties.

Over the course of human history, people have developed many inter-connected and validated ideas about science. Those ideas have enabled successive generations to achieve an increasingly comprehensive and reliable under-standing of the human species and its environment. The means used to develop these ideas are particular ways of observing, thinking, experimenting, and validating. These ways represent a fundamental aspect of the nature of science and reflect how science tends to differ from other modes of knowing.

It is the union of science and technology that forms the scientific endeavor and that makes it so successful. Although each of these human enterprises has a character and history of its own, each is dependent on and reinforces the others.. Why it is necessary to understand the very nature of science:'

- When we know what is the nature of science and how it works and how the experiments of science reach scientific conclusions, and what the limitations of such conclusions are,

we are more likely to react thoughtfully to scientific claims and less likely to reject them out of hand or accept them uncritically.

- Once we gain a good sense of how science functions along with a basic inventory of key science concepts as a basis for learning more later—we will be able to understand the science adventure story as it plays out during our lifetimes.
- The images that many people have of science and how it works are often distorted. The myths and stereotypes that young people have about science are not dispelled when science teaching focuses narrowly on the laws, concepts, and theories of science. Hence, it is very important to understand the basic nature and functioning of science.

The nature of science is generally compared to the structure of a building. In this framework the assumptions are the foundations on which the structure is built. Lacey in his book "Guide to Science Teaching" has listed some 15 assumptions for the nature. The most important among them are:

1. Principle of Causality: Belief in cause and effect relationship.

2. Principle of Consistency: When 2 sets of conditions are same, the same consequences are expected.

3. Principle of Continuous Discovery: Unfolding of the laws of nature will take place till a complete understanding of the universe is reached.

4. Principle of Dynamism: Nature is dynamic

5. Principle of Objectivity: Ability to examine facts and suspend judgment. "

The methods and processes of science form the horizontal Beams for the structure. The generalizations are the vertical beams. The work in science goes on with the methods and processes and they clarify, extend and add to these new generalizations.

Study of nature of Science is important as:

- It provides the basic knowledge required for understanding the natural phenomena in the light of facts, theories and laws of nature.
- It helps in developing scientific temperament and scientific attitude among the students.
- It helps in developing the curiosity and creativity among the students.
- It helps in recognizing the self-potentialities and capabilities and helps in building self-confidence among the students.
- It helps in generating values like broadmindedness, intelligence, creative thinking and dedication in the students.
- It helps in training students in scientific techniques.

Acquiring scientific knowledge about how the world works does not necessarily lead to an understanding of how science itself works and Neither does knowledge of the philosophy and sociology of science alone lead to a scientific understanding of the world. The challenge for educators is to weave these different aspects of science nature together so that they reinforce one another. *J.B. Conant* described the nature of science in the following manner: "Science emerges from the progressive activities of man to the extent that new concepts arise from experiments and I observations and the new concepts in turn lead to further experiments and observations". The description can be diagrammatically viewed as

Concepts -» Improved Concepts-» Modified Concepts-» New Concepts-» Body of Knowledge

The above diagram clearly states that the scientific knowledge is dynamic in nature and it is modifiable. Science is dynamic in nature and provides knowledge based on the system facts, concepts, theories, laws and generalizations.

1.3 Scope of Science

Man has always been curious to find answers to the mysteries posed by the reality he lives in. One of the deepest and most profound is the one that in itself searches for the answer to how he came to be, to how his world originated, to how and when he and all living beings merged from the nature they live in. All these questions are answered by science.

In a world filled with the products of scientific inquiry, scientific literacy has become a necessity for everyone. Everyone needs to use scientific information to make choices that arise every day. Everyone needs to be able to engage intelligently in public discourse and debate about important issues that involve science and technology. And every one deserves to share the excitement and personal fulfillment that come from understanding and learning about the natural world.

Scientific literacy also is of increasing importance in the workplace. More and more jobs demand advanced skills, enquiring that people be able to learn, reason, think creatively, make decisions, and solve problems. An understanding of science and the processes of science contributes to these skills. Other countries are investing heavily to create scientifically and technically literate workforce. To keep pace in global markets, our country also needs to have an equally capable citizenry. We may not realize it but everything we do has a scientific base. Try this though an experiment. Imagine a job that doesn't need some background in science. Law? Farming? Running a restaurant? Business? Hooking? Leg-spin bowling?

Lawyers must know about DNA testing, forensic evidence, which isresponsible, liable, in the operating theatre. Farmers are swamped with genetic modification choices, salinity problems, and worries about the lesser spotted godwit or precious purple frog requiring protection in the lower paddock. Business people are challenged constantly by

new technology, hookers by STDs and, as for leg-spin bowlers, think shoulder operations, drug tests and mobile phone evidence.

The point is there is no job in the 21st century that can be done effectively without some feeling for science. It has been truly said that as science and technology progress it encourages the study of some subjects. Most of the effort in science teaching is directed, these days to improve conditions of life and in tackling the new problems that arise. Therefore the importance of life sciences teaching in schools is increasing. The study of life sciences is quite helpful in eradication of certain problems. With the fast changing times more and more emphasis is put on the health of man. India shall need specialists in the fields of medicine, health, agriculture, animal husbandry, etc. The talent in these fields shall come from the study of biological science. It is for these reasons that the subject has become so popular in our secondary schools and is taught as a compulsory subject in secondary schools. It has now been realized that biological science has a grea trole to play and so it should be given its proper place in school curriculum.

Importance of Science

We cannot compare any subject with science as far as utility and importance in our daily life is concerned. Ours is an age of science. All the modern gadgets, which made our work easier, are a result of science. There is no doubt that science has helped in improving our standards of living. Some of the areas of science, which have a lot of utilitarian values, are: *Science and Agriculture:*

Science plays a very important role in the development of agriculture. Green revolution is the gift of science to the society. Development of a range of pesticides to ill different pathogens and insects (causing damage to the crop) possible due to scientific interventions and resulting in the higher yields. Several fertilizers essential for the growth of plants in development of different farming techniques and implements are also possible

due to scientific knowledge. Development of hybrids and transgenic plants resistance to diseases and pests are the most important contributions of science in the field of agriculture.

Science and Our Health:

Science made innumerable contributions in the field of medicine for improving our health. It provided medicines for almost all the known diseases and helped inventing different operational implements for the surgeons to operate on the patients. Awareness about personal hygiene and sanitation is possible due to the knowledge of science.The products of medical research and development like lasers, mechanical cardiac assist devices, mechanical valves, automatic internal defibrillators, have saved many lives. Science and technology will expand the current frontier of medical knowledge. Armed with this new knowledge, we will identify the causes, and eliminate most of the effects of the diseases that now plague mankind

Science and Industry:

The invention of radio, TV, printing machine and computers is the product of science. The development of several industries like pharmaceutical, alcohol, garments etc and the initiation of industrial revolution are the consequences of scientific knowledge.

ScienceandtheEnvironment:

Due to increased activities of man (pollution) and surplus exploitation of natural resources there is a danger of ecological imbalance and destruction of the environment. In this situation the only rescue for his survival could come from the intervention of science. *Science and its Role in Democracy:* For a responsible citizen of a democratic country, qualities like open- mindedness, cooperation, ability to accept new ideas, hardwork,

perseverance etc are essential. And science contributes a major share in the development of these qualities in the citizen.

1.4 Meaning of Biological Science

Biological science is the study of life and living organisms. It is also called as "Biology". The Greek word 'bio' means life and 'logos' means study of. In the late 1700s Pierre-Antoinede Monet and Jean-Baptiste de Lamarck coined the term 'biology'. Earlier study of living things was restricted to the pure sciences like Botany and Zoology that together comprise Biology. But as the time passed, new branches evolved, new technologies developed in pure subjects as well as in applied fields, giving rise to a very broad science called 'Biological Science'. Biological science is an extensive study covering the minute workings of chemical substances inside our cells, to broad scale concepts of ecosystems and global environmental changes. It is also concerned with the physical characteristics and behaviors of organisms living today and long ago, how they came into existence, and what interactions they possess with one another and their environments. Intimate study of details of the human brain, the composition of our genes, and even the functioning of our reproductive system are dealt within Biological Science. Today it is also called by a new name-Life Sciences. Life sciences can be defined as "a systematic study of living things or study of nature". Teaching of life sciences basically deals with providing information about the latest developments in the field of Biological Science all over the world.The knowledge of Biological Science helps the student

- To develop the individual's sensitiveness to nature and make him feels at home with it.
- To explain the living world in terms of scientific principles and appreciating why organisms behave indifferent ways, and show capabilities, which differ from one another satisfy the curiosity of students generate interest abou this surroundings.

1.5 Scope of Biology

The knowledge of biology is useful to know about the morphology, cytology, physiology, and reproduction of living organisms. It helps us to know the ecological relationships and evolution of organisms on this earth. The knowledge of biology helps in understanding the biochemical processes and the metabolic reactions occurring in the living cells. It throws light on the genetic material the DNA, RNA and their role in heredity and reproduction. It provides knowledge about the nature and importance of microorganisms on this earth. It also gives an insight into applied advanced scientific subjects like Biotechnology, molecular biology, biophysics, astrobiology, etc.

Biologists study many different facets of life from the molecules that make up individual cells to the behavior and ecology of animals and plants. Their studies encompass both basic and applied science because today's biologists play an singly important role in the progress of agriculture, human, animal health, and in business and industry.

Whether in the laboratory, in the office, or in the field, Biologist meet the daily challenges of preserving our environment, developing new defenses against disease, increasing cultural productivity, and expanding our understanding of the basic processes of life. There is an increasing need for biological scientists to meet the challenges.

The importance of Biology

The knowledge of Biological Science development of human race. Biological understanding the origin of life on earth.

- It helps in development of appreciation environs.
- It helps man to value the existence of other living organisms on earth.
- It helps in development of appreciation environs.
- It helps man to value the existence of other living organisms on earth.
- It develops discipline and orderliness in individual's life.

- It develops the power 'of observation and critical thinking and trains in problem solving.
- It develops scientific attitude and scientific methodology.
- It correlates the knowledge of other subjects with life of the individual.
- It develops open mindedness and truthfulness and prepares the individual to lead a modern lifestyle.
- It helps the individual to apply the important concepts like nutrition, health, natural resources and pollutions for betterment of his existence.
- It helps the individual to play a fruitful role in a society as responsible citizens of society.

The study of biology is very important because:

1. Biological Science teaches systematic usage of natural resources.
2. It helps in development of healthy living conditions.
3. It provides knowledge for production of hybrid breed of animals and varieties of crops.
4. It helps in planning the career.
5. It develops the interest and curiosity in students.
6. It develops modern outlook and living in individuals.
7. It improves scientific understanding and develops love for fellow human beings.
8. It helps in the control of diseases and population

Branches of Biological Science

Biological Science is basically divided into three branches:

1. Pure sciences
2. Applied sciences and
3. Related branches

Pure Sciences

They are botany and zoology which deal with the basic aspects about the plants and the animals respectively. Applied science have arisen from these pure science to

study in detail the particular fields Now the branches that have arisen from the pure science emerged as separate subjects due to huge research and developments in those fields.

Botany: It is the branch of *science* concerned with the scientific study of *plants*

Zoology: Zoology is the branch of science which deals with *animals*

Applied Sciences

Aerobiology: It is a branch of *biology* that studies airborne organisms and airborne biological particles, for example, *pollen* and *spores*.

Anatomy: Is the branch of *biology* that deals with the structure and organization of living things; thus there is animal anatomy *(zootomy)* and plant anatomy *(phytotomy)*. The major branches of anatomy include *comparative anatomy* and *human anatomy*.

Biochemistry: It is the study of the chemical reactions and interactions that take place in living *organisms*, especially the structures and functions of their components, such as *proteins*, *carbohydrates*, *lipids*, *nucleic acids*, and small molecules present in cells..

Biotechnology:

Application that uses derivatives thereof, to specific use. Biotechnology is any technological biological systems, living organisms, or make or modify products or processes for specific use

Cell Biology (Cytology): It is the *study* of the physiological properties of *cells* and their interaction with one another and their *environment*, on the *microscopic* and the *molecular* level.

Genetics: It is that branch of *science* that relates to the study of *genes* and *biological inheritance* by which a predisposition to parental traits is passed on to offspring at *conception*

Microbiology: It is the study of *microorganisms*, including unicellular (single-celled) *eukaryotes* and *prokaryotes*, *fungi*, and *viruses*

Paleontology: It is the study of ancient *plants* and *animals* based on the *fossil record*, and evidence of their existence preserved in *rocks*. This includes the study of body *fossils*, tracks, burrows, cast off parts, fossilized *feces*, and chemical residues.

Phylogeny (orphylogenesis): It is the origin and *evolution* of a set of organisms, usually *species*. A major task of *systematics* is to determine the ancestral relationships among known species (both living and extinct),

Physiology: It Is a branch of *biology* that deals with the mechanical, physical, and biochemical functions of living organisms. Physiology has classically been divided into *plant physiology* and *animal physiology*.

Toxicology: It is the study of the symptoms, mechanisms, treatments and detection of biological *poisoning*, especially the poisoning of people.

Virology: It is the study of *viruses* and their properties

Xenobiology (orexobiology, or astrobiology):It is the term for a speculative field within *biology* which considers the possibility of, and possible nature of, *extraterrestrial life*.

Related Disciplines

Medicine: Medicine an area of human knowledge concerned with restoring *health*. It is, in the broadest sense of the term, the science and practice of the prevention and curing of human diseases, and other ailments of the human body or mind. However, it is often used only to refer to those matters dealt with by academically trained *physicians* and *surgeons*.

Agriculture Science: It is concerned with the cultivation of the field, tilling of the land, sowing of the seeds, planting and similar operations on the land.

THE CORRELATION OF BIOLOGICAL SCIENCE AND OTHER SUBJECTS

"Why does this magnificent applied science which saves work and makes life easier bring so little happiness. The simple answer is —because we have not learnt to make a sensible useof iit".

--Albert Einstein

The word correlation means a reciprocal relation between various subjects in the curriculum. The whole world is integrated and inter-related. The various phenomena and the processes that occur in the nature are all related to one a nother. No concept or a p r o c e s s can be understood in isolation. The entire universe is an integrated whole. The word correlation' occupies an important place in education. All the subjects in education are related. Education is also related with life. The principles of correlation maintain that various subjects should contribute to the child's education and help him to understand his environment in a better way. The various concepts and facts and principles have a relation with one other. These things have an application in the life of an individual. The child becomes interested in knowing the various phenomena of this world. He tries to develop the knowledge of these real life experiences. These principles are to be integrated while teaching the subjects. The field of biology incorporates a number of principles of physical science. The physical sciences include a number of mathematical derivations. The concepts of geography and history are related to development of general science. In this way all subjects are to be correlated to remove in teaching and providing a unified knowledge.

Science is an inter-disciplinary subject and it cannot be taught in isolation. It is not a watertight compartment and it requires integration and correlation with other subjects for an effective development of scientific understanding. The experience of students in learning of science can be greatly enhanced by correlating it with other fields of study. The application of science to human life is immense. A teacher's effectiveness lies in integrating the various

concepts of science to real life situations. Life science is a combination of various branches of science like• Biochemistry, Agriculture, Medicine, Microbiology, Genetics, Biotechnology etc. In addition to relating with general concepts, it has to be related with other subjects also. General science should be taught in the schools as an integrated whole rather than as a collection of unrelated topics. Cooperation of the science teacher with teachers of different subjects is of great value in the process of teaching science as an integrated whole.

The concept of correlation can be studied under the following subheads:

Correlation of science with life

Correlation of science with other school subjects

Correlation of science subjects with each other.

Correlation of Science with Life

The development of human race is directly related with the development of science. They are interwoven with each other. The knowledge explosion and modernization are related with each other. Science is the backbone of modernization of the society. It has penetrated deep into over everyday life. We find application of science in all general aspects of human life. The scientific knowledge encompasses almost all the areas of human requirement. We utilize the scientific knowledge from the time we start our day to the time we rest. We utilize the principles of science for cooking our daily meal. We understand the importance of science when we use transportation. We recognize the harmful effects of pollution because of our scientific knowledge. We understand the need for conservation of our environment and balance of our ecosystem as a result of science. The development of vaccines, the control of harmful pathogens, the improvement in their overall health and wellbeing of human beings is the result of science. Everything around us is directly or indirectly related to science. Therefore it is imperative on the part of the science teacher to relate the developments of science and application of scientific principles to the lives of the human beings. The teacher should

always provide simple real life examples while teaching a topic. These correlations create an interest and a realistic view of science among the students. The students tend to understand the importance of science in day-to-day life. The teacher should range visits to science museums, organize exhibitions, conduct science fairs and provide a deeper knowledge of application of science to human life.

The teacher can make a visit to an agricultural farm to quaint the students with the agricultural practices. A visit to a poultry farm or a dairy farm may give them an idea about the growth and development of these animals. The visit to a thermal station may provide an idea about the physical principles. The wage of disinfectants for eradicating the pathogens, manures for rowing the plants, a mirror for teaching the principles of light are some simple and common examples, which can relate the studyof science with life.

Correlation of Biological Science with Other Subjects

Correlation unifies the knowledge of different subjects and makes learning a meaningful whole. All the subjects possess a correlation among themselves. Biological Science is such a subject, which can be correlated very easily with others. This correlation in associating the knowledge the student gained in different subject classes. This makes the learning more meaningful. The relation of Biological Science with other subjects has been given below.

Correlation with Mathematics

Study of Biological Science is not complete without a basic knowledge of mathematics. The knowledge of ratios, proportion, patrons, graphs, and statistics, is necessary for a comprehensive understanding of Biological Science, especially Biophysics, informatics etc. In a school co-operation between mathematics and a science teacher is very essential for developing a comprehensive knowledge of these subjects. The basic physical concepts cannot move a step further without the usage of mathematical principles. The data analysis of any topic requires an in-depth knowledge of statistical principles. Scientific

principles are given as examples when teaching mathematics and the knowledge of mathematical principles like co-ordinate geometry, quadrate equations, and trigonometry are used in teaching of science. Hence the teachers of mathematics and science should correlate and coordinate with each other for developing a comprehensive understanding of these two important subjects.

Correlation with Geography

Science and geography share many common principles. Both subjects are interdependent and inter-related. The lessons in geography are related with Biological Science. The topics on rainfall, climate, soil types, inter-relationships between plants and animals, movement of planets in the universe are all related in both Biological Science and geography. The geographical experiments utilize the scientific instruments. Secondary education commission has realized the interrelation between these two subjects and included geography in the science group. The teachers of science and geography should correlate these topics wherever necessary to make them interesting to the students.

Correlation with History

Science becomes very interesting when we relate it to the history. A number of scientific discoveries found their place in history. Historical events when connected with the scientific discoveries make an interesting study. The development of surgery and medicine, medical the inventions of instruments - all these make an interesting historical reading. The history of science is history of civilization of mankind. Hence the teachers of science and history may cooperate and design some projects, to correlate the scientists and scientific discoveries with historical data and further enhance the students' knowledge and an interest in the subject of science.

Correlation with Language

The language is a means for expressing the scientific ideas. Language is essential to express the individual views in a clear proper and appropriate manner. It is the responsibility of a Biological Science teacher and a language teacher to develop the required language skills like listening, reading and writing in the students. The student should be able to express his views, write the answers, and translate some material. Proper command on the language will help the students to participating in seminars, conferences and write scientific articles.

Correlation with Art

Art is also science and knowledge of Arts forms a base for Biological Science. Science needs creativity. Artists are creative. Art is dependent on creativity, and creativity is very much a part of science. The craft and drawings are important in science. The students draw diagrams, prepare charts and models. They need to know the appropriate usage of colors and proper spacing of visuals. For developing these skills a Biology student should possess a basic knowledge of art. He should be trained in drawingand painting.

Correlation of Science with Environment

Today's student is tomorrow's citizen. A Biological Science student should be aware of the importance of the environment. It is essential for a student of Biology to possess knowledge of environment. A number of scientific principles can be correlated with environment like the concepts of pollution, afforestation, conservation of natural resources, and production of bio-products. Students should be able to relate classroom learning with the environment. The role of the science teacher is as a facilitator. She has to develop value judgment in the students. The students should understand the importance of the fact that conserving our environment is safe-guarding ourselves. The plants and animals also have a right to existence and a role to play in balancing our ecosystems. The principle of

correlation helps a student to become a good citizen aware of the need and importance of environmental conservation.

Correlation with in Science

Science is a n inter disciplinary subject. All the branches of science are interrelated and interdependent on each other, as there are a number of facts and principles, which are common to a number of science subjects. The subjects of Botany, Zoology, Physics and Chemistry are all related through some common principles in them. New and applied sciences like Biochemistry, Biophysics, Biotechnology, and. Molecular Biology have been developed from traditional subjects Botany and Zoology. They are all inter-related with each other. An efficient science teacher has to integrate the different concepts of science wherever required to develop a comprehensive knowledge of science. The teacher should not bother about specialization in science as it is done for the sake of convenience. He /she should not remain tied down to their own subjects but venture into other areas to provide more clarity to learning.

Some examples of correlation within Science are:

Topics on food and health are related to maintaining health and hygiene and nutrition of the individual.

Working of parts of the body is related to some physical principles. E.g. structure and functioning of the eye can be related with functioning of the camera.

The photosynthetic activity is related to the bio- chemical reactions taking place in the plant body.

The various metabolic activities in the living organisms are related to physiology as well as biochemistry.

Principles of Light can be used to explain the mechanism or Vision in the eye.

The formation of curds and the softening of bread can be related to the processes of microbial fermentation.

The types of soil may be related with agricultural practices. The structure of cells, 'atoms and molecules all form part of biology and also organic chemistry.

Science when studied with a holistic approach will really give a comprehensive knowledge and understanding of the subject and benefit the mankind.

VALUE OF TEACHING BIOLOGICAL SCIENCE

There is an increasing demand for science education in the society as we are living in an era of science and technology. Science education is very important for the individual benefits and for the development of the society on the whole. Science is also very important in our day-to-day lives. Science education not only develops knowledge and competence in the subject but also helps in developing values of life. Knowledge of science prepares the individual to face the challenges of the ever-changing modern world. We can inculcate a number of values in the students through Biological Science education. The most important value among them are:

Intellectual Value

Biological Science develops our thinking and reasoning skills. It gratifies our intellectual instincts and makes us aware of our surroundings and ourselves. It increases our understanding of the complex matters existing around us. The primary aim of science education is the development of intellectual ability. Biological Science education inculcates the knowledge of facts, he spirit of enquiry, he technique of assumption, the power of obervation, and value judgment in the students. It helps in developing logical thinking, reasoning, analysis, and creativity in the students. It develops the scientific attitudes and provides raining in scientific methodology. It develops rational thinking in an individual and prepares him to face the challenges of the modern world with a scientific outlook. It sharpens our

minds and makes us intellectually honest and critical in our observation and reasoning. We usually tend to arrive at conclusions without any bias in the light of science Some of the important scientific attitudes, which are appreciated with science knowledge, are open-mindedness, curiosity, systematic thinking and reflective thinking. Biological Science helps in understanding and solving many problems like social, economical, political or cultural.

Utilitarian Value

As it is mentioned earlier, Biological Science has a number of applications in our every day life. Development of Biological Science can be related with the development of human race. The advances in the fields of medicine, improvement in the health and hygiene thereby improving the lifespan of human beings, is due to the enormous explosion of scientific knowledge. Science has influenced the lives of people so much that today we cannot imagine our lives without the involvement of science. Biological Science has a major impact in the field of medicines and health, preventing and curing number of diseases. The increased production of food for the ever-increasing population of the world is also the gift of Biological Science for the survival of man.

Vocational Value

Biological Science is a multi disciplinary subject and creates a lot of awareness about many aspects of modern development. As a subject it has helped in generating a number of vocations. It has many applications and the students fit better into any vocation as they have a basic knowledge of science. Biological Science is a part of Dairy, Poultry, Agriculture, Veterinary, Microbiological, Bio-chemical, and Paramedical fields. Biological Science graduates may enter teaching, or enter industries related to Bio• products. The knowledge of science develops a number of skills like reasoning, analysis; critical thinking. It helps individuals to become technically competent and professional in their attitudes. It helps them to become self-sufficient. Scientific hobbies motivate the students to become

creative in their outlook. In every vocation scientific knowledge is required and hence basic knowledge science education is a must for every student. '

Moral Value

Biological Science as a process and product is based on belief in important values like truth, beauty and goodness. Among these values truth is most important, as the scientific experimentation is based mainly on truthfulness and honesty. We an say that science is truth. Success in science is purely dependent on the truthfulness of work. A student working on

',cicntific procedures should inculcate the values like patience, perserverance, truthfulness, honesty and determination. He should be rational in outlook and should accept critical feedback from others. A person who is pursuing science is considered as a seeker of truth. No success is achieved without being truthful. Thus, science not only develops scientific thinking skills but also develops moral values in students.

Aesthetic Value

Ours is a beautiful universe with many unfolding mysterie it. As a part of this beautiful universe we should be able to appreciate our mother nature. Aesthetic sense has its origin in nature. Biological Science helps us in unfolding the mysteries of this universe. A Science student appreciates the nature in a better way. Nature exhibits an order, which is governed by general laws and thus possesses a beautiful harmony. Einstein called it as "the pre-established harmony" We all know that the discovering of such beautiful harmonies is the concern of science. Keats once stated that "Truth is Beauty" and it is established that science is nothing but truth. Thus, Biological Science is the teacher, who teaches us to recognize the beauty of nature, appreciate the nature and make our lives worth living.

Cultural Value

Biological Science plays an important role in the civilization of man. From ancient civilization to the present modern world Science has become part and parcel of our everyday life. Science has a great impact on the culture of man in any society. Its application to the material and maintenance system brought a drastic evolution in the culture. The study of science inculcates scientific attitudes and methodology in the individuals. This affects the way of thinking and the way of living of the individuals. Science has aided the growth of our consciousness by developing awareness about the various facts, concepts, beliefs, customs and traditions of the world. This has heightened our intellectual abilities and helped in refining, understanding and discriminating the facts of life. Science develops cultural value as it forms an integral part of one's life and influences our social heritage. The knowledge of science has a major influence in bringing about a renaissance in our culture and traditions. The scientific knowledge helps in bringing about a cultural balance between the traditions of the past and the advances of the present, as they are undergoing constant change due to the practical applications of the scientific discoveries. The development of *our* society or civilization or culture is wholly dependent on scientific progress. Thus, science is an integral part of our cultural treasure.

Creative Value

Creativity is defined as an activity resulting in new products of a definite social value. It is the ability to think, create or do something new or original. It includes a series of actions, which create new ideas, thoughts and physical objects. We can say that science is also a product with social value, which is due to creative thinking of many scientists over a period of time. Science develops creativity in students. Students learn new concepts, identify new techniques and perform innovative experiments. They observe the

processes, conduct experiments successfully and even develop alternative methods of study. These develop the creativity in the learners.

Disciplinary Value

Science brings mental and physical discipline in the life of the individual. Problem solving, decision-making, critical thinking, perseverance and commitment to tasks are some of the mental disciplines, which a student develops by the study of science. The study of science teaches the student to undertake physical work like practical experimentation for long hours in the laboratory, collect the data, record, analyze and interpret the data and arrive at conclusions. All these activities result in development of self- discipline in the students.

Development of Scientific Attitudes

The knowledge of science results in the development of attitudes like critical observation, open-mindedness and unbiased thinking. It frees individuals from the superstitious beliefs and improves their rational thinking. Science brings a positive change the attitudes of individuals, which improve the life of the individual and help in satisfying the basic instincts of curiosity, creativeness, self-assertion, self-expression etc. The development of scientific attitude has a great impact on an individual's psychology i.e., the way of thinking.

Training in Scientific Method

The study of science trains the students to solve the problems by applying the scientific principles. They approach the problem using a definite scientific procedure called scientific method. Explanation or problem-solving scientifically is called as scientific methodology. With the help of scientific method, one easily solve any problem comfortably. Therefore, it, is necessary that the students are taught and trained in these scientific methods so that they can attack the problem instead of aping from it. The students make a survey of the problem, collect the data, formulate the hypothesis, analyze the

result, draw the conclusions and give the generalizations. Once the student is familiar with all the scientific methods, they can solve any type of problem even in their real life.

Value of Proper Utility of Leisure Time

An idle brain is a devil's workshop. It is very important for students' to utilize their leisure time in a proper manner. The knowledge of Biology should create interest and motivate the leaners to use their leisure in an appropriate manner. The leisure should be used to take up small time projects, or hobbies like collection of specimens of plants or insects and preserving them. The teacher may take the students to plant nurseries or poultry or dairy farms to develop the knowledge about the growth and development of plants and animals. The students may be asked to write articles for the newspapers or school magazines. They may also take up science club activities or take part in science fairs and make the best use of their leisure for enhancing their knowledge of biology.

Value of Science as a Basis for Better Living

The explosion of scientific knowledge has lead to much advancement in the field of science and technology. This made the human beings to lead a more peaceful, healthy and happy life. The developments in the field of medicine, health, industry, food and nutrition, environment and sanitation and also electronics and communication have revolutionized the world. They made this world a more happier and pleasurable place to live.

Objectives of Teaching Biology

Introduction

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 behavior of the learner. The learning experiences are provided by the teaching activities to achieve the educational objectives The change of behavior of the learner is evaluated by 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 ety 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 ful and efficient citizen of the modern society. More stress is given to the practical aspects of science teaching. The knowledge skills, ethics, and values are gives more prominence the curriculum today. The teaching of science should prepare individual to face the challenges of this modern technological in The science education aims at making the individual 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 plan the experiences and evaluate the success. Only when we have clear goals can we compare the success of our endeavor 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 behavior or learning outcome of the pupil at the end of teaching-learning process.

The terms aims' and objectives' are usually taken as snonymous terms in education. Aims are ideals 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 down into smaller objectives, which may be helpful in providing the learning experiences and bringing desirable changes in the individuals.

Differences between Aims and Objectives

Sl. No.	Aims	Objectives
1	Aim is an 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 mam 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 modem 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 not be ambiguous.

III. It should be clear in specifying the required outcomes.

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

V. **Practicable:** The objectives should provide practical experiences in learning.

VI. **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. Understand the utility of biological science to the modern life.

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

Recommendations of Various Commissions on Science Education

To develop science as a core subject in education mainly in schools and at a later level in colleges, the government of India after independence appointed a number of commissions to work out the syllabus, infrastructure, evaluation procedures, teaching study material, and qualified staff, and other allied problems in recommend suggestions. A number of eminent educationists worked on these problems and their recommendations led to the development of science curricula and

establishment of science as core subject at various levels of education. Some important commissions and their recommendations have been elucidated:

University Education Commission or Dr. Radhakrishnan Commission (1949)

This commission was constituted after independence to study the feasibility of starting science as a core subject in schools. It recommended the following:

- Improvement of libraries and laboratories.
- Against any narrow specialization in sciences.
- Curriculum should be relevant to the physical and social environment of the student
- Curriculum should include sciences, and language at secondary level.
- The three-year degree course should have two optionals as science and developing science education:
- Mathematics.
- Admissions to postgraduation should be on merit basis at postgraduation level.

The Secondary Education Commission or Dr. Mudaliar Commission

'One of the most important commissions, which recommended:

To retain General Science as a core subject in the school curriculum –a significant milestone in the history of science education in India Teaching of General Science as a compulsory subject in higher and secondary schools. Envisaged teaching of specialized sciences at advanced levels by competent and qualified teachers. All India Seminar On Teaching Of Science {1956}: Held at Taradevi in Simla hills in 1956. Its main function was to: Evaluate the draft syllabus of Physics, Chemistry and Biology.

To examine Elementary Science syllabus at primary and middle school stage.

To consider various other aspects of teaching such as equipment, apparatus, methods of examinations, teaching aids in science and other allied topics like textbooks, science clubs, museum etc.,

9.3.3 Indian Parliamentary And Scientific Committee (1961)

This committee was set up under the chairmanship of Shri Lal Bahadur Shastri. This committee took up the study of science in schools. It included:

- Increase in the school going children.
- Shortage of qualified teaching staff.
- Need for technically trained manpower.
- Need for changing the process and aims of science.
- Study the structure of school system and the required content of the subject.
- Bridging the gap between what is taught and what should be taught at various levels.

Indian Education Commission or Kothari Commission(1964-66)

An important commission on promoting education particularly science education, it suggested:

- Upgrading school curricula by research in curriculum development, revision of textbooks and teaching learning material.
- Science and Mathematics should be taught on a compulsory basis to all pupils.
- Emphasis should be on acquisition of knowledge and ability to think logically, to draw conclusions and make decisions at higher levels.
- Science teaching should be linked to agriculture and technology.

- At lower secondary level experimental approach to the learning of science should be stressed.
- The methods of science should be modernized. Investigatory approach and laboratory work should be stressed.
- Curriculum should cater to the special needs of gifted pupils.
- Development of science must derive nourishment from our spiritual and cultural heritage.

Ishwarbhai Patel Committee (1977)

It was appointed to review the curivculum of ten-year school. The terms of reference are:

- To scrutinize NCERT syllabus and textbooks.
- To review the scheme of studies and the time allocated for various subjects.
- To ensure that teacher has adequate time for experimentation, creative work, and remedial instruction.
- To accommodate the needs of bright children for advanced level courses.

Today science is regarded with due admiration and respect. The curricula and textbooks are upgraded and new innovations have been included. Science has been given a practical orientation. National Science Talent Search Examinations are conducted to pick up talented students. Application of science to life and correlation of sciences are stressed in the school curricula. In this scenario of advancement of science and technology, the teacher plays an important role as a facilitator of scientific knowledge.

9.4 National Policy on Education 1986

Almost 18 years after the introduction of 1968 policy, a new education policy was developed in 1986. It was felt that our delivery system is not able to meet the needs and aspirations ol the people. The National Policy on Education 1986 reaffirmed the decision of the 1968 policy that science and mathematics hold remain ass compulsory subjects in the first ten years ol howl education It must be strengthened because all the areas of development and technology based and for that we

need experts, middle-order workers and scientifically literate citizens.

Regarding science education, the Policy stipulates

- Science and mathematics will remain as core subjects in the first ten years of school education.
- In order to develop scientific temper and to attain other goals, it is necessary to define the objectives to be fulfilled through science education.
- Involvement of community, non-government and voluntary agencies is required to pool the resources by establishing networks among different institutions. Efforts should be made to generate manpower at the grassroot level that will spearhead the implementation of ideas stated in NPE.
- Special programmes are needed for the educationally backward states and educationally backward schools of the society. This is necessary for the removal of disparities, attainment of women's equality and education of scheduled castes and scheduled tribes and other educationally backward sections and areas.

- For universal enrolment and retention, improvement in the quality of education is necessary. Each student learns in a different way and each student has the right to learn. The teaching/learning of science should be designed in such a way that it serves that basic right. Science education at the elementary level will be so designed that instead of loading the child with content information, it should provide him with the joy of learning.
- Science education will be extended to the vast numbers Who have remained outside the pale of formal education. This is to be kept in mind while planning science education for non-formal system.
- Science and mathematics curriculum will be designed for the secondary level for conscious internalization of healthy work ethos. This will provide valuable manpower for economic growth as well as for ideal citizenship to live effectively in the science/technology-based society.
- Science curriculum for general education will be implemented in the pace-setting schools with sufficient scope for innovation and experimentation.
- Science up to Class X should be treated as one. The laws and principles of science, which are operating in the environment, should be used for creating desired teaching/ learning situations.The performance of activities will be given top priority in teaching/learning of science

Types of Objectives

The objectives can be classified into two major categories. They are:

I. Educational objectives

II. Instructional or teaching or learning objectives.

Educational Objectives

An educational objective is a desirable change that is brought about in the behavior of the students through the teaching learning process. Educational objectives are based on the aims of education. These are in turn related to the philosophy of the nation. The objectives of education should specify the observable and measurable changes. The objectives of education are in consonance with the values of education. They provide a basic platform for the development of the educational system.

The educational objectives are general statements, which imply changes we try to produce in the child. Educational objectives are not the only goal towards which curriculum is shaped and instruction is guided. It should also provide a detailed specification for construction and use of evaluation techniques

The educational objectives indicate the change that is brought in the child by the education. The educational objectives are broad ideals that are related to the educational system. They are general statements based on the philosophy of education. The educational objectives are achieved by the learning experiences provided by the teacher. The teaching learning activities provide experiences and the change of behavior is evaluated in terms of

these objectives. Thus educational objectives are the basis for teaching activities and evaluation techniques.

The whole education system is directed towards achieving the aims and objectives of education which lead to an all round development of the learner. It is not possible to realize all the

aims of education in a school, as they include a total programme of education and out-of-the school experiences also. The school programme forms only a part of total educational programme.

Bloom defines educational objectives, as "the educational objectives are not only goals towards which the curriculum is shaped and towards which the instruction is guided but they are also the goals which provide the detailed specification of the construction and use of the evaluative technique.

The hierarchy of the objectives can be understood as

Aims of Education

Objectives of Education

Instructional Objectives

Instructional Objectives

The expected behavioral changes that are to be brought through the classroom instruction are termed as instructional objectives. The teaching objectives are specific instructional objectives, which bring about immediate behavioural changes in the learner as a result of classroom instruction. Instructional objectives are those statements, which express specific and measurable terms the skills and attitudes, which the students develop as a result of following a particular method of instruction. The instructional objectives provide guidance and direction to the method of teaching. Instructional objectives are related to learning outcomes of the learner.

The teaching objectives are framed by the teacher and are achieved in a short duration of around 40 minutes. The teaching objectives are specific and are purely concerned with the

classroom teaching. They are based on the psychological principles. The teaching objectives are identified based on the content analysis. They are determined during the lesson planning.

Comparison of the Educational and Instructional Objectives

Sl. No.	Educational Objectives	Instructional Objectives
1	They' are broad ideals, which are based on aims of education.	They are specific objectives derived from educational objectives.
2	Based on the principles of educational philosophy	Based on principles of psychology
3	They require a longer duration for achievement	They are short-term goals. Can be achieved at the end of classroom instruction.
4	Educational objectives cover the entire process of education	Cover individual subjects seperately
5	They include the teaching objectives	They are part of the educational objectives
6	Eg. Development of scientific attitudes, feelings of national integration etc.,	Eg. Developing knowledge, skills, and understanding of concepts.

Blooms Taxonomy of Educational Objectives and its Limitations

The word taxonomy means classification. It is the classification of ideas and objectives. Taxonomy of educational objectives means an analysis of instructional objectives in terms of the learning outcomes resulting from appropriate teaching learning situations. The classification of educational objectives assumes that the modification of the behaviour of the learner is the result of the learning experiences generated by the teaching learning process. Taxonomy means a

categorization of an object. I hus taxonomy of instructional objectives implies categorization f instructional objectives. It means an analysis of instructional bjcctives in terms of the precise and specific teaching outcome. The taxonomy, of educational and instructional objectives has worked out on the assumption that the teaching –learning ocess may be conceived as an attempt to change the behaviour the pupils with respect to some subject matter. Behaviour of the divided into three domains-Cognitive (knowing), reflective (feeling) and Psychomotor (doing). They are related to id, heart and hand. The taxonomy of educational and rctional objectives have also been considered to belong to three domains. The behavior modification of the learner is divided into domains.

- Cognitive domain
- Affective domain
- Psychomotor domain

Taxonomy of the educational objectives is useful as

- Objective tool of an evaluation
- Helps in proper coverage of all aspects learners' growth.
- Helps in the meaningful understanding of various dimensions of learner's development.
- Helps in identifying and grading the teaching learning situations, which can be an important source for selecting proper evaluation tools.
- It acts as a link for communication between teachers, evaluators, research workers, psychologists and behavioural scientists.
- Opens new avenues for research in the field of education.

- In 1948, the convention of American Psychological Association considered classifying educational goals for evaluating the performance of students. The educational objectives provide the basis for building the curricula and tests for the measuring the understanding of those curricula by the students. These educational objectives have been classified into three major domains based on the behaviour modification they bring in the learner. This classification of objectives is called as the "Taxonomy of Educational Objectives".

The advantages of the Taxonomy of Educational Objectives are:

- It helps in clarifying the doubts pertaining to the objectives of education.
- It acts as a convenient system for describing and ordering test items, examination techniques and evaluation procedures.
- The taxonomy of educational objectives would help in comparing the various educational programmes.
- It would provide an order for the educational objectives.

In the year 1965 Benjamin Bloom – A professor, University of Chicago along with a few others published a book on "Taxonomy of Educational Objectives". The book influenced every aspect of formal education; from the way the curriculum designed to the way performances of the students were evaluated at class level. As a follow up they also published two handbooks - one on the cognitive domain and other on the affective domain.

According to them most of the educational objectives could be placed in one of the three major domains of classification - cognitive, affective and psychomotor.

The cognitive domain includes those objectives that deal with recall or recognition of knowledge and development of the intellectual abilities and skills.

The objectives of affective domain describe "changes in interest, attitudes, and values and the development of appreciations and adequate adjustment".

The psychomotor domain pertains to " the manipulative or motor skill area".

Cognitive Domain

The largest proportion of educational objectives falls in this domain. Bloom has divided this domain into six major classes. They are --

- Knowledge
- Comprehension
- Application
- Analysis
- Synthesis
- Evaluation

The classes are arranged hierarchically as objectives of higher classes typically build on behaviours found in lower lasses. Most of the teachers and learners consider that acquisition f knowledge is the primary if not the sole aim of education. If a tudent is able to recall or recognize the idea or phenomena countered in learning, he satisfies the requirements of first level f this domain. But true knowledge involves relating and judging, anizing and reorganizing. It requires a higher degree of mitive capability. These enhanced capacities are realized in higher classes of mitive domain. Although information or knowledge are ognized as an important outcome of education, very few teachers regard this as primary or sole outcome of instruction. What is needed is that the

students can do something with their knowledge so that they can apply the information to new situations and problems.

Affective Domain

These objectives emphasize a feeling of tone, an emotion, or a degree of acceptance or rejection. Affective objectives vary from simple attention to selected phenomena to complex but consistent qualities of character and conscience. Objectives like intrest, attitudes, appreciation, values and emotional sets are included here. There is a broad relation between the objectives of cognitive domain and affective domain. Once the objectives of cognitive domain are developed, the development of the affective domain objectives follows. This suggests that the affective behaviours develop when appropriate learning experiences are provided for students much the same as cognitive behaviors develop from appropriate learning experiences. The objectives of the affective domain are structured hierarchically. A learner perceives a phenomenon, attends to that phenomenon, responds with positive feeling, places value upon it, organizes the value within valuation system, and finally characterizes the value complex within his/her entire outlook of life. This domain includes

- Receiving
- Responding
- Valuing
- Organizing
- Characterizing

Psychomotor Domain

The major organizational principle is that of complexity with attention to the sequences involved during the performance of a motor act. With the psychomotor learning the learner should be able to perform physical or motor skills as a result of education or training programme. This domain comprises

- Imitation
- Manipulation
- Precision
- Articulation
- Naturalization

CLASSIFICATION OF EDUCATIONAL OBJECTIVES

Bloom and his associates have developed the most portant classification of objectives of cognitive domain in the 1956. The affective domain objectives by Krath wohl, Bloom "' l Masia in 1964, and psychomotor domain objectives by simpson in 1969

Taxonomy of Educational Objectives of Cognitive domain

Knowledge

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

Knowledge is the recall of specifics, methods and processes, recall of a pattern, structure or settings. It includes:

Knowledge of terminology

Knowledge of facts

Knowledge of conventions

Knowledge of trends and sequences

Knowledge of classifications and categories

Knowledge of methodology

Knowledge of universals and abstractions

Knowledge of principles and generalizations and

Knowledge of theories and structures

Verbs Related to Knowledge

Defines; describes; enumerates; identifies; labels; lists; matches; names; reads; records;

Comprehension

Comprehension is defined as the ability to grasp the meaning of material. Translating material from one another, by interpreting material, and by estimating future may show this. These learning outcomes go one step beyond simple remembering of material, and represent the lowest level understanding.

Comprehension includes:

• Translation

• Interpretation

• Extrapolation

Application

Application is the ability to use learned material in the new situations. It involves the ability to apply the knowledge of concepts gained in the classroom to new situations outside. It requires the higher levels of understanding than those of the comprehension

Verbs Related to Application

Acts; administers; articulates; assesses; charts; collects; computes; constructs; contributes; controls; determines; develops; discovers; establishes; extends; implements; includes; informs; instructs; participates; predicts; prepares; preserves; produces; provides; relates; reports; shows; transfers; uses; utilizes.

Analysis

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

It includes the breakdown of a communication into its tituent elements or parts so that the ideas and concepts remain Involves the

- Analysis of elements
- Analysis of relationships

- Analysis of organizational principles

Words related to Analysis

Breaks down; correlates; diagrams; differentiates; ruminates; distinguishes; focuses; illustrates; infers; limits; lines, points out; prioritizes; recognizes; separates; subdivides

Synthesis

A plan of operations (research proposal), or a set of abstract relations (scheme for classifying information). Learning outcomes in this area stress creative behaviours, with major emphasis on the formulation of new patterns or structure. Synthesis includes putting together elements and parts into a new whole. It involves

- Developing unique communication
- Developing a new set of operations
- Arriving at a new set of abstract relations

Verbs Related to Synthesis

Adapts; anticipates; categorizes; collaborates; combines; communicates; compares; compiles; composes; contrasts; creates; designs; devises; expresses; facilitates; formulates; generates; incorporates; individualizes; initiates; integrates; intervenes; models; modifies; negotiates; plans; progresses; rearranges; reconstructs; reinforces; reorganizes; revises; structures; substitutes; validates

Evaluation

Evaluation is concerned with the ability to judge the value of material for a given purpose. The judgments are to be based on definite criteria. These may be internal criteria

(organization) or external criteria (relevance to the purpose) and the student may determine the criteria or be given to them. Learning outcomes in this area are highest in the cognitive hierarchy because they contain elements of all the other categories, plus conscious value judgments based on clearly defined criteria. Evaluation judges the values of the materials and methods for the given objectives. They are

- Judging the evidences internally
- Judging the criteria externally

Verbs Related to Evaluation

Appraises; compares & contrasts; concludes; criticizes; critiques; decides; defends; interprets; judges; justifies; reframes; supports.

Objective	**Ability**	**Associated verbs**
I. Knowledge	Recall Recoznize	Define, state, list, Recognize name, write, recall label, underline, select, reproduce, measure.
2 Comprehension	Sees relationships cites examples Discriminate verify generalize	Identify, justify, classify, judge, justify
3. Application	Give reason, Formulate Hypothesis, Establish relation, Give inference	Predict, assess, choose, demonstrate, construct, show, compute
4. Analysis	Analyze	Identify, conclude, differentiate, separate, compare, contrast, break down, resolve, criticize
5. Synthesis	Synthesize	Combine, summarize, organize, derive, relate, conclude, generalize
6. Evaluation	Evaluate	Determine, defend, criticize, evaluate.

Limitations of Bloom's Taxonomy

Blooms taxonomy has been criticized for its total commitment to the behavioral objectives. It is difficult to convert the theoretical concepts into behavioral objectives. The behaviour

specification of the objectives may not enhance student learning as specified by Bloom. They may also reduce the learner's individuality. Bloom's classification is not applicable to all areas of the curriculum. This classification lays emphasis more on measurable behavior and does not give importance to work of the pupils.

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 behavior – the change in their behaviour which is a result of learning

- Instructional objectives indicate the 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.

Writing Learning Objectives in Behavioral Terms

Need of writing objectives in behavioral terms

Writing the statement of instructional objectives in behavioral terms or performance terms is called as writing objectives in behavioral terms. Taxonomic categories of objectives do not specify the form of teaching and learning activities. Behavioral objectives indicate learning activities in a classroom situation. In the present scenario there is utmost need to write objectives in behavioral 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 behavioral change?
- What will be the expected level of performance?
- For answering the above questions the teacher has to write down the instructional objectives in behavioral terms. Hence the need for writing these objectives is:
- Teaching activities are determined and delimited.
- Teaching and learning process may be integrated for effective learning outcomes
- Selecting teaching strategies for effective learning.
- To make teaching and testing objective-centered.

Guidelines for writing the behavioral 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 behavioral objectives

Advantages of behavioral objectives

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

Instructional Objectives arid 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

Specifications:

- 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

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

Specifications:

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

Specification:

- The pupil develops the skill of manipulation: The pupil
- Handles the apparatus carefully Arranges them systematically Observes the readings precisely Develops improvised apparatus

Specification:

- The pupil develops the skill of preserving the specimens. The pupil
- Identifies the particular specimen
- Collects the specimen carefully
- Mounts the specimen using relevant procedures
- Preserves the specimen following the appropriate technique.

Specification:

- 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

Specification:

- The pupil develops skill of observation: The pupil Distinguishes between the different parts of tho specimen.
- Identifies various parts of the specimen. Notices the relevant parts carefully. Reads an instrument accurately.

- Detects errors in the experimental setup

Specification:

- The pupil develops the skill of reporting:
- Uses appropriate biological terms in describing the spec1mens
- 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.

Specification:

- 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

Specification:

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

Objective appreciation: The pupil develops appreciation of nature and its utility to the human beings.

Specification:

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.

Principles of Curriculum Construction

Introduction

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 the 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 to 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 of 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 from 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".

Smith, Stanley and Shores: "Curriculum is a sequence of potential experience set up in school for the purpose of disciplining children and youth in group ways of thinking and action".

Beauchamp: "Whatever the mode of expression, the subject matter is the substantive hard core of the curriculum.

Concept of Curriculum

The modern concept of curriculum

Education earlier was considered as the tool to acquire a large body of information. Curriculum was considered synonymous with the syllabus, which includes the subjects of instruction. But today curriculum is considered as a dynamic process. Curriculum is not confined only to the courses of study, but is the sum total of the experiences of the students, which they come across in the classroom, in the playground etc. The informal contacts between the teacher and the student also constitutes curriculum. In short, the whole life of the student in the school is the curriculum. Science curriculum is the part of the whole curriculum and helps a student in developing balanced personality. Science curriculum not only helps in acquiring scientific knowledge but also helps in developing scientific attitudes, interest, skills etc. The many concepts of curriculum,

enunciated over the past half a century, have been classified by many experts in different ways, based on the theoretical pronouncements on curriculum.

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 sense of value development of the body, and informal contact with the society in many ways. Thus, it includes all the educational activities of the school in the widest possible sense.

The difference between curriculum and the syllabus

The basic meaning of curriculum is to teach the students. It is more than the process of learning and studying. All the experiences faced by the learner during his/her tenure in the school constitute the curriculum. The experiences which the students come across in the classroom, library, or even in the playground are also counted as curriculum. It represents more than any textbook, or subject matter or a study course. Therefore, the whole period of student learning in the school could be considered as curriculum.

The curriculum is viewed as a programme of studies to provide the learning person (student) with a coherent sequence of impressions, exercises and cognitive subjects by virtue of which he can participate consciously, conscientiously, and productively in the cultural development of the nation and of mankind as a whole.

Science Curriculum is a comprehensive concept, which takes into consideration all the possible educational activities in the school. It considers the activities for widening aesthetic experience, for developing a moral sense among the students, for the physical development of the students, for science education tours and excursions, and informal contacts between children and teachers on the playground and other places, apart

from learning the subject alone. Extra-curricular activities are now very much a part of science curriculum.

If curriculum can be taken as the base on which the activities, studies, and experiences a pupil has to undergo in his school life, the syllabus becomes the execution part of such experiences, a structure built over the base. It frames the portion to be taught, the particular tasks to be undertaken, stipulating the goals to be achieved and standards to be accomplished. Therefore, the basic steps are laid down by the curriculum and the means to achieve them are delivered through the syllabus.

The general concept of curriculum

The concept of curriculum, given by **Albert Oliver is** as follows: Curriculum is nothing but educational programme, which consists of three basic elements namely:

- Program of studies
- Program of activities
- Program of guidance

Program of studies: This deals with listing of the subjects for each grade and levels of information. Since, the listing of subjects emphasizes on cultural exploration, the basic function of school of transmitting cultural heritage of mankind to youth is served. In a curriculum the information is selected and organized properly.

Program of activities: It helps in vitalizing the curriculum; the educational programme should include students experiences represented by activities in addition to cultural experience represented by studies. Therefore, this programme helps students not only in acquiring knowledge, but also in experiencing a method of facing life.

The emphasis of this programme varies at different levels of schooling. At elementary level, the programme of studies and the programme of activities are combined so, that students while learning new concepts also experience working

activity. At the secondary level, more emphasis is given on the programme of studies and the programme of activities is termed 'co-curricular' activities. At the college level, both the programme of studies and the programme of activities are separated widely and programme of activities refers to life of the students on the campus.

Programme of guidance: Guidance is an integrative course both for an individual as well as for an educational program. The programme of guidance helps in solving an individual's problem. The problem may be an interpersonal one or occurring in-group situations. It mainly helps the student to become competent to face his/her own problem and to make proper decisions.

Characteristics of Curriculum

The following are the important characteristics of curriculum:

• **Curriculum is dynamic:** As the society's scientific beliefs and the social needs change from time to time there is a need for revision of science curriculum. No single curriculum is suitable for all the times. The curriculum has to change in accordance with the change in social strata due to industrial growth, scientific process and social advancement.

• **Curriculum is related with the aims and objectives:** Aims and objectives of the people in a society have to be fulfilled through the experiences provided. These experiences are planned and spelt out in the curriculum. The different stages involved in the curriculum process are formulation of objectives; selection of learning experiences, selection of the content, organization of the content and evaluation makes the curriculum a scientific process. It is no more based on a rigid tradition but supported by psychological, philosophical and social considerations.

• **Curriculum involves evaluation:** Evaluation is a modern concept of the traditional examination. Whereas the old system is the results with reference only, the evaluation is

concerned of the results with reference to aims and objectives. The goals and aims are balanced in evaluation.

- **Curriculum is a broad and comprehensive process:** Curriculum is much more than classroom instruction. It is not confined to the four walls of the classroom. All the experiences provided by the school both inside and outside the school are under curriculum.

Curriculum Styles

There are basically three types of curriculum styles. They are: **Instrumental curriculum:** In this type of curriculum more emphasis is placed on the utility value or vocational value of science. It makes learning an intense competition among students. The basic approach in such a curriculum is disciplinary and emphasizes the acquisition of knowledge or information. The teacher dominates the scene in this type of curriculum.

Interactive curriculum: This type of curriculum is society- oriented and lays more emphasis on the social development of child. In this type of curriculum class room instructions becomes an interactive or a cooperative process. The approach is interdisciplinary and the curriculum is loosely structured and consists of learning packages.

Individualistic curriculum: This approach is also interdisciplinary and major emphasis is laid on personal development of the child. It helps in the creative development of the child. The students base this type of curriculum on self-calculation.

Important Recommendations for the Science Curriculum in Indian Scenario

Science curriculum suggested by Indian Education

Commission 1964-1966

The Indian Education Commission has recommended that science and mathematics should be taught on a compulsory basis to all the students as a part of general education during the first ten years of schooling. In addition, there should be provision for

special courses in these subjects at the secondary stage for students of more than average ability.

For the lower primary classes I or IV, the focus should be the child's environment-social, Physical and biological. There should be emphasis on cleanliness, formation of healthy habits, personal hygiene, sanitation and development of powers of observation; school gardening should be a regular activity.

In the higher primary stage, IV to VII, the emphasis should be on acquisition of knowledge, ability to think logically, draw conclusions and to make decisions. Science now should be taught as physics, chemistry, biology, geology and astronomy.

The Commission felt that the disciplinary approach in learning science would be more effective in providing necessary scientific base to young people. It felt that the general science approach has been so far a futile attempt.

In the lower secondary classes, physics, chemistry, biology and earth sciences should be taught as compulsory subjects for all the pupils. They should be made to cover wider areas and should go deeper into the content.

At the higher secondary stage where diversification of studies will take place, science will not be studied as a compulsory subject. When option is called for, there should be no rigid grouping. For e.g. one can choose two sciences and one arts subject. Similarly it should be possible for an arts student to take up the study of physics or biology or any other subject in the science group as an elective. Such a combination will prevent narrow specialization. Provision of courses in science at higher level should be made for the talented students.

The other suggestions are:

Lower primary-class I to IV

In the lower primary classes the focus should be on the child's environment -social, physical and biological.

Personal Hygiene and sanitation

Introduction to formal areas of science such as

Plants and animals is his surroundings;

The air he breathes;

The water he drinks;

The weather that affects his daily life;

The earth he lives in; The simple machines;

The body of which he should take care; and

The heavenly bodies he looks at Gardening Roman alphabets

Higher primary stage-classes V to VII

At this stage science should be taught as

Physics Biology Astronomy

Geology

The allocation of these subjects among the three classes is

as follows:

Class V- physics, geology, biology

Class VI – physics, chemistry

Class VII- physics, biology, chemistry and astronomy

The General Science approach to the teaching of science, which has been widely adopted at the elementary stage during the last ten years, has not proved successful and hence the above structure was recommended.

Low secondary stage-classes VII to X

Physics Chemistry Earth science

Biology

All the above subjects were to be treated as compulsory.

Higher secondary stage-XI and XI,

Science will not be suited as a compulsory subject in this stage. Those who want to opt for specialization may choose three electives from the science group only or may choose two subjects from science group. Science includes physics, chemistry, biology, geology and mathematics.

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

Science Curriculum Project

UNICEF - Assisted Science Education Programme (SEP): To study the state of the education in India, a planning mission from UNESCO visited several states and Union Territories in

1964. It recommended for improvement in teaching of science in Indian schools. The Government of India started a pilot project, which was funded by UNICEF and covered primary classes and middle classes. This project was called UNICEF-Assisted Science Education Programme (SEP).

NCERT: The National Council of Educational Research and Training (NCERT) is an apex resource organization set up by the Government of India, with headquarters at New Delhi, to assist and advise the central and state governments on academic matters related to school education.

NCERT has been the key player in all aspects of science education in schools. Its first major attempt was made in 1975 when it published the curriculum framework for first ten years of schooling. This was built up around the recommendations of the Kothari Commission. The Commission emphasized that primary stage science teaching should be related to child's environment to facilitate understanding of internationally accepted symbols of scientific measurements and use of charts, maps and tables. At the upper primary stage, it recommended acquisition of knowledge and ability to think logically as well as to draw conclusions and make decisions. At the lower secondary stage science was recommended to be developed as a discipline of mind and knowledge. Newer concepts of physics, chemistry and biology as well as the experimental approach for learning of science were to be emphasized. The Commission also recommended science courses at advanced level in selected lower secondary schools for talented students with necessary facilities of staff and laboratory. It also emphasized linking science teaching to agriculture in rural areas and technology in urban areas. The new curriculum developed by NCERT was critically received, particularly for being heavy in Classes IX and X. Basic features of the curricula were appreciated and put to implementation practically throughout the country. The magnitude and extent of success at implementation however, remained a point of discussion. The 1986 National Policy on Education and its revision in 1992 took note of all the past achievements and experiences and formulated the following statements on science and mathematics education Science and Mathematics education will remam as core subjects in the first ten years of school education.

- In order to develop scientific temper and to attain other goals, it is necessary to define the objectives to be fulfilled through science education.
- Involvement of community, non-government and voluntary agencies are required to pool the resources by establishing network arrangement between different institutions. Efforts

should be made to generate manpower at the grassroots level spearhead the implementation of ideas stated in NPE.

- Special programmes are needed for the educationally backward states and educationally backward schools of the society. This is necessary for the removal of disparities, attainment of women's equality and education of Scheduled Castes and Scheduled Tribes and other educationally backward sections and areas.
- For universal enrolment and retention, improvement in the quality of education is necessary. Each student learns in a different way and each student has the right to learn. The teaching/learning of science and mathematics should be designed in such a way that it serves that basic right. Science and mathematics education at the elementary level will be so designed that instead of loading the child with content information it should provide him with the joy of learning.
- Science education will be extended to the vast numbers. Who have remained outside the scope of formal education. This is to be kept in mind while planning science and mathematics education for non-formal system. Science and mathematics curriculum will be designed for the secondary level for conscious internalization of healthy work ethos. This will provide valuable manpower for economic growth as well as for ideal citizenship to live effectively in the science/technology-based society.
- Science and mathematics curriculum for general education willbe implemented in the pace setting schools with sufficient scope for innovation and experimentation.
- Science up to Class X should be treated as one. The laws and principles of science, which are operating in the environment, should be used for creating desired teaching/ learning situations. The performance of activities will be given top priority in the teaching/learning of science.

National Institute of Education

The National Institute of Education (NIE) in New Delhi through its vanous departments carries out research and development functions related to pedagogical aspects of curriculum; prepares prototype curricula and other supplementary instructional material; develops school education-related database and undertakes experiments in preschool, elementary and secondary stages to nurture all-round development of the learner.

B.S.C.S.- The Biological Science Curriculum Study Project

The Biological Science Curriculum Study (BSCS) was organized in 1959 by the American institute of biological science. It was necessitated by the inadequacies and defects found in the conventional Bio- science teaching. BSCS differs 'from conventional method in treating biology in three different aspects.

It shows unity among topics.

Lays emphasis on molecular and physiological aspects.

More stress on practical work.

Main functions of BSCS is to:

- Evaluate the content of the present biology course.
- To produce classroom material for average students at secondary school level.
- To produce textbooks and handbooks for the teachers.
- To produce lab manuals for laboratory work. *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. Stress is 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.

Nuffield Foundation

Nuffield Foundation Science Teaching Project arose from a general interest in curriculum development in science in U.K. It is a charitable educational foundation. The essence of Nuffield course in Biology is "science for all . The main intention was to

provide a balanced and up-to-date view of the subject suitable for pupils who leave the school at the age of 16 years. The course is designed to foster a critical approach to the subject with an emphasis on experimentation and enquiry rather than mere assimilation of facts. Issues like relationship of structure and function, adaptation and interaction of organism and environment are given stress in the course.

The main aims of the Nuffield Science Projectare:

- To make science an accessible subject to all the pupils in the schools.
- To make science a practically useful tool in the hands of students.
- To develop course material that will help the teachers in presenting the science subject in a lively and exciting manner.
- To develop the interests and curiosity to learn science.
- To develop an approach of experimentation and enquiry rather than mere assimilation of facts
- To develop in essence a new approach to teaching.

The Nuffield Biology project course falls into two categories- The Introductory course has a general approach and the second course is a Quantitative course with greater emphasis on experimentation and reasoning. The Nuffield project has developed textbooks, teacher's guides, films and visual aids. They stress on enquiry and process approach. All these provide a qualitative insight into the subject of science.

- *Textbooks:* Designed with a variety of teaching approaches, these provide a clear indication of overall structure of the course, investigatory approach to subject matter, laboratory experiments and manuals.
- *Teacher's guide:* These are available for various textbooks, which help in the methodology of teaching.

- *Films and visual aids:* Supplemented with the films, film loops are made available which are silent.

Nuffield Science Programmes emphasize on enquiry and process approach rather than facts. They stress on qualitative insight rather than quantitative approach.

Curriculum Organization

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 so 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.

Determinants of Curriculum

The main determinants of the curriculum are:

- Objectives
- Content or subject matter
- Method and organization

• Evaluation

All the four determinants are in tum affected by Philosophy, Sociology, and Psychology.

1. **Objectives:** An objective may be defined as an intended learning of a curriculum or the goal towards which a school sponsored activity is directed. Educational objectives may be of three types: Philosophical, Sociological, and Psychological. The main goal of the curriculum is to achieve these three objectives.

ii. **Content or subject matter:** The content helps in determining the nature and type of learning experiences that should be provided to the students. It also evaluates the tools to be employed for this learning. Knowledge of content is essential for the rational action. Basic knowledge is essential for knowing the concepts, and principles and to discover the new facts.

iii. **Methods and organization:** Educational objective is achieved only if proper method is selected. For classroom teacher's organization of learning activities acts as functional aspect in achieving the concept of education. A teacher is responsible for creating conducive atmosphere for informal and formal interactions between teacher-student, student-student, and student with oneself. Therefore, the curriculum depends on the organization of the content and the learning experiences.

iv. **Evaluation:** Technical evaluation is the integral part of the curriculum. The achievement of the educational objectives is the measure of the effectiveness of the curriculum, which is assessed, with the help of evaluation. Evaluation is not confined to the end of the lesson or a chapter; instead it is a continuous process, i.e. during the lesson. It clearly, shows theteacher's goals and point-of-view of life science teaching.

Evaluation is one of the techniques to assess the student's progress and it helps in getting the feedback from the students. It also helps in assessing and modifying the teaching procedures. Hence we can say that curriculum is never static.

22.3 Principles of Curriculum Organization

Curriculum organization is a scientific process involving the basic principles on which the entire credibility of the curriculum rests. Some important principles of curriculum organization are: -

- **The principle of child-centeredness:** The curriculum should be able to provide suitable opportunities for fulfilling the varied needs of the learner. It implies that the curriculum should satisfy the physical, emotional and social needs of the learner.
- **The principle of utility:** Curriculum should help the learners to live a wholesome and fulfilling life. It should provide sufficient opportunities for the academic and social growth of the child. A living curriculum has to be developed to meet the demands of the fast changing realities of the life. A student should be able to use his/her knowledge in solving day-to-day problems.
- **Principle of creativity:** The curriculum should place the child in the place of a discoverer and time for creative activities should be included in the curriculum.
- A pleasant atmosphere and basic facilities to encourage the creativity has to be provided to a student so as to fulfill the objective of creative thinking.
- **Principle of activity-centeredness:** The curriculum should emphasize learning by doing. Emphasis should be on laboratory work and other field experiences. Nature should act as laboratory for the students. Real-life experiences should be given importance.
- **Principle of variety:** The curriculum should not be rigid. It should be flexible to cater to the students, the changing needs of the learners and society. It should be broad-based to satisfy the needs and interests of the individual learners. The students should be given

enough freedom to express their views and autonomy to select their course of action seemg to it that they reach the goal in the right pathway.

- **Principle of readiness:** The curriculum should be based on the sound principles of learning. They should be based on the level of maturity of the learner and the degree of receptivity.
- **Principle of social relevance or community-centeredness:** It should be based on the purposes of the society. It should be relevant to the needs and requirements of the society. While organizing a curriculum the future of the student should be kept in mind. In this technological age, inclusion of computers and Socially Useful Productive Work (SUPW) is very important. The student should be provided with the knowledge of all the new terms, so that once he/she leaves the school they should be able to face the society with ease.
- **Principle of conservation:** The curriculum should help in preserving and spreading the traditions and culture of our nation. This objective can be fulfilled if the schools include environmental education as one the subjects, which enables a child to learn about nature and its problems. This principle enables a student,
- To observe the environment and enrich his experience
- To develop skills like observing, communicating,
- measuring, hypothesizing, and experimenting.
- To develop better understanding of the facts and concepts of science through nature study.
- To develop application of science through the
- development of scientific attitude.
- To develop creativity in science.

- **Principle of balancing:** Curriculum should be able to balance the objectives and content, objectives and abilities and objectives and learning experiences. It should create a balance between the content to be presented, the teacher and the taught. It should be properly graded and broad based.

•Principle of integration: Curriculum should integrate the child's needs on one hand and needs of the society on the other. The curriculum should be based on individual needs as well as the priorities of the nation. A well-planned curriculum should provide suitable experiences to integrate the abilities, aptitudes and interests of learners with different social backgrounds and make them productive citizens of the country.

Process of Curriculum Development

Curriculum is a basic cycle involving the processes of analysis, design, implementation and evaluation. Curriculum planners set up goals, plan out the experiences, select the content and assess the learning outcomes. Curriculum development is an orderly process of coordinating the various elements of time, space, materials and equipment and personnel. The cycle of curriculum development guides the process of curriculum improvement. The cycle of curriculum development is analyzed as –

Analysis: The step of analysis identifies the values and sets up goals. The objectives are set up keeping the following in the mind. They are: -

- The curriculum should match the student's mental development.
- The introduction of the topics should be on concrete level.
- More emphasis on experimental work or learning by doing.
- Ambiguous and doubtful contents should be excluded .

Design: After framing the objectives and deciding the content the data must be organized into an action plan, which identifies what, is to be done, the changes to be made and the time needed to bring about the changes. Usually designing the curricula is

carried out in the workshops organized at the national level.Improving the infrastructure facilities in the laboratories

• Developing proper scheme of evaluation procedures.

Evaluation: The curriculum framed should be properly evaluated to assess the achievement of the desired objectives. Evaluation helps in identifying the drawbacks and aids in improving the curriculum. The role of evaluation completes with the returning of pointer to the analysis stage. This completes the development of curriculum cycle.

Implementation: This stage involves the execution of the curriculum designed. It includes the application of the resources and training for providing the required skills. The implementation of the science curriculum involves-

- Training the teachers in advanced techniques by carrying out in-service programmes for the teachers.

Approaches Involved in Curriculum Organization

Organization of curriculum is based on a number of approaches. The major approaches of curriculum organization are:

- **Topical approach:** This is simplest of all approaches. Based on the importance the topics are selected and placed in a systematic order. Topics, which are relevant to day-to-day life and today's world, are included in the subjects of higher classes. They may not provide the continuity of the knowledge. Sometimes, this may lead to defective syllabus due to imbalance, lack of sequence and lack of coherence in the curriculum. This arrangement makes the teaching- learning process very interesting and suits to their Psychological needs. In this approach, topics of immediate interests to the pupils are selected carefully and lessons are developed in an interesting way. But this approach has its own limitations. A piece of information is related to many sources. Now, where to include it to get the maximum benefit, becomes a problem. Another serious limitation is

about the teachers. They have to be all-knowing and versatile. The other danger is that the development of the topics becomes artificial and hence uninteresting.

- **Logical approach:** Science is nothing but accumulated and systematized body of knowledge. The knowledge becomes meaningful if the contents are arranged in a logical order. This way of arrangement is quite in consensus with adult thinking and in the higher stages of education this approach is based on hierarchy or level of difficulty. It is also called as funnel approach. It caters to the needs of the learner. Based on the psychological principles such as readiness, transfer of training, reinforcement etc. framing of the curriculum takes place. The curriculum includes simple topics followed by difficult topics.
- **Subject-centered approach:** Importance is given to the entire content of the subject. The topics in it are arranged accordingly. It stresses the acquisition of factual knowledge because facts lead towards the general development of the subject. The sequence involves acquisition of the facts, acquisition of concepts by students and then followed by practical work.
- **Activity approach:** The subjects are important and the teaching is centered on the activity base method in it. Any theory teaching should follow practical method. It depends on the teacher's flexibility. Learning by doing is the principle followed in this approach. Four criteria of activity Observation and interpretation of results is a part of the activities. Facts and principles taught to the students should be in accordance with the needs and requirements of the students as well as the society.
- **Integrated curriculum:** Importance is given to all the subjects. And teaching is carried out in an integrated manner. It tries to inspire the pupils to have a coherent view of science by establishing the numerous links between the various branches of science. In India, the integrated approach for science teaching is widely used.

- **Concentric approach:** This approach involves addition of knowledge from basic to advanced level. It is a continuous process. In this method the various topics, which are to be introduced, are developed gradually. The general science syllabus gives scope for this way of approach. Here all topics are taught in all classes, the difference being only in the depth of the content matter. As the child grows the subject also grows in ever widening concentric circles. The child may not be able to understand the advanced principles and concepts of a topic at lower stages. Hence in this system complicated content areas are presented only when the child is mature enough for that, simpler facts being dealt with in the lower grades.

  This system becomes highly successful if one teacher handles the subject continuously in different years. If different teachers handle the subject in different classes, there will be the danger of too much of repetition and the subject loses it freshness and power of appeal. The teacher should be very careful to see that the charm of the subject is not exhausted in the first year itself. As Elizabeth Zechariah says "there should be always new problem to be solved, new difficulties to be overcome, new mysteries and wonders to be seen". Use of experimental approach Instruction based on problem solving

Micro -teaching is a system of controlled practice that makes it possible to concentrate on specific teaching behaviour and to practice teaching under controlled conditions. Teaching is a complex activity. Even teachers with long standing face difficulties sometimes. The condition of the novice student teacher on the eve of completing his training remains very miserable. The sight of the student teachers with trembling legs and palpitating heart on the fateful day of the first teaching encounter, is not uncommon. He is unprepared and finds himself in shallow waters. He is not confident whether he would swim or sink, whether he would be able to control the pupils, able to communicate effectively and follow the sequence of activities. The poor fellow is almost bewildered especially when the supervisor assesses his teaching with a global overview. In short, there are a number of serious handicaps for the student teachers in facing the actual teaching situations effectively. A few deficiencies in this respect are listed. below:

1 Inadequate preparation of the student-teachers for the block student-teaching programme.

2. Sudden exposure to complex teaching situation, where

i. Full Class size comprising 30--40 pupils poses management and discipline problems to the beginner.

ii. the duration of 30-40 minutes lesson is unduly long for a beginner

iii. use of several component teaching skills in the full scale lesson cannot be satisfactorily presented by the beginner.

iv. global supervisory comments fail to provide systematic and specific feed-back to the student teacher to make Improvement in subsequent teaching.

WHAT IS MICRO-TEACHING?

(Micro-Teaching defined)

Micro-teaching is a teacher training technique. It is defined as a system of controlled practice that makes it possible to concentrate on specific teaching behaviour and to practise teaching under controlled conditions.

(Allen and Eve, 1968).

The complexity in a teaching encounter is reduced by practising teaching skill one at a time. This complexity is further **reduced** by having a small number of pupils, short duration of time and the content being reduced to a single, simple concept and one component skill **is** practised at one time.

A MINIATUREISED CLASSROOM TEACHING

Micro-teaching may be considered as a miniaturised class-room teaching or *mini-teaching.* It may be described as a *'scaled down' eaching encounter* in class size and class time. (Allen and Ryan 1969) In 1976, Clift described it in these words, 'Micro-teaching is a teacher training procedure which reduced the teaching situation to a simpler and more controlled encounters achieved by limiting the practice teaching to a specific skill and reducing teaching time and **the** class size.

Micro-teaching technique was first developed in 1963 at Stanford University and was used for the training bf Secondary School teachers. The concept has never been a static one. It continues to grow, change and develop both in focus and format. Some of The countries like Usa, Uk, Scotland and Netherlands have set up microteaching laboratories. In India, a lot of work has been done in the centre of Advanced Study of Education, Baroda and N.CE.R.T. The Technical Teachers Training Institute, Chandigarh has its micro-teaching laboratory.

STEPS GENERALLY FOLLOWED IN MICRO-TEACHING

(Principles of Micro-Teaching)

The steps generally followed in a micro-teaching setting are :

I. A student teacher teaches a *small class* of 5 to 10 pupils (micro-class) for 5 to 10 minutes. There may be real pupils or peers acting as pupils.

II. The content of a lesson is generally a single concept The whole lesson is built around a single teaching skill so as to maximise the use of the behavioural components involved in that skill during teaching.

III. A micro-lesson is carefully planned on the basis of a pre-decided model The lesson can be observed either by a supervisor or peer Spervsor using a specially developed evaluation performa for the skill. It can be recorded on a video tape for later evaluation. This session is known as teach session.

IV. After this session, the trainee is given the *feed back*. This is known as view,'assess/feed back/critique session.

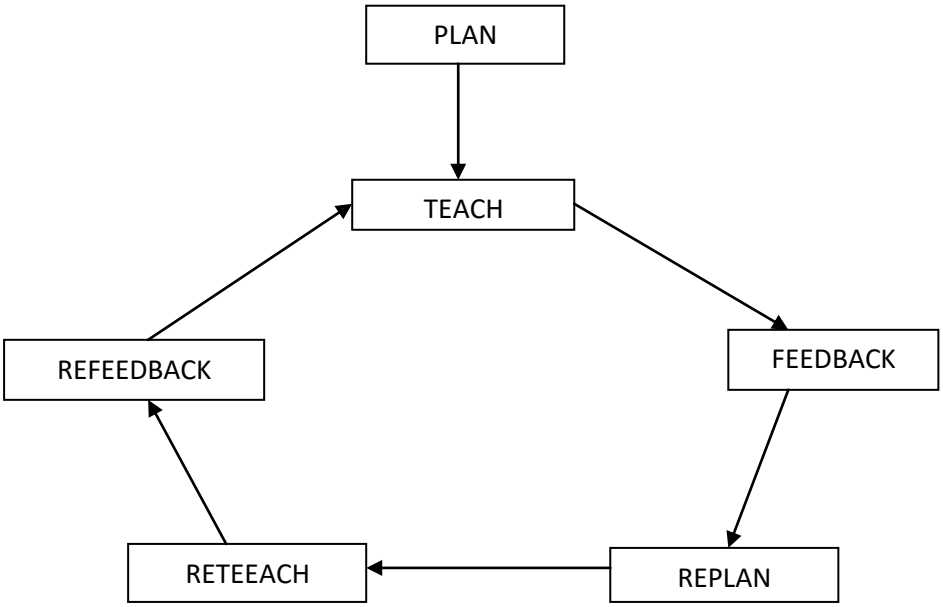
V. During the next session, the trainee goes to another room where he re-plans or re-structures his lesson in the light of the feedback received. It is also known as *re-plan* session.

VI. Next is the *re-teach session* where the trainee re-teaches to different set of pupils the same unit which is re-structured.

VII. After re-teach session there will be re-feedback regarding the lesson. This session is termed as *re-view/re-assess/re-feedback*

All the session may be together called as one microteaching cycle.

It may be represented as shown diagrammatically below:



The basic principles of micro-teaching are very simple. A student teacher teaches a short lesson of about five minutes' duration to a small number of pupils. At the end of the lesson the pupils leave and the student teacher discusses the lesson with the supervisor. After a short practice the student teacher repeats the lesson with a different group of pupils making use of the feed back from the supervisor to improve his previous lesson. He thus gets re-feed back.

PROCEDURES USED IN MICRO-TEACHING

Different procedures have been used by different persons. **A** mention is made of the following procedure used by Mishra, Goswami and Kulshrestha (1979)

- Teach-6 minutes
- Feedb ack--6 minutes
- Re-feed back by actual evaluation4 minutes
- Re-plan -+7 minutes
- Re-teach 6 minutes
- Re-feed back---6 minutes
- Total time35 minutes.

There can be many variations within this broad outline ; the size of the class may vary from 3 to 10 pupils ; time may vary from 3 to 28 minutes ; the pupils may be either real or peers acting as pupils ; the sources of feedback may be from one or many sources like self, pupils, peers acting as supervisors, teacher educators, audio-tape recording, video-tape recording and the like ; the feedback can be immediate or delayed, prescriptive or descriptive, qualitative or quantitative ; and variations in length of time devoted to any phase of the micro-teaching cycle.

MAIN PROPOSITIONS OF MICRO-TEACHING

Allen and Ryan (1969) have mentioned the following as the main propositions of micro-teaching :

1. Micro-teaching is *real teaching.* Although the teaching situation is a constructed one, nevertheless bonafide teaching does take place.
2. Micro-teaching lessens the cotplexities·of normal class-room teaching. Class size, scope of content, and time are all reduced.
3. Micro-teaching focuses on training for the accomplishment of specific tasks.
4. There is provision for increased control of practice. A number of factors ‘variables can be manipulated. A high degree of control can be built into the training programme.
5. Micro-teaching greatly expands the normal knowledge of results or feedback dimension in teaching. Sever a source of feed- back are at his disposal. All this feedback can be immediately translated into practice when the trainee re-teaches shortly after the critique conference.
6. The main focus in micro-teaching is to train teacher trainees

Plan + Teach + Feedback + Replan + Reteach + Re-feedback in specific teaching skills although learning on the part of the pupils is no less important.

7. Micro-teaching is also possible under simulated situations

TEACHING SKILLS

Micro-teaching is based on the assumption that the process of teaching can be analysed into a number of skills called the teaching skills which can be 'defined, observed, measured and controlled'.The term 'teaching skill is said to be a "group of teaching act behaviours intended to facilitate pupils' learning directly or indirectly.

NUMBER OF SKILLS

The exact number of skills involved is very difficult to decide, Different authors have drawn their list of skills. However, no list is final. It is also not necessary, perhaps will never be, that a particult lesson will need all the skills with equal importance to teach it effectively The Centre of Advanced Study in Education, Baroda (CASE) ha identified twenty one teaching skills. They have studied thirteen of those in detail and prepared the Baroda General Teaching Competence Scale (BGTC) and measuring criteria for each of these skills. Thee

skills are :

1) The skill of writing instructional objectives.
2) The skill of introducing a lesson.
3) The skill of fluency in questioning
4) The skill of probing questions
5) The skill of explaining
6) The skill of illustrating with examples.
7) The skill of Stimulus variation
8) The skill of silence and non-verbal cues.

9) The skill of increasing pupil participation.

10) The skill of increasing pupil participation.

11) The skill of using black-board.

12) The skill of achieving closure.

13) The skill of recognizing attending behavior.

RATIONALE FOR MICRO-TEACHING IN INDIA

The existing teacher-education programme in India has a number of loop-holes. We find that the practice teaching conducted these days is not so effective due to the defects in the supervisory system, and certain points of disagreement and other apparent drawbacks. The important elements in the micro-teaching technique offer tentative solutions to some of the loop-holes. Following points may be noted for justification for the technique be implemented in India: --

Micro-teaching the trainee concentrates on practicing a well-defined teaching skill which includes a set of related teaching.

1) Micro-teaching provides for pin-pointed feed-back in behavior
2) It is not easy but safe for the student teachers to teach a small group. They will have less problems of class-room discipline.
3) There will be less administrative problems for teacher educators in arranging lessons for student teachers when the teaching sessions are arranged with peers as students.
4) Micro-teaching provides an opportunity to undertake research studies with better control over conditions and situations.

The studies conducted in India indicate that micro teaching is an effective technique in the modification of teacher behaviour. It is certainly a better technique than that of the traditional approach. Micro-teaching is a new departure in teacher training

programme. Because of its merits it is a useful supplement in the present day teacher training programme. It is in no way a substitute to the existing practice teaching programme. Similarly, it is _not a panacea for all the ills teacher education. It has its own limitations and shortcomings. It is a skill based technique. Micro-teaching the trainee concentrates on practicing a well-defined teaching skill which includes a set of related teaching.

COMPARISON BETWEEN CONVENTIONAL STUDENT TEACHING AND MICRO-TEACHING BASED STUDENT TEACHING

Conventional Student Teaching	Micro-Teaching based Student Teaching
Objectives are not specified in behavioral terms.	Objectives are specified in behavioural terms.
The class consists of 30 to 40 student-teachers	Class is divided into small groups of 5 to 10
Teaching becomes complex and threatening.	Teaching is relatively simple and non-threatening.
Feedback is not immediately provided.	Immediate feedback is provided
The role of the Supervisor s vague and not helpful to Improve teaching.	The role of the Supervisor is specific and well-defined to 1mprove teaching.
Patterns of class-room inter- action cannot be objectively studied	Patterns of class-room interaction can be objectively studied.
Student teacher practices whole complex teaching behaviour	Student teacher One skill practiced at a time.
Time duration is 35 to 45 minutes	Time duration is 5 to 10minutes.

CHARACTERISTICS OF MICROTEACHING

- *Micro element:* Micro teaching reduces the complexities of the teaching situation in terms of i) duration of the lesson ii) length of the content iii) number of students to be taught and iv) the one skill taken up for practice. at a time.

- *Teaching skills* are categorized as Pre-instructional Instructional and post-instructional skills. Microteaching enables the trainees to develop these skills and perfect them in such a way as to master the teaching strategies.
- safe *practice ground:* Microteaching provides simulated conditions of teaching in which the safety of trainee is used
- *The teaching models:* The trainee gets many opportunities to study the desired pattern of behavior for each skill through the demonstration given by the supervisor, audio-tape or videotape. With the help of these perceptual models as the guides the trainees develop their own models.
- *Defining the skill:* A particular skill is defined to student teachers in terms of specific teaching behaviors and the objectives, which are meant to be achieved.
- *Planning the lesson:* The student teacher prepares a lesson plan based on the model on a suitable topic relating to the particular skill which he proposes to practice.
- Observation schedules filled in by the peer group, audio and videotape recording.
- *Demonstrating the skill.* A lecturer of the teachers' college gives a demonstration lesson using a particular skill and he may also present a prepared lesson with the help of an audio or videotape.
- *Discussion:* The trainees get doubts clarified of the model lesson given, by way of discussion with the lecturer.
- *Micro Teaching Practice:* The student teachers, after suitable planning for the skill teach the lesson to a small group of pupils. The supervisor observes the lesson, peer group also observes with observation schedule and the micro lesson is audio\videotaped..

- *Feedback:* The lesson delivered by the trainee is followed by discussion to provide him feedback. Peers who participated in the lesson as learners, peer observers or the supervisor can provide the necessary feedback.
- *Re-planning the lesson:* In the light of the feedback and or a different lesson In order to use the skills more effectively.
- *Re-teaching the lesson:* The revised lesson is taught to different or same group of pupils. The lesson is again observed with the help of observation scheduled *Re-discussion or re-feedback:* The ' feedback is provided on the lesson re-taught.

SKILL OF STIMULUS VARIATION

Having captured the interest of his pupils, the teacher's main problem will be to sustain the attention of his pupils throughout the lesson. What psychological principles will the teacher need to use to prevent monotony in the class? We know that attention tends to shift from one stimulus to another frequently. So it is extremely difficult to hold the attention of the pupils unless the teacher introduces variation in the stimulus.

Boredom is often a major problem in the classroom and the instructional styles of many teachers do not even recognize this factor. They remain stationary at a place or speak in a monotonous voice throughout. This skill is related to procedures by which the attention of the classroom can be secured.

A set of related teaching acts or behaviours that help the teacher to draw and maintain the attention of the students throughout the class is called the Skill of Stimulus Variation.

Teacher movement

Teacher's movement in the classroom facilitates useful shifts for attention. Standing still at one place without moving tends to create boredom, as we know that movement attracts attention. The teacher may either move towards the specimen or model being used, she may move towards the pupils to examine their work or she may move towards black board to write a new word or to discuss a point on the black board. Hence in order to secure a sustained attention in pupils, a teacher has to move about in the class. But he should make purposeful movements. Body movements can be used for emphasis. The head movements like nodding for approval or shaking head for a negative response can be effectively used. Gestures can be made by movements of the parts of the body to direct attention, to emphasize importance, lo explain emotions etc. Gestures are classified as *body language.*

Change in speech pattern

By introducing changes in tone, volume and pace in his speech, he can hold the attention of his pupils. By modulating his voice, by raising his voice or dropping it and by sudden changes in pitch he will force his pupils to pay attention to what he is saying. By deliberate use of pauses, he can secure the attention of his students.

Change in sensory focus

Focusing pupils' attention to particular point, can include verbal statements or gestures or movements or both verbal statements and gestures.

Verbal focusing

When you say, "look at this diagram", "listen carefully to this" etc pupils attention will be directed immediately.

Gesture focusing

It takes place when the teacher points to something important on a map, picture or to important words on the black board. He may also underline the important words on the black-board .

Verbal and Gesture focusing

This involves both verbal gesture focusing. You can focus pupils' attention both by pointing to figure and saying verbally "look at this figure". This is more effective than either used alone.

Pupil Talk

It involves getting verbal participation of students in the classroom teaching. These teaching acts keep the students mentally alert.

Pupil movement

Besides getting students, verbal participation by answering question, he can ask them to (i) make notes drawings or diagrams in their note books (ii) come forward to the black board and write or draw on it (iii) examine the model, specimens or use the apparatus for an experiment etc. Physical participation in the classroom teaching enables the teacher to sustain the attention.

SKILL OF PROBING QUESTIONS

Questioning is one of the most important teaching skills, It is indispensable for good teaching. He who never questions never teaches. Questioning plays a very important part in learning, teaching and testing. It is said that the success and efficiency of our teaching depends more on the skill and judgment with which we put questions than on any single circumstances. The minds of the learners and the teacher can be brought into close touch through this device. Teaching is not just like that of filling an empty pot. The students through their mental process must attain the knowledge. For that they ask questions. We can very easily answer a question. But it is difficult to construct a question involving higher order mental abilities. Asking question is an art. A teacher must learn to ask suitable, appropriate and meaningful questions. Questions, which fit in with the following, are· called meaningful questions: I. Structure 2. Process and 3. Product Structure includes grammatical part and content part of question which when taken together convey the intent of her. Process refers to the way of asking the questions. Product refers to the pupil's response. Many a time it happens that nothing is wrong with the mixture or the process of the questioning. But even then the pupils do not give any response; they give partially correct responses incorrect response and completely correct responses. to handle such responses of the pupils? In case of all such situations except completely correct responses, you will have to d the pupils to the correct response if you want to be an effective teacher. That is you will have to go deep or probe into pupils' responses by asking a number of questions about what already know and to lead them to the correct responses. Even the response is correct you will have to help the pupils to view from a broader perspective. A set of related teaching acts that tend to help the teacher o deep in "Pupils" response by asking a series of subsequent questions is called the *skill of probing Questions.*

Components

Prompting Techniques

This involves the teacher to give clues or hints to the pupils nd ask leading questions. Here, the teacher neither supplies the were nor does he redirects the question to some other pupils. It helps the pupil to answer the question himself. This technique lows the teacher to probe by prompting the pupil even though at its instance it appears that the pupil cannot answer the question. This technique is used when the students says ' I don't know' and gives incorrect response. Keep two things in mind that the teacher foes not discourage the pupil for his no or wrong response. Secondly the teacher helps the pupil to arrive at the criterion response by means of systematic and step by step questioning process.

Seeking Further Information

It consists of asking the pupil to supply the additional information to bring initial response to the criterion level and expected level. "

Refocusing

This technique is used when a student gives correct response. The teacher relates the present answer with the topic already covered. This technique consists of enabling the pupil to view his response in relation to other similar situations.

Redirection

It involves putting or directing the same question to many pupils for responses. The purpose of this is to increase more pupils participation.

Increasing Critical Awareness

This involves, asking 'how' and 'why' *of* completely correct response. The teacher asks the pupil to justify his response rationally. Therefore this technique elicits rational for his response.

Skill of Explaining

Generally, a teacher is said to be explaining when he is learning *'how'* and *'what'* of a concept, phenomenon, event, or condition. (Explaining can also be defined as an activity related about in understanding in some one about concept, etc. In a classroom, an explanation is a set of interrelated statement made by the teacher related to a phenomenon, an idea etc.in order to bring about or increase understanding in the pupils about it. Now the question that may come to a teacher's mind is he can become an effective explainer in the classroom. It requires a skill on his part for being so. A teacher should always endeavor to explain the concepts, generalizations or rules in such y that they are understood by the students. The ability to explain logically and clearly is one of the most important skills. And a teacher must strive to perfect it. Hence it is necessary that the teacher plans his lesson carefully to ensure that his notions are clear and logical, The following are the component behaviours relating to the skill of explaining.

COMPONENTS

Desirable Behaviour

Explaining links (or) Cognitive links:

These involve words and phrases in the statements of an explanation. Such links made the explanation clearer by continuity in the statements used. They are generally conjunctions or prepositions which explicitly indicate the causes, consequences, reasons behind, means or purposes of an event, concept, action or conditions. The following are some of the cognitive links which are generally used: - *the result of, therefore, in order to, since, as a result, because, due to, before etc.*

Using beginning statements

Generally, before an explanation certain statements are made for setting the minds of the listeners. The beginning statements create a mental readiness on the part of pupils to listen to what is going to be explained.

Testing Pupils Understanding

This behavior of the teacher involves putting questions to people to test whether or not they have understood what has been explained. It helps in knowing whether the purpose of explaining the concept or phenomenon has been achieved or not.

Concluding Statement

After the explanation, certain statements are made which conclude the whole explanation. The concluding statements help in consolidating what has been explained

Undesirable behavior

Irrelevant Statement:

While explaining, a statement becomes irrelevant when it is not related to and does not contribute to the understanding of the concept being explained. Such statements distract the students' attention from the subject of explanation and thus lead to confusion.

Lacking in Continuity

This refers to break in the sequence of ideas presented during explaining. During explaining, continuity breaks in the following situations:-

(When a statement is not logically related to the previous statement.)

When a topic already taught is referred to without showing its relationship with the subject of explanation. When the statement is irrelevant.

Lacking* in *Fluency

It occurs when a teacher speaks incoherently. When there is a lack in the influence, it not only distracts pupil's attention, but also hinders their understanding of the subject or explanation

Vague words and phrases

Sometimes while explaining a teacher uses such words and phrases which indicate that he is failing to make something illicit) The use of such words and phrases not only hinders the understanding of what is being explained but also irritates the listeners (Some words and phrases, which are commonly used, are given below I Think, o.k., Say, I mean, You know etc.,)

Inappropriate Vocabulary

This involves using terms unknown to most of the pupils if that age group and grade level. Sometimes more difficult technical terms are used to explain certain simple terms.

SKILL OF REINFORCEMENT

While teaching, a teacher encounters a variety of student's behaviors. Obviously he would like the student's desirable behavior and criterion responses to be retained and strengthened and undesirable behavior to be eliminated. A set of related teaching acts (or) behavior that enables the teacher to encourage reinforce the desirable behaviour and eliminate undesirable behavior is *called skill of reinforcement.*

The skill of reinforcement refers to the effective use of reinforces. The skill is used when the teacher reinforces a good behavior with a smile, praises a good answer, encourages a slow learner (or) writes 'well done' on a piece of work slow reinforcement can increase pupil's attention , maintains motivation and improves pupils learning.

Components:

- *Positive verbal reinforcers*

With the use of such words as *'good', 'yes',* 'correct,' 'excellent' etc., a teacher can reinforce pupil's desirable behavior.

- *Extra verbal cues*

Words like 'Um', *'aha'* etc., are used to strengthen the desirable behavior of the pupils.

- *Positive non-verbal reinforces*

They are made without use of words. Non-verbal cues like *nodding, smiling, looking attentively* etc., reinforce positively a desired response.

- *Repeating and rephrasing*

Teacher repeats (or) rephrases the response given by the student. This teaching act strengthens the desirable behavior.

- *Writing the pupil's answer on Blackboard*

This teaching behavior reinforces the desirable behavior of the student.

- *Negative non-verbal reinforces*

This is brought out using such behaviors such as frowning, nodding the head in negative way, staring at angrily etc.,

- *Negative verbal reinforces*

The teacher expresses his disapproval of the response of the pupil by such words as *no, wrong, incorrect etc*. This type of reinforcement affects learning negatively and decreases the motivation of the pupils. Hence you avoid giving this type of reinforcement.

- *Wrong use of reinforcement*

Approving the wrong responses or disapproving the correct response are the examples for the occurrence of this component.

- *Inappropriate use ofreinforces*

Using reinforces in a delayed manner is an example of the occurrence of this component.

SKILL OF USING BLACKBOARD

The black board is the most widely used teaching aid. Inspite of newer and better devices in use, it is indispensable in the classroom, as it is still the cheapest and most economical. It is valuable as it intensifies pupil's interest and attention on the main aspects of the lesson, allowing the teacher to proceed at a pace commensurate with the understanding of the pupils.

The following list of items, for which a blackboard may be used, indicates the versatility and effectiveness of this visual aid of drawings sketches, graphs maps, diagrams, defitions utilities, giving assignments, tests solving problems, etc. But the black board technique needs to be learned and practiced. It is extremely important that the teacher's own handwriting is legible. He must ensure neatness in the black board work and the summary, maintained on the black board should be appropriate. A set of teaching acts or behavior that enables the teacher to use the black board effectively during the teaching learning process is called the *skill of using blackboard.*

Legibility

1. Every letter is distinct. 2) Adequate spacing is there between two letters 3) Adequate spacing is there between two words. 4) The slant ness of each letter is closer to the vertical 5) The size of the letter is large enough to be read from the far of the 6) The size of the capital letters is just bigger than the all letters 7) All the capital letters are of the same size. 8) All mall letters are of the same size. 9) The thickness of the lines of the same width.

Neatness

1. The words and sentences written are parallel to the base of the black board 2) There is adequate spacing between two lines here is no overwriting 4) Only the relevant matter, which is der the focus of classroom discussion, is retained on the board.

Appropriateness

I) There is continuity in the points being presented on the black board 2) The points written on the black board are brief and simple 3) Only the important points are underlined to draw the pupils' attention. 4) Colour chalks are used suitably 5) Diagrams / illustrations are developed along with the lesson 6) The diagrams are simple, large, clear and proportionate in size 7) There are no unnecessary details in the diagrams / illustration.

SKILL OF CLOSURE

Achieving closure is similar to a step as recapitulation in Herbartian steps. It is a process of associating new facts with the old knowledge, applying new knowledge in various situations and ensuring repetition of the facts in the best possible way. The new knowledge and facts are not repeated mechanically but are reviewed from various points of view for developing insight into their meaning.

It may be necessary to use this skill at convenient points during the lesson for definite summing up at every step when there are too many ideas in the lesson.. At the end of a lesson, it is absolutely essential to make a quick review of what has been taught.

Components

Consolidation of Major points

This involves summarizing the main points covered during the lesson into a meaningful whole. This can be done either by the teacher with or without the involvement of the students or by the pupils alone.

Application of the present knowledge in new or different situations

It refers to creating situations where the pupils can make use of what they have learnt during the lesson in different or new situations. For this purpose the teacher may use some media/approaches in the form of oral, written, non-verbal or termination

Linking the past knowledge with the present knowledge.

Past knowledge and the present knowledge involves helping the pupils to see the relationship between them, it enables them to get a clear view about the present knowledge.

Linking the present knowledge with the future knowledge

It refers to relating the present knowledge to the home k or assignments given to the pupils. It may also require them to learn on their own.

Link Practice

According to Gestalt psychology complex learning like concept formation and problem solving can be brought about only hen various bits of information are structured and received as a hole. This whole is something more than the simple summation of the analyzed elements.

Micro-teaching is definitely a helpful technique for their trainees not only in knowing the teaching skills but also able them to gain confidence in teaching. It helps them acquire proficiency only one skill at a time. But a macro lesson involves the combination of several skills. Hence to give practice in integrating the various skills required for teaching a macro lesson, *link lesson* for 20 minutes is also attempted in the college. This provides an opportunity to the trainee for smooth transition from minute's micro-lesson to 45 minutes macro lesson. A link practice lesson is for 20 minutes duration integrating the different skills required for teaching a sizeable chunk of subject matter.

COMPARISON OF MICRO, LINK AND MACRO LESSONS

CHARACTERISTICS	**MICRO-LESSONS**	**LINK-LESSONS**	**MACRO-LESSONS**
Time limit for practice	5 minutes	20 minutes	45 minutes
Class size	5 or 6 peers	20 peer group students	40 students
Number of skills	One	Skills required for teaching the content and integration	All the relevant skills for topic
Size of content	One single concept	A part of a lesson	Probably a complete lesson