Centre for Distance and Online Education

Punjabi University, Patiala

Class : B.Ed.-I **Semester : I**

Paper : IV & V (Teaching of Science)

Medium : English **Unit: I**

Lesson No.

1.1 : Nature and Significance of Science: Nature, Scope, importance and Value of Science.

1.2 : Science as an integrated area of study: Science and modern Indian society

1.3 : Relationship of science and society.

1.4 : Aims and Objectives of Teaching Science in elementary and Secondary Schools; Blooms Taxonomy of educational Objectives.

1.5 : Pedagogical Analysis- Meaning and need, guidelines for conducting pedagogical analysis.

1.6 : Science Curriculum : Meaning, Principles and various approaches to science curriculum construction, developing learner-centred curriculum in science.

PAPER- IV & V: PEDAGOGY OF A SCHOOL SUBJECT (PART-I)

(VI) TEACHING OF SCIENCE

SUBJECT CODE: EDUBED1104T
SUBJECT CODE : EDUBED1105T

M.M. 50
External: 35
Internal:15

(A) COURSE OUTCOMES

After completion of the course the student teacher will be able to:

- Understand the nature, scope values and objectives of teaching science at Secondary level.
- Develop competence in teaching different topics of Science effectively.
- Develop scientific temper & provide teaching in scientific method to their student.
- Use various methods with appropriateness of content, level and classroom situations to make pupil's learning meaningful.
- Utilize the instructional materials effectively in the teaching of Science.
- Organize Co-curricular activities & practical work in Science.

(B) SYLLABUS

SECTION–A

(i) Nature and Significance of Science: Nature, scope, importance and value of science; Science as an integrated area of study; Science and modern Indian society: Relationship of science and society;

(ii) Aims and objectives of teaching science in elementary and secondary school; Bloom's Taxonomy of educational objectives, Pedagogical analysis: Meaning and need, guidelines for conducting pedagogical analysis.

(iii) Science curriculum: Meaning, Principles, Various approaches to science curriculum construction, developing learner-centered curriculum in science.

SECTION–B

(iv) Science textbook: Meaning, importance and qualities, acritical analysis of science textbook of state board and NCERT.

(v) Learning Experiences and Teaching aids: Concept, Edgar Dale's Cone of Learning Experiences, Importance, Use and Classification of Teaching Aids, Integrating ICT in science teaching.

Activities (Any one of the following)

(i) Writing instructional objectives in behavioural form for any five topics.
(ii) Developing a low-cost teaching aid in Science
(iii) Pedagogical analysis of any one topic.

Head,
Department of Education & C.S.,
Punjabi University, Patiala

(C) BOOKS RECOMMENDED

1. Cutting, Roger and Kelly, Orla (2014). *Creative Teaching in Primary Science.* Sage.
2. Dunne, Mick (2014). *Primary Science*(2nded.). Sage.
3. Their, H.D. (1970). *Teaching Elementary School Science: A Laboratory Approach.* New Delhi: Sterling Publishers.
4. Vaidya, N. (1989). *The Impact Science Teaching.* New Delhi: Oxford and IBH Publishing Company.
5. Mohan, R. (2002). *Innovative Science Teaching.* Delhi: Prentice-Hall.
6. Collete, Alfred T. and Eugene L. Chiappeta (1994), Science Instruction in the Middle & Secondary Schools, Macmillan, New York.
7. JerryWellington (1996), Teaching Science in Secondary Classes, Routledge, USA.
8. Kaur, Rakshinder (2007), Teaching of Science, Twenty First Century Publications, Patiala.
9. Kohli, V.K. How to Teach Science, ShriKrishna Publication, Ambala.
10. Mohan, Radha (2004), Innovative Science Teaching for Physical Science Teachers, Prentice Hall of India, New Delhi.
11. Siddiqi & Siddiqi (2002) Teaching of Science Today and Tomorrow, Doaba House, New Delhi.
12. Sundarajan, S (1995) Teaching Science in Middle School: A Resource Book. Orient Longman, Hyderabad.
13. Tony Turner & Wendy Dimareo (1998), Learning to Teach Science in Secondary School, Routledge Publication, USA.
14. UNESCO (1966) Source Book for Science Teaching; UNESCO: Paris.
15. Vaidya N. (1999) Science Teaching for the 21st Century, Deep and Deep Publishers, New Delhi.
16. Venkataiah S. (2000) Science Education, Anmol Publications Pvt. Ltd., New Delhi.

(D) EVALUATION

External Examination	35 Marks
Internal Assessment	15 Marks
Attendance	3
Written Assignment/Project work/Response Sheet	6
Two Mid-term Examinations/House Test	6

(E) INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three Sections: A, B, and C. Section A and B will have two questions from the respective sections of the syllabus and will carry 12 marks each. Section C will consist of 5 questions of 2 marks each and one objective type question of one mark which will cover the entire syllabus uniformly.

(F) INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt one question each from the sections A and B and the entire section C.

Head,
Department of Education & C.S.,
Punjabi University, Patiala

Lesson No. 1.1 **Author: Dr. Jasraj Kaur**

Last updated on July, 2025

Nature and Significance of Science: Nature, scope, importance and value of Science

Structure

1.1.1 Objectives

After going through this lesson learners will be able to:

- Understand meaning and nature of science
- Comprehend the scope of science
- Discuss importance of science in daily life
- Explain value of science for mankind

1.1.2 Introduction

Scientific knowledge is tentative although it is supported by a huge amount of data from repeated trials. Scientists test and challenge previous assumptions and findings from time to time. After all, science is a human endeavour and we know human perspective is limited. This idea of fundamental uncertainty is vital to scientific studies and is the basis of great scientific discoveries. Scientific concepts do not emerge automatically from data or from any amount of analysis alone. Inventing hypotheses to imagine how the world works and then figuring out how they can be put to the test of reality is as creative as writing poetry, composing music, or designing skyscrapers. Sometimes discoveries in science are made unexpectedly. But knowledge and creative insight are usually required to recognize the meaning of the unexpected. Aspects of data that have been ignored by one scientist may lead to new discoveries by another.

1.1.3 Nature and Significance of Science

Science is a human activity through which problems and questions dealing with natural phenomena can be identified and defined, and solutions proposed and tested. In this process, data are collected and analyzed, and available knowledge is applied to explaining the results. Through this activity, investigators add to the store of knowledge, thereby helping people better understand their surroundings. Applications of this knowledge also may bring about changes in society and the cultural order and may have a direct bearing on the quality of life (Wisconsin Department of Public Instruction, 1986).

1.1.3.1 Nature and Scope

In general, the nature of science refers to key principles and ideas which provide a description of science as a way of knowing, as well as characteristics of scientific knowledge. Many of these intrinsic ideas are lost in the everyday aspects of a science classroom, resulting in students learning skewed notions about how science is conducted. A theoretical model of the nature of science was developed by Kimball (1968) out of extensive study of the literature on the nature and philosophy of science. The declarations forming this model are: curiosity is the fundamental driving force in science; science is a dynamic, ongoing activity; science

aims at comprehensiveness and simplification; the methods of science are characterized by attributes which are more in the realm of values than techniques; a basic characteristic of science is a faith in the susceptibility of the physical universe to human ordering and understanding; science has a unique attribute of openness; and tentativeness and uncertainty mark all of science. This model is consistent in its agreement with views expressed by Conant (1961) and Bronowski (1953), and additional support for each assertion is found among the writings of other philosophers of science. Cotham and Smith (1981) identify the tentative and revisionary nature of science as an important goal of education because of its implications for the public's understanding and support of the scientific enterprise. They agree that an understanding of the tentative and revisionary nature of science may serve as an antidote to cynicism about science. The cynicism often results when citizens who hold the view that science is a collection of immutable facts are presented with the changing knowledge claims of rapidly developing disciplines.

According to Kothari Commission (1964-66), "We lay great emphasis on making science an important element in the school curriculum. We, therefore, recommended, that science and mathematics should be taught on a compulsory basis to all pupils, as a part of general education during the first ten years of schooling. In addition, there should be provision of special courses in these subjects at the secondary stage for students of more than average ability."According to UNESCO's Report (1972), "Science and Technology must become essential components in any educational enterprises, they must be incorporated into different educational activities intended for children, young people and adults, in order to help individual to control social energies as well as natural and productive ones thereby achieving mastery over himself, his choices and actions and finally, they must help a man to acquire a scientific turn of mind so that he becomes able to promote science.

As is written in report of National Policy on Education (1986), "Every effort will be made to extend science education to the vast numbers who have remained outside the pale of formal education." The National Policy has made science as a compulsory subject at school level. It goes further, saying that science education may be given even to out of school youth and adolescents. Science education will be strengthened so as to develop in the child well defined abilities and values such as the spirit of inquiry,

creativity, objectivity, the courage to question and an aesthetic sensibility. Science education programs will be designed to enable the learner to acquire problem solving and decision making skills.

Science has been given a core place in the curriculum because of some special values provided by only science and not by other subjects. In India through the efforts of National Council of Educational Research and Training (NCERT) science has been made a compulsory subject throughout the secondary stage of the school.

1.1.3.2 Importance of Science

It is the noise of machines, cars, mills and factories, etc. which awakens us every-day in the morning. The food we eat, the clothes we wear, the books and papers we read, the recreations we enjoy all have something or other to do with the application of science. Scientists do not work only with data and well-developed theories. Often, they have only tentative hypotheses about the way things may be. Such hypotheses are 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 reject it. The use of logic and the close examination of evidence are necessary but not usually sufficient for the advancement of science. Scientific inquiry is not easily described apart from the context of particular investigations. There simply is no fixed set of steps that scientists always follow, no one path that leads them unerringly to scientific knowledge. There are, however, certain features of science that give it a distinctive character as a mode of inquiry. These features are especially characteristic of the work of professional scientists, everyone can exercise them in thinking scientifically about many matters of interest in everyday life. Science presumes that the things and events in the universe occur in consistent patterns that are comprehensible through careful and systematic study. Scientists believe that through the use of the intellect and with the aid of instruments that extend the senses, people can discover patterns. Science also assumes that the universe is, as its name implies, a vast single system in which the basic rules are everywhere the same. Knowledge gained from studying one part of the universe is applicable to

other parts. For instance, the principles of motion and gravitation that explain the motion of falling objects on the surface of the earth also explain the motion of the moon and the planets. With some modifications over the years, the same principles of motion have applied to other forces—and to the motion of everything, from the smallest nuclear particles to the most massive stars, from sailboats to space vehicles, from bullets to light rays.

Scientific ideas are subject to change as science is a process for producing knowledge. The process depends both on observations of phenomena and on inventing theories for making sense out of those observations. Change in knowledge is inevitable as new observations may challenge prevailing theories. No matter how well one theory explains a set of observations, it is possible that another theory may explains wider range of observations. Most people have a basic understanding of natural processes such as how moisture evaporates then condenses and falls as rain or how oxygen travels through the body in the bloodstream. Science is the reason for the ever-increasing understanding that people have about the world around them. Scientists are employed by universities, hospitals, business and industry, government, independent research organizations, and scientific associations. They may work alone, in small groups, or as members of large research teams. Their places of work include classrooms, offices, laboratories, and natural field settings from space to the bottom of the sea. Because of the social nature of science, the dissemination of scientific information is crucial to its progress. Some scientists present their findings and theories in papers that are delivered at meetings or published in scientific journals. Those papers enable scientists to inform others about their work, to expose their ideas to criticism by other scientists, and, of course, to stay abreast of scientific developments around the world. The advancement of information science (knowledge of the nature of information and its manipulation) and the development of information technologies (especially computer systems) affect all sciences. Those technologies speed up data collection, compilation, and analysis; make new kinds of analysis practical; and shorten the time between discovery and application.

Scientific work involves many individuals doing many different kinds of work and goes on to some degree in all nations of the world. Men and

women of all ethnic and national backgrounds participate in science and its applications. These people—scientists and engineers, mathematicians, physicians, technicians, computer programmers, librarians, and others—may focus on scientific knowledge either for its own sake or for a particular practical purpose, and they may be concerned with data gathering, theory building, instrument building, or communicating.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 common sense. Scientists may often disagree about the value of a particular piece of evidence, or about the appropriateness of particular assumptions that are made—and therefore disagree about what conclusions are justified. But they tend to agree about the principles of logical reasoning that connect evidence and assumptions with conclusions.

Short in text questions

Q1. Write in brief about nature of science.

.....

.....

Q2 write three facts about importance of science.

.....

.....

1.1.3.3 Value of Science

The things that we use in our daily life are mostly due to science. Our clothes are made in factories where scientific methods are used. We can write on paper only because the piper mills can turn out large quantities of it. Cloth and paper we had even before science came on the scene but no one could then think of the large quantities in which they are produced now. Science has conquered time and distance. We can travel from one place to another in a short span of time. In the morning, we get news of events that happened yesterday in all parts of the world. If we want to send a message to a person in America, we can send an

email and he will get it in a few hours. If we want to speak to our friends far from us, there is the telephone that will connect us.

It is, indeed, true that science has added tremendously to the comforts and conveniences of mankind. By conquering time and distance science has brought mankind together and so far made life richer. By inventing medicines it has made our day-to-day existence relatively free from disease, and has, indeed, added to our length of life. The fan and light works from the application of electricity. Electricity is one of the wonders of modern science. The means of transport work with fuel. This is possible only because of the application of science. Medical science is another achievement of modern science, the marvel of medicine. From the above, it is clear that science is playing an important part in our everyday life. Scientific knowledge is durable although scientists reject the notion of attaining absolute truth and accept some uncertainty as part of nature. The modification of ideas is the norm in science, as powerful constructs tend to survive and grow more precise and to become widely accepted. Moreover, 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.

1.1.4 Summary

It cannot be denied that there is some truth in the above criticism. But we cannot now go back to the old days. We should have all the comforts and conveniences, and we should try to improve upon them. But we must try to be masters of scientific appliances and not their slaves. We should make use of machines, but our life must not be mechanized. If we can do so, science will make our lives richer and in conquering. Science makes everyday life easier than it ever has been. The most powerful example is the importance of electricity; the scientific discovery of a method for harnessing electric energy changed people's lives forever. Electric light benefits people every day in inventions such as traffic lights, refrigerators and communication devices. Science is the reason for the quick pace of modern life. A journey that took weeks on foot or horseback was shortened to a few days' travel by the use of

steam-powered locomotives followed by personal automobiles. Finally, travel by airplane allowed people to make the same journey in just minutes. Science makes life safer as well; antibiotics and vaccines protect people from diseases that were once feared as deadly, such as measles or syphilis.

1.1.5 Keywords

1. **Science-** the study of and knowledge about the physical world and natural laws.
2. **Decision making**- ability and skill of taking quick decisions or the process of making choices by identifying a decision, gathering information, and assessing alternative resolutions.

1.1.6 Self-check Exercise

Fill in the blanks:

(a) Science is _____ .
(b) Science is systematized body of _____ .
(c) Science makes everyday life _____ .
(d) Science Is a blend of logic and _____ .

(a) empirical (b) knowledge
(c) easier (d)imagination

1.1.7 Suggested Questions

Q: Discuss nature and scope of science with the help of suitable examples.

Q: Explain importance of science in our daily life.

1.1.8 Suggested Readings

Rajasekar,s.(2005) Methods of Teaching Physical Science.Neelkamal Publications, Hyderabad.

Kohli,V.K.(2005) How to Teach Science. Shri Krishna Publication,Ambala Cantt.

B.E.d (semester-l) Paper – IV & V Part-I (opt- VI)

Teaching of Science

LESSON No. 1.2 **AUTHOUR : Dr. MEENA THAKUR**

Last updated on July, 2025

STRUCTURE

1.2.1 Objectives

The main objectives of this unit are that after it is thoroughly read, the students shall be able to:

1 Define the concept of integration of science within the subject and with other subjects.

2 Understand the importance of science in modern Indian society.

3 Critically analyze the integration of science with other subjects.

1.2.2 INTRODUCTION

Science is an integral and indispensable area of study that plays a pivotal role in shaping modern Indian society. As a systematic pursuit of knowledge, science encompasses various disciplines such as physics, chemistry, biology, and more, facilitating a deeper understanding of the natural world and its phenomena. It drives progress, innovation, and technological advancements that uplift society's standards and improve the quality of life. From healthcare to agriculture, communication to transportation, science touches every aspect of modern Indian life. Embracing scientific principles empowers individuals to make informed decisions, fosters critical thinking, and nurtures a culture of curiosity and inquiry, leading to a prosperous and progressive nation.

1.2.3 Science as an integral area of study:

1.2.3.1 Meaning and Importance of Integrating Science Education

The Secondary Education Commission has recommended that every secondary school pupil should study general science as a compulsory subject, so that he gains a basic quantum of scientific knowledge as a part of his general education. The rapid advancement of science and technology and increasing need for scientists and technologists have made it all the more important to provide for science based education in the schools. To facilitate and serve the purpose in a better way, therefore, attempts are made to divide the subject matter and knowledge of the science into some distinctive branches like Physics, Chemistry, Zoology, Botany, Microbiology, Astronomy, Medical Science, Biotechnology, Biochemistry etc. such division helps in the deep and thorough study of the specific area covered by a particular branch and ultimately in this way one may b e led in a proper way to understand oneself and his environment. The objective of education is the intellectual development of the individual. With its accelerating importance in our society; science has become an increasingly important part o general education and knowledge. Science has now become a compulsory subject

in the school curriculum because of its multifarious value to the individual as well as the society.

The major aim of education is the unification of knowledge existing in different branches of learning. To achieve such unification, a conscious effort has to be made by teachers teaching various subjects. However as discussed above secondary school curriculum generally consists of a number of separate subjects having little or no coordination between them. This may largely be due to the training received by secondary school teachers and the examination-ridden orientation of the subject and curriculum. In recent years, some attempts have been made to bring about an integrated curriculum of science subjects but much need to be done to consider other areas such as languages, mathematics and social sciences. The primary school curriculum has to a considerable extent become integrated and a large number of good primary school teachers possess a broad background, which enables them to guide their pupil's learning on a variety of topics.

Integration one of the essential aspects, devices and techniques of the modern pedagogical system that makes the study of a subject more purposeful, interesting, permanent and effective by seeking essential coordination and integration within the different pieces of knowledge along with their application. No subject can be taught in isolation particularly the subject known as 'science'. This is because knowledge neither exists nor works in isolation. Therefore, it is not wise to treat one subject or one piece of knowledge as complete, isolating it from other subjects and alienating it from the needs of one's physical and social environment.

The study of science can be considered from the point of view of the following types of integration:

A Integration of science subjects with one another.

B Integration of science with day to day social and physical environment.

C Integration of science with other subjects.

A. Integration of science subjects with one another

All the branches of science such as botany, zoology, physics, chemistry, geology, agriculture, physiology, biochemistry, biotechnology are interdependent upon each other and there are a number of facts and principles which are common to various science subjects. This justifies the saying that science cannot be taught in isolation as the subject science is intra- and interrelated with other areas of study. One sided specialization of teacher is responsible for the ineffectiveness in teaching science. The state of ignorance of the teachers and the absence of willingness to learn from other branches of science results in the loss of interest of the pupils in a particular subject. However, the teacher must be aware of the limits up to which he should venture into areas which are not his own. For example while teaching a lesson on coal formation and its utilities, a teacher must be aware of the materials and process leading to coal formation and the chemistry behind it being a source of energy. Similarly, in studying the structure of the eye in physiology, a teacher must have the supportive knowledge of physics of image formation and lenses. It is necessary to bring out correlation of one branch of science with another branch to make science education more meaningful and effective. The teacher should bring about correlation whenever desired in order to make the teaching learning process interesting and natural. For this, one should have adequate knowledge of subject other than his own. Almost all the topics in all the branches of science are somehow related to one another and the teacher should try to bring about effective integration between them while teaching the respective topics.

B. Integration of Science with day to day Social and Physical Environment

Science has a deep influence into the life and activities of modern living. We are living in an age of science and all our activities are controlled and governed by science. What we experience and use in our day to day life is influenced by the knowledge and principles of science. Science has changed the whole pattern of society and has affected the social as well as the physical environments. We cannot expect to live and adjust in the world of today by remaining aloof and ignorant of the knowledge and facts of science. It is the role of the science teacher to relate the

classroom teaching with the social and physical environments by quoting examples from the daily life of the child. The teaching and learning of the scientific facts and principles may get extra impetus and become more interesting and purposeful if it is correlated and integrated with the actual happenings in one's life and environment.

The application of various scientific instruments, appliances and gadgets which have made our life so happier and comfortable cannot be understood and appreciated without establishing a correlation between the study of science and its usefulness and applications in daily life. The teaching of science will be isolating its purpose if it does not take into account the experiences of children in daily life. Excursion, tours, visits, observation of actual process thus forms important base for planning study of sciences.

C. Integration of science with other subjects

The various subjects which are taught in the schools are complementary to each other in one way or the other. This is because all these subjects strive for a common goal of achieving the aims of education. Science is such a subject which can be easily correlated with any other subject. Hence, teachers should make deliberate efforts to strive to establish some degree of correlation between science and other school subjects. This will arouse interesting in the pupils who associate the knowledge he is gaining with the knowledge he has already gained in other subjects. In fact, while teaching one subject some help is necessarily taken from other subjects to bring out its full and clear comprehension. To understand this point of view, following correlation can be considered as example:

a. Science and Mathematics:

For an advanced study of science subjects like physics, chemistry, life sciences, astronomy and medical sciences, assistance from mathematics in the form of mathematical numerals, symbols, formulae and computation is always needed. This is because science as such cannot be taught effectively without involving mathematics. It is mathematics that has given a sound footing to the scientific laws. It is necessary to have mathematical background before starting a particular topic in science e.g. physics is such a subject which cannot precede even a step

without mathematics. To mention a few areas where mathematics is relevant in studying the science topics, examples can be mentioned of the quantitative work in gas laws, calculations of chemical equations, genetics and the relation of statistics, mechanics and light with trigonometry, etc. It is obvious that both science and mathematics are complementary and can be studied simultaneously and together. Therefore, while teaching mathematics examples from the field of science can be easily taken and vice versa.

b. Science and Language:

It is essential that science students should be able to express their thought in clear, concise, correct and attractive language. Fluency of language is necessary to express accurately all scientific laws and principles. The vocabulary of different languages has been enriched by adopting uniform technical terms, symbols, formulae etc. The science teacher and the language teacher should take up a joint responsibility for the cultivation of good style in answering and writing capacity. While seeking correlation, a teacher may ask his students to write essays on the topics related with science. He may also pay attention to the correctness of the language and in this way try to seek proper correlation between science and language. The language teacher may emphasize on writing on some inventions or life-history of a scientist as an assignment.

c. Science and Social Studies:

The study of the various stages of human victory over the forces of nature and its control over the land, sky and the seas forms the history of the development of human society and of modern civilization. Science and social studies are related to each other to a great extent as there is a good impact of science on our way of thinking and the standard of living. Science has direct intellectual effect in dispelling many traditional superstitions and beliefs and the introduction of the scientific method, thereby changing the outlook of people. The advanced electronic system of communication and control and eradication of certain diseases are further proof of how science is responsible for the advancement in the knowledge of history, geography, social science etc. Its effects on the industry resulted in profound change in social organization which are gradually bringing about corresponding political changes.

Science study has direct correlation to history as the history of inventions and discoveries provide useful background for the teaching of history. Reference can be made of such inventions and discoveries to the reign of certain kinds. Similarly, certain topics in geography are directly connected with science, such as formation of rocks and soil, topics on universe, earth, moon, planets, change of seasons, eclipses, tides etc. One cannot learn weather phenomenon in geography without the scientific knowledge of humidity, rains, temperature, thermometer, barometer, rain gauge etc. A teacher may correlate science with social studies on different occasions by providing suitable relations of relevance.

d. Science and craft:

Most of the applied sciences are nothing but a craft e.g. agriculture and its relation with science need not be emphasized. Other crafts like wood work, metal work, cardboard modeling, clay work etc. can be successfully made use of in the improvisation and construction of science apparatus. The knowledge of science is also important in the production of crafts as the constitution of materials used in such crafts must be known to the individual.

The work experience subjects like spinning, weaving, wood, leather, earthen works etc. all bear a close relationship with the study of science. The knowledge and skills of the science subject is helpful in selecting the appropriate raw material and devising ways and means for the improvement of processes and products. The science teacher must also take care of all the occasions and opportunities where he can take care of all the occasions and opportunities where he can make his students conscious and aware with the application of scientific facts and principles in gaining useful experiences and skills related with various work experiences or crafts taught in the school.

e. Science and Civics:

The correlation of science and civics can be understood from the point that both the subjects are taught with the same aim of making students good and useful citizens. Science helps students to understand the utility of scientific inventions. This makes them more responsible and helpful in society as they adjust themselves to become good citizens.

Science helps students in leading a healthy life, understanding civics and health, infectious diseases, cleanliness of environment and makes them dutiful citizens to lead an ideal civic life.

f. Science and Art:

It is not only that the art subjects derive benefit from the study of sciences. The reverse is true also. There is no doubt that science has contributed a lot in enriching all types of arts such as painting, drawing, music, dance and handicrafts. However, a science teacher cannot dream to be a successful teacher without the adequate knowledge and skills of the arts subject especially of drawing, painting and some essential handicrafts. He has to draw a number of diagrams, construct a number of models, and improve a number of scientific apparatus, charts, pictures, posters and other graphic aids to relate many facts with his subject. Similarly, an artist needs the knowledge of science for maintaining the quality of his colors and background keeping in mind the essential principles of light and shade, objects and background, depth and distances etc. Likewise, the knowledge of different notes, typical vibrating system in strings and air columns, musical scales etc. are essential for the learning of music. Therefore, it is essential for teachers to seek essential correlation and integration between the science subject and arts.

Summary

Thus, it becomes quite obligatory on the part of the science teacher to take into account all the possibilities of making use of the technique of the integration in the teaching-learning process for the attainment of better results and achievement of goals of education. Science education must be connected with the daily need and environmental surrounding of the children to make his subject more powerful, effective and permanent. Artificial division of science into various branches is a matter of convenience and not of necessity. This at times has caused the treatment of various subjects as a separate and isolated entity. As a result, there is a great difficulty in teaching as well as learning the essential concepts, principles and facts of science. There is no coordination between the theory and practice. What is learned in one subject, area or branch remains completely unutilized in the learning of other subjects, areas or branches. The remedy lies in the art of

correlation by integrating and relating the study of science with the study of other subjects, its own branches and the environmental surroundings. While teaching a subject of science like biology, we cannot afford to confine ourselves to biology alone because other physical sciences have equal contribution to the field of biological sciences. The integration of different subject is important for checking artificiality of treatment of science and for achieving unity of knowledge.

1.2.4 Science and Modern Indian Society

1.2.4.1 Introduction

Man, the animal, has worked his way up in the world and has gain primacy by virtue of his success in the struggle for existence. He has adjusted himself better to the conditions than his competitors in the cosmic strife. For his successful progress from the savage state, he is largely indebted to his curiosity and desire to penetrate the mysteries of nature and to gain the knowledge of hidden things. It is his curiosity, manual dexterity and scientific imagination out of which science has gradually emerged. To the Greeks, science was knowledge, not merely of the material and physical world, but of all that concerned man. The feeling of wonder in men originally gave rise to philosophy. Their interest was first excited by obvious problems and then advanced little by little to the phenomena of the moon and the sun, the stars and the genesis of the universe.

The advance of science transformed man's outlook on life and had an impact on every branch of intellectual activity. Newton's genius was such that for long men felt that the Universe had been fully explored. Copernicus and Galileo revolutionized the history of scientific thought by giving a new conception of man's place in the universe. Science explores the unknown world and leads to discoveries which transform the world and make life more interesting. It deals with the domain of positive knowledge in the field of nature and universe, man and society.

With the help of science, space has been conquered, water has been controlled and fire has been yoked to the service of man. All forces of nature, which in primitive ages, were worshipped as cruel masters, have now been trained as useful servants. The airplane, the railway, the telegraph, the telephone, the gases, the steam engine, the spinning and

the weaving machine, motor cars, bicycles, canals and bridges, all these are products of scientific knowledge. Distance has been shortened, time has been saved and material prosperity has been promoted beyond measure. The object of science is to study nature. It deals with concrete phenomena. It is the search after truth. It encompasses all branches of knowledge. In its restricted sense, it means physical science, the branch that deals with matter and material things. The study of science makes a man exact and precise.

In the sphere of practical knowledge the world owes much to India in the realm of mathematics, which was developed in the Gupta times to a very advanced stage. Indians had a clear conception of the abstract number, while Greek mathematical science was largely based on menstruation and geometry. Varahamihira, the great astronomer of ancient India says: "The Greeks are barbarians, but the science of astronomy originated with them, and for this they must be revered like gods". Hindu astronomers had discovered that the heavenly bodies were spherical and shone by reflected light; they were aware of the motion of the earth on its axis and had calculated its diameter. Brahmagupta in 628 A.D. anticipated Newton by declaring that all things fall to earth by the law of nature, for it is the nature of the earth to attract and keep things".

Describing the positive achievements of science, Jawaharlal Nehru said: "It made the world jump forward with a leap, built up a glittering civilization, opened up innumerable avenues for the growth of knowledge and added to the power of man to such an extent that for the first time, it was possible to conceive that man could triumph over and shape his physical environment. There is no visible limit to the advance of science".

The gifts of science had added greatly to the dignity and sublimity of human civilization, and science has been acclaimed as an 'angel' of creative ideals. But at the same time, the grim aspect of science, playing a destructive role, cannot be ignored. Today science is responsible for creating a balance of terror by its invention of the most devastating weapons of mass-destruction. We know how one atom bomb wrought havoc in the peaceful and prosperous city of Hiroshima. Atom Bomb, and still more, the hydrogen bomb, have caused new fears involved new doubts as to the effect of science on human life. Some eminent

authorities, including Einstein, were constrained to point to the danger of the extinction of life on this planet. Indeed, in some ways science has made man the worst type of a criminal!.

The fact is that science has done both service and dis-service to mankind. But neither can we praise science for the service it has rendered, nor can we denounce it for the dis-service, alleged to have been done. Knowledge can never be had in itself. As Shakespeare has said, "There is nothing good or bad, only thinking makes it so". Science is not to blame for the harrowing devastation it has let loose on mankind. It is man and man alone who is responsible for his misfortunes and miseries he has brought on himself by the misuse of science. He has prostituted its fair and creative aspects. Atomic energy, for instance, which was mis-used for destroying the world, is one of the most creative and constructive forces of nature. It can change the earth into a paradise of eternal bliss.

1.2.4.2 Impact of Science on Modern Indian Society

Science has brought about changes in our way of thinking, attitudes, outlook and our life style, as such the average span of human life has been doubled by bringing about a change in health, medicine and sanitation. There is a revolutionary change in communication, transportation, agriculture, engineering, power etc. The material benefits are immense and universal. The impact of science is evident in agriculture, industry, health, modern civilization, democracy etc.

(i). **Science and Agriculture:** Green revolution in India was possible because of science. It mechanized agriculture and farming. The tools invented by science are now used for ploughing, sowing, reaping, harvesting etc. The destruction of pests using pesticides and insecticides increased the crop yield. The present day agriculture is stressing on the use of bio-pesticides and bio-fertilizers to retain the natural properties of soil and sustains its productivity (Indian Education Commission).

(ii). **Science and Health:** The third stage of demographic transition propounded by T.R. Malthus which is evident in modern days is the contribution of science. The use of various preventive techniques such as vaccination, inoculation, surgery etc. has prevented the human society of contagious diseases and

epidemics. The average life span of human has been doubled due to science as it has helped us in diagnosis, treatment and prevention of various diseases reducing death rate and increasing the longevity of an individual. Science has made us health conscious through the development in fields of hygiene and sanitation, diet, biochemistry of life, physical exercises etc.

(iii). **Science and Industry:** The ways and processes in industries have experienced drastic changes from the discoveries of science. The different tasks in industrial process today are performed by machines and human beings are required only to operate the machines. Industries like textile, printing, radio and television, pharmaceuticals, agriculture etc. are revolutionized by the development in science.

(iv). **Science and Modern Civilization:** The modern civilization can be called scientific civilization as it owes it existence to science. Various advances in fields of agriculture, medicines, cosmetics, transport, communication etc. have affected our way of living and behavior. Science has helped us to get rid off and taboos of superstitions and removed illiteracy and ignorance. It has brought about a change in our attitude towards religion, birth control, sanitation, ways of living etc. We have developed into a good citizen by changing the outlook to receive new ideas and to have a capacity for clear thinking.

(v). **Science and Research:** Universities are providing opportunities to the scholars to carry out research in various fields like industry, agriculture, fuel technology, food development, U.G.C., CSIR, ICMR, IARI other scientific agencies sponsor many programmes in this context.

(vi). **Science and Living Conditions:** Science and technology involves with the development of human society. Its benefits are available to society at large, leading to an overall improvement in the living conditions. Each time a technology is introduced and adopted, it changes man's way of life and also provides him with newer abilities to do things that could not have done before.

(vii). **Science and Women:** Science has improved the status of women. In past, the women were facing a lot of health hazards due to traditional smoky chulas. She had to walk a longer distances to

fetch water for fulfilling the daily needs of the family but now a days things have been changed a lot with the blessings of science.

(viii). Science and Communication: It is an important discovery of science. Now a day's programmes of higher education are broadcasted on D.D. Channel for specific time by U.G.C. some other agencies are also telecasting the educational programmes on television. The satellite channels have played a significant role here. The advancement in the field of internet has made the world interconnected. According to the Scientific Policy Resolution of the Government of India (1958), "The dominating feature of the contemporary world is the intense cultivation of science on a large scale and its application to meet the country's requirement".

(ix). Science and the Food Problem

With the increasing population of the world we must look for ways and means of increasing food supply. This requires an active role of agriculturists, botanists, biochemists, zoologists and genetists. Attempts have been made to synthesize artificially. The role of life sciences in connection with our food problem can be considered under the following hands.

a) **Growing Healthier Crops:** In order to increase agricultural produce we need high yielding varieties, necessary fertilizers and earth surface to grow crops. As land surface cannot be increased, in order to increase our production we can use improved varieties of the crops, fertilizers and better tools and techniques of farming. A lot of work has been done in the fields of soil chemistry, plant breeding and production of nitrogenous and other fertilizers artificially. But in India agricultural practices are traditional, so production is low. In America one farmer produces food for himself and 25 other people. In our country most of the population is engaged in farming but people still starve at times. We can double or triple our grain production, without clearing more of our forests, provided we have soundly trained biologists and agriculturists who can give better varieties of crops and can educate the masses about application of fertilizers and better agricultural practices.

b) **New Sources of Food:** Botanists have studied the process of photosynthesis in detail and it is estimated that out of the total light energy falling on plants, on 0.5% is utilized by crops on the average and only 2% by the best crops. The problem is that most of

the light falls on the ground and secondly much of the organic matter produced is inedible. In order to locate new sources of food experiments in America show that chlorella can utilize 20% of light energy falling on it and the whole of plant is edible. It is estimated that an acre of afga can produce 40 tons of dry matter out of which 20 tons is protein alone. But farming of chlorella involves technical difficulties and is still impracticable. In this direction growing of Anabaena and Nostoe can be more useful as they can also fix nitrogen from the atmosphere. All this will require a change in our feeding habits.

c) **Improving live stock:** India's cattle population is the largest in the world but there is inefficiency in live stock management. A cow in Netherlands produces 10 kg. Milk per day but in India it is ½ kg. Religious sentiments demand retention of useless crows for the entire life period. Our poultry also needs improvement and scientific methods be adopted to grow fish and meat producing animals. More non-vegetarian eating habits require more land to be cultivated as it requires about seen times as much land to grow food in the form of meat, egg, mild and poultry as it does to grow grain and vegetables which contain the same number of calories. If all people make adjustment, much land can be freed from inefficient production of live stock and poultry.

(X) Conservation of Natural Resources and the Role of Science:

The forests buried millions of years ago provide us with the coal and oil that power much of our industry and home comfort. Today's forests give us timber for furniture, raw material for paper industry, rubber, drugs, gums, resins, turpentine and camphor etc. Forests also help in distributed rains and check oil erosion and floods. But the forests have been cleared for making towns, cities, farming and easy money making purposes. Recently the need of forests has been recognized by biologists and national policy makers. Now the Central as well as State Governments employ hundreds of men to conserve forests. Extensive areas are being replanted with trees, fire break, telephone systems, roads and lookout stations are being constructed and attempts are being made to eliminate insect pests and fungal diseases. The clearing of forests has led to the extinction of several species of plants and animals as that of ferns, conifers, birds and mammals. In our country tigers, manned lions and wild elephants are becoming extinct every year somewhere in the

world. Due to the importance of forests and wild life in the balance of nature most countries now a day's maintain wild areas designated as National Forests and National Parks where hunting and other similar activities, that interfere with animal life are banned.

(XI) Science and its Impact Upon Improvement of Plants, Animals and Man:

There have been great advancements in genetics and plant breeding. Hybridization and selection for disease, drought, frost resistance and for increased yield have become usual routine for agriculturists. The yield of maize, cotton, sugarcane, wheat, rice and of fruits and vegetables has nearly doubled since these practices were adopted. Breeding is rearing process as newer high yielding varieties are in constant demand on the one hand and we need disease resistant varieties on the other, as strains of pathogens are developing constantly and one crop disease resistant to-day ay fall victim to some pathogen tomorrow. Induced mutations and cross breeding have also produced high milk, meat and egg yielding varieties of domestic animals. Genetics have employed sources like radiation and chemicals for induced mutations and interspecies and interspecies crosses are constantly, being tried.

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

(XII) Sciences and Atomic Radiation:

A very significant advancement in Physical Sciences during the 20th century has been exploitation of atomic energy. When this energy can be used for large scale generation of power and other economic purposes, it can also be used in preparation of Nuclear bombs which can explode in seconds and can destroy large cities like New York, Moscow and Calcutta in no time. Besides this destruction the radiation fall out is

of more importance from biological point of view, as it causes genetic and physiological hazards in the organisms. In Japan deformed babies are still being born due to the effects of atomic explosions that took place in 2nd World War. There has been increase in radio-activity in our environment, since the nuclear tests were started. As experimental testing has been increasing. Radio-active pollution has increased. We find more radio-activity in organisms then ever before and it may reach the magnitude of affecting human race genetically and physiologically. Necessity of studying organisms in relation to radio activity has given out a new discipline- Radiation Biology.

(XIII) Science in Relation to Space Travel:

Today space travels are mainly employed for military purposes. It is thought that satellites and rockets can be used for communication, geophysical survey and fast travel. While in the space ships the human passengers face several difficulties like that of low pressure, high temperature, natural radioactivity, gravitational force, jerks, food and oxygen etc. life science have contributes to overcome several of these difficulties. In order to avoid draining of blood in upper and lower part of the body during landing and take-off, people should lie parallel to the direction of flight so that heart may function normally. Pressurized cabines and pressure-suits are recommended for high altitudes. For high temperature and radioactivity, insulators are used. Compact food material and compressed oxygen is today used in space travels but attempts are going on to provide closed ecosystems in the spaceships in which algae like chlorella can recycle the human wastes and provide food and oxygen in the space.

(XIV) Science and Ways to Control Population Explosion:

Expanding population has been the root cause of unhappiness and war. It is supposed that Japan joined Second World War to find additional land for its population. Similarly Germany declared war with Russia as it had eyes on the vast wheat fields of Ukraine. It is estimated that in the stone age there were only 10 million people in the world and around 4000 B.C. (when Mahabharata war took place) it was 1000 million. It increased to 200 million and Christ was born and today it has grown to more than 4000 million. In 2000 A.D. it is expected to be 5000 million. Every second three new babies are being born, which means 180

new months to feed every minute. In India an average couple has four children. It is estimated that with this rate of growth in population, in the next 600 years the population of the world will be 25 million of millions, with just about 5 square metres of land for each person to stand on. The situation is more tragic in the sense that rate of population growth is more in already populous countries like China and India. The population cannot be allowed to increase indefinitely, if we are to survive. As biologists, we have a responsibility in educating our people. We have to devise methods of controlling high fertility. Several drugs have come to the markets but these have after effects of use. As thalidomide which was considered harmless sleep inducing drug, the women who used it gave birth to deformed babies although they themselves had no effects. So there is a need to develop safe contraceptive devices, pregnancy termination methods and drugs, and educating the masses regarding the magnitude of the problem.

Short –in text questions

Q1. Brief the relation of science with social science.

.....

.....

Q2. Write the relation of science with physical environment.

.....

.....

1.2.5 Summary

While science and technology has permeated every aspect of life and society and provided significant benefits, it has also raised new issues for society due to its application in all facets of society and the level of sophistication it has brought advances in science and technologies, such as global communication, satellite, images of earth, together with the popular fascination with dinosaurs etc., have irrevocably expanded the space and time scales with which people at many levels of society now view their world. Science is largely responsible for a growing public awareness that people share the planet with all other living creatures, that the environment which supports all life is subject to change, and the human activities are presently changing this environment and threaten to change it seriously. In the cast two countries, science has been used mainly as a tool for economic

expansion and military power for wealthier segments of human race. It is now clear that the current consumption of natural resources and increasing stresses on the regional and local environment cannot continue indefinitely without breakdown of the natural support systems that make present civilization possible. Science, which helped to bring about this situation, now has an over-riding responsibility to help societies make a transition from an obsession with growth to achievement of a dynamically stable and sustainable ecological and economic system. In this transition, an alliance between modern technical science and the holistic wisdom from indigenous societies and philosophers from all cultures can be very important.

1.2.6 Key Concepts

1. **Live stock** – refers to domesticated animals raised by humans for various purposes, primarily for agricultural production.
2. **Green revolution**- included the adoption of genetically improved crop varieties, increased use of synthetic fertilizers, irrigation systems, and pest control measures.

1.2.7 Self-check exercise

State whether true or false -

1. Science is an optional and non-essential area of study.
2. The study of science encompasses various disciplines like physics, chemistry, and biology.
3. Science plays a negligible role in shaping modern Indian society.
4. Scientific advancements have no impact on improving the quality of life in India.
5. Science drives progress, innovation, and technological advancements in India.
6. Embracing scientific principles has no effect on society's decision-making process.
7. A culture of curiosity and inquiry is nurtured by scientific pursuits.
8. Modern Indian society does not rely on science in fields like healthcare and agriculture.
9. Science contributes little to India's economic growth and development.
10. Scientific understanding empowers individuals to make informed decisions in various aspects of life.

Answers

1. False	2. True	3. False	4. False	5. True
6. False	7. True	8. False	9. False	10. True

1.2.8 Suggested Question

Q.1 Discuss science as an Integral area of Study.

Q.2 Discuss the correlation and integration of science with other teaching subjects.

1.2.9 Suggested Reading:

1. Vaidya, N. (1989).*The Impact Science Teaching.* New Delhi: Oxford and IBH Publishing Company.
2. Mohan, R. (2002). *Innovative Science Teaching.* Delhi: Prentice-Hall.
3. Kaur, Rakshinder (2007), Teaching of Science, Twenty First Century Publications, Patiala.
4. Kohli, V.K. How to Teach Science, Shri Krishna Publication, Ambla.
5. UNESCO (1966) Source Book for Science Teaching; UNESCO: Paris.

Lesson No. 1.3 **Author: Dr. Meena thakur**

Last updated on July, 2025

The Relationship of Science and Society

Structure

1.3.1 Objectives:

After going through this lesson the students shall be able to:

1. Explain about the deepening relationship of science and society.
2. Critically discuss about the role of science and technology in new century.

1.3.2 Introduction

The unification of knowledge present in different branches of learning is the main aim of education. Every subject of school curriculum contribution towards the all round development of child. The coordination between different subjects which are being taught in the school will definitely enhance the understanding level of students towards various concepts and will help them to find the relationship or dependency of various subjects on each other. In this chapter let us discuss the importance of integrating science education & society, which will further clarify the relationship between them.

1.3.3 Relationship of Science & Society

1.3.3.1 Science and Society

This section proceeds with an analysis of the deepening relationship today between science and society. Scientific and technological progress has had various effects on society. These effects have not been limited to the improvement of society's material wealth, but have also extended to altering the paradigms under which society operates. Information and telecommunications technology (IT) is one example of a paradigm-changing technology. Furthermore, as progress in science and technology has broadened and enlivened human activity, new issues have appeared in society, and these have in turn led to demands for new sciences and technologies capable of resolving the new issues arising from the changes in society. Following are some important points regarding relationship of science and society:

1 Prosperity in society due to scientific progress

Science and technology have formed the foundations for progress in society, and have helped to make people's lives more materially prosperous. In particular, since the rise of the Industrial Revolution in the latter part of the 18^{th} century, science and technology have shown accelerated progress in energy, physical materials, information and communications, medicine, and many other sectors, resulting in vast improvements in people's health, economic prosperity, and living conveniences. Progress in energy and materials technologies has given rise to a variety of new transport modes, such as the railroad, the automobile, and the airplane, vastly improving human mobility in terms of both time and space. Moreover, progress in materials technology has resulted in the ability to produce diverse types of material items. Meanwhile, progress in medical technology has greatly extended people's average life spans and reduced infant and child mortality rates, resulting in a dramatic rise in the world's population

2 Qualitative Changes in Society on a Worldwide Scale

Scientific and technological progress does not merely make people's lives more convenient and prosperous; it has also brought huge changes to how society itself operates. Two clear examples in recent years of society undergoing a major change are globalization and the IT revolution.

(a) Changes in Society Due to Advancing Globalization

The free movement of people, goods, capital, and information across national borders in vast quantities has accelerated sharply since the late 1980s. This rapidly advancing globalization is already changing the nature of society. These developments form the backdrop for advances in

energy and materials technologies, which have led to the appearance of larger scale, faster transport systems, to dramatic progress in information technologies, and to other advances in science and technology. This rapidly advancing globalization has greatly expanded the realm of individual activities, with international exchanges on a global scale becoming ever more common at all levels of society, from individuals to corporations and regions. Globalization has thus served to boost people's prosperity, and to broaden their range of activities, to the point that the very nature of international society is changing. This trend has also given rise to issues that society has never faced before. For example, the advance of globalization has led to the need for new policies that span international borders, including rules for governing electronic commercial transactions, and better responses to international organized crime.

(b) Changes in Society Due to the IT revolution

A major driving force in the IT revolution has been the Internet. The roots of the Internet can be traced back to 1969, when the U.S. Department of Defense set up the ARPA net for military purposes, and use for private or commercial purposes was prohibited. These advances in information technology dramatically reduced the costs and time required for information distribution, and made possible the manipulation of vast quantities of information. The IT Charter states, IT is "one of the most powerful forces for shaping the 21st century," and "its revolutionary effects extend to how people live, how they learn, how they work, and how the government interacts with civil society." In addition, utilization of IT should lead to realization of "a society in which people can demonstrate their own potential, and can boost the possibility of achieving their own hopes." Achievement of this kind of society will, according to the Charter, "allow everybody wherever they may be to participate profitably in the global information society" and "no person should be excluded from this profit

1.3.3.2 New Societal Issues Arising from Scientific and Technological Progress

While scientific and technological progress has broadened the range of people's activities, and made their lives more prosperous, new societal issues arising from the progress of science and technology have also become apparent. The most representative example of these issues is

undoubtedly the global environmental issue. The content of global environmental issues can vary widely, from global warming to acid rain, destruction of the ozone layer, destruction of tropical rainforests, and desertification, and a common characteristic of these issues is that they can be traced to increased human activity due to progress in science and technology. Scientific and technological progress helped mankind to build industrial societies in the 20th century that made wide use of underground resources, and to create prosperous societies and lifestyles. The result, however, was a society based on large-volume production, large-volume consumption, and large-volume waste. But the Earth's resources are obviously not limitless, and there is a limit to the ability of the natural environment to assimilate large volumes of waste. The idea of a "Spaceship Earth," which most vividly demonstrates the Earth's limited nature, was first broached in 1965 by Andrew Stevenson, then U.S. ambassador to the United Nations, who said in a speech that "We travel together, passengers on a little spaceship, dependent on its vulnerable reserves of air and soil." Later, in 1972, the Club of Rome further developed the "Spaceship Earth" concept in stating that there are "limits to growth." In that same year, the United Nations Conference on the Human Environment in Stockholm convened under the theme of "Only One Earth," as the world's people have increasingly come to recognize the limited nature of the planet that they live on. Since then, discussions about the global environment have proceeded at various levels. At the same time, development has also progressed rapidly, contributing to a deepening crisis for the global environment, a situation made abundantly clear by ever more sophisticated methods of monitoring the globe.

4 Increase of New Factors Threatening Societal Safety and Security

So far, this section has mainly focused on the effect of scientific and technological progress on society. However, if a suitable relationship is to be built between science and technology and society, it is important that science and technology respond appropriately to what society demands. In the past, societal demands on science and technology centered mainly on people's prosperity, on such things as increasing economic prosperity, health, and other aspects of people's lives. While demands for a prosperous life remain strong even today, of course, people have responded to changing conditions in recent years at home and abroad

with increased expectations for science and technology to ensure the societal safety and security that is a precondition for prosperous societies and lifestyles. There are also threats from emerging or reemerging infectious diseases. Furthermore, the advance of globalization means that risks arising in certain countries or regions can quickly spread to locations anywhere in the world, as can be seen by the global spread in recent years of such diseases as avian influenza, BSE, and SARS. In response to these myriad risks, people have in recent years become much more concerned about safety and security

5 Science and Technology and the State

At the time of the Industrial Revolution, the role of putting the results of science and technology to practical use in society was assumed mainly by entrepreneurs. These entrepreneurs used scientific and technological results for the development of products and improvement of production systems, in order to turn a profit. Where new scientific and technological results led to the creation of new industries, the needs of entrepreneurs also led to the creation of new sciences and technologies. Basically, the interaction between scientists, technologists, and entrepreneurs resulted in scientific and technological progress, and the people of society received the benefits of scientific and technological results. As the years passed, moving from the 19^{th} century into the 20^{th} century, the situation gradually changed. Entrepreneurial utilization of science and technology, and the resultant dissemination of scientific and technological results to society, grew in size as the scale of economic activities expanded. Meanwhile, as competition between nation-states became more intense, the state also came to focus on the importance of science and technology as a source of national power from the point of view of national security. As can be seen from the power in the military sphere that science and technology demonstrated in the two world wars, nations everywhere were increasingly recognizing the importance of science and technology to the point that, after World War II, science and technology policy came to be positioned as an integral part of national policy. In this way, the nation-state joined entrepreneurs in the role of promoting science and technology, and putting its results to practical use in society. Of course, the nation-state was not interested in the products of science and technology merely for the enhancement of national prestige or for military uses, they were also used for the promotion of industry, soil preservation and flood control measures, the development of road and

rail networks, the development of sewer and water lines, assurance of energy sources, and many other societal infrastructure improvements.

6 Science and Technology and the Individual

Until recent years, the relationship between science and technology and the individual, has basically been one of the individual passively receiving the results of science and technology. While the benefits of science and technology have varied to some degree depending on the country or region, they have basically been recognized as being shared all across society and the reception of people to scientific and technological progress has generally been positive and shared. In addition, individuals had a relatively wide range of choices in regards to whether or not to utilize the results of science and technology. While the utilization of home electrical appliances such as refrigerators or washing machines, for example, offers everyone the same kind of benefit in terms of reduction of labor, if an individual were for some personal reason to decide not to make use of these devices, the only result would be a missed opportunity to reduce his or her own labor, a situation that would cause little inconvenience to the society at large. In recent years, however, advancing globalization, as well as the IT revolution and other advances in science and technology, are inducing great changes in the very nature of society, so that individuals no longer have any choice but to be swept along by the effects of scientific and technological advances. Moreover, the global environmental problems that have arisen in the wake of the expansion of human activities due to scientific and technological progress adversely affect individuals regardless of their own choices. And as the case of gene-recombinant crops shows, those who benefit from the utilization of scientific and technological results are beginning to steer a different course from those who must bear the risks. Meanwhile, society's demands on science and technology are rising, as can be seen by the expectations society places on science and technology in regards to the safety and security issue. The relationship between science and technology and individuals, therefore, is becoming close and inseparable, and is also becoming more diverse, according to the needs of each individual. As a result, the time is approaching when individuals will need to make decisions on how to relate to science and technology. Toward this objective, individuals will need to have an interest in science

and technology, and to possess enough knowledge to be able to make an informed decision.

1.2.3.2 New Responsibilities for Science and Technology in the 21st Century

The World Conference on Science (Budapest Conference) convened in the Hungarian capital of Budapest in July 1999 under the joint auspices of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Council for Science (ICSU) was an event that marked a global turning point, with scientists re-examining the future of science and technology, and the nature of science.

The background to convening this conference can be described as follows: Where scientific and technological progress over the past several decades brought economic prosperity, it also had a negative side, such as environmental problems, that needed to be newly resolved. In recognition of the fact that the negative problems could not be resolved without the appropriate and timely utilization of science and technology, and that , it was necessary for science society, industry, government, and citizens to meet at a single location, the conference attracted about 1,800 people from around the world, including scientists, technologists, legislators, journalists, bureaucrats, and ordinary citizens, to talk for six days about the nature of science in the 21st century.

The conference adopted the "Declaration on Science and the Use of Scientific Knowledge" and the "Science Agenda – Framework for Action" to state the new responsibilities for the promotion of science in the 21st century.

The preamble to the Declaration states "the sciences should be at the service of humanity as a whole, and at the same time, should contribute to providing everyone with a deeper understanding of nature and society, a better quality of life, and a sustainable and healthy environment for present and future generations."

Furthermore, the Declaration adds "today, whilst unprecedented advances in the sciences are foreseen, there is a need for a vigorous and informed democratic debate on the production and use of scientific knowledge. The scientific community and decision-makers should seek the strengthening of public trust and support for science through such a debate," and then lists four concepts as responsibilities for science in the

21st century, including the already functioning "science for knowledge," as well as the new "science for peace," "science for development," and "science in society, and for society" concepts.

The "Science Agenda – Framework for Action" presents specific actions that governments and the community of scientists should take to fulfill the contents of the Declaration.

Overview of the "Declaration on Science and the Use of Scientific Knowledge"

Preamble

The sciences should be at the service of humanity as a whole, and should contribute to providing everyone with a deeper understanding of nature and society, a better quality of life, and a sustainable and healthy environment for present and future generations.

Today, whilst unprecedented advances in the sciences are foreseen, there is a need for a vigorous and informed democratic debate on the production and use of scientific knowledge. The scientific community and decision-makers should seek the strengthening of public trust and support for science through such a debate.

The main text consists of the following four sections:

1. Science for knowledge; knowledge for progress
   - Promoting fundamental and problem-oriented research is essential for achieving endogenous development and progress.
   - The public sector and the private sector should work in close collaboration and in a complementary manner in the financing of scientific research for long-term goals.
2. Science for peace
   - Worldwide cooperation among scientists makes a valuable and constructive contribution to global security and to the development of peaceful interactions between different nations, societies and cultures.
   - The natural and social sciences and technology need to be used as tools to address the root causes and impacts of conflict.
3. Science for development
   - Enhanced support should be provided for building up an adequate

and evenly distributed scientific and technological capacity through appropriate education and research programmes as an indispensable foundation for economic, social, cultural, and environmentally sound development.

- Science education, in the broad sense, without discrimination and encompassing all levels and modalities, is a fundamental prerequisite for democracy and for ensuring sustainable development.
- The building of scientific capacity should be supported by regional and international cooperation, and progress in science requires various types of cooperation.
- In each country, national strategies and institutional arrangements and financing systems need to be set up, or the role of sciences in sustainable development enhanced.
- Measures should be taken to enhance those relationships between the protection of intellectual property rights and the dissemination of scientific knowledge that are mutually supportive.

4. Science in society, science for society

- The practice of scientific research and the use of knowledge from that research should always aim at the welfare of humankind, including the reduction of poverty, and be respectful of the dignity and rights of human beings, and of the global environment.
- Each country should establish suitable measures to address the ethics of the practice of science and of the use of scientific knowledge and its applications.
- All scientists should commit themselves to high ethical standards.
- Equal access to science is not only a social and ethical requirement, but also essential for realizing the full potential of scientific communities worldwide, and for scientific progress that meets the needs of humankind.

Up through the 20^{th} century, science has progressed based on "science for knowledge," so that while it produced various results and benefits for society, it also produced negative environmental problems. The

Declaration is undoubtedly the result of recognition by the community of scientists that they are in danger of losing the trust and support of society if science and technology in the 21st century cannot contribute to the resolution of these negative issues.

Short –in text questions

Q1. Brief the factors threatening social society.

.....

.....

Q2. Write changes occurred in society due to IT revolution.

.....

.....

1.3.4 Summary

The following can summarize what has been said so far in this section regarding the current relationship between science and technology and society. First, science and technology has not only made human society more prosperous, it has been the engine driving the evolution of the very nature of society. Moreover, expectations are high that science and technology will continue playing this role in the future, and will also be responsive to new issues that arise as times change, such as ensuring the safety and security of society. Next, as seen in such areas as global environmental problems and bioethical issues, examples where scientific and technological progress can have both good and bad effects on society already exist, and as seen with information technology, there exist sciences and technologies that are becoming absolutely essential for society and people's lives. In a word, the relationship between science and technology and society, and particularly with individuals, is becoming close and inseparable, and the time is approaching when individuals must think clearly about what kind of relationship they should have with science and technology. Despite this situation, however, people's interest in science and technology appears to be on the decline, at least in advanced countries such as Japan. What is needed in this situation is for science and technology to respond flexibly to the needs of society as they change over time, or in other words, to become a "science and technology for society." At the same time, scientists, technologists, and other people involved in science and technology should be aware of the role that science and technology plays

in society, and of its influence, and should actively strive to convey information about their own activities to society. They should also try to help people at the individual level to obtain a deeper interest in and knowledge of science and technology, so as to able to utilize science and technology themselves. Moreover, cooperation among the community of scientists, corporations, individuals, and every other level of society should be harnessed to promote science and technology and thus help society to develop. In other words, what is needed is "science and technology in society." The path that science and technology needs to take in the future is thus "science and technology for society, and in society." Only when these viewpoints are understood can science and technology move on to contribute even more to the future development of human society who had been invited to represent the community of scientists, clearly stated in a speech that "the science and technology community bears a responsibility to engage with the issue of general and comprehensive sustainable development through education, training, research, and the technological revolution. Scientists and technologists should be responsive to demands for knowledge required by society, the private sector, and government in order to devise solutions and choices regarding sustainable development." Earlier, in 2001, about 90 science academies from around the world joined to establish the Inter Academy Council (IAC), for the purpose of offering scientists' advice for policymaking by the United Nations and other international institutions. Efforts to implement the specifics of the Budapest Conference Declaration are currently in progress. In Japan, as well, the Second Science and Technology Basic Plan now in effect positions "building a new relationship between science and technology and society" as its basic philosophy, and developing policies for the establishment of communications between science and technology and society, and for returning scientific and technological results back to society. In addition, consideration of the future of the Science Council of Japan, which represents the community of scientists in Japan, was conducted, and a proposal was completed in July 2003. In line with the Budapest Conference Declaration, the new proposal places emphasis on the council's functions for policy recommendation and for communication with society. UNESCO and ICSU are currently doing follow-up on the progress since the Budapest Conference Declaration and Science Agenda.

1.3.5 Key concepts

1. **IT** – information technology
2. **Technology**- the scientific knowledge and/or equipment that is needed for a particular industry, etc.

1.3.6 Self check exercise

State whether true or false –

1. Science and society are completely independent of each other. (False)
2. Scientific advancements have no impact on societal progress and development. (False)
3. Science is influenced by societal needs and demands. (True)
4. Society is influenced by scientific discoveries and innovations. (True)
5. Scientific knowledge remains static and unchanging over time. (False)
6. Societal values and beliefs have no effect on scientific research and development. (False)
7. Science plays a crucial role in addressing societal challenges and issues. (True)
8. Society's support and funding for scientific research are not essential for progress. (False)
9. Ethical considerations in science can have significant implications for society. (True)
10. The relationship between science and society is constantly evolving and dynamic. (True)

Answers –

1. False 2. False 3. True 4. True 5. False 6. False 7. True 8. False 9. True 10. True

1.3.7 Exercise Question

Q1 How has science influenced the lives of modern Indian society? Discuss it critically.

Q2 What is the responsibility of science towards society?

1.3.8 Suggested Readings

1. Vaidya, N. (1989).*The Impact Science Teaching.* New Delhi: Oxford and IBH Publishing Company.
2. Mohan, R. (2002). *Innovative Science Teaching.* Delhi: Prentice-Hall.
3. Kaur, Rakshinder (2007), Teaching of Science, Twenty First Century Publications, Patiala.
4. Kohli, V.K. How to Teach Science, Shri Krishna Publication, Ambla.
5. UNESCO (1966) Source Book for Science Teaching; UNESCO: Paris.

B. Ed. PART-I (SEMESTER-1) **PAPER-IV & V (PART-I) OPT.(vi)**

TEACHING OF SCIENCE

Aims and Objectives of Teaching Science in elementary and Secondary Schools; Bloom's Taxonomy of educational objectives.

LESSON NO. 1.4 **AUTHOR : DR. S. S. MANN**

Structure

1.4.1 Objectives

After going through this lesson students will be able to-

1. Understand the meaning and bases of objectives
2. Write the objectives in behavioural terms
3. Describe Bloom's Approach of writing objectives.
4. Discuss objectives of Science at different levels of school education.

1.4.2 Introduction

Before starting teaching of science, it is necessary to keep in mind the general aims of education. Kothari Commission has claimed that the most important and urgent reform needed in education is to transform it, to endeavour to relate it to the life, needs and aspirations of the people and thereby making it the powerful instrument of social, economic and cultural transformation necessary for the realization of the national goals. For this purpose education should be developed so as to increase productivity, achieve social and spiritual values. Out of these four aims of education two are directly related to the teaching of science subjects, like Physics and Chemistry etc. as we know any subject in school curriculum can justify its position if it tries to achieve the general aims of education. It is the aims and objectives of teaching of science that can guide all the rest of our planning and modify our work seriously. There cannot be any doubt that in all we teach, what we teach and how we teach are controlled consciously or unconsciously by our aims, by the outcome we expect. Again science have grown many times and been taught for many centuries. But now in this scientific age we face grave problem of world-wide need to know

science and understand these subjects in a proper context. In a country like India we need skilled scientists and technologists, having full knowledge of science. We need other technical people with scientific training. Everywhere educated citizens, inside scientific work and outside it, need to understand science so that they can live in this scientific age in a better way. Before starting the teaching of science. It is necessary to keep in view the aims and objectives of such teaching. Objectives are the standards that guide the working of life and society. It is necessary for the society as the education to work in accordance with scientific aims and objectives. A teacher must know about objectives that inspire the teachers. Again aims of teaching science are determined firstly by the values it has to achieve and secondly the values prevailing in society. In the society weded to the ideals of democracy, democratic ideals are the most important bases of the aims and objectives of the teaching of science. The aim of the teaching in democratic countries is to enable the students to bring about the change in their behaviour, with a view to adjust themselves with the changing environment and grow into successful citizens. Successful citizens are those who are to discharge their duties towards the society in a successful manner. It can be made clear with the following representation given by Duggal.[1]

Life-Social norms (values)—Aims of Education-General objectives of teaching science-Specific objectives of teaching Science

1.4.3 Bases of the objectives : Objectives of teaching of science cannot be laid down without certain consideration. These objectives should be formulated on a sound psychological, philosophical, sociological and scientific footings. The utility, appropriateness, practicability and timeliness of objectives should be considered. Mainly following points should be the basis of objectives :

1. The objectives should be based on psychological principles i.e. interests, aptitude etc. of the students.
2. The teaching based on these objectives must change the behavioural pattern of the students i.e. growth, development of students by imparting knowledge for understanding, inculcating skills, abilities and attitudes, infusing the scientific thinking and the spirit of enquiry etc.
3. The aims and objectives of Teaching of science are not only to lay a foundation of the democracy but also to make it successful by providing a training of character, a habit of independent judgement, qualities of discipline, co-operation, social sensitiveness, tolerance etc.
4. The objectives should be such that they should be helpful in the practical life of the students and also fulfil needs of life after completing the education. It can be said that teaching of science must be guided by the consideration of democracy and the development of the personality.

Again according to Thurbar and Collect following criteria may be used in the selection of objectives :

(a) **Usefulness :** The desired learning should have value in the lives of the pupils.

1. Duggal, S. P. et. al. : *Teaching Chemistry in Indian Schools.*

(b) **Timeliness :** Learning should be concerned with material, familiar at the present time, not with obsolete devices and ideas.

(c) **Fitness :** The learning should fit into sequence leading towards broad objectives.

(d) **Appropriateness :** The learning called for should be appropriate for the maturity and background of the pupils concerned.

(e) **Practicability :** Experiences needed in the development of the learning should be possible.

Apart from these following should be sources for formulation of objectives :

1. the needs and capabilities of the learners;
2. the needs of the society;
3. the nature of the subject matter;
4. the nature of the educational system;
5. feasibility constraints.

1.4.4 Statement of Objectives in Behavioural or Performance Terms

There is, an important attempt in the recent times relating to objectives of teaching of science in behavioural terms. This attempt is based on the fact that education is considered as a process of modification of behaviour of the educand in a desirable direction. This change in the behaviour of students is the outcome of teaching-learning process. Objectives represent the desired change in the students. It is what the pupil is expected to do after studying a course. The change is definable, observable, measurable, and controllable. In this case objectives should not be descriptions of what the lesson is about but the objectives are the statement of what the learner will be able to do at the end of the learning activity.

From the above it is clear that there are two dimensions, one is the process and other is the product. It can be said that instructional objectives would indicate learning outcome that teaching-learning activities and process denotes learning experience given to the students. The following example is worth noting in this context.

I.To enable the students to acquire the technique of fitting up the apparatus for the preparation of ammonia gas (Activity Process).

II. The students understand the sequence of the items of the apparatus used for the preparation of ammonia gas (Outcome Product).

In the first case, stress is on student's activity rather than on the learning outcome, thus indicating the learning process. In the second case stress is on students' understanding, the product of learning. So the product is termed as objective. In the above example the objective of teaching science is understanding.

The relation between process and product or activity and learning outcome can be given as follows :

Process	***Product***
(Learning experience)	(Learning outcome)
Preparing model of telescope.	1. Knowledge of laws of refraction. 2. Understanding laws of refraction.

3. Applying the laws for designing the model.
4. Skill to handle tools.
5. Ability to locate faults.

In the above example there are five objectives of teaching of Physics namely knowledge, understanding, application, skill and ability. So when the teacher is clear about learning outcome we can organise teaching-learning activities. Such activities involve the use of appropriate subject matter, method of teaching, and instructional material for proper learning experience. Therefore it can be said that when the objectives are viewed as learning outcomes, they can be categorised in terms of various dimensions.

1.4.4.1 Bloom's Approach on the Taxonomy of Objectives

In education there is one serious problem that there is no common view about the different objectives. This is due to the fact that teachers lack understanding of the objectives. Objectives are not categorised so as to have a clear picture of their organisation and interrelationship. Even there are different interpretations of the same objective by different people. Bloom's taxonomy of objectives is an attempt to solve this difficulty. With this approach the teacher should be, in a position to define and translate the objectives. It may be termed as a scientific approach as it facilitates development of curriculum and evaluation devices. Again this approach is based on educational, logical and psychological principles.

In this approach the human development is divided into three domains or areas as follows :

1. Cognitive Domain 2. Affective Domain 3. Psychomotor Domain.

The cognitive domain includes those objectives which deal with recall and recognition of knowledge and development of intellectual abilities and skills. The affective domain includes interests, attitudes, values and development of appreciation and adjustment. Objectives under this domain are not stated very precisely and clearly. It is difficult to describe behaviour under this domain because internal feelings and emotions are not as clear as overt behaviour manifestations. What is more the testing procedures for this domain are not standardized. The psychomotor or motor skill domain was also recognised though not much has been in classifying the objective under this domain.

THE COGNITIVE DOMAIN : The taxonomy of educational objectives is organised under six major classes :

(A)	Knowledge	(D)	Analysis
(B)	Comprehension	(E)	Synthesis
(C)	Application	(F)	Evaluation

(A) **Knowledge :** It includes the knowledge of :

1. Specific and isolated facts and information.
2. Terminology.
3. Dates, events, persons and sources of information.
4. The ways of organising, studying, judging and criticising ideas and phenomena.
5. Trends and sequences.
6. Classification and categories.
7. Criteria by which facts, principles and opinions are tested and judged.
8. Methodology.
9. Universal and abstractions.

10. Principles and generalisations and their application.

11. Theories and structure and their interrelation.

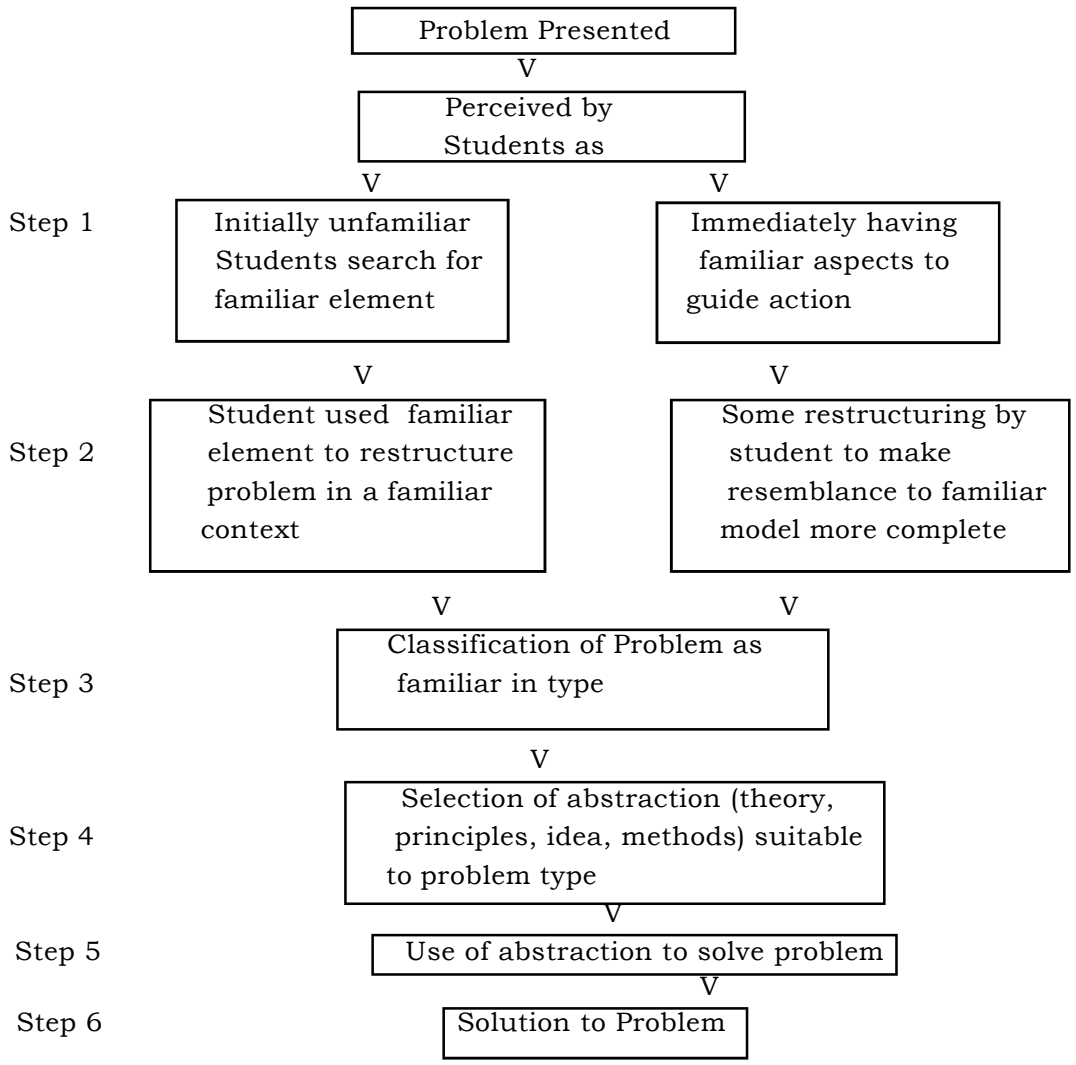
(B) **Comprehension :** This includes three types of behaviour :

(i) Translation (a) From one level of abstraction to another.
(b) From symbolic form to another form and vice-versa.
(c) From one verbal form to another.

(ii) Interpretation

(iii) Extrapolation, which includes behaviour like drawing conclusions, prediction etc.

(C) **Application :** This category can be illustrated with the help of following diagrams :



(D) Analysis : In comprehension the emphasis is on the understanding of meaning and content of material. In application the emphasis is on the remembering and bringing to bear upon the given material the appropriate generalisation and principles. Analysis emphasises the breakdown of the material into its constituent parts and of the way they are organised. The category includes :

(i) Analysis of elements.

(ii) Analysis of relationships.

(iii) Analysis of organisational principles.

(E) Synthesis : Synthesis can be defined as the putting together of elements or parts so as to form a whole. This category includes :

1. Production of unique communication.
2. Production of plan or proposed set of operations.
3. Derivation of set of abstract relations.

(F) Evaluation : Evaluation aims at making judgement about the value, ideas, works, solutions, methods, materials, etc. This consists of valuation in terms of internal evidence and in terms of external evidence.

THE AFFECTIVE DOMAIN : The affective domain includes, attitudes, interests, values, appreciation etc. The objectives relating to these characteristics are difficult to define and evaluate. However, a research like that of the cognitive domain has been developed by 'Krathwohl' and others in which each category is more abstract and complex than the previous one. The different categories of the affective domain are briefly discussed here.

1. Receiving : This is the first and the lowest level of the affective domain and includes individual's awareness of various sources of information on science and recognised, these sources when encountered.

2. Responding : This is a higher level than simple awareness or attention to making some response to a stimulus or phenomenon. This stage includes reading about science and engaging in various co-curricular activities or project of science.

3. Valuing : This is the third level of affective domain and indicates internalization of and commitment to certain ideals or values. The objectives under this category include development of scientific attitudes. For example : a preference for information acquired from controlled experiments rather than opinions of other people : a disregard of superstition : suspended judgement until there is ample evidence to make a judgement etc.

4. Organisation : This level pertains to the building of a system of values. A value is conceptualized in the abstract and the conflicts between the values are resolved and interrelationships are established. This involves the cognitive behaviour of analysis and synthesis. The maturity level required for this level is beyond that attained in the beginning year of formal education.

5. Characterization by a value or value set : This is highest level of the affective domain and includes characterization of a person's behaviour by certain controlling values, ideas, or beliefs and the integration of values and attitudes into a world view or total philosophy of life.

1.4.5 Instructional objectives of science Teaching : From above discussion it is evident that we must enlist the instructional objectives of teaching of science in a classified way. The main objectives can be categorised under following headings.

1. Knowledge 2. Understanding 3. Application 4. Skills 5. Abilities 6. Attitudes 7. Training in scientific Methods 8. Interest and Habits 9. Appreciation 10. Providing work for leisure 11. Forming basis for vocational career 12. Training for better living.

The above stated objectives of teaching of Physics and Chemistry can be understand clearly by the following discussion.

1. Knowledge :- This is the major aim of teaching of science. It may be pointed out that much of the time is devoted to this aim at the cost of other aims. However, the average knowledge of Indian students in the subjects of science at the school is much below the level of international standard. The subjects of Science at school level have very poor back-ground. The students studying these subjects should acquire :

(i) Knowledge of fundamental concepts, terms, principles, laws, theories, formulae and processes connected with science. For example, we must impart the knowledge of gas reactions, gas laws, kinetic theory, Avogadro's law, mole concepts, electrical nature of matter, atomic theories, latest concept of atom, conservation of mass, law of chemical combination, periodicity, matter and change of matter, elements, compounds, solutions, structure of atoms, molecules and crystals, energies, bonding, organic compounds, environment and science in industry etc.

(ii) Knowledge of scientific facts in relation to science.

(iii) Knowledge of trends, sequences, development in science i.e. changing faces of science.

(iv) Knowledge of science for plants and animals kingdom.

(v) Knowledge of natural phenomenon like cloud, rain, hails, snow, dew, fog, smog, frost, rainbow etc.

(vi) Knowledge of literature concerned with science.

(vii) Knowledge of science of human health.

2. Understanding : Knowledge gets transformed into understanding when the subject matter of science is dealt with properly. At this stage the subject matter is digested and assimilated. Science are to be taught in way that gives a clear understanding. This will be of lasting value to all educated citizens. On the other hand a dozen years after, school educated adults will not remember the facts clearly

of even the general principles unless they understand the science we teach them.

It can be said that the second important objective of teaching of science is to develop an understanding of basic facts, concepts, principles, theories, process and phenomenon and in addition to it to develop understanding of the consequences of science on man and his physical and biological environment.

The above said objective could be considered to be achieved if a student is able to :

(i) Explain facts, concepts, principles, process, phenomenon etc.

(ii) Discriminate between closely related concepts, facts, principles, process, phenomenon like the different forms of carbon.

(iii) Translate tables, symbols, formulated terms and concepts from one from to another.

(iv) Illustrate scientific terms, facts, concepts, phenomenon etc.

(v) Locate errors in faulty statement, definitions, diagrams, experiments etc.

(vi) Interpret graphs, charts, datas, theories etc.

(vii) Identify relationship between various facts, concepts, process etc.

3. Application : In the underdeveloped countries like India where there is extremely low level of living and widespread unemployment, the only way to improve conditions is to lay stress on the application of science in industry, agriculture, transport, communication, distribution etc.

A student realising this aim would be required to have :

(i) Analytic and synthetic thinking

(ii) Inductive and deductive reasoning

(iii) Convergent and integrative thinking

(iv) Capability of predicting new happenings.

(v) Ability to focus attention in day-to-day utilities.

4. Skills : Science should develop various types of skills in the students so that in the later life they may not only be in a position to do the work efficiently but also have a love for work. The slogan of their life should be that 'work is workship'. This can only be possible if needed skills are developed in the students while teaching science. Major skills like, laboratory skills drawing skills, observational and recording skills, communication skills, mathematical skills, aesthetic skills, safety skills, abstract skills are to be developed at the school level.

5. Abilities : The teaching of science should also aim at developing certain abilities in students such as to sense a problem, things to discuss, develop reliance on facts, to organise science fairs, exhibitions, clubs etc. to form independent judgement, to develop power of observation, explorations and classification.

6. Scientific Attitude : The success of the individual in his life depends upon his outlook. Attitudes are the mental dispositions of the individuals. It may be a social condition of readiness for certain type of activity. Attitudes are even more important than the facts. Attitudes are mainly of two types i.e. positive attitudes and negative attitudes. A teacher can not be successful if he does not have a positive attitude towards teaching profession, towards students. We know attitudes are the particular bent of mind of the individual towards ideas, events based on scientific explanations. Again attitudes are the things which can not be taught but cultivated in the student by creating a proper atmosphere and conditions of work. We know in the underdeveloped countries the most urgent need is to establish and develop scientific outlook and experimental attitude of mind to acquire knowledge of natural and social forces. There is a need to take decision in rational manner and in accordance with principles of scientific or objective validity, based on relevant data and correct reasoning. This is only way to replace superstitions, out-dated customs or dogmas, and to bring about a change in society to make conditions suitable for rapid economic and national development. Again scientific and rational outlook is an essential condition for the modernisation of the countries like India.

In brief following points are involved in the scientific attitude :

(a) Open mindedness.
(b) Eagerness to know and understand various scientific phenomena.
(c) Mathematical accuracy i.e. to make two and two four.
(d) Judgement made on facts.
(e) Readiness to test and verify conclusions.
(f) Faith in cause and effect relationship.
(g) Truthfulness.
(h) Accepting no conclusions as final.
(i) Respecting other's point of view in the light of view and accurate facts.
(j) No belief in superstitions.
(k) Being critical in observation.

7. Training in Scientific Method : The study of science trains the students in attacking the problem according to a definite and distinct procedure which may be termed as scientific method. In the scientific method there are fixed steps and by following these steps one can solve the problem. The scientific method may be called a scientist's method.

A scientific method involves the following steps :

(a) Sensing and defining the problem.
(b) Analysing the problem i.e. observations relevant to the problem.
(c) An hypothesis consistent with the observations is formulated.

(d) Collecting data.

(e) Selecting the most likely results.

(f) Drawing conclusions and applying these to other similar situations.

8. Interests and Habits : Teaching of science should arouse interest in students about scientific literature by reading books, supplementary books like story of earth, story of moon, lives of scientists, journals, periodicals etc. The students should be encouraged to contribute write ups to magazines, newspapers etc. A Science programme must be prepared for the active participation of students in science clubs, science fairs, science exhibition, debates on scientific topics. Arrangement may be made in school for preparations of various types of scientific games, preparation of soap, nail polish, oil etc. A student may be asked to collect his own specimens. Students must be encouraged to observe physical and natural phenomena i.e. rusting action of food acids utensils, purification of dead matter, minerals in saline soil etc.

Again by teaching science the habits of honesty, truth, tolerance, self confidence, self-reliance can be inculcated in the students.

9. Appreciation : On giving a student a real fact and admiration of science, a student should be able to appreciate discoveries and inventions in these fields. The adventures of scientists in exploring the truth should be told by the teacher. The teacher must make the student to appreciate contribution of science in the progress of civilization, and culture. Students must appreciate benefits and comforts bestowed by Physics and Chemistry upon mankind.

10. Providing work for leisure :- Problem of leisure time is solved through teaching of science. Students who are conscious of scientific activities as preparing articles for daily use, students should use their leisure time in some economic and socially desirable activities as making and maintaining of aquarium, gardening, collection of seeds, leaves, flowers etc.

11. Forming basis for vocational career :- Science form the basis of many courses and careers of purely vocational nature and thus prepare pupils for various professions e.g., Engineering, Medicine, Agriculture. With the development of Five Year Plans in our country, more and more avenues for employment are coming up. There are a number of training courses being offered by ITIs for which basic study of science is essential. Similarly quite a large number of careers absorb science students.

12. Training for better living : The students of science should know the laws of health and hygiene and should be given training in healthy living. They should be taught to take special care of the body, improve their surroundings, and there-by improving the standard of living. He should know the ways and means of prevention with his own domestic, social and natural environment and the economic and cultural conditions.

1.4.6 OBJECTIVES OF TEACHING OF SCIENCE AT DIFFERENT LEVELS OF SCHOOL EDUCATION

Mainly there are three levels of school education that is :

1. Primary level.
2. Middle level.
3. High and Higher Secondary stage.

Various commissions have recommended the objectives of science according to the levels of education. The study of these objectives is of historical importance. The recommendation are given below in summary.

Taradevi Report (1956)

According to the all India Seminar on Science Teaching, held at Taradevi, aims and objectives of Elementary Science should be :

I. Primary Level

1. Arousing and maintaining interest in nature and in the physical and social environment, arousing love for nature and the habits of conserving nature and its resources.
2. Developing the habit of observation, exploration, classification and a systematic way of thinking.
3. Developing the child's powers of manipulation and the creative and inventive faculties.
4. Developing neat and orderly habits.
5. Inculcation of habits of healthy living.

II. Middle School Level

In addition to the above, the following aims and objectives are suitable for, inclusion at the middle school level :

6. Acquisition of a fund of information concerning nature and science which may also serve as the basis for a later General Science course.
7. Developing the ability to reach generalizations and to apply them for solving every day problems.
8. Understanding the impact of science upon our way of life.
9. Developing interest in scientific hobbies.
10. Inspiring children by stories about scientists and their discoveries.

III. High and Higher Secondary Stage

At the High and Higher Secondary stage, the aims for the teaching of Science should be :

1. To familiarize the pupil with the world in which he lives and to make him understand the impact of science on society so as to enable him to adjust himself to his environment.
2. To acquaint him with the 'scientific methods' and enable him to develop the

scientific attitude.

3. To give the pupil a historical perspective, so that he may understand the evolution of scientific developments.

Kothari Commission (1964-66)

The Education Commission of 1964-66 clearly stated :

1. The aims of teaching science in the primary school should be to develop proper understanding of the main facts, concepts, principles and processes in the physical and biological environments.
2. Both deductive and inductive approaches should be utilized to unravel these ideas, though more emphasis may be laid on the deductive approach of the use of the scientific method. For different school stages, following recommendations are made :

I. Lower Primary Stage

(i) At the lower primary stage the focus should be on the child's environment-social physical and biological.

(ii) In classes I and II, the emphasis should be on cleanliness, formation of healthy habits and development of power of observation.

(iii) In classes III and IV, the study should also include personal hygiene and sanitation.

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

(v) Developing proper understanding on the main facts, concepts, principles and process in the physical and biological environment.

II. Higher Primary Stage

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

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

III. Secondary Stage

(i) At the secondary level science should be taught as a discipline of the mind and a preparation of higher education.

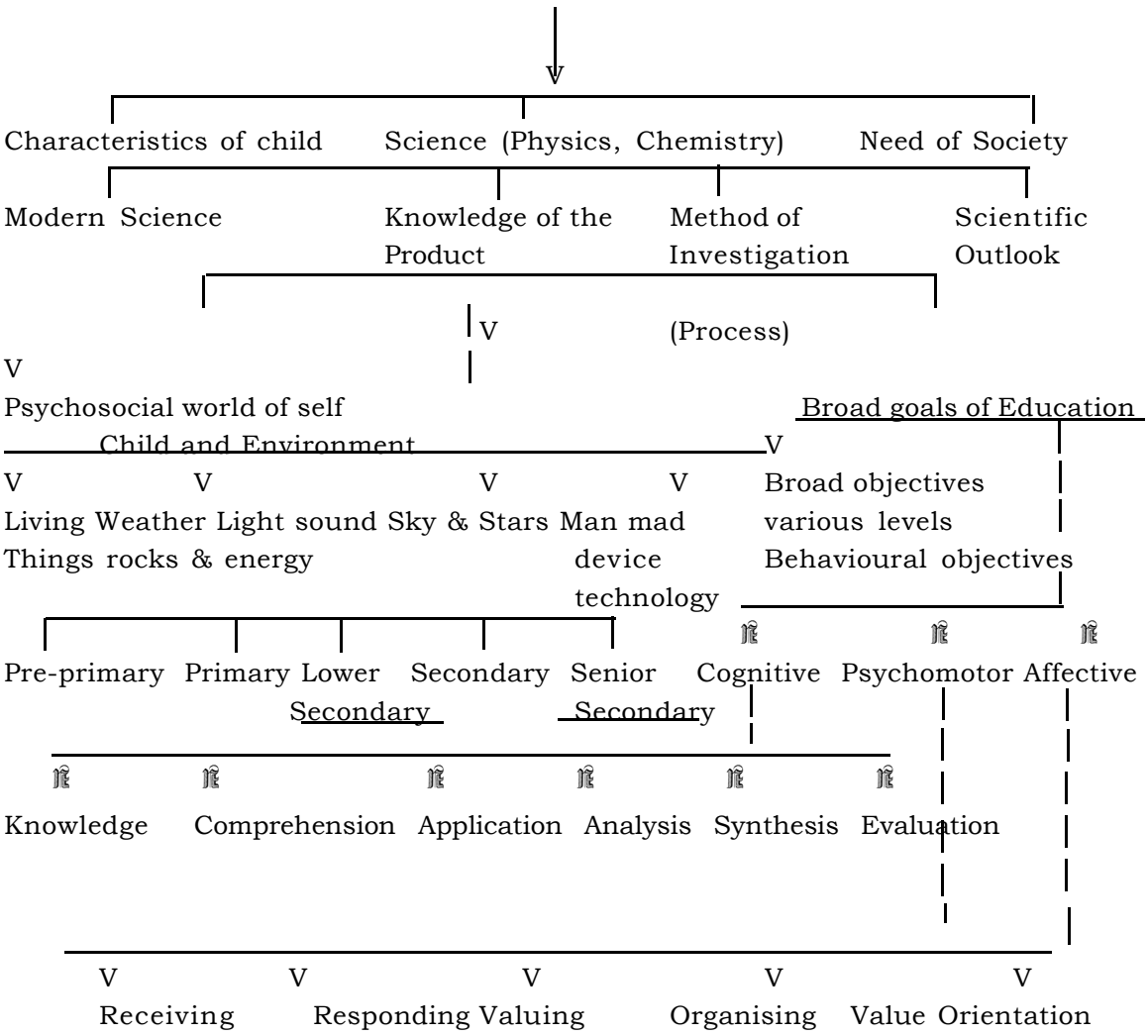
(ii) In the lower secondary classes Physics, Chemistry, Biology and Earth Science should be taught as compulsory subjects for all the pupils.

(iii) At the higher secondary stage there should be diversification of courses and

provision for specialization.

For the recapitulation of this lesson the following Chart may be useful:

Science Education



1.4.7 SUMMARY

To sum up we can say that it is necessary for a teacher to keep in mind the aims and objectives of teaching science before starting the real teaching learning process. Objectives are the standards that guide the working of life in the same way the objectives related to any subject keep the teacher and students on the right track and show them the path to be followed to achieve the objectives of education. These help the students to draw out the best from their behaviour.

1.4.8 Key concepts

1. **Cognitive** - connected with the processes of understanding
2. **Affective-** relating to moods, feelings, and attitudes.
3. **Conative** -relating to the origination of movement in conscious mental activity.

1.4.9 Self-check exercise

1. **..... i**s the lowest level of Bloom's Taxonomy, focusing on recalling or remembering facts, information, or concepts.
2. At the..... level of Bloom's Taxonomy, learners are required to understand and explain the meaning of information.
3. Applying knowledge or concepts to solve problems or complete tasks is associated with the ..... level of Bloom's Taxonomy.
4. **.....** is the level of Bloom's Taxonomy that involves breaking down complex ideas into simpler parts and understanding the relationship between them.
5. **.....** requires learners to use critical thinking and judgment to evaluate the value or quality of information, ideas, or solutions.
6. Creating or generating new ideas, products, or solutions is associated with the..... level of Bloom's Taxonomy.
7. Bloom's Taxonomy is a hierarchical framework used for classifying educational ..... .
8. By using Bloom's Taxonomy, educators can design ..... that target specific levels of cognitive skills.
9. Bloom's Taxonomy was revised in 2001 to include..... levels instead of the original six.
10. Bloom's Taxonomy is widely used to develop ..... and assessment strategies in educational settings.

Answers for self-check exercise

1, Knowledge 2. Comprehension 3. Application 4. Analysis 5. Evaluation 6. Synthesis 7. Objectives 8. Lessons 9. Six 10 . curriculum

1.4.10 SUGGESTED QUESTIONS

1. What are the objectives of teaching science at different levels.
2. Discuss Bloom's Taxanomy of objectives.

1.4.11 BOOKS FOR FURTHER STUDY

1. Armstrong H. E. : *The Teaching of Scientific Method*—Macmillian Co., New York.
2. Duggal S. D. : *Teaching Chemistry in Indian Schools.*
3. Heiss E. D. : Obourn, E. S., Hoffman, C. W. : *Modern Science Teaching,* Macmillan Co. New York.
4. Twiss, G. R. : *Principles of Science Teaching.* The Macmillan Co. New York.
5. Narinder Vaidya : *Problem Solving in Science*—S. Chand & Co., New Delhi.
6. *Report of the All India Seminar on the teaching of Science in Secondary Schools,* held at Taradevi (Shimla Hills), All India Council for secondary Education, Ministry of Education, New Delhi.
7. *Report of the Education Commission (1964-66),* Manager of Publication Govt. of India, New Delhi.

LESSON No. 1.5

Last updated on July, 2025

Pedagogical Analysis - Meaning and need, guidelines for conducting pedagogical analysis.

Structure

1.5.1 Objectives

After going through this lesson students will be able to-

1. Define the term pedagogy.
2. Explain the meaning of Pedagogical Analysis.
3. Understand the meaning of Pedagogical Analysis.
4. Understand the importance of Pedagogical Analysis in Science.
5. Discuss and describe the guidelines for conducting pedagogical analysis.

1.5.2 Introduction

In order to be an effective teacher, one must study the science of pedagogy and instructional design. By learning how to manage activities and instruction in the classroom a teacher can empower himself/herself to facilitate courses that optimize the learning potential of every student. A teacher who has to deal with students of all ages must know the concept of pedagogy and its importance in teaching before entering the classroom. A teacher requires an understanding of where students are coming from in reference to the subject being taught. The reason behind knowing this is, in order to teach material well, teachers must to know what the students bring to the table as far as prior conceptions, feelings, and strategies. For example, many students tend to have personal thoughts about math word problems and thought they are complicated, hard to understand, and boring. A math teacher with pedagogical content knowledge would address each of these prior conceptions, and show why each one is inaccurate. He would help the students to understand how to break down word problems to make them clearer and see them from a different perspective. The introduction of information technology into schools has necessitated changes in pedagogy; teachers are adopting new methods of teaching facilitated by the new technology.

1.5.3 Meaning of Pedagogy

Etymologically pedagogy is a discipline that deals with the theory and practice of education; it thus concerns the study and practice of how best to teach. Its aims range from the general (full development of the human being via liberal education) to the narrower specifics of vocational education (the imparting and acquisition of specific skills).

The word pedagogy comes from the Greek word (paidagogia) in which (paidos) means "child" and (ago) means "lead"; The word pedagogue was

originally used in reference to the slave who escorted Roman children to school. In Denmark, a pedagogue is a practitioner of pedagogy. The term is primarily used for individuals who occupy jobs in pre-school education (such as kindergartens and nurseries) in Scandinavia. But a pedagogue can occupy various kinds of jobs, e.g. in retirement homes, prisons, orphanages, and human resource management. These are often recognised as social pedagogues as they perform on behalf of society.

It literally means "**to lead the child**". In English the term pedagogy is used to refer to instructive theory; trainee teachers learn their subject and also the pedagogy appropriate for teaching that subject.

Pedagogy means : 1. The art or profession of teaching.
2. Preparatory training or instruction.
3. the function or work of a teacher; teaching.
4. the art or method of teaching; (pedagogics)

Pedagogy is the study of being a teacher. The term generally refers to strategies of instruction, or a style of instruction.

Pedagogy is also occasionally referred to as the correct use of instructive strategies. In correlation with the instructive strategies, the instructor's own philosophical beliefs of instruction are harbored and governed by the pupil's background knowledge and experience, situation, and environment, as well as learning goals set by the student and teacher. The teaching of adults, however, may be referred to as andragogy.

In nowadays the term pedagogy - the art or science of being a teacher - refers not only to strategies or styles of instruction but also to the facilitation and management of sustainable transformations, whether individual, social, structural or institutional. In this respect, most pedagogies should be regarded

as inherently formative with respect to the role they play in the development of individuals.

Pedagogy can also be defined as many different types and variations of teaching. Gagné developed some of the earliest instructional design models and ideas and continues to influence pedagogy and instructional designs.

The Science of Pedagogy

Pedagogy is the science and art of education, specifically instructional theory. An instructor develops conceptual knowledge and manages the content of learning activities in pedagogical settings. Modern pedagogy has been strongly influenced by the theories of three major heavy-weights in the science of human development: Jean Piaget's cognitive theory of development and Lev Vygotsky and Jerome Bruner's social interaction and cultural theory. Piaget argued that children construct an understanding of the world around them, and then experience discrepancies between what they already know and what they discover in their environment. Vygotsky and Bruner's theory complimented Piaget's discovery. The social-interactionist theory stated that pedagogy should be designed around the fact that learners construct the new language through socially mediated interaction.

Teachers use an array of teaching strategies because there is no single, universal approach that suits all situations. Different strategies used in different combinations with different groups of students to improve their learning outcomes. Some teaching strategies are better suited to teaching certain skills and fields of knowledge whereas some strategies are better suited to certain student backgrounds, learning styles and abilities. Pedagogy, incorporating an array of teaching strategies that support intellectual engagement, connectedness to the wider world, supportive classroom environments and recognition of difference, should be implemented across all

key learning, and subject areas. Pedagogical practice promotes the wellbeing of students, teachers and the school community - it improves students' and teachers' confidence and contributes to their sense of purpose for being at school; it builds community confidence in the quality of learning and teaching in the school.

Short In Text Questions

1. Describe the meaning of pedagogy.

   .....

   .....

2. What do you mean by science of pedagogy?

   .....

   .....

1.5.4 Meaning of Pedagogical Analysis

The term pedagogical analysis is composed of two words pedagogy and analysis. It stands for a type of analysis based on pedagogy. To understand this concept better let us try to be acquaint ourselves with the term 'analysis' and 'pedagogy'. Analysis as a term stands for a process of breaking or separating a thing into its smaller parts, elements or constituents. Actually it is a process of breaking teaching unit into its constituents –subunit, topics or single concepts etc. through the process of unit analysis. In addition, we can break the contents of the prescribed course in a subject into its various constituents – major and minor sections, sub-sections, units and sub-units, major concept and minor concepts, topics etc by carrying out a process of content analysis.

On the other hand another component 'pedagogy' is an art or method of teaching. Teaching is a simple term, it referred as a either an occupation or profession of a group of peoples known as teacher or an activity or activities to help an individual to learn or acquire some knowledge, skills, attitudes or interests. Pedagogical analysis refers to a systematic examination and evaluation of teaching and learning processes to ensure their alignment with educational objectives and the needs of learners. It involves a deep inquiry into

various elements of the educational context to identify strengths and weaknesses in instructional strategies, materials, and assessments. Pedagogical analysis aims to optimize teaching effectiveness and enhance student learning outcomes. It helps educators understand how their practices impact learners and provides insights into areas that may need improvement. By engaging in pedagogical analysis, educators can make informed decisions about refining their teaching approaches and selecting appropriate educational resources.

Definitions of teaching:

1. According to E. Amidon: Teaching is defined as an interactive process, primarily involve in classroom talk, which takes place between teachers and pupils and occurs during certain definable activities.
2. N. L. Gage define teaching as a form of interpersonal influence aimed to change the behavior potential of another person.
3. B. O. Smith- Teaching is a system of actions intends to produce learning. Above all a good or effective teaching must accomplished the following objectives:

1. It should tell whether teaching is a process or product.
2. It should clearly indicate its constitutional elements or factors.
3. It should reveal its objectives.
5. It should say about its organizational or structural aspects.

Thus, "Teaching is a triadic relation and tripolar process involving the source of teaching, student and a set of activities and manipulation to bring changes in the behavior of the students".

Therefore, "the analysis of a given content material in any subject any topic carried out well in the spirit of the science of teaching (Pedagogy) is known by the term pedagogical analysis of the contents".

1.5.5 Guidelines for Pedagogical Analysis in sciences

Pedagogical analysis is a systematic process used to evaluate and design effective teaching and learning strategies for a particular subject or discipline. In the context of sciences, such as physics, chemistry, biology, or any other natural or physical science, pedagogical analysis is crucial for enhancing

student understanding and engagement. Here are some guidelines for conducting a pedagogical analysis in sciences:

1. Identify Learning Objectives: Start by clearly defining the learning objectives for the specific science topic or concept you want to teach. What do you want your students to learn and understand at the end of the instruction? Ensure that the objectives are specific, measurable, achievable, relevant, and time-bound (SMART).

2 Analyze the Audience: Consider the characteristics of your students, such as their age, prior knowledge, learning styles, and interests. Understanding the needs of your audience will help you tailor your teaching methods and materials to effectively engage them.

3 Consider Curriculum Standards: Take into account the relevant educational standards or guidelines established by your school, district, or educational authority. Aligning your pedagogical approach with these standards will help ensure your students meet the required learning outcomes.

4 Select Appropriate Teaching Methods: Choose teaching methods that align with the learning objectives and are suitable for the science topic you're teaching. Common methods in sciences include lectures, demonstrations, experiments, group work, case studies, and hands-on activities.

5 Utilize Active Learning Techniques: Active learning involves engaging students in the learning process rather than passively listening to lectures. Encourage students to participate actively, ask questions, solve problems, and collaborate with peers.

6 Incorporate Technology: Integrate technology tools and resources that can enhance the learning experience. These may include simulations, virtual labs, interactive software, online resources, or multimedia presentations.

7 Use Real-World Examples: Relate scientific concepts to real-life situations to help students understand their relevance and applications in the world around them. This connection can increase student motivation and engagement.

8 Assess Student Learning: Develop appropriate assessment methods to measure students' understanding of the science concepts. Use a variety of assessment techniques, such as quizzes, tests, projects, presentations, and self-assessment, to gauge their progress.

9 Provide Constructive Feedback: Offer timely and constructive feedback to students to help them improve their understanding and performance. Feedback should be specific, actionable, and focused on the learning objectives.

10 Continuously Reflect and Improve: Regularly evaluate the effectiveness of your teaching methods and materials through student feedback, self-reflection, and assessment results. Use this feedback to make improvements and optimize your pedagogical approach.

Remember that the pedagogical analysis process is an ongoing one. As you gain more experience and insights into teaching sciences, you can refine

your methods to create a more effective and engaging learning environment for your students.

1.5.6 Elements of Pedagogical Analysis:

Pedagogical analysis involves a comprehensive examination of various elements related to teaching and learning. The key elements include:

1. Learning Objectives: Clearly defined and measurable goals that indicate what students are expected to know or be able to do after completing a lesson or course.

2. Content: The subject matter or topics that educators teach to students, including its relevance, accuracy, and appropriateness.

3. Teaching Methods: The strategies and techniques employed by educators to deliver the content and engage students actively in the learning process.

4. Assessment Techniques: The methods used to evaluate students' understanding, progress, and mastery of the learning objectives.

5. Learning Environment: The physical and psychological atmosphere in which learning takes place, encompassing factors such as classroom setup, student-teacher interactions, and peer relationships.

6. Educational Resources: The materials, tools, and technologies used to support teaching and learning, including textbooks, multimedia resources, and educational software.

Short In Text Questions

1. Define pedagogical analysis
2. Discuss the elements of pedagogical analysis.

1.5.7 Need of Pedagogical Analysis

The importance of pedagogical analysis lies in its potential to bring about significant improvements in the educational system. The following reasons underscore the need for pedagogical analysis:

1. Enhancing Teaching Effectiveness: Pedagogical analysis enables educators to critically evaluate their instructional methods and identify effective strategies that align with the learning needs of their students. This continuous self-assessment improves their teaching effectiveness and fosters a positive impact on students.

2. Catering to Diverse Learners: Learners vary in their abilities, learning styles, and preferences. Pedagogical analysis helps educators recognize these differences and adapt their teaching methods to accommodate diverse learners effectively.

3. Improving Learning Outcomes: By analyzing the effectiveness of teaching techniques and learning materials, pedagogical analysis facilitates the selection of methods that lead to better learning outcomes and higher levels of student achievement.

4. Identifying and Addressing Challenges: Pedagogical analysis sheds light on challenges faced by both educators and learners. This understanding enables the development of targeted interventions and solutions to improve the overall educational experience.

5. Aligning with Educational Goals: Educational institutions often have specific objectives and standards. Pedagogical analysis ensures that teaching practices and resources align with these goals, promoting a cohesive and purposeful educational process.

1.5.8 Summary

Students in this chapter we have discussed the concept of pedagogy and pedagogical analysis. Pedagogy is the discipline that deals with the theory and practice of education. Pedagogy is also occasionally referred to as the correct use of instructive strategies. In correlation with the instructive strategies, the instructor's own philosophical beliefs of instruction are harbored and governed by the pupil's background knowledge and experience, situation, and environment, as well as learning goals set by the student and teacher. that pedagogical analysis is the analysis of all aspects of teaching by involving least efforts for drawing the maximum possible better teaching outcomes, or in other words we can also describe them as the ways and means provided to utilize by a teacher for managing his task of teaching as smoothly and effectively as possible by involving his least efforts for drawing the maximum possible better teaching outcomes**.**

Based on the latest developments in pedagogy, teaching has become more than an activity that conserves valued knowledge and skills by transmitting them to succeeding generations. Therefore, teachers also have the responsibility to challenge existing structures, practices, and definitions of knowledge; to invent and test new approaches; and, where necessary, to pursue organizational change in a constant attempt to improve the school. Effective teaching through pedagogy display skills at creating curricula designed to build on students' present knowledge and understanding and move them to

more sophisticated and in-depth abilities, knowledge, concepts, and performances. In addition, pedagogy helps to make a range of instructional strategies and resources to match the variety of student skills and to provide each student several ways of exploring important ideas, skills, and concepts. Pedagogy makes a teacher: how to work as facilitators, coaches, models, evaluators, managers, and advocates. Moreover, teachers know how to utilize various forms of play, different strategies for grouping learners, and different types of media and materials. Through pedagogy teachers observe and assess students in the context of ongoing classroom situation like collecting and interpreting a variety of types of evidence to evaluate where each student is in a sequence or continuum of learning and development and know how to move from assessment to decisions about curriculum, social support, and teaching strategies, to increase the prospects for successful learning.

1.5.9 Key Concepts

1. Pedagogy – pedagogy is the discipline that deals with the theory and practice of education; it thus concerns the study and practice of how best to teach.
2. Analysis - process of breaking or separating a thing into its smaller parts, elements or constituents.
3. Pedagogical analysis- the analysis of a given content material in any subject carried out well in the spirit of the science of teaching i.e. Pedagogy is known as the term pedagogical analysis.

1.5.10 Self check exercise

Find out the true and false statements:

1. Pedagogy is an art of learning.
2. The process of breaking or separating a thing into its smaller parts, elements or constituents is called synthesis.
3. The analysis of a given content material in any subject carried out well in the spirit of the science of teaching is known as pedagogical analysis.
4. Pedagogical analysis leads to effective teaching.

5. Teaching is a system of actions intends to produce learning.

Answers 1. False 2. False 3. True 4. True 5. True

1.5.11 Suggested Questions

1. Define pedagogical analysis. Discuss its need in relation to effective teaching.
2. Explain the elements of pedagogical analysis and guidelines for conducting pedagogical analysis.
3. Discuss the relation between pedagogical analysis and teaching.

1.5.12 Suggested readings and Web sources

1. How to teach science – V. K Kohli
2. Teaching of Science- Rakshinder Kaur

Web sources

1. http://edu-creation.blogspot.in/2010/02/pedagogical-analysis.html
2. http://basicresearchjournals.org/education/pdf/Bhowmik%20et%20al.pdf
3. https://en.wikipedia.org/wiki/Pedagogy

B. Ed. Semester-I **Paper–IV & V (Part-I) Option (vi)**

Teaching of Science

Lesson No. 1.6

SCIENCE CURRICULUM: MEANING PRINCIPLES AND VARIOUS APPROACHES TO SCIENCE CARRICULUM CONSTRUCTION, DEVELOPING LEANER CENTRED CURRICULUM IN SCIENCE

Structure

1.6.1 Objectives

After going through the present lesson, students will be able to

(i) Define curriculum.
(ii) Describe the principles of curriculum construction.
(iii) Discuss different methods of curriculum organization in science.
(iv) Explain different styles of curriculum development in science.

(v) Analyze the defects in existing science curriculum.
(vi) Justify the relevance of present science curriculum and will try to provide suggestions for the improvement of existing curriculum.

1.6.2 Introduction

Earlier the major aim of education was the acquisition of a fund of information.

But now education is regarded as a dynamic process and so the aims and objectives have changed. Our present day curriculum is jumbling of facts it has been badly criticized and it is not possible to attain the modern aims and objectives of education. To be dissatisfied with the existing curriculum is natural in a keen and up-to-date teacher of any subject, particularly if, like sciences that subject is itself undergoing change. Such dissatisfaction provides the impulse for reform of science curriculum within schools and leads, usually gradually, to changes in both content and teaching strategy.

1.6.3 Curriculum

Science teaching has been introduced at secondary stage to achieve specific objectives. To achieve these objectives it is necessary that the learner be provided certain learning experiences so as to develop their knowledge, skills and also the desirable attitude and interest.

It has been said that, "Curriculum is the soul of the process of education. It is the heart of the educational institution and mind of the course and all that only goes with it."

The word curriculum is derived from a Latin word 'Currere', which means 'to run'. So, "the curriculum means a course to be run for reaching a certain goal". Curriculum is a list of lessons and topics which are expected to be covered in a specified period of time in any class. However, this traditional concept of curriculum has undergone a change in modern time. Now curriculum refers to the "Sum total of the experiences that the pupil receives through his involvement in various activities in the school – in the classroom, laboratory, play ground or through numerous informal contacts between the teacher and taught". Thus according to modern concept curriculum includes the whole life of the school. Thus, those activities which were previously referred to as co-curricular or extra-curricular activities have now become curricular activities.

Sometimes curriculum is confused with syllabus. Syllabus is just the outline of the course content which the teacher is expected to teach. Thus it is a part of the curriculum. Curriculum is much more than the syllabus. According to Cunnigham, "Curriculum is the tool in the hands of the artist (teacher) to mould his material (the pupils) according to his ideals (aims and objectives) in his studio (the school)."

According to Munroe, "Curriculum embodies all the experiences which are utilized by the school to attain the aims of education".

According to Crow and Crow, "Curriculum includes all learners experiences in or outside the school that are included in a programme which has been devised to help him develop mentally, physically, socially, emotionally, spiritually and morally".

Dear students, by now you must have grasped the meaning of curriculum. From the above discussion we can conclude that physical science curriculum should stand for all those experiences that can be included for the study of physical science at a particular level. These experiences are considered essential for the realization of the set goals or objectives of the subject. The learning experiences are received through a number of activities going inside or outside the school in formal or informal settings.

1.6.4 Principles of Curriculum Construction

Curriculum is the sole mean through the implementation of which the teacher can achieve the aims and objectives of education. It is a very important tool in the hands of a teacher with the help of which he moulds the behaviour of his students. Teaching of physical science aims at imparting training in scientific method. It should create an awareness and better understanding of the living world around us. This is possible only when we are skilled enough to apply the attained knowledge for our betterment. So, to achieve the said aims and objectives, curriculum construction should be based on sound principles. Some important principles for curriculum construction are as follows:

1. **Principle Of Child Centredness:**
   The curriculum should be based on the present needs and circumstances of the child. Due consideration should be given to the abilities and interests of child. Activity and information imposed on the child by the adult inhibits the development of his natural potentialities.

2. Principle Of Creativity:

In the curriculum those activities should be included which enable the child to exercise his creative and constructive powers. Curriculum should take care that none of child's native gift should escape our notice and development. Therefore, curriculum must have a definite bias towards creative activity.

3. Principle Of Preparation For Life Education:

Education must prepare the individual for life. Preparation for life includes many aspects. Development of useful skills, aptitude and healthy attitude can prepare a person to face challenges of life successfully as well as make him a useful member of society who works for the benefit of society. So, while preparing curriculum of any subject this aspect should be kept in mind.

4. Principle Of Conservation:

This principle lays emphasis on conserving the past knowledge and skills. It believes in the saying that a nation lives in the present, on the past and for the future. It is being increasingly recognized that certain form of skills and knowledge which have proved to be useful to past generations should be continued for the benefit of coming generation. However, what should be retained should be carefully decided. The knowledge that we have, provides a solid base to stand upon it and this base must be accepted. Thus the curriculum should use the durable base of the past body of knowledge with certain desirable changes meeting the needs of present day.

5. Principle Of Activity:

Growth and learning are affected by activities and experiences. Therefore, the curriculum should be thought in terms of experiences and activity rather than knowledge to be acquired and facts to be stored. Field visits, laboratory experiments and outside practical activities are some of the activities which plays an important role in the curriculum of physical science. The curriculum must ensure the activity of body and mind.

6. Principle Of Community Centredness Chlid:

Child of today is the useful citizen of tomorrow. Loading the child with information not related to the need of society/community will render him useless and unacceptable member of community. Curriculum therefore, should emphasize activity involving welfare of the community.

7. Principle Of Maturity:

Different stages of development are marked by particular characteristics. Interests, abilities and requirements change with the development. Curriculum therefore, should be designed keeping in view maturity characteristics of different stages. Experience provided should match the development characteristics of a particular age.

8. Principle Of Flexibility:

Curriculum should not be rigid. It should have an adequate scope for changes with respect to the need and demand of society as well as child. It should be progressive and up to date. It should be dynamic not static.

9. Principle Of Intercorrelation:

All the subjects of school curriculum through their respective learning experiences are to attain the goal of realizing the aim of education. So, it should be carefully observed that the learning experiences provided in physical science at different levels should be essentially correlated with learning experiences of other subjects of the school curriculum.

10. Principle Of Vertical And Horizontal Articulation:

There should be a continuity of the year to year curriculum of physical science so that the present year's curriculum is based on that of previous year and next year's curriculum on the present one. Further the topics in curriculum should be in increasing order of difficulty.

11. Principle Of Leisure:

In science curriculum there should be some provision for the healthy and purposeful activities for leisure time and these activities should be according to the goals of the physical science study.

12. Principle Of Developing Scientific Attitude:

In Physical science curriculum such learning experiences should be organized which may promote scientific attitude. Such experiences which may help children in dispelling imaginary fears, false beliefs and superstition should be included. It should develop the attributes like open mindedness, critical observation, independent thinking and using scientific method for solving the problem, which are essential for the development of scientific attitude.

13. Curriculum should lay emphasis on learning to live rather than on living to learn.

14. The curriculum should be realistic and rationalistic.

15. Curriculum should provide a fullness of experience for the children.

As far as the curriculum of physical science is concerned it should be elastic and variable, child centred, community centred and activity centred. It should help the child in adjustment in life and his environment. It should be helpful to conserve and transit the traditions, culture and civilization. It must help in arousing creative faculties of the children.

1.6.5 Approaches to Curriculum Construction

The curriculum can be organized depending on the objectives to be achieved. While developing the curriculum any one or combinations of the below given approaches can be used. Let us discuss these approaches of curriculum organization.

Disciplinary Approach: Physical science is such a subject that it has its own concepts, facts, theories and explanation etc., which make it as a sole and major subject. Thus, it is taught by the disciplinary approach.

Systems Of Organizing Curriculum: The content in the curriculum can be organized by keeping into consideration the objectives to be achieved and facilities that are available. The content can be organized in different ways.

1) Logical Order Method: In this method the topics or lessons will be arranged in increasing order of difficulty from simple to complex and

from abstract to concrete knowledge. This method will give comprehensive knowledge about the subject.

2) Concentric Method: The topics in this method, will find a place in different classes of different years of a course in a progressive manner. The content will be included from simple to complex as the classes progress so that the pupils understand the content according to capabilities that is present in chronological and mental ages.

3) Topic Method: In topic method, the content selected will be explained in detail in the same class at the same point. Once completed, there will be no future learning about that topic. This method can be used in covering the basic concepts in the curriculum because certain basic concepts are important to be taught at particular age and cannot be extended to further classes.

4) Psychological Method: In this method the subject matter will be selected on the basis of psychological level of the pupils. The curriculum should be based on psychological level of the pupils such as interests, intelligence, abilities, past experiences, motivation etc. Mental age is the major factor in the placement of content. Chronological age is important to understand complex process and various skills.

5) Historical Method: Subject matter will be arranged as per its historical development. With the help of this method students will be able to remember development of certain concepts and theories.

1.6.6 Styles of Curriculum Development

Basically the curriculum may be classified in following three styles:

1. Instrumental style curriculum
2. Interactive style curriculum
3. Individualistic style curriculum

1. Instrumental style curriculum: This type of curriculum emphasise the utility value or vocational value of physical science. It makes learning an intense competition among students.

This style follows disciplinary approach and emphasise on acquisition of knowledge. Teacher plays dominant role here.

2. **Interactive style curriculum:** In this type of curriculum instruction becomes an interactive or a cooperative process. This is society oriented curriculum style which emphasise social development of child. It follows interdisciplinary approach and in this case curriculum consists of learning packages and thus, loosely structured.

3. **Individualistic style curriculum:** This type of curriculum emphasise personal development of the individual. It is based on interdisciplinary approach. It helps to develop creativity in the individual.

1.6.7 Defects in the Present Curriculum of Physical Sciences

A careful examination of physical science curriculum reveals its weaknesses and strengths. The defects or the weaknesses of present physical science curriculum are as follows:

1. It lacks adequate relevance to the aims and objectives of teaching science.
2. In our country the science curriculum is examination-oriented.
3. It is subject-centred, academic and stereotyped.
4. In our schools the curriculum in science emphasise the acquisition of knowledge of certain scientific facts, theories and generalizations rather than their applications in day to day life.
5. The curriculum has not been prepared keeping in mind the interest of the students because it is not activity-centred. Students at school level are more curious. They cannot sit and listen to theoretical concepts only. They are supposed to be involved in activities to learn.
6. It is not in accordance with the needs of society and students.
7. The curriculum aims at producing only scientists and not good citizens who can adopt new innovations and appreciate the impact of modern science on present civilization.
8. The curriculum covers wide range of topics but not in depth.
9. Present science curriculum is rigid and static, otherwise it should be dynamic and flexible.
10. It does not specify the evaluation procedures to be adopted by the teacher.

11. It is devoid of scientific activities.
In this context, Secondary Education Commission has observed the following defects in the present curriculum. These are as follows:

i) narrow in conception
ii) bookish and theoretical
iii) contents voluminous but not rich and significant
iv) leads to one-sided personality development
v) examination ridden
vi) cut-off from the life around and
vii) bereft of the technical and vocational subjects

In the light of above defects in the present science curriculum at the school level; it becomes necessary that the following points should be kept in mind while re-orientating new curriculum.

1.6.8 Developing learner Centred curriculum in Science

While constructing the curriculum of science the following points should be kept in mind.

1. It should be made relevant to the aims and objectives of teaching science. It should develop scientific attitude among children and impact training in scientific method.
2. Topics included in the text books should have both vertical and horizontal linkage. Indepth study should increase as we move from lower to higher classes.
3. There is need to change the system of evaluation so that the curriculum no more remain examination ridden and should prepare the child for life not for examination.
4. While framing curriculum interests and abilities of the child should be the criteria.
5. It should provide more opportunities for practical work and first hand experiences to the children.
6. Scientific activities like science clubs and scientific hobbies should occupy a good proportion of the curriculum.
7. Curriculum should be flexible so as to accommodate the needs of various groups.

8. There should be a provision for continuous evaluation for active continuous learning of the child and feedback for the teacher.
9. There should be a provision for visits to the places of scientific interests and doing projects etc.
10. In this technosavi world the knowledge of ICT should be given to the students so it should also be a part of curriculum.

1.6.9 Summary

Dear students, in this chapter we have discussed the curriculum of sciences. Curriculum is the sum total of the experiences that the pupil receives through his involvement in various activities in the school –in the classroom, laboratory, playground or through numerous informal contacts between the teacher and taught. Curriculum is much more than syllabus. The principles for curriculum construction are (i) Principle of child centredness, (ii) Principle of creativity, (iii) Principle of preparation for life, (iv) Principle of conservation, (v) Principle of activity, (vi) Principle of community centredness (vii) Principle of maturity, (viii) Principle of flexibility, (ix) Principle of intercorrelation, (x) Principle of vertical and horizontal articulation, (xi) Principle of leisure, (xii) Principle of developing scientific attitude.

In the curriculum the content can be organized by following different methods as: (i) logical order method, (ii) concentric method, (iii) topic method, (iv) psychological method and (v) historical method. There are three styles of curriculum development (a) instrumental, (b) interactive and (c) individualistic.

A careful examination of science curriculum reveals certain defects. These are – it is not in accordance with the aims and objectives of teaching science. It is examination centred, subject centred, stereotyped, unable to prepare the child for life, not based on psychological principles. It is rigid and static and devoid of scientific activities.

Thus, while reforming the present curriculum of science certain points should be kept in mind. It should be based on psychological principles. It should have vertical and horizontal linkages. It should be child-centred and community centred. There should be provisions for scientific activities, first hand experiences and practical works and continuous evaluation. It should be flexible.

1.6.10 Key Concepts

1. Curriculum: A course of study.

2. Creativity: Power to create something.
3. Interdisciplinary: Interrelation of different disciplines or areas of study.
4. Disciplinary: Pertaining to branch of knowledge or area of study.
5. Concentric: Having a common center.

1.6.11 Self Check Exercise

Match the Columns:

COLUMN A	COLUMN B
A. Interdisciplinary	a. Utility or vocational value
B. Individualistic	b. Co-operative process
C. Interactive	c. Novelties or discoveries
D. Instrumental	d. Interrelation of more than one areas of study.
E. Innovations	e. Related to personal development

Answers: A-d, B-e, C-b, D-a, E-c

1.6.12 Suggested Questions

Q1. Define curriculum. Discuss various principles of curriculum construction.

Q2. What are the major defects in the curriculum of sciences at school level and how these can be overcome?

1.6.13 Suggested Readings

(1) Yadav,M.S. –Teaching of chemistry
(2) Aggarwal, D.D. – Modern methods of Teaching Chemistry
(3) Veer, Udai – Modern Teaching of Physics
(4) Mann, S. S. – Teaching of Physics
Sharma, R.C. – Modern Science Teaching

Mandatory Student Feedback Form

https://forms.gle/KS5CLhvpwrpgjwN98

Note: Students, kindly click this google form link, and fill this feedback form once.