C-6&7 PEDAGOGY OF SCIENCE-I

UNIT-I

MEANING, NATURE AND SCOPE OF SCIENCE, IMPACT OF SCIENCE AND TECHNOLOGY ON SOCIETY.

Introduction : Every scientific activity is characterized by two partial activities. On is some form of observation or perception. It can be taken through senses. Another part is the form of thought activity. It penetrates to the observation though activity gives the name to observation and make more specific conceptual analysis of them. It has given a reality to our thoughts. Science has played a tremendous role. In our lives during the last century and is now changing our entire existence in such important aspects as health, power communication and transportation. The artificial silk fabric of the chair covers has been made from wood-pulp.

Meaning : Science has been derived from a Latin ward "Scientia" which means knowledge. It is a systematized body of knowledge which may pertain to any subject. Science is an organized common sense. Science is a heap of truth. Science is an organized common sense.

Definitions of Science

1. **B.F. Skinner** : "Science is first of all a set of attitudes. It is a disposition to deal with facts rather than with what someone has said about them."

2. **J.H. Poincare**: "Science is built up with facts as a house is with stones, but a collection of facts is no more a science than heap of stones is a house."

3. **Albert Einstein** : “Science searches for relations which are thought to exists independently of the searching individual.”

Meaning and Nature of Science

The word science has its roots in the latin word Scientia, meaning knowledge".

Definition: Science as a process -In modern use, "science" more often refers to a way of pursuing knowledge, not only the knowledge itself. Experimentation - It is a process in the sense it helps to explore the truth and involves certain systematic procedures and mental faculties as reasoning, analysis and synthesis. The process of science is the scientific method. This is the process of constructing an accurate, reliable, repeatable model of the real world, by scientists collectively working towards this goal over time. Scientific ideas are developed through reasoning.

The process of science is not predetermined.

1. Science is a Process as well as Product It is a process in the sense it helps to explore the truth and involves certain systematic procedures and mental faculties as reasoning, analysis and synthesis. It is a product because it results in an organized body of systematic knowledge.

2. Science helps to make descriptions It answers questions like how , where, when, under what circumstances.

3. Science makes predictions Extending knowledge to further situation is prediction. It involves the use of generalizations or application of knowledge in new situations.

4. Science is based on observation Meticulous observation followed by inference drawing is an essential part of science. These observations and their conclusions are objective in nature. Unbiased approach is followed in science.

5. Science is concerned with past, present and future Science answers questions about the past.eg why could the dinosaurs have become extinct? It is involved with the present. eg search for remedies to diseases. It also dwells in the future.eg what fuels can be used in the future?

6. Scientific ideas are subject to change It is never a finished product. There is a lot more to be discovered. The quest in science is unending. Scientific laws are tentative and may be changed with further research . Science is an eternal quest for truth. Science in its nature is dynamic.

Values of science in socio-cultural context.

Science has immense value in an individual's life and his life in society.

INTELLECTUAL VALUE

MORAL VALUE

AESTHETIC VALUE

CULTURAL VALUE

VOCATIONAL VALUE

UTILITARIAN VALUE

SOCIAL VALUE

SCIENTIFIC TEMPER

Impact of Science & Technology on Modern living

Modern era is the age of science & technology Science has revolutionized our modern living through changes in the way of thinking, attitudes, outlook etc. Science has great effect on our life and surroundings. It has brought revolution in the fields of health, communication, transportation, power, food products etc. Science has made the life of modern man easy. It has bestowed its blessing over areas like agriculture, education, industries etc. Science play role in our day to day life which shows its impact.

1. **Impact of Science and Agriculture** : Food is the most important need of any living thing. Some ten thousand years ago, it was discovered that certain plants can be cultivated to get regular supply of food. Agriculture implies that one has not a gather food daily. The Green revolution in this context is showing the impact of science in this field. The frequent and effective use of fertilizers and pesticides, advanced methods of cultivation, improved varieties of seeds, separating grains from chaff have all increased the yield of the crop. Spraying of insecticides over crops through spraying pumps saves the destruction of crops by harmful insects.

2. **Science and Health** : Science has played a significant role in this field. In recently time thousands of the people in the world died of diseases like small pox, malaria and plague every year. During these epidemics, people had to move away from their places to another. Now a days we don't even hear about plague or small pox. The Medicines & Vaccines have proved to be a saviour of mankind. Today more than 90% of human and animal diseases are being cured

by synthetic drugs, X-rays, radio active isotopes, TMT, CAT, MRI scan, NMR scan, ECG, EEG, EMG, are some of the important scientific discoveries to maintain our health.

3. **Science & Industry** : The discoveries of science accelerated the rate of growth of industries. The only source of energy available to man was his own muscular energy, but now machines do work for man. It has made the work easy and at the same time fast. All the processes including preparation of soaps, detergents, dyes, chemical fertilizers, pesticides, insecticides are carried out by the automatic machines, steel production, railways, automobiles and electrical products are some examples of industry.

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

5. **Science and living conditions** : We have seen that science and technology evolves 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 never abilities to do things that could n't have done before.

6. **Science and Women** : Science has improved the status of women. In past, the women were facing lot of health hazards due to use of traditional chulahs. She had to walk a longer distances to fetch water for fulfilling the daily needs of the family but now a day the things have been changed a lot with the blessing of

science, she is not only a house wife now but a doctor, engineer, teacher, pilot at the same time. She is working side by side with men in laboratories, research institutions, industries hospitals etc.

7. **Science and Communication** : It is an another important discovery of science. Now a days programmes of Higher Education are broadcasted on Doordarshan for specific time by U.G.C. Sometimes agencies are also telecasting educational programmes on Television. The satellite channels have played a significant role here. The news are being brought by radio waves now. These waves travel with the speed of light and go round the earth seven times in one second. The recent advancement in this field is E-mai8l and internet which have made the world interconnected.

8. **Impact on Employment** : Due to the vast increase in the field of science education day by day. We get more opportunities of getting technically trained employee. Vast field of science and its branches has made much more vacancies for the individuals. One can go into different field of its choice and capability. To avoid unemployment different courses of free or less fee education has been established.

9. **Impact on education** : All the areas of the education is the product of science like Botany, Zoology, Chemistry, Physics, Mathematics, Geography, Economic, Education Technology, Computer Science etc. To improve the facilitate science education National Policy of Education in 1986 initiated a scheme under which financial assistances, science has increased the educational field to great extent with the help of education we are able to produce crop production, resistance to pest, artificial insemination high yielding qualities of crops and prevention from communicable disease.

10. **Impact of Science on Democracy** : Demoracy is meant for open mindness and independence which has brought about by in our behaviour by science. Science has helped us in independent thinking, outlook of receiving new ideas and capacity for clear or rational thinking. It has developed moral values among individual like respect, co-operation. It has helped us to develop humility, loyalty etc. All these qualities in an individual leads to make a person democratic.

Conclusion : So we can say, science plays an important role in our daily life. Science is a common sense. It is an interconnected series of concept and conceptual schemes that have developed as a result of experimentation and observation. The concept as abstraction of a series of experiences that defines a class of objects or events.

2. AIMS AND OBJECTIVES OF TEACHING SCIENCE - BLOOMS' TAXONOMY OF EDUCATIONAL OBJECTIVES (REVISED FORM ALSO), INSTRUCTIONAL OBJECTIVES OF TEACHING SCIENCE AT SECONDARY AND SENIOR SECONDARY LEVEL.

Introduction : The aims and objectives of teaching science have undergone numerous changes during the last few decades. There was a times when science was not a compulsory subject in the secondary schools. Only a few selected student opted for it. At that time, the major stress was on the teaching of facts of science. Later on owing to tremendous developments in Science & Technology. Science was made a compulsory subject not only in secondary schools but in primary classes as well. Now a days, science is a

compulsory subject for all the children in all the schools from 1st to 10th classes. The stress or the aim of teaching science shifted from fats to application aspect of science.

Meaning : Aim is a declaration of intent. It gives the direction. The education in the real sense, is the modification of behaviour of the pupils in the desirable and useful direction. To line as an efficient member in the modern society, each citizen should know some facts of the natural phenomenon laws, properties of matter, their application in the daily life.

Definitions of Aims

1. **John Dewey** : "An Aim implies an ordered activity."
2. **Professor Gurrey** : "It is desirable to know exactly what one is hoping to achieve as it is in all a great undertaking.
3. **W. Pauti** : "The aim of science teaching is n't the acquisition of information and a few skills but to attain the understanding of the relationship which connects the answer to the problem.

Definitions of objectives

1. **Davies** : "Learning objectives is a statement of proposed change."
2. **Acc. to Dictionary of Education** : "The end towards which a school sponsored activity is directed."
3. **B.S. Bloom** : "Objectives as the desired goal or outcome at which instruction is aimed."

Criteria of Selection of Aims

1. **Usefulness** : Derived learning should be have value in the life of pupil.
2. **Practicability** : Experiences are needed for learning in the life.
3. **Fitness** : Learning should lead toward broad objectives.
4. **Timeliness** : Learning should concerned with material that is familiar at the present time.
5. **Appropriateness** : Learning should be appropriate for the maturity of the pupils.

Difference b/w Aims and Objectives

	Aims	Objectives
1.	Aim is broad. It is not much used by teacher.	Objectives are small. These are meaningful clear and specific.
2.	It gives direction to a teaching programme.	These are particular point in that direction.
3.	The answer to the question of why a subject is taught.	The answer to the question what will be achieved after teaching.
4.	Indefinite and vague.	Clear and definite.

5. School, society & nations are responsible for their achievement and fulfillment.	Teacher is responsible
6. Close to ideals that cann't be fulfilled.	Can be achieved easily.
7. Time consuming for achievement	Not of much duration.
8. Can be achieved in one day	Step by step achieved.

Bloom's Taxonomy of Educational objectives

These objectives are introduced by Dr. Benjamin S. Bloom of Chicago University. He classified objectives in three domains.

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

1. **Cognitive Domain** : These domains include those objectives which deal with recall or recognition of knowledge and the development of intellectual abilities and skill. It helps in curriculum development. In cognitive domain the taxonomy of educational objectives is organized under six major classes :

a) **Knowledge** : Knowledge includes those behaviours which include memorizing, recognitional phenomenon.. The knowledge include :

a) Real of specific and Isolated facts and information.

b) Dates, events, persons, places, sources of information

c) Terminology

d) Conventions

e) Process, directions and movement of phenomenon w.r.t. time.

f) Classification & Categories.

b) **Comprehension include** :

(1) Translation (2) Interpretation (3) Extrapolation

	Translation	**Interpretation**	**Extrapolation**
1.	From one level of abstraction to another.	Ability to interpret various types of the social data.	It include drawing conclusion & predication etc.
2.	From symbolic form to another form.		The ability to differentiate value judgement from predictions of

consequences.

3. From one verbal form
   to another

c) **Applications** : This can be illustrated by applying to comprehension of method following by the principles. It is said that student comprehens something that can apply it. Principles are followed that can apply to generalized ideas procedure to solve the problem.

d) **Analysis** : It means breakdown of material into constituent parts and the way they are organized. It includes :

   a) Analysis of elements

   b) Analysis of relationship

   c) Analysis of organizational principles.

e) **Synthesis** : It is putting together of all elements or parts as to form a whole. It includes :

   a) Production of unique communication

   b) Production of plan

   c) Derivation of a set of abstract relations.

f) **Evaluation** : It's aims at making judgement about the values, ideas, works, solution, method material etc. It involves the use of criteria as well as

standards for appraising the extent to which particulars are accurate, effective, economical etc.

2. **Affective Domain** : It includes objectives which deals with attitudes, values, interest and appreciation. The affective domain is divided into 5 major classes of objectives :

a) **Receiving** : It means to orient the learners to learn which is 1st step It includes awareness, willingness to receive, controlled or selected attention.

b) **Responding** : This class comes after the learner has given his attention. It includes :

   a) Compliance in responding

   b) Willingness to respond

   c) Satisfaction in response

c) **Valuing** : It includes acceptance of a value, preference for a value and commitment. It includes :

   1. Acceptance of a value

   2. Preference for a value

   3. Commitment.

d) **Organization** : When the learner develops certain values, he encounters situations for which more than one value is relevant. It includes :

   a) Conceptualization of a value

b) Organization of a value

e) **Characterising** : The individual starts acting constantly in accordance with the values he has developed. It includes :

a) Generalized set

b) Characterization of value

3. **Psychomotor domain** : Psychomotor domain is related to activity.

1. **Perception** : Ability to make preparatory adjustment.

2. **Initiation** : Ability to follow directions.

3. **Manipulation** : Ability to perform according to given instructions.

4. **Precision** : Ability to perform complex task.

5. **Articulation** : Ability to establish sequence and harmony or to perform with accuracy, speed and time.

6. **Naturalization** : To perform with smoothly, naturally, automatically or spontaneously.

Conclusion : The aims of teaching science, the basis of their formation should be child, society and subject matter. Apart from all these aims discussed, the most important function of science education should be the development of all dimensions of child's efficiency. This can be possible only if we shift our forms from acquisition of knowledge to development of scientific attitudes reflective thinking favourable or useful skills.

OBJECTIVES at UPPER PRIMARY STAGE

1. At the upper primary stage, the child should be engaged in learning the principles of science through familiar experiences, working with hands to design simple technological units and modules (e.g. designing and making a working model of a windmill to lift weights) 2. The students should continue to learn more about the environment and health, including reproductive and sexual health, through activities and surveys. 3. Scientific concepts are to be arrived at mainly from activities and experiments. Science content at this stage is not to be regarded as a diluted version of secondary school science. 4. Group activities, discussions with peers and teachers, surveys, organisation of data and their display through exhibitions, etc. in schools and the neighbourhood should be important components of pedagogy.

Objectives at Secondary stage

1. The students should be engaged in learning science as a composite discipline. 2. The students should be engaged in working with hands and tools to design more advanced technological modules than at the upper primary stage. 3. The students should be involved in activities and analysis on issues concerning the environment and health, including reproductive and sexual health. 4. The students should be engaged in systematic experimentation as a tool to discover/verify theoretical principles. 5. The students should work on locally significant projects involving science and technology.

OBJECTIVES at HIGHER SECONDARY STAGE

1. At the higher secondary stage, science should be introduced as separate disciplines, with emphasis on experiments/technology and problem solving. 2. The curriculum load should be rationalised to avoid the steep gradient between secondary and higher secondary syllabi. 3. The core topics of a discipline, taking into account recent advances in the field, should be identified carefully and treated with appropriate rigour and depth.

3. Formulation of specific objectives in behavioral terms (Magers approach and RCEM approach).

Unit-II

METHODS OF TEACHING SCIENCE- PROBLEM SOLVING METHOD

Problem Solving

In Hammonds Carsie's Words—

"Problem solving in teaching refers to the task of making decisions or doing things that learner wants to
make or to do, the nature of which he is able to understand but for which at the time he has no solution."

Problem-solving method was born as a result of litigation purposes. Problems related to the students
before the student presents his text and Students according to their interests and abilities is to look at
their solution. This method should be placed in clear terms the problem faced by students and their
learning should be based on experiences. With the help of the teacher student synthesis or analysis of
problems and solutions to be able to reach

The method includes the following steps—

(1) Selection of problem,

(2) Presentation of the problem,

(3) Aggregation of facts,

(4) Hypotheses,

(5) reach on conclusions,

(6) Assessment,

(7) Drafting work.

Characteristics

(1) Students learn to solve problems automatically.

(2) They develop observation and reasoning.

(3) They are able to generalize.

(4) The integration of data, assessment and conclusions are familiar with the procedures.

(5) Learn to use the old facts in a new context.

(6) Would infuse a spirit of working together.

(7) This is motivational method.

(8) It is based on "Learning by doing"

Demerits

(1) Is a waste of time and energy.

(2) In this method, confusion could be the wrong conclusion.

(3) This method requires the use of qualifi ed teachers.

(4) This method is not useful in small classes.

Which method for teaching a particular subject should be selected and will be more useful approach to teaching which, on the subject of the next chapter highlights.

Write down fi ve characteristics of problem solving method.

LECTURE CUM DEMONSTRATION METHOD,

Introduction : This method is also called as **Demonstration method.** The main drawback with the lecture method is that it is one sided process. The teacher talks too much and the students are totally neglected. The best method is that which involves a kind of ebb and flow b/w the teacher and taught, where the teacher and the children are really part of an educative process. It is in an atmosphere of this kind that children develop in the best way. The demonstration method takes stock of this fact and thus while in a lecture method the teacher merely talks.

Meaning : Demonstration means 'to show'. In the lecture method teacher just tells but in the demonstration method he also shows and illustrates certain fundamental phenomena and the various applications of abstract principles through a series of experiments. This method is also in accordance with the maxims of teaching **"from concrete to Abstract."** The students see the actual apparatus and experiment and thereby they feel interested in learning.

Characteristics of Good Demonstration :

1. **Visibility** : A demonstration should be visible in most of its significant details to all the students of the class.

2. **One major idea at a time** : Only one major idea at a time should be taken so that students become aware of the objectives of demonstration.

3. **Clear Cut** : The demonstration should be clear cut, for this, the teacher should be clear of the purpose of demonstration. He should know the aims of demonstration before hand.

4. **Convincing** : It should be convincing so that students get a training in scientific method of solving problem.

5. **Rehearsal** : It is necessary before demonstration so that teacher becomes well versed in handling the apparatus.

6. **Supplemented with other teaching aids** : Demonstration should be supplemented with other teaching aids like charts, models etc. to make it more interesting.

7. **Asking relevant questions** : The teacher should ask suitable and relevant reflective type questions. It also helps to keep the students alert.

8. **Neat, Clean & Tidiness** : The teacher should see the general order, neatness, cleanliness and tidiness of the demonstration table. The table should be occupied by the apparatus and materials relevant to the lesson. It is always better to keep the used apparatus right hand side and the apparatus to be used on left hand side.

9. **Sequence of Experiments** : The teacher should carry out the experiments in such a way that the students should learn how to carry it out by themselves.

10. **Simple & Speedy** : Demonstration should be simple and speedy.

11. **Acc. to time and season** : While planning and performing the demonstration, it should be kept in mind that the demonstration should be in

accordance with the time and season otherwise it will prove to a failure and wastage of time.

12. **To Write Observation** : The students should be asked to draw diagrams and to write, what they observe.

13. **Black Board** : The blackboard behind the demonstration table helps the teacher to summarise the principles and concepts related and also the student to note it down.

14. **Sufficient time** : For recording data, the students should be give sufficient time.

15. **Apparatus** : The apparatus used for demonstration should be larger in size.

16. **Teacher to act as performer** : For maintaining the interest of the students sometimes the teacher act as a performer, showman or actor.

17. **Spare parts for the apparatus** : Reserve or spare parts for the apparatus should be there on the table.

Common Errors in a Demonstration lessons :

1. The demonstration may not to be visible to all.
2. The set up of apparatus may not be at a good height.
3. The lighting and ventilation may not be adequate.
4. The speed of demonstration may not be accurate, either too fast or too slow.
5. The apparatus may not be ready to use.

6. Students are not involved.

7. The purpose of demonstration may not be clear.

8. The teacher may arrive at the generalization himself without getting it done by the students.

9. The students may not be given sufficient time.

10. The apparatus may not be arranged in proper order and the teacher may flounder while performing the experiment.

Conduct of Lecture-cum-Demonstration

1. **Planning & Preparation** : While planning a demonstration the following points should be kept in a mind.

a) **Subject matter** : The subject matter should be thoroughly prepared. If the teacher knows it, even then he should go through the subject matter.

b) **Lesson Planning** : The teacher should plan how to introduce the lesson, the way to present it, types of questions to be asked in experimentation and recapitulation.

c) **Rehearsal of experiment** : The demonstration should be rehearsal well in advance as it provides confidence to the teacher too. In this way, his lesson will go on smoothly and systematically.

d) **Collection and arrangement of apparatus** : The apparatus and chemicals should be properly arranged on the demonstration table. Only such materials should be pro kept on the table as are required for

2. **Introduction of Lesson** : The lesson may be introduced on the following basis :

a) Student's personal experience or incident.

b) Student's environment

c) Telling story

d) A simple and interesting experiment.

3. **Presentation of the subject matter** :

a) The teacher must study the subject matter on broad basis taking into consideration the interest and experience of students.

b) While demonstration is going on, questions should also be asked which helps the students to understand the underlying principles.

c) The teacher should try to illustrate the facts and principles. the experiment in progress. b/z too many things at a time divert the attention of students.

d) Language used by teacher should be simple and clear.

4. **Experimentation**

a) Demonstration should be properly spaced and striking, clear and convincing.

b) The demonstration table should have only apparatus related to the lesson.

c) The experiment should be simple and speedy.

d) All the apparatus should not be displayed at once.

e) Reserve or spare apparatus can be kept for emergency.

5. **Black board work** : A big black board behind the demonstration table is necessary in order to summarise the principles and other matters of demonstration and also to draw necessary diagrams and sketches.

Advantages

1. **Economical** : This method is economical as it helps in economizing resources. Some equipments are too expensive for general use and thus demonstrating the experiment to the whole class becomes an economical exercise.

2. **Psychological Method** : Demonstration method is psychological as the students are shown concrete things. They have not to enter into false imagination.

3. **Student participation** : This is one of the best techniques to get participation of students.

4. **Save time & effort** : This method saves teacher's time and effort as it is easier to perform one experiment than to supervise 45 experiments.

5. **Helpful to promote useful discussion** : This method can help to promote relevant and useful discussion in the classroom and also provides opportunity to question and to review.

6. **More efficient method** : Discussion method is more efficient than laboratory method as a teacher is more competent to handle apparatus than students.

7. **Activity Centred** : By this methods students are kept busy in various activities like observing, taking notes, answering questions, drawing diagrams etc.

8. **Useful for all types of students** : This method is suitable for all types of students i.e. from average to above average.

9. **Helpful for teacher** : This method is useful and helpful for teacher also he can be in position to explain each and every step and to ensure that all the students see and interpret all the work in uniform manner.

Disadvantages

1. **Ignore maxim of education** : The maxim of education "Learning by Doing" and the principle of psychology of learning has no place in this method. The students don't get chance to perform experiment themselves.

2. **Visibility** : It is main problem for a teacher b/z all the students may not be able to see the details and results of a demonstration.

3. **Speed of Experiment** : Either too fast or too slow speed of demonstration some times may create trouble in understanding what is going on.

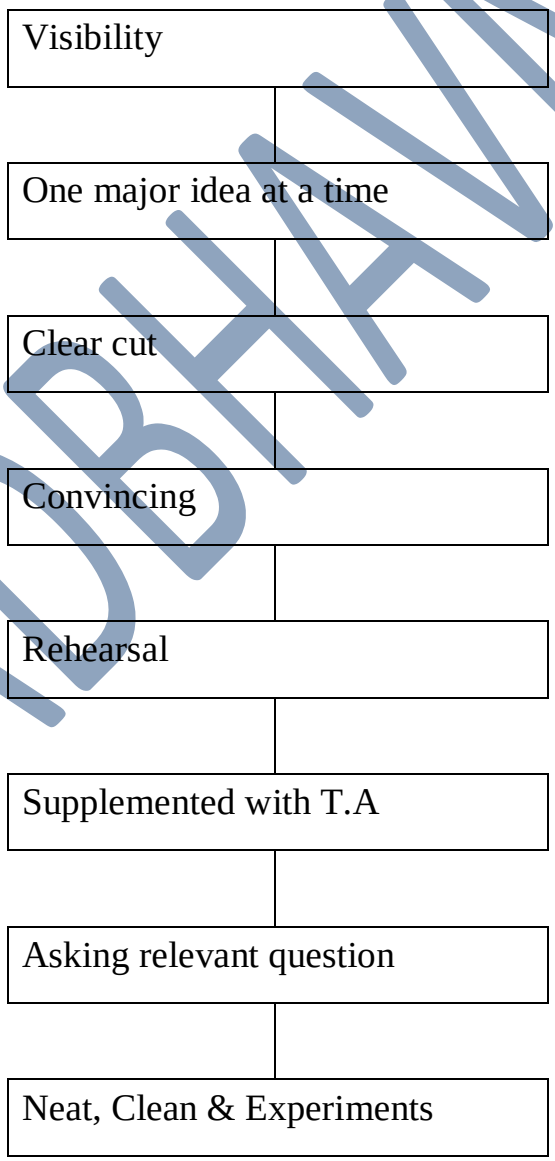
4. **Ignore individual difference** : This method totally ignores the main principle of psychology 'there is always individual difference' slow learners and genius are made to sail in the same boat.

5. **Hinder progress** : This method some how hinder the development of laboratory skills among the students.

6. **Not useful for developing scientific attitude** : This method does n't help the students for inculcation of scientific attitude.

7. **Problem of indiscipline** : Some time students may get into mischief, thereby creating a problem of indiscipline.

Diagram showing the Characteristics of Lecture-cum-demonstration Method :



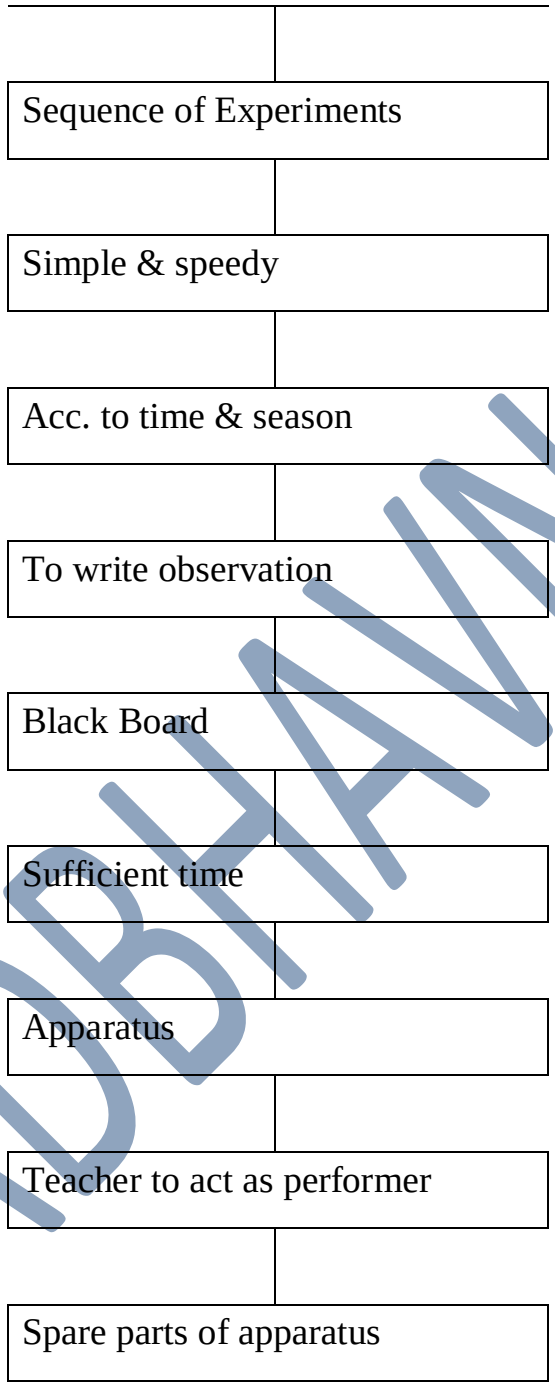
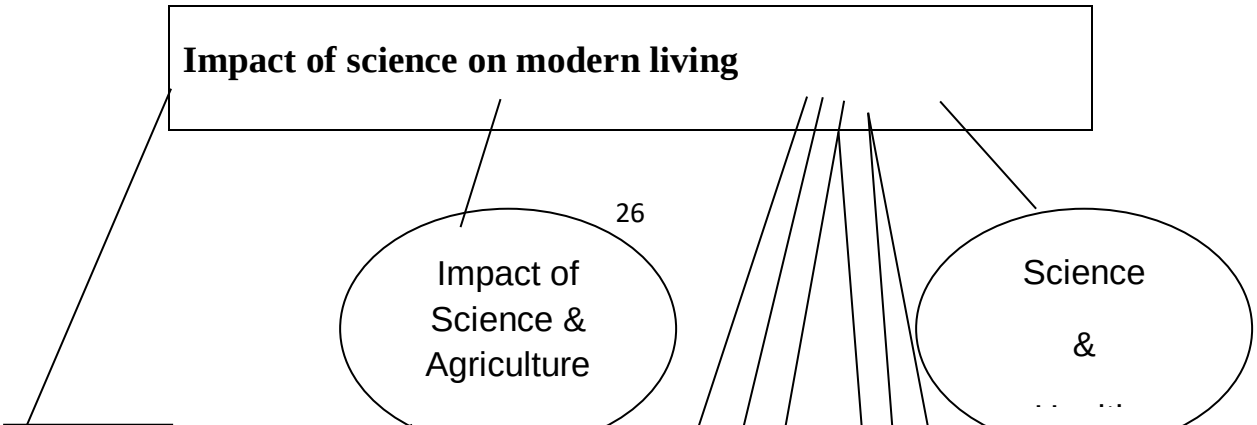
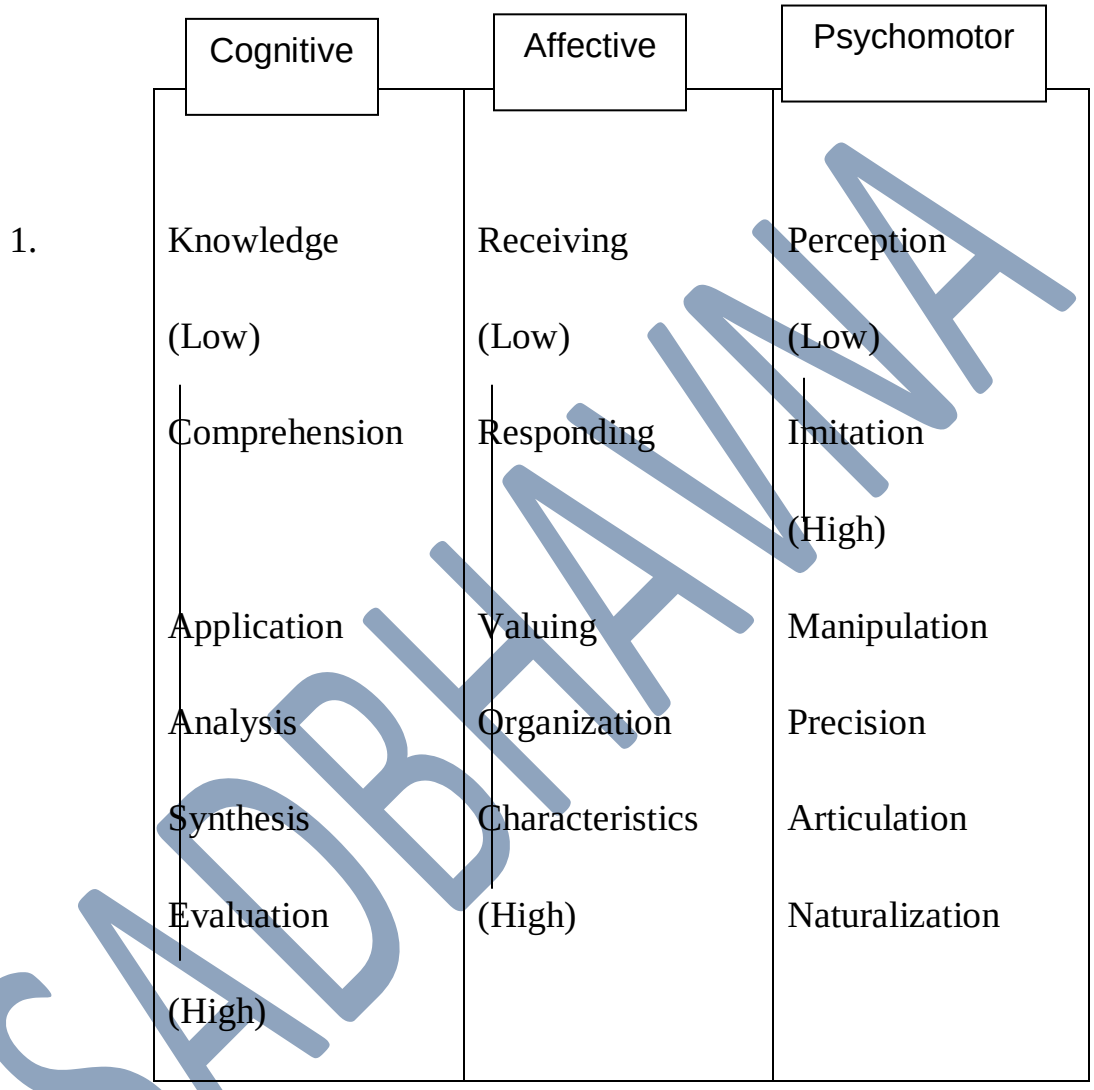


Diagram showing Impact of Science on modern living



3. **Table showing educational objectives in the three Domains : Blooms's Taxonomy**



	Cognitive	Affective	Psychomotor
1.	Knowledge	Receiving	Perception
	(Low)	(Low)	(Low)
	Comprehension	Responding	Imitation
			(High)
	Application	Valuing	Manipulation
	Analysis	Organization	Precision
	Synthesis	Characteristics	Articulation
	Evaluation	(High)	Naturalization
	(High)		

PROJECT METHOD,

Project Method : Based on the philosophy of pragmatism and to lesson the gap between school life and the life in society, project method was devised by Kilpatrick & it was perfected by Stevenson with the objective of bringing life into school.

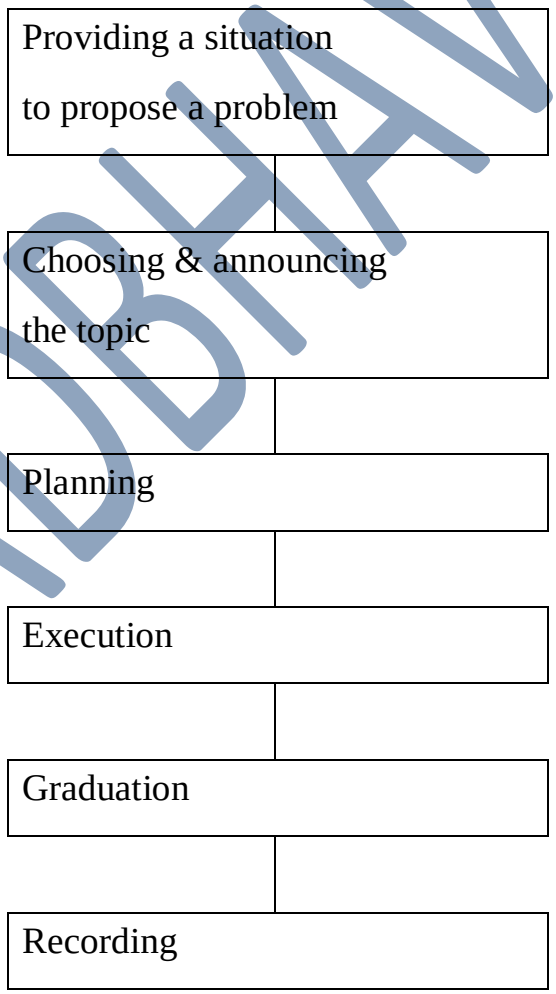
Definitions :

1. **Ballard** : "A project is a bit of real life that has been imparted into school."

Stevenson : "A Project is a problematic act carried to completion in its natural setting."

Dig. Shows

Steps involved in the Project Method



Role of the teacher :

a) **Well informed** : The teacher has to be well informed. He should himself collect articles, reports, illustrations, charts, specimens, to keep his interest alive.

b) **Helping** : He should help students in selecting projects acc. to their ability, interest and age level.

c) **Encouraging & inspiring** : He should be encouraging and inspiring.

d) **Alert** : He should be alert enough to check whether the project is running along right lines.

e) **Suggestive :** He should suggest books for references, place to visit, people to ask and so on.

f) **Training in scientific method** : He should help to develop a scientific attitude in the students and give training in scientific method.

g) **Accessible** : He should be accessible to the students.

h) **Guide & friend** : He should act as a guide, a friend and a working partner.

i) **Provide democratic atmosphere** : He should provide democratic atmosphere in the class.

Advantages:

1. **Based on laws** : This method is based upon laws of learning law of readiness, law of exercise, law of effect.

2. **Critical thinking** : This method helps in developing critical thinking.

3. **Correlation** : By this method correlation of various subject is achieved and knowledge is obtained.

4. **Freedom of work** : In this method, student can work at their own speed, they plan and execute the project.

5. **Problem solving** : This method stresses on problem solving approach and hence scientific attitude is developed.

6. **Dignity of labour** : This method upholds the dignity of labour.

7. **Social relationships** : This method promotes social interaction and co-operation amongst the students.

8. **Challenges** : It sets up a challenge to solve a problem and in the face of real life difficulties.

9. **Interest** : It develops interest in science hobbies in the right use of leisure time later on.

10. **Educational value** : It provides maximum educational value as educational content is emphasized.

Disadvantages :

1. **Teacher** : This method heavy demands on the teacher. The teacher required for this method should be exceptionally gifted, knowledgeable and alert.

2. **Time** : This method is time consuming. The syllabus cann't be completed on time by this method.

3. **Text books** : Instructional materials and text books written on these lines are not easily available.

4. **Superfacial knowledge** : This method gives a superfacial knowledge of the subject.

5. **Expensive** : This method is expensive. The cost of education goes up as more expenditure will have to be incurred on well equipped library.

6. **Work load** : In this method, the work load on teacher is increased a lot.

HEURISTIC METHOD.

Heuristic

Students learn by looking at the policy itself. The teacher's task is only a guide. Mistakes help improve

the proper time. Student - such as work and are using it - it leads to knowledge they are innovative.

Creator of this policy was **Prof. Armstrong**. According to his belief "Process of learning any subject

sensual exploration and students themselves must fi nd facts and principles."

Student can perform as an exploration of the policy. In the beginning the student does not use the

information. To fi nd the desired information itself and a number of principles that are required to use,

as well as to study the available literature.

Characteristics

(1) Students develop the scientifi c method and spirit.

(2) This method has been faithful and true to the students near delivers

(3) The student has acute observation and reasoning power is activated.

(4) Work is to develop the ability and interest.

(5) Students' activity, confi dence and independence increases.

(6) This method prepares students for life.

(7) This knowledge is more stable.

(8) Increases in students thinking and perception.

(9) Because the work is completed in class does not require homework.

(10) This is psychological method.

Demerits

(1) Being slow to teaching full time course can not be taught in precribed time limit.

(2) Student experiences diffi culty in reaching conclusions.

(3) The teacher has to make special preparations to use this method.

(4) This method is not suitable in small classes.

(5) This method needs good laboratory and good library.

(6) More money is spent.

(7) This method is hard to teach large groups.

(8) It is not useful for weak students.

(9) The entire course can not be taught.

Suggestions

(1) As a method of investigation must be genuine.

(2) Over the course of only a few selected text to go to teach this method.

(3) Teachers must fully conscious and aware of their responsibilities.

APPROACHES OF TEACHING SCIENCE: INDUCTIVE AND DEDUCTIVE APPROACH.

INDUCTIVE METHODS:

It leads from concrete to abstract, particular to general and from examples to formula. It is the method of constructing a formula with the help of a sufficient number of concrete examples**.** It is based on induction which means proving a universal truth by showing that if it is true for a particular case and is further true for a reasonably adequate number of cases, it is true for all such cases. A formula or generalisation is thus arrived at through a convincing process of reasoning and solving of problems. After a number of concrete cases have been understood, the student successfully attempts the generalisation.

Deductive Method:

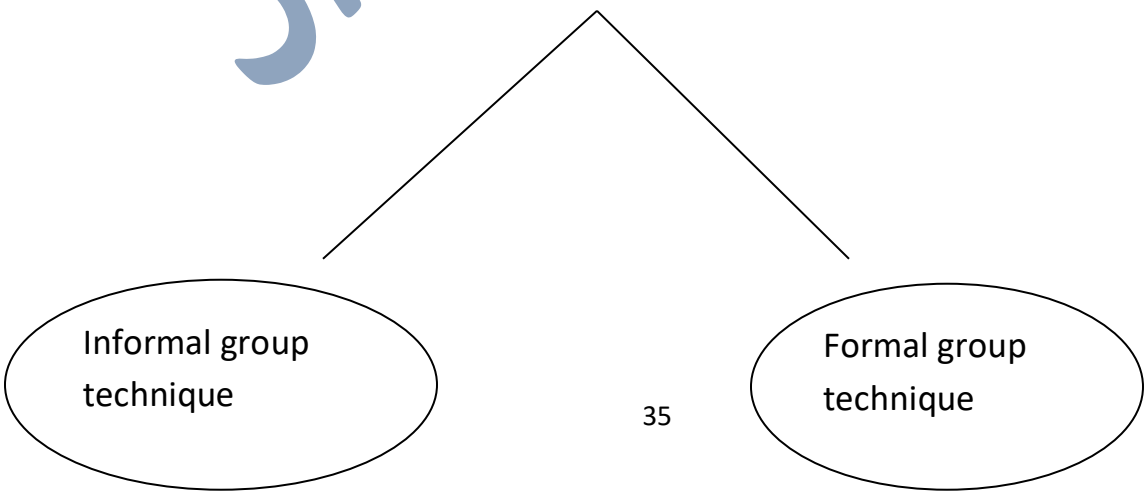
It is the opposite of Inductive Method. Here the learner proceeds from general o particular, abstract to concrete, and formula to examples. A pre constructed formula is told to the students and they are asked to solve the relevant problems with the help of that formula. The formula is accepted by the learners as a pre-established and well-established truth.

COOPERATIVE LEARNING,

Cooperative Learning approach is a sort of group learning task in which the whole class or a group of it takes part. It can take various forms like a seminar, a debate, a panel discussion, a symposium, a brain trust or a workshop.

According to yoakam and simpson: "in Cooperative Learning approach students/children are discussing, questioning, reporting, planning working in natural ways. The teacher is a guide, counselor, advisor, contribution and director in the best sense of the world, trying to get children discover things for themselves rather than to have them merely listening to them."

Forms of Cooperative Learning approach



1. **Informal group technique**: In it, students and teacher discussed about their experiences and problems. Any member of a group can start discussion any member can ask question and explanation and demand for clarification.
2. **Formal group technique**: A formal committee is organized to discussion. Every student get opportunity to lead others.

    - **Seminar:** The seminar is an advanced level of socialized technique useful for seminar students. Teacher is leader of the seminar. He control the discussion seminar is an organized process. Every member participate in it and give their views.
    - **Debate:** A debate is a programme in which two or more students holding contradictory opinions on a particular problem present argument.
    - **Symposium:** We think of a symposium as a group of comments. Either spoken or written, which portrays contrasting or at least different points of view.
    - **Panel Discussion:** Panel discussion is a discussion among a selected group of four to six persons, a large enough for variety and a small enough for purposeful deliberations.
    - **Brain storming:** In brain storming the brains of the students are stimulated to create a storm of ideas and deliberation to find whether or not they are meaningful and purposeful.

- **Workshop:** Workshop is the latest form of socialized recitation technique. It is different from a seminar as it emphasizes practical work more than theoretical discussion. The group is devided into some sub group to complete the activity.
- **The workshop is guided by some expert called resource persons or consultant.** They give their expert advice to the interested group or the whole group. They also deliver lecture or give demonstration.
- **Conference:** In conference discussion is on higher level. The member of the conference speaks on the different theme. It is different from seminar. In seminar there is one theme. And they discuss their themes on higher level and at last in common session. They present conclusion of their themes.
- **INQUIRY BASED APPROACH**
- **What is inquiry-based learning?**
- An old adage states: "Tell me and I forget, show me and I remember, involve me and I understand." The last part of this statement is the essence of inquiry-based learning, says our workshop author **Joe Exline** [1]. Inquiry implies involvement that leads to understanding. Furthermore, involvement in learning implies possessing skills and attitudes that permit you to seek resolutions to questions and issues while you construct new knowledge.
- **1.**

- "Inquiry" is defined as "a seeking for truth, information, or knowledge -- seeking information by questioning." Individuals carry on the process of inquiry from the time they are born until they die. This is true even though they might not reflect upon the process. Infants begin to make sense of the world by inquiring. From birth, babies observe faces that come near, they grasp objects, they put things in their mouths, and they turn toward voices. The process of inquiring begins with gathering information and data through applying the human senses -- seeing, hearing, touching, tasting, and smelling.

Part 1 of 2

Part 2 of 2

- **A Context for Inquiry**
- Unfortunately, our traditional educational system has worked in a way that discourages the natural process of inquiry. Students become less prone to ask questions as they move through the grade levels. In traditional schools, students learn not to ask too many questions, instead to listen and repeat the expected answers.

Some of the discouragement of our natural inquiry process may come from a lack of understanding about the deeper nature of inquiry-based learning. There is even a tendency to view it as "fluff" learning. Effective inquiry is more than just asking questions. A complex process is involved when individuals attempt to convert information and data into useful knowledge. Useful application of inquiry learning

involves several factors: a context for questions, a framework for questions, a focus for questions, and different levels of questions. Well-designed inquiry learning produces knowledge formation that can be widely applied.

-
- **Importance of Inquiry**
- Memorizing facts and information is not the most important skill in today's world. Facts change, and information is readily available -- what's needed is an understanding of how to get and make sense of the mass of data.
- Educators must understand that schools need to go beyond data and information accumulation and move toward the generation of useful and applicable knowledge . . . a process supported by inquiry learning. In the past, our country's success depended on our supply of natural resources. Today, it depends upon a workforce that "works smarter."
- Through the process of inquiry, individuals construct much of their understanding of the natural and human-designed worlds. Inquiry implies a "need or want to know" premise. Inquiry is not so much seeking the right answer -- because often there is none -- but rather seeking appropriate resolutions to questions and issues. For educators, inquiry implies emphasis on the development of inquiry skills and the nurturing of inquiring attitudes or habits of mind that will enable individuals to continue the quest for knowledge throughout life.
- Content of disciplines is very important, but as a means to an end, not as an end in itself. The knowledge base for disciplines is constantly expanding and changing. No one can ever learn everything, but

everyone can better develop their skills and nurture the inquiring attitudes necessary to continue the generation and examination of knowledge throughout their lives. For modern education, the skills and the ability to continue learning should be the most important outcomes. The rationale for why this is necessary is explained in the following diagrams.

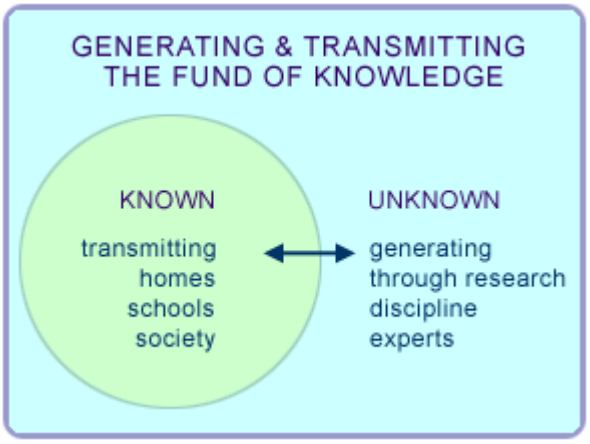


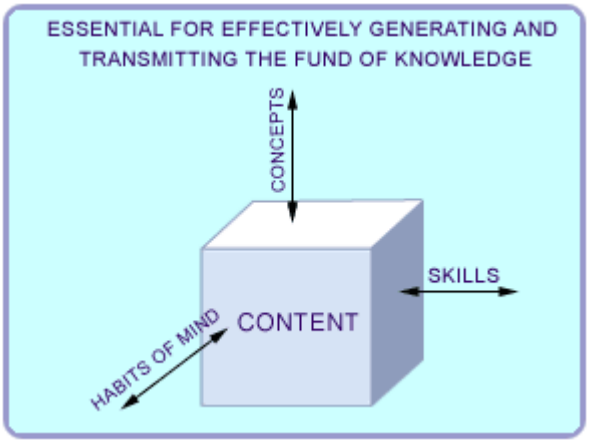
Illustration developed by Joe Exline

This figure illustrates how human society and individuals within society constantly generate and transmit the **fund of knowledge** [2].

- **2.**
- Human society and individuals within society constantly generate and transmit this fund of knowledge. Experts, working at the boundary

between the known and the unknown, constantly add to the fund of knowledge.

- It is very important that knowledge be transmitted to all the members of society. This transmission takes place through structures like schools, families, and training courses.
- Certain attributes are necessary for both generating and effectively transmitting the fund of knowledge. The attributes that experts use to generate new knowledge are very similar to the qualities essential for the effective transmission of knowledge within the learners' environment. These are the essential elements of effective inquiry learning:

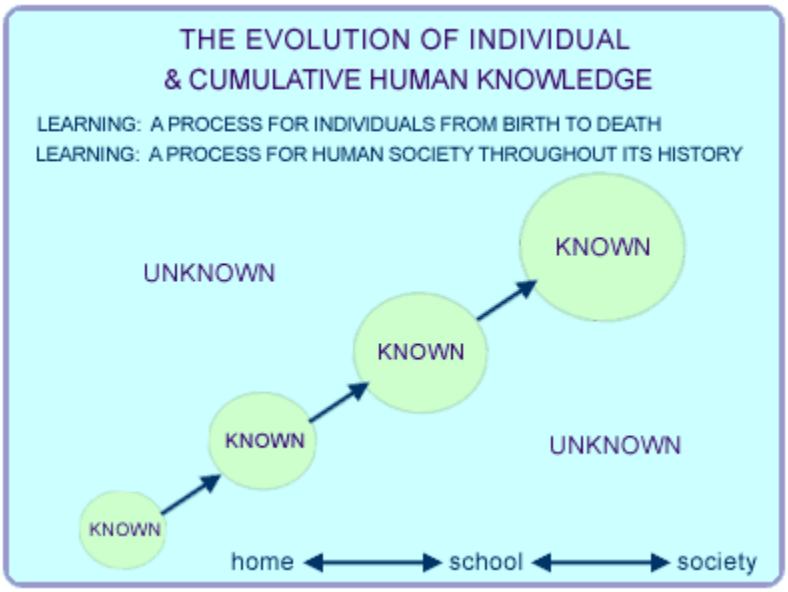


This figure illustrates the attributes necessary for both generating and effectively transmitting the fund of knowledge.

- We propose that the attributes experts use to generate new knowledge are very similar to the attributes essential for the effective

transmission of knowledge within the learner's environment -- the essentials of effective inquiry learning.

Inquiry is important in the generation and transmission of knowledge. It is also an essential for education, because the fund of knowledge is constantly increasing. The figure below illustrates why trying to transmit "what we know," even if it were possible, is counterproductive in the long run. This is why schools must change from a focus on "what we know" to an emphasis on "how we come to know."



This chart illustrates that while knowledge is constantly increasing, so is the boundary of the unknown.

- An effective and well-rounded education gives individuals very different but interrelated views of the world. All disciplines have important relationships that provide a natural and effective framework for the organization of the school curriculum, as shown in the chart below. The subject matter of disciplines can be set in the larger context of a **conceptual framework** [3]. This framework is crucial for understanding change and also for the organization of the discipline and its application to the natural and human-designed worlds.
- **3.**

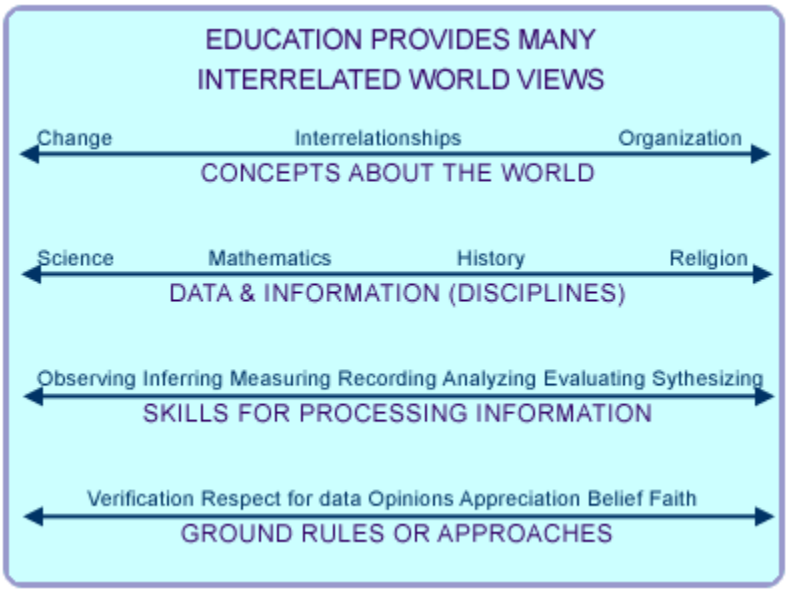


Illustration developed by Joe Exline

This chart illustrates that skills for processing information are similar across all disciplines.

- **The habits of mind** [4], values, or "ground rules" of a particular discipline provide that discipline's unique perspective. The sciences,

for example, demand verification of data, while the study of literature often relies on opinions and subjective interpretations as a source of information. Habits of mind vary in their rigidity across disciplines. This doesn't mean that one is right and the other is wrong, but simply that the "ground rules" are different.

- **4.**
- **The Application of Inquiry**
- While much thought and research has been spent on the role of inquiry in science education, inquiry learning can be applied to all disciplines. Individuals need many perspectives for viewing the world. Such views could include artistic, scientific, historic, economic, and other perspectives. While disciplines should interrelate, inquiry learning includes the application of certain specific "ground rules" that insure the integrity of the various disciplines and their world views.
- **Outcomes of Inquiry**
- An important outcome of inquiry should be useful knowledge about the natural and human-designed worlds. How are these worlds **organized**? How do they **change**? How do they **interrelate**? And how do we **communicate** about, within, and across these worlds? These broad concepts contain important issues and questions that individuals will face throughout their lives. Also, these concepts can help organize the content of the school curriculum to provide a relevant and cumulative framework for effective learning. An appropriate education should provide individuals with different ways of viewing the world, communicating about it, and successfully coping with the questions and issues of daily living.

- While questioning and searching for answers are extremely important parts of inquiry, effectively generating knowledge from this questioning and searching is greatly aided by a conceptual context for learning. Just as students should not be focused only on content as the ultimate outcome of learning, neither should they be asking questions and searching for answers about minutiae. Well-designed inquiry-learning activities and interactions should be set in a conceptual context so as to help students accumulate knowledge as they progress from grade to grade. Inquiry in education should be about a greater understanding of the world in which they live, learn, communicate, and work.

ROLE OF TEACHER IN INQUIRY

The teacher reflects on the purpose and makes plans for inquiry learning.

- He plans ways for each learner to be actively engaged in the learning process.
- She understands the necessary skills, knowledge, and habits of mind needed for inquiry learning.
- He understands and plans ways to encourage and enable the learner to take increasing responsibility for his learning.
- She insures that classroom learning is focused on relevant and applicable outcomes.
- He is prepared for unexpected questions or suggestions

from the learner.

- She prepares the classroom environment with the necessary learning tools, materials, and resources for active involvement of the learner.

The teacher facilitates classroom learning.

- The teacher's daily, weekly, monthly, and yearly facilitation plans focus on setting content learning in a conceptual framework. They also stress skill development and model and nurture the development of habits of mind.
- She accepts that teaching is also a learning process.
- He asks questions, encouraging divergent thinking that leads to more questions.
- She values and encourages responses and, when these responses convey misconceptions, effectively explores the causes and appropriately guides the learner.
- He is constantly alert to learning obstacles and guides learners when necessary.
- She asks many Why? How do you know? and What is the evidence? type of questions.
- He makes student assessment an ongoing part of the facilitation of the learning process.

What are the benefits of inquiry-based learning?

One of the important missing pieces in many modern schools is a coherent and simplified process for increasing knowledge of a subject from lower grades to upper grades. Students often have difficulty understanding how various activities within a particular subject relate to each other. Much more confusion results when the learner tries to interrelate the various subjects taught at school.

Part 1 of 2 **Part 2 of 2**

Too little effort is devoted to defining important outcomes at the end of high school and planning backwards and across subjects. Inquiry-based learning can help make these connections.

Specific content such as photosynthesis has much more relevance for the learner if set in a larger context of understanding the **interrelationship** of the sun, green plants, and the role of carbon dioxide and water. Social studies content, such as industrial development, set in the context of **interrelating changes** in the human-designed world can add new perspectives to this important natural process. Students can still learn content of both science and social studies, but through a series of well-planned experiences, they will grasp the larger conceptual context and gain greater understanding.

Within a conceptual framework, inquiry learning and active learner involvement can lead to important outcomes in the classroom. Students who actively make

observations, collect, analyze, and synthesize information, and draw conclusions are developing useful problem-solving skills. These skills can be applied to future "need to know" situations that students will encounter both at school and at work.

Another benefit that inquiry-based learning offers is the development of habits of mind that can last a lifetime and guide learning and creative thinking.

SCIENTIFIC ATTITUDE AND ITS DEVELOPMENT.

1.**Acco. to NSSE** : "Scientific attitudes can be defined as open mindness, a desire for accurate knowledge, confidence in procedure for seeking knowledge and expectation that the solution of the problems will come through the use of verified knowledge."

2. **Views of NCERT** : The National Council of Education Research and Training conducted a workshop at Chandigarh and evolved the following specific behaviour of a pupil who has developed scientific attitudes.

The pupil :

1. Is clear and precise in this statements and activities.
2. Bases his judgement on verified facts.
3. Is willing to consider new ideas and discoveries.

4. React favourably to efforts made to use science towards human welfare.

5. Is prepared to reconsider his own judgement.

6. Arranges the apparatus, material etc. in their proper places at the end of work.

7. Suspends judgement in the absence of sufficient data.

8. Is free from superstition.

9. Is objective in the approach.

10. Is honest and truthful in recording and collecting scientific data.

3. **Pulp B – Dlederich** :

1. Scepticism

2. Faith in the possibility of solving problem.

3. Desire for experimental verification.

4. Precision

5. A liking for new things

6. Willingness to change opinion

7. Humility

8. Loyalty to truth

9. Aversion to superstition

10. An objective attitude

11. Linking for scientific explanation

12. Desire for completeness of knowledge.

13. Suspended judgement.

14. Awareness of assumptions

15. Distinction b/w hypothesis and solution

16. Judgement of what is fundamental and of great significance

17. Respect for theoretical statement

18. Respect for qualification

19. Acceptance of probabilities

20. Acceptance of warranted generalization

Techniques for developing scientific attitudes

As discuss, there is no clear cut definition of scientific attitudes. Scientific attitudes are certain mind-sets in a particular direction. The following suggestions for planning learning experiences to inculcate scientific attitudes.

1. Increase the degree of consistency of the environment.

2. Increase the opportunities for making satisfying adjustments to attitude situations.

3. Provide opportunities for the analysis of problem or situation so that a pupil may understand and then reset intellectually in the desirable attitudes.

Diagram

Techniques developing Scientific attitudes

1.	Use of Wide Reading
2.	Use of Planned Exercise
3.	Removal of Superstitions
4.	Co-curricular activities
5.	Advanced Teaching Method
6.	Proper use of laboratory period
7.	Class Room Atmosphere
8.	Preparing Science Room
9.	The personal example of the teacher

1. **Use of Wide Reading** : According to the study made by curtis, the pupil who engage themselves in wide reading in science, develop scientific attitudes more than those who study only one text book. A teacher should

inculcate love for reading among students. The students should be encouraged to read library books and supplementary books on science.

Ex : Reading news paper, Encyclopedia, Magazine related to Science, see discovery channels.

2. **Use of planned exercise** : Some magazines devoted to science provide exercises for developing certain attitudes. Proper use of such exercise should be made quite frequently. Good text books contain exercises at the end of each chapter which developed fulfill the aim of scientific attitudes.

   Ex : Cutting from news papers can also be used for this purpose, certain pictures and cutting may be displayed on the bulletin board and used again and again for direct teaching.

3. **Removal of Superstitions** : To develop scientific outlook of the students, it is necessary to remove the existing superstitions amongst the students. While teaching science lessons, teacher can encourage the students to practically investigate some common superstitions and come to their own conclusions by actual survey and study.

   Ex : If a cat crosses the path, one should not turn black and find a new road, see empty basket, broker mirror in the home.

4. **Co-curricular activities in science** : Teaching of the subject can n't be limited to its subject matter. The teacher should encourage the students to participate in specialized activities. The requires the inclusion of co-curricular activities.

Ex : Science club, science hobbies, science fair, science exhibition, educational trip, eco-club, science conferences.

5. **Advanced Teaching Method** : The teacher should use effective and impressive methods of teaching science. The teacher should adopt those methods which give the students an understanding of the basic concepts, promote interest in science and also acquire laboratory skills.

   Ex : Through PPT, group discussion, science quiz, teaching aids etc.

6. **Proper use of laboratory period** : Laboratory work involves students in hand on activities that help them participate in scientific investigation and to verify for themselves scientific laws, principles and concept, so the science teacher should carefully plan and organize the laboratory activities.

   Ex : Give the precautions for the students by teacher. Proper discussion with student before the starting experiment etc.

7. **Class Room Atmosphere** : If the internally setting of the class is properly arranged and the room is decorated in a manner which contributes to the development of proper atmosphere secondly the role of the teacher is also very imp. to develop desirable atmosphere in a class. The attitude of the teacher will not help to develop proper atmosphere in a class.

   Ex : Proper data collection, friendly behaviour with the student etc.

8. **Preparing science room** : The environment in science room should be stimulating and interesting where science staff and students can work with initiative towards appropriate goals. The science room must be decorated in proper way. The laboratory apparatus should be arranged in systematic way.

Ex : Class room decorated with science charts and models etc.

9. **The personal example of the teacher** : Perhaps the greatest force for the inculcation of scientific attitudes is the personal examples of the teacher. The teacher must be open minded, critical in thought and action in his day to day dealings.

Conclusion : So we can say, the scientific attitudes can be open mindness a desire for accurate knowledge. Scientific attitude is the clear and precise in his statements and activities. They are bases his judgement on verified facts. A teacher should inculcate love for reading among students. Laboratory work involves students in hands on activities that help them participate in scientific investigation.

UNIT- III: INSTRUCTIONAL MATERIAL AND AIDS

a) Instructional resources in Science: Meaning, importance, classification,

Science is an inspiring process of discovery that helps satisfy the natural curiosity with which we are all born. Unfortunately, traditional instruction that misrepresents science as a body of facts to be memorized and the process of science as a rigid 5-step procedure can deaden students' spirit of inquiry.

Students should come away from our classrooms with an appreciation of the natural world — fascinated by its intricacies and excited to learn more. They should view and value science as a multi-faceted, flexible process for better understanding that world. Such views encourage life-long learning and foster critical thinking about everyday problems students face in their lives. You can

cultivate these ways of thinking in your students through science instruction that accurately and enthusiastically communicates the true nature of science and that encourages students to question how we know what we know.

Fortunately, fostering such understandings needn't require reorganizing your entire curriculum. Simple shifts in how content and activities are approached can make a big difference in overcoming student misconceptions and building more accurate views of the process of science. Educational research supports the following strategies for teaching about the scientific endeavor:

- **Make it explicit:** Key concepts regarding the nature and process of science should be explicitly and independently emphasized. Engaging in inquiry and studying the history of science are most helpful when the nature-of-science concepts they exemplify are explicitly drawn out in discussion and interactions.
- **Help them reflect:** Throughout instruction, students should be encouraged to examine, test, and revise their ideas about what science is and how it works.
- **Give it context, again and again:** Key concepts about the nature and process of science should be revisited in multiple contexts throughout the school year, allowing students to see how they apply to real-world situations.

A. INSTRUCTIONAL RESOURCES

- School-based Instructional Resources
  a. Displays and exhibits of collections; Flower garden
  b. Mini-library, canteen, museum, fish ponds
- Community Resources
  a. City/Town museum, reading center, parks, plaza
  b. Art gallery, hospital, zoo, gym
- Nature Trips
  a. Hill, mountain, mining area, green fields, river
  b. Valley, forest, orchidarium
- Human Resources
  a. Mayor, barangay captain, civic leader
  b. Businessmen, agriculturist, teachers, historian

B. LEARNING EXPERIENCES PROVIDED BY INSTRUCTIONAL RESOURCES AND USEFUL MATERIAL THAT CAN BE STUDIED

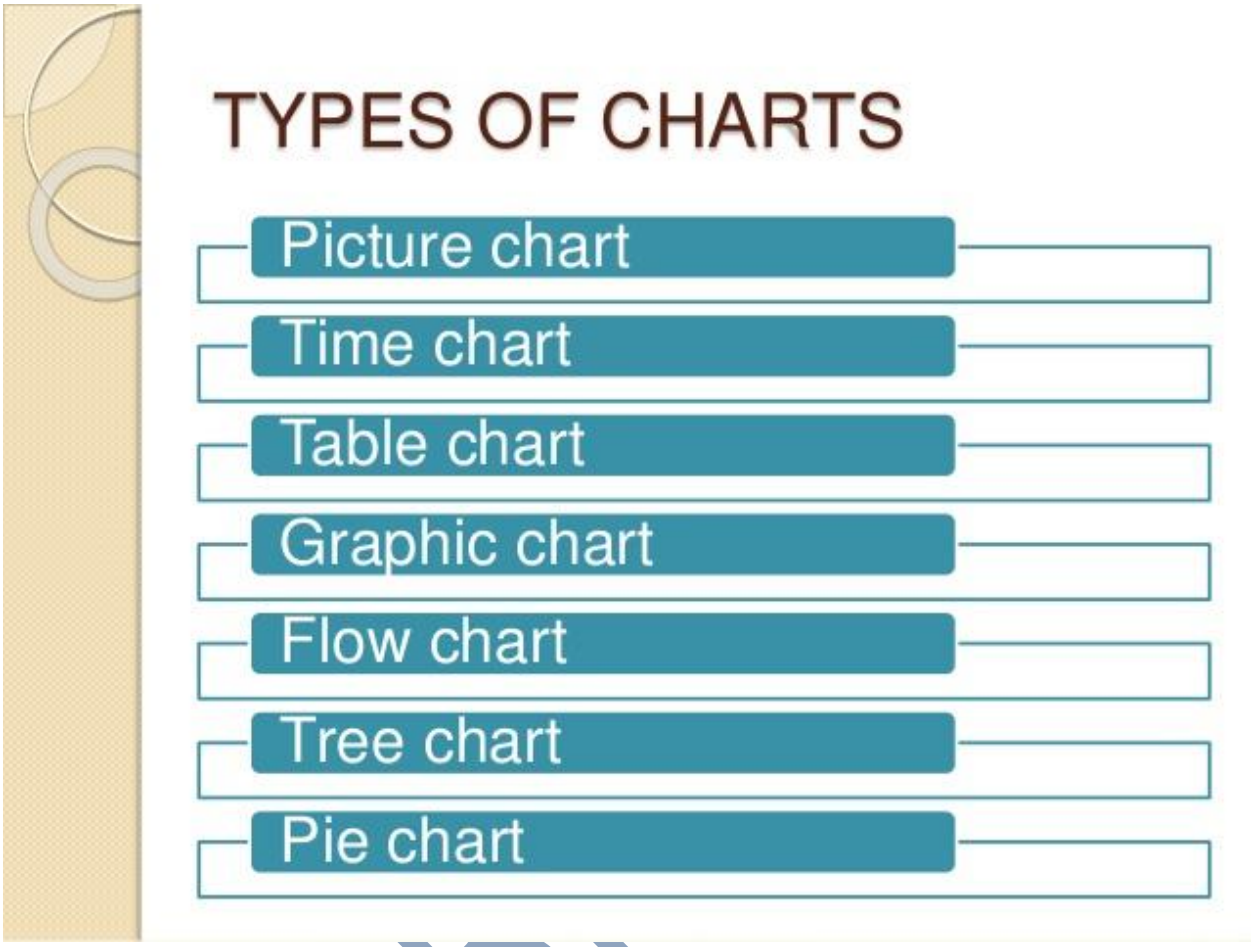
- Collections
  a. Shells, gems, minerals, books, clippings
- Replicas
  a. Globe, diorama, models, miniatures
- Living Things
  a. Live pets, kinds of plants, small animals
- Devices
  a. Measuring instruments, simple machines
- Learning Activities
  a. Gardening, preserving specimens, essay writing
- Information that can be Gathered
  a. Role of civic leaders, development of the different landforms

C. SETTING UP LEARNING RESOURCE CENTERS AND ACTIVITIES

1. Preparing exhibits
2. Visiting natural history museums
3. Taking care of a mini-zoo, pond and aviary
4. Growing plants in a home or school garden
5. Using videos and other electronic gadgets
6. Setting up a mini-reference section
7. Undertaking field studies
8. Familiarizing and linking with community officials, experts in industries and businesses
9. Joining interest clubs and professional organizations
10. Regular visits to recreation centers in the community

CHART

- A chart is a useful way to present and display information or instructions, especially in a classroom or other educational situation. It can range in size from a large wall chart to a single piece of paper.
- Acc to Edgar Dale , “a chart is a visual symbol summarising or comparing or contrasting or performing other helpful services in explaning subject matter”


TYPES OF CHARTS
Picture chart
Time chart
Table chart
Graphic chart
Flow chart
Tree chart
Pie chart