B. Ed. Spl. Ed. (M. R. / H. I. / V. I)-
ODL Programme

AREA - A

A - 4 (PART-I) : PEDAGOGY OF TEACHING SCIENCE

A COLLABORATIVE PROGRAMME OF
NETAJI SUBHAS OPEN UNIVERSITY
AND
REHABILITATION COUNCIL OF INDIA

AREA - A
CROSS DISABILITY AND INCLUSION
COURSE CODE - A4 (PART-I)
PEDAGOGY OF TEACHING SCIENCE

Chairman		**Prof. Subha Sankar Sarkar,** Vice Chancellor, Netaji Subhas Open University, Kolkata-64
Convenor		**Prof. Atindranath Dey,** Director, School of Education, Netaji Subhas Open University, Kolkata-64
Course Writers		
Unit - 1	Sub-Unit-1.1	Dr. Papiya Upadhyay
	Sub-Unit-1.2	Dr. Papiya Upadhyay
	Sub-Unit-1.3	Shri. Palash Das
	Sub-Unit-1.4	Shri. Palash Das
	Sub-Unit-1.5	Dr. Papiya Upadhyay
Unit - 2	Sub-Unit-2.1	Shri. Palash Das
	Sub-Unit-2.2	Dr. Papiya Upadhyay
	Sub-Unit-2.3	Shri. Palash Das
	Sub-Unit-2.4	Shri. Palash Das
	Sub-Unit-2.5	Dr. Papiya Upadhyay
Unit - 3	Sub-Unit-1 to 5	Dr. Papiya Upadhyay
Unit - 4	Sub-Unit-1 to 5	Dr. Papiya Upadhyay
Unit - 5	Sub-Unit-5.1	Shri. Palash Das
	Sub-Unit-5.2	Shri. Palash Das
	Sub-Unit-5.3	Shri. Palash Das
	Sub-Unit-5.4	Shri. Palash Das
	Sub-Unit-5.5	Dr. Papiya Upadhyay
Editor	Dr. Bijan Sarkar	
Processing		
General and Format Editing		Dr. Papiya Upadhyay & Ms. Swapna Deb
In-house Processing In-charg		Ms. Swapna Deb & Mr. Samir Chakrabarti

The Self Instructional Material (SIM) is prepared keeping conformity with the B.Ed.Spl. Edn.(MR/HI/VI) Programme as prepared and circulated by the Rehabilitation Council of India, New Delhi and adopted by NSOU on and from the 2015-2017 academic session.

Sri Mohan Kumar Chattopadhyay
Registrar

Netaji Subhas Open University

From the Vice-Chancellor's Desk

Dear Students, from this Academic Session (2015-17) the Curriculum and Course Structure of B. Ed.- Special Education have been thoroughly revised as per the stipulations which featured in the Memorandum of Understanding (MoU) between the Rehabilitation Council of India (RCI) and the National Council for Teacher Education (NCTE). The newly designed course structure and syllabus is comprehensive and futuristic has, therefore, been contextualized and adopted by NSOU from the present academic session, following the directives of the aforesaid national statutory authorities.

Consequent upon the introduction of new syllabus the revision of Self Instructional Material (SIM) becomes imperative. The new syllabus was circulated by RCI for introduction in the month of June, 2015 while the new session begins in the month of July. So the difficulties of preparing the SIMs within such a short time can easily be understood. However, the School of Education of NSOU took up the challenge and put the best minds together in preparing SIM without compromising the standard and quality of such an academic package. It required many rigorous steps before printing and circulation of the entire academic package to our dear learners. Every intervening step was meticulously and methodically followed for ensuring quality in such a time bound manner.

The SIMs are prepared by eminent subject experts and edited by the senior members of the faculty specializing in the discipline concerned. Printing of the SIMs has been done with utmost care and attention. Students are the primary beneficiaries of these materials so developed. Therefore, you must go through the contents seriously and take your queries, if any, to the Counselors during Personal Contact Programs (PCPs) for clarifications. In comparison to F2F mode, the onus is on the learners in the ODL mode. So please change your mind accordingly and shrug off your old mindset of teacher dependence and spoon feeding habits immediately.

I would further urge you to go for other Open Educational Resources (OERs) - available on websites, for better understanding and gaining comprehensive mastery over the subject. From this year NSOU is also providing ICT enabled support services to the students enrolled under this University. So, in addition to the printed SIMs, the e-contents are also provided to the students to facilitate the usage and ensure more flexibility at the user end. The other ICT based support systems will be there for the benefit of the learners.

So please make the most of it and do your best in the examinations. However, any suggestion or constructive criticism regarding the SIMs and its improvement is welcome. 1 must acknowledge the contribution of all the content writers, editors and background minds at the SoE, NSOU for their respective efforts, expertise and hard work in producing the SIMs within a very short time.

Professor (Dr.) Subha Sankar Sarkar
Vice-Chancellor, NSOU

B. Ed. Spl. Ed (M. R. / H. I. / V. I)-
ODL Programme

AREA - A

A-4 (PART-I) : PEDAGOGY OF TEACHING SCIENCE

First Edition : August, 2016

Printed in accordance with the regulations and financial assistance of the
DEB-UGC, Government of India

Netaji Subhas Open University

AREA - A
A-4 (PART-I) : PEDAGOGY OF TEACHING SCIENCE

A-4 (Part-I) ❐ Pedagogy of Teaching Science

Unit - 1 ❑ Nature & Significance of Science

Structure :

1.1 Introduction

Nature implies two things, one is the natural world & the other is character of an individual or a thing. It is the usual way in a person's behavior, i.e, a part of their character & the basic qualities of a thing. It is this meaning of nature with which we are concerned when we deal with the nature of science. When we talk about the nature of all Sciences, we are concerned with their characteristic features. To understand the nature of Sciences, we have to see how Science works. Science is a particular way of understanding the natural world. It extends the intrinsic curiosity with which humans are born. The world in which we live is by and large the same as it has been always. It is the world of sun, light and darkness; the world or earth, land, sea plants and animals; the world of seasons, climate; the world of being born, growing and dying. The world also has the simplest of tools and the most complicated of equipments. There are infinite things and events like these which are governed by science. Human beings have learnt how to live in this world by adjusting to the nature. They explore. understand and change the surroundings according to their

needs and requirements. This process of diligently observing, describing, exploring and using the world is science.

Childern often try to find answers to their questions which begin with "what is it ?". Science as a process involves various stages of an activity, establishing steps for gathering in formation and then retaining it. Two types of skills are required through the process of science-basic skills and special skills. Through these skills, students learn about nature and adjust to it according to their needs and requirements. Thus, a systematic process of learning takes place. Science is an accumulated and systematized learning in general usage restricted to natural phenomenon. It is an endless series of empirical observations which result in the formation of concepts and theories subject to modification in the light of further empirical observations. Hence Science is both a body of knowledge and the process of acquiring it.

Learners should be able to appreciate the contribution of science in the progress of civilization. The appreciation must come as an outcome of science teaching and the teacher must make the learners conscious of the benefits bestowed by science for the comforts of the mankind. The adventures of scientists in exploring the truth should be told by the teachers.

The objectives of teaching science have been changing from time to time. The rapid progress of science and technology in recent years and the stress from mere knowledge of facts was shifted to the development of concepts, abilities attitudes, skills, appreciation etc. Since education is a dynamic process, the whole life in the school constitutes the curriculum that plays an important role in the evolution of balanced personality of the child. There is an increasing trend in science teaching in some developed countries to emphasize the social implications of science.

In addition to being an integral part of general Education, whole science programme at secondary stage should prepare the learners for some vocation and specialization in the individual subjects. So, a different type of knowledge and training should be given to those learners who intend to go for higher studies or want to enter some profession. This should form a basis for further pursuit in the field of science.

1.2 Ojectives

Upon completion the learners will be able to-

1) gain an in depth knowledge of nature, scope, importance and value of science
2) analyse science as an integrated area of study

3) relate science and modern Indian society

4) explain the impact of science on different socio-cultural issues

5) comprehend the role of science pertaining to sustainable development

1.3 Nature, Scope, Importance & Value of Science

Definition of Science :

In the words of J.W.N. Sullivan, ''Science is the activity where truthfulness is obviously an essential condition for success. Its success in fact is measured by its truthfulness.

Henri Poincare explains, ''Science is built of facts as a house is built of stones; but an accomulation of facts is no more a science than a heap of stones.'' In another way it could be said that science is more a verb than it is a noun.

- Science is an accumulated & systematized learning in general usage restricted to natural phenomenon. The progress of Science is marked not only by an accumulation of fact, but by the emergence of Scientific method & of the Scientific attitude.
- Science is a cumulative & endless series of empirical observations which result in the formation of concepts & theories, with both concepts & theories being subjects to modification in the light of further empirical observation.
- Science is both a body of knowledge & the process of acquiring it.

The Structure of Science : It consists of the following—

- **Facts** are the basis of all knowledge. They are said to be grass-roots for any theory or law. The whole process of the Scientific enterprise is continuously replenished by new facts & discoveries.
- **Concepts :** is a generalized idea suggested to the individual by object, symbol or situation. It is an understanding of almost undefinable something.
- **Generalization :** are very helpful in deriving useful conclusions regarding the scientific facts. Actually, the facts, concepts & generalizations are inter-related & interdependent.
- **Theory :** is based on facts, it is precise & clear & it must be grounded in empirical data. It follows the law of parsimony & open to interpretation & verification. It has applicability & a meaningful structure as well.

- **How :** A scientific law may be defined as a factual statement of what always happens in certain circumstances.
- **Nature of Science :** learning of science is a lengthly & continuous process Knowledge acquired through this is refered to as product. The following are the criteria of nature of Science.
- **Science is a process :** A process involves planning various stages of an activity, establishing steps for gathering information & then retaining it. In Science, gathering information, thinking, solving problems, etc. are called the 'processes of Science.' Two types of skills are acquired through this—basic skills & special skills.
- **Basic Skills**
    - **Observation :** It is not merely 'looking' at or 'seeing' something. Through observation they come to know their environment.
    - **Classification :** What ever is observed by the students is grouped on the basis of similarities.
    - **Communication :** Students observe & learn many things. This learning is transmitted to others through some means of communication. Communicating the knowledge could be in the form of a name, label, sign, symbol etc.
    - **Measurement :** It is recording the precise & accurate observation.
    - **Estimation :** are made by the learners whenever accuracy is not required.
    - **Predictions :** This skill enables to know the behaviour of a particular object or phenomenon before it happens.
    - **Inferences :** On the basis of above mentioned skills, ability to draw inferenced develops, inferences can be made about any process or phenomenon.
    - **Special Skills :** Along with basic skills, certain special skills are needed for an experiment or to solve any problem. These skills are as under–
    - **Identification & control of variables :** There are dependent independent & extraneous variables in any experimental set us. So, identification & control of there variables, (excepting the constants) are an important parameters.
    - **Hypothesis formation :** Science students acquire a basic skill of prediction. If the predictions are tested, they are called hypothesis. They are the guess about the result of an experiment.

- **Experimentations :** Experiments are conducted to test a hyprothesis. The effects of various vareables are studied here.
- **Tabulation :** Data collected in the expriments is tabulated is an organized manner.
- **Interpretation :** The analysis of the tabulated data leads to the interpretations & conclusion.

Through these basic & Special skills, students learn about nature & adjust to it according to their needs & requirements. Thus a systemmatic process of learning takes place.

- **Science as a product :** The information that is acquired through the process of sciences or the body of knowledge formed is called 'product of science'. Knowledge of any from consists of development of facts, concepts, principles, theory & ultimately law.
- **Importance & values of Science :** Science helps to develop a scientific temper, scientific outlook & a Scientific attitude. There are certain values (Fig 2) attached to science which are as follows :
- **Intellectual value :** The great value of science is that is has introduced us to new ways of thinking & reasoning. The chief part played by Science in helping to develop consciousness of man it to be found in the new thoughts that it has made us think. Science helps us to understand, evaluate & solve the problems of life. It enables the students to became more logical, develop reasoning ability & creativity. Students get various opportunities to develop the power of observation, reasoning, thinking, analysis, synthesis and evaluation.
- **Utilitarian value :** of Science need not be emphasised. Science has entered in our life & daily activities to much that our existence would became impossible without it. Its achievements in almost all spheres are marvellous science has wrested from nature almost all the hidden treasures. If we look around yourself & will see that somehow or the other connected with sciences. No subject can claim to be as utilitarian as science. Modern age is the age of scientific inventions & we are surrounded with electrical gadgets, everything si guided by Science.
- **Vocational Value :** In today's world, many Science based inter disciplinary vocations have come up, eg, poultry, diary, agriculture etc. knowledge of science is needed for research work as well. Amongst all, mobile repair & cyber cafe are the latest vocations which are based on science & technology.

- **Disciplinary value :** Science promoter team work, healthy exchange of thoughts, spirit of enquiry & a balanced judgement. Science promotes organized behaviour & systemmatisation in every work. Study of Science enables an individual to live a confident & disciplened life.
- **Moral & aesthetic value :** Science inculcates moral & aesthetic values in the students. A highly moral person is honest, truthful & has are integrated personality. By studying Science, qualities of punctuality, patience, Self-control, self respect & determination are developed in students, making them highly moral individuals. In the words of keats, ''Truth is Beauty''. In nature everywhere we come across what Einstein calls 'Pre-established harmonies', which is beautiful & the discovery of such harmonies is the concern of Science. So, again there is a compromise between the artist & the man of Science or in others words science & art are basically the same.
- **Social & cultural value :** Science has played are important role in determining the culture & civilization of a country from time to time. It has affected our way of thinking & way of living. The effect of Science is multifarious. It has a direct influence is dispelling many traditional beliefs & the adoption of others suggested by the success of scientific method. As a result of which the social organizations have been amply changed & hence there is corresponding political changes. Science has its own literatures which makes are appeal is no way less powerful & elevating than the humanistic studies. The cultural & social aspect of science should, be fully appriciated by science students.

Indian Education Commission, 1968, documents, ''If science it to be pursued with full vigour & Zest & is to become a mighty force in the Indian renaissance, it must drive its 'nourishment' from our cultural & spiritual heritage & not by pass it. Science must become an integral part of our cultural & spiritual heritage.''

- **Psychological Value :** The teaching of Science is based on sound psychological footing. The principle of acturty is the main basis of teaching of Science & satisfies the instincts of curiosity, creativeness, self-assertion, self-expression etc. of the pupils. It is quite clear that science has a subject is closely connected with our daily life, is justified to be included in the curriculum. Science is the result of an intense struggle of human intellect & has wrested from nature not only her secrets but processes also which underline them. It has emerged as almost a decisive force & its role in education needs to be adequately understood.

- **Training in the Scientific method :** This comprise of the following steps :

⇒ Making an accurate survey of the problem.

⇒ Setting up the method of attacking the problem.

⇒ Collecting data regarding the problem.

⇒ drawing conclusions from the collected data.

It is due to this scientific method of attacking a problem that has achieved wonders in all fields of human activity.

Development of Scientific attitudes : This value is monopolised involve critical observation, open-mindedness, suspended judgement, free from superstition & false belief etc., The attitude once developed in the student proves useful in later life of the child.

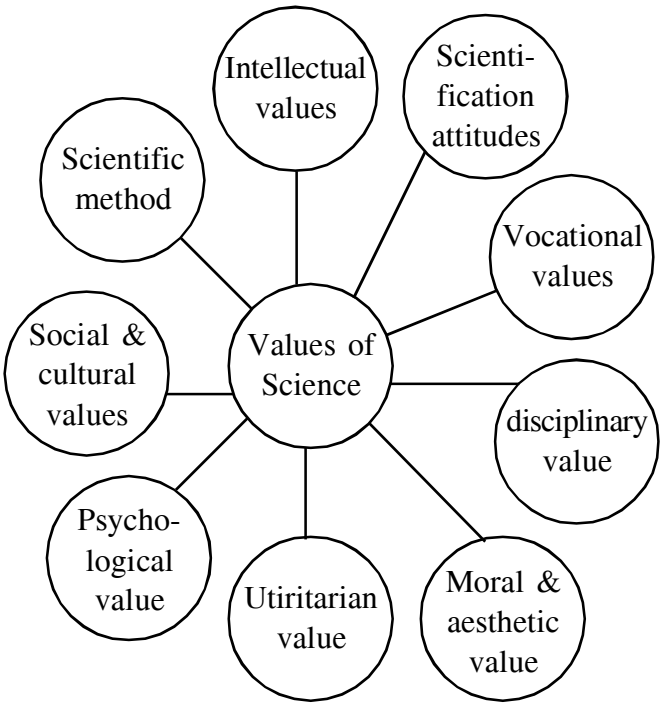


Fig : 1—Values of Science

1.4 Science as an integrated area of study

Background

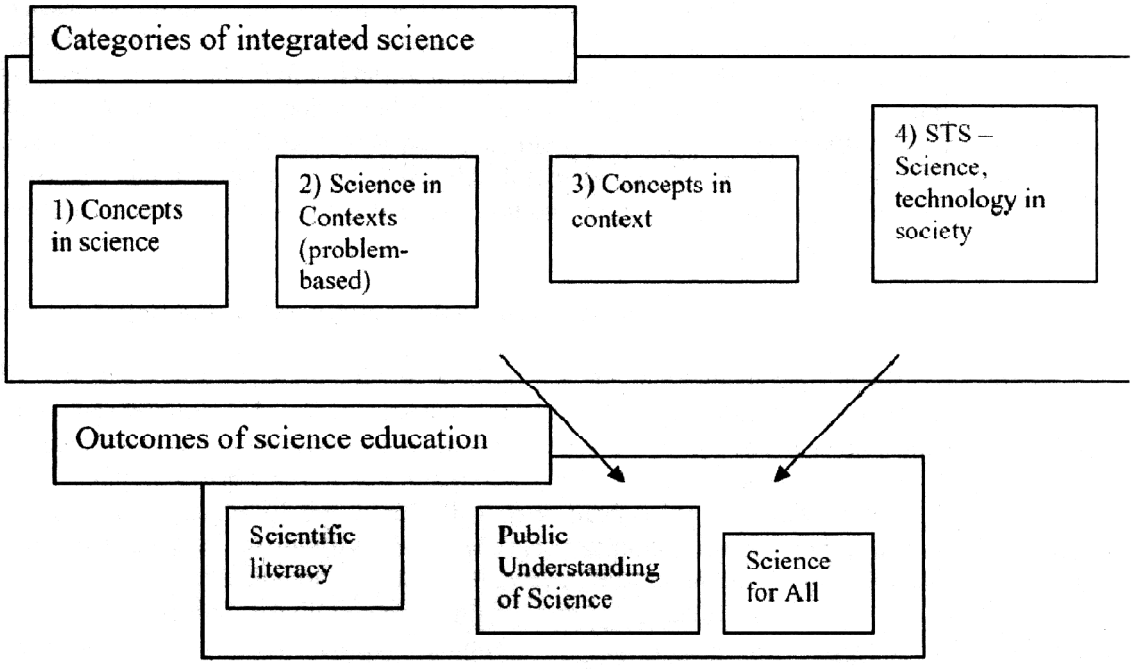
Science Education in India has suffered from an inherited separation of the study of natural worlds (material & biotic) & the human worlds. As a result, natural

sciences and humanities & social sciences. Insulated spaces have developed in India as two insulated spaces, each with its exclusive and narrow focus. However our experiences of the 'real world' show us repeatedly that the real world is never split into two restricted worlds - the natural and the human; these two worlds are far from separate; they are interconnected, inter-related and often flows into each other; such that natural science studies are not just studies of natural phenomena; they have to them large elements of the human world. Hence, at the level of knowledge production what we need is an integrated approach - integrating objects of enquiry and methodologies emanating from the hitherto separate study of both worlds.

Given the separation and the divide, the Integrated Science Education needs an integrated approach connecting not just natural and social sciences but also:-

(i) Extant disciplines within the natural/social sciences, (ii) Material, biotic and human worlds, (iii) Experiences and knowledge (iv) Service delivery and the recipient (v) Technology and technology user (vi) Interests of stakeholders.

Fig. - 2 : Concept of Integrated Science



Historical basis of Integration efforts in India & abroad

It is not that in India, we have not had anxieties about this separation. Our best attempts at attending to this separation - the setting up of Humanities and Social Science (HSS) departments, in a largely techno-scientific atmosphere in the IITs - have not solved the problem of the inherited separation. Instead, science students have found HSS courses to be an unnecessary and alien addition to their already demanding science-technology courses. In this model of integration HSS departments are in effect never integrated within the science- technology institution. Here social science and humanities questions and methods are seen not as offering anything fundamental to science but merely imparting some version of value-based education to science students.

The other model of integration is one where primarily three social science subjects, namely philosophy, sociology and history emerge as gatekeepers or final arbiters of what science is doing, through philosophy of science, sociology of scientific knowledge and history of science. Here social science subjects emerge as critiques of science, of scienti fie knowledge production and of laboratory life. Social sciences in this case seem to be judgemental in establishing its credibility.

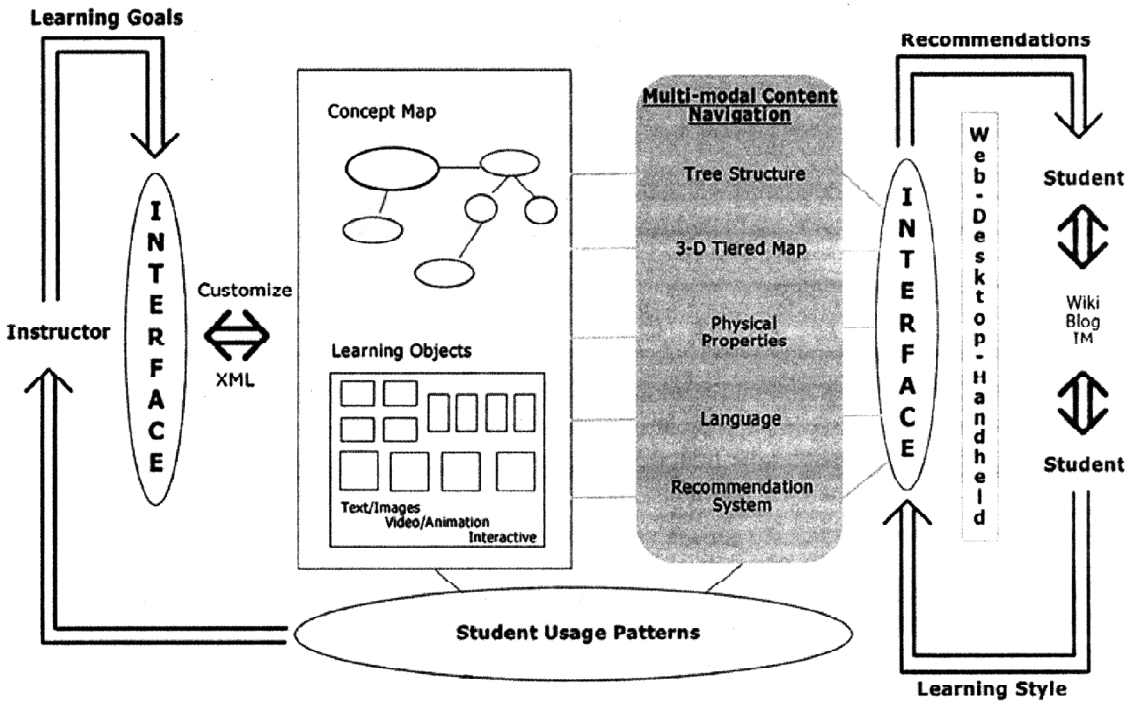
The 20th century in the USA has witnessed a continuous discussion about integrated Science education. Intertwined with this discussion has been a discussion of progressive education based on Dewey's ideas. The demand for integrated education reached its climax in 1970 when the U.S. Advisory Committee for Science Education of the National Science Foundation recommended a curriculum that related Science and Technology to human and social affairs. During the same time period, two large international organisations started a continuous mapping and development of integrated Science education. One of these organisations is UNESCO, which publishes the report series 'New trends in integrated Science teaching' and the other is CASE, the International Council of Associations for Science Education, an association of teacher organisations with the goal of integrating Science education.

Science Education : Integration, content & structure:

The Science education community expresses different views about how Science education should be organised. The relative merits of integrated versus subject-specific Science in compulsory schools are disputed among teachers, scientists and teacher educators. Fensham gives a comprehensive description of a problem area in Science education. First, Fensham points to the social changes of the 1960's that

gave Science new groups of learners, with all the difficulties entailed. Arbitarily, the academic disciplines have developed over the years in response to the expansion of knowledge. However, this nature of disciplines I snot a justification for the destruction or elimination of disciplinary boundaries. Every discipline possesses characteristics that are clearly unique to that discipline. Integrated and thematic curriculum/ instructional approaches ignore the conceptual, procedural, and epistemological differences that exist between the various areas of mathematics and the sciences. For example, problem solving is quite different among the various sciences let alone across mathematics and science in general. Within an interdisciplinary approach, the unique and valuable aspects of the various academic disciplines can be maintained while still developing students' understanding of interconnectedness.

Fig-3 : Inter-relationship of Science subject



Inter-relatedness of science & other subjects:

It is always said that science cannot be taught in isolation. All the branches of science are inter dependent upon each other & there are a number of facts & principles which are common to various science subjects. As a result of this new subjects like

physical chemistry, Geo-physics, Bio- Physics, Bio-Chemistry, Soil- Chemistry etc have been introduced. One of the most important factors that is responsible for the ineffectiveness in teaching in teaching science is the lob-sided specialization of teachers. For eg, a teacher while teaching the sense organs say, eye, should be able to make a parallelism with a camera, which the students have learnt in Physics.

In Basic Scheme of education, inter-relationship of subjects occupies the pivotal position & it is not the craft that makes the school basic but it is this relationship that makes it really basic.

For over all development of the students, various subjects are included in the curriculum. These subjects are selected on the basis of decision taken after proper consideration and analysis.

Usually those subjects are included in the curriculum that are complementary to each other, as the main objective of all of them is to achieve a given set of objective of education that is over all development of the students.

Science is quite a complex and a vast kind of subject, because of which the task of correlating it with other subjects of curriculum seems to be quite an easy task. Deliberate effort should be made by the science teacher to bring about co-relation in between the science and other subjects of the curriculum, that are being imparted to the students.

By the help of this, students will find the opportunity to relate the knowledge which they have already gained, with the knowledge which they are gaining. This kind of relation activity leads to development of interest among the students.

While imparting knowledge of one subject, teacher gets much help in communicating her ideas if she makes use of examples or reference of concepts covered by other subjects. Although it is not very easy to co-relate various subjects with the complex subject like science, but it is not impossible. This can be done in the following manner:-

Science and Language:

Since science is a practical subject, it is very important for the learners to be able to express their views and ideas in clear and attractive form. For this purpose, it is necessary that they should have thorough knowledge of language which they use. Student who does not have good control over the language cannot express his views

and various scientific laws and principles in front or others and especially in front of teacher.

Today, as a result of adoption of uniform technical terms and symbols, vocabulary of different languages have been enriched to considerable extent. In making students able to give answers of various scientific queries, in effective manner, either in written form or orally, science teacher and language teacher should take up ajoint responsibility on their shoulders.

To co-relate science with language subjects, students can be asked to write essays on some scientific topic. If student make any kind of grammatical mistake, then the teacher can ask him to make correction in his language. Likewise, language teacher can give the task of writing about some scientific happening in the assignment designed for them. In this manner, he can correlate science with the language.

Science with Mathematics :

A large number of scientific principles and rules are represented in the form of mathematical expressions, for which it is very necessary for the student or person intending to get advanced study of science subjects to have sound mathematical basis. Without making use of mathematical expressions and rules, it is not possible for any teacher to conduct science teaching in effective manner.

The significance of mathematics in the science can be proved by the views of the experts that mathematics has given sound footing to the scientific laws and principles. Before beginning any topic in the science, it is essential for the teacher to make sure that mathematical basis of all the students is strong and vast.

Probably, mathematics is considered to be sole language of science because of which real understanding of science is considered to be impossible without adequate knowledge of mathematics. Some of the useful mathematical tools which are generally used in the science teaching are Algebraic equations, Geometrical formulas, Graphs etc.

Correlation existing in between one of the subject of science and mathematics can be understood. Astrology is an advanced branch of science in which it is predicted or enumerated that which planet revolves at which speed and when it will get appeared to the people of earth.

This is quite complex area, and no one can enter into this complex area without having a sound mathematical basis. Likewise, mathematical rules and theories are also applied to considerable extent in physics, in which no one can intend to take even single step without relying on the subject of mathematics.

Thus, it can be said that science teacher should make all efforts by which she can establish co-relation in between the subjects of science and mathematics. It will not be improper in any way to consider both of these subjects as complementary to each other, which can be studied simultaneously or at the same time.

Hence, it can be said that without making use of examples from mathematics, it is not possible for a science teacher to explain various scientific principles and concepts properly to the students. To make it possible, sincere and deliberate efforts should be made by science as well as mathematics teacher to co-relate both the subjects in accordance with the syllabus.

Science and History :

It sounds quite amazing that some kind of correlation can exist in between the science and history as earlier subject is practical in nature while nature of later subject is purely theoretical. However, it is possible to co-relate these subjects with each other.

While mentioning about the various scientific discoveries taken place in the earlier periods, teacher can relate with the major events of the world history. Students should be told about that what was the situation of science at the time of various kings or rulers. Teacher should narrate to the incidences which inspired various scientists to find out the medical remedies of various diseases.

Not only this, the function of co-relating science with history can be done by mentioning the kind of standard of living people used to experience at different parts of the human history. With such knowledge, they will become aware of the scientific concepts like sanitation and healthy living.

Science and Geography :

Geography is the subject in which various concepts relating to earth on which we live are dealt with. Everything existing on earth, on different planets of the universe are also main subjects of geography. Which kind of crop should be sown in which kind of soils, how many kinds of rocks are found on the earth are some

of the main topics which are covered by Geography. One will be surprise by this fact as these topics are also covered by the subject of Science.

In science, various concepts relating to the atmosphere and earth in which living and non-living beings exist are made. For this reason, temperature, wind directions and measurement of rainfall are conducted in the subject of science by making use of various apparatus.

Results obtained by science in terms of climate and the manner in which it affect the human beings and earth are being interpreted by subject of Geography. The manner in which it is mentioned by the geography that how soil gets produced through crushing process of rocks, it makes the subject a special branch of science.

Therefore, geography lessons on these subjects will be best understood and appreciated if they have been discussed in length by the science teacher. There are various topics which are of common interest for geographers and scientists. Thus, it can be said that both of these subjects are complementary to each other. Both of these subjects are very near to each other, thus science teacher will not find any kind of problem in relating science with the subject of geography.

Science and Social Studies :

If one explores the history of development of human society, he will find various incidences in which human got victory over forces of nature, by which he got control over the land, sky and seas. As said that an important impact of science teaching is that outlook and perspective of students or people become scientific in nature, as a result of which, various kinds of changes take place in their way of living.

Scientific thinking affects the standard of living of human beings to considerable extent, as through such information, outlook and perspective of human beings become more wide and they can free themselves successfully from the clutches of superstitions and false beliefs.

Various evidences can be found in our life which can show the significant way in which life style of human beings have got affected by inclusion of scientific developments in their life. Today, we can find various kinds of machines for performing different functions, about which primitive men even did not think.

As a result of these machines, our life has become very easy and smooth and now we can accomplish complex functions within short period of time, which were considered to be very time consuming. Not only this, various research works has led

to development of various medicines with the help of which physicians have found the remedies of various diseases, which were once considered to be incurable and were responsible for bringing about heavy loss of life in earlier times.

Not only this, earlier a large number of manpower was being engaged in the agricultural sector, but now we are moving towards industrialization era, as a result of which we are ready to participate in the competition taking place in global market. We have third highest number of professionals engaged in different areas of the world.

Now a large number of students intend to get education from foreign universities, but they want to serve their own nation and want to play effective role in bringing about development of the nation with greater pace. Earlier people were not provided with the developments taking place in the scientific area, as a result of which they used to accept all the orders imposed on them.

But now, in a scientific advanced time, people have learned that being human beings, they have certain rights, and if any attack is being made on their rights, they begin to agitate. This can be the possible reason that why women of our nation has attained those rights which were not permitted to them in the earlier time.

Another change which has taken place in our society through such reasoning ability is the manner in which people belonging to minority section of the society are asking or reservations in various spheres of the life. They are asking about reservations in educational institutions and even in parliament of the nation.

Thus it can be said that science and social sciences are two subjects which can be co-related with each other without much problem. A science teacher can correlate science with social studies on different occasions by providing suitable relations of relevance.

Science and Civics :

The main objective of imparting information of both the subjects is to create good and useful citizens for the nation, thus it is possible to correlate both of these subjects with each other. Through science, students become able to understand the utility of scientific inventions in their life, by which they become more responsible.

They begin to realise a sense of responsibility, which help them in playing important role in development of the nation. Through information of scientific facts, students get to know about various kinds of diseases and the role which they can

play in creating a healthy and clean atmosphere around them. Through this kind of information, they become more responsible citizens and play an important role in creating an ideal civic life in the society and nation as a whole.

Science and Art:

It is considered by the majority of people that it is science who has contributed a great deal in developing the field of art, but this is not true, as both of these subjects or areas has played important roles in enriching each other. All types of arts have got enriched as a result of scientific developments, but it is not possible for a science teacher to impart information relating to various scientific facts and principles without having thorough control over the art.

As known that science is a practical subject, as a result of which, science teacher is required to draw various kinds of diagrams, models and charts, which cannot be performed unless he does not have sound artistic skills. Not only this, it is equally important for an artist to have thorough knowledge of scientific principles, as without it, he will find it difficult to keep the colour contrast of his images in attractive and controlled position.

An artist should know the principles of light and shade, objects and background for drawing or keeping the colour contrast in attractive condition. Thus, it can be said that some common features are found in the subjects of science and art, because of which they can be co-related with each other effectively.

Science and Music :

In our nation, music has its own importance as different kinds of songs are found in different parts of the nation. There are songs and theories of music in different languages. Various musical stars got born in our nation, but the number of persons engaged in musical area has diminished to considerable extent as now people consider it as wastage of time and efforts.

To encourage people and especially students to get involve themselves in professions having their roots in music, this has been accepted as an independent subject in various schools and institutions and it forms an integral part of school curriculum. For the students of music, knowledge of resonance, vibration systems in strings and air columns is very necessary and important.

To make improvements in their voice and manner of singing, various scientific equipments are being used today, which could not come into being without scientific

developments. Thus, it is only through the utilization of scientific developments in the real life that led to the development of various apparatuses used in the musical field. Science teacher can relate subject of science with the music by narrating the students that what led to development of various equipments used by the musicians and on which principles do they operate or function.

Science and Craft Works :

Some people will find it quite unsound to relate science and craft works with each other, but various kinds of improvements can be brought about in ability of students to understand various scientific principles and facts. During craft periods, students can be provided with the task of designing various pieces of scientific apparatuses and equipments.

Through such step, scientific interest can be developed in the students, which will help in arousing the interest of students in various scientific incidences. An urge will get developed in them to see or observe the equipments or apparatuses designed by them in reality, by which they will be motivated to get more and more information regarding the research functions conducted in the scientific field through various means and sources.

Thus, it can be said that if a science teacher can relate science with other subjects of the curriculum, then more justifiable and satisfactory results will be obtained.

1.5 Science and Modern Indian Society : Relationship of Science and Society

Science :

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

Actually there is no one definition of science which is universally accepted. What is Science and how does it grow are the basic questions which all students of science must understand.

Modern Indian Society :

The society in which more dramatic changes occurs, specially in the area such as Urbanization, liberalization, globalisation of the economy, the IT revolution, the affirmation of religions identities and reaffirmation of ancient world views and new political landscapes denote some of these processes. As the world's largest democracy emerges as an economic and cultural super power, there is a pressing need for a more sophisticated and renewed understanding of Indian culture and Society. So the science plays an important role for the development of Indian society.

Relationship between Science and Society :

Actually without science, our society would not be able to function. Science has allowed us to take control of and develop the world where we live intoday.

Nobody can deny that science has rendered invaluable service to mankind in various spheres. It is due to discovery of science that we have been able to find a cure of most diseases and prevent the out break of epidemics, thereby vastly inreasing life expectancy.

Science gives to mankind the supreme self confidence. It has given man the assurance that instead of being a slave to his environment, he can control and modify it to suit his needs in the environment.

With the help of Science we have builts huge dams to supply waters through Perennial canals, manufactured fertilizers which enormously increase agriculture production, produced effective pesticides, learnt how to prevent soil erosion, introduced multiple cropping and devised other ways to improve output.

Population control would still be needed if food production is to keep pace with the growth in numbers, but the Spectral progress with scientific cultivation has made possible in the field of agriculture. So thanks to the application of science to industry.

The machine has not only relieved man of heavy burdensome tasks, but has also provided him with ample leisure in which he can engage himself in cultural parsuits, cultivate various kinds of hobbies and travel. It is through science that has been able to invent new sources of entertainment and education, such as cinema, radio, television and etc.

Democracy would have been impossible without the printing press. The modern media of mass communication is another fruitful source of education, are being spent on mansfacturing weapons on mass annihilation and space exploration.

The rapid increase of communication like railways, the telegraph, internet has developed by the enhancement of science progress.

By the application of science we can create a rule of law which compels all organisation to submit their disputes to negotiate, mediate and arbitrate rather than settle them by strikes which paralyse national life and put the community to get inconvenience.

1.6 Impact of Science with special reference to issues related with Environment, Industrilisation and Disarmament.

Impact of Science on Environment :

Science has the Universal impact on different areas. By relating science education with the environment of a learner has been the prime concern of educationists.

In science we learn about the environmental phenomena of both natural and man made interventions affecting the environment. The science education should be made to integrate science with learning environment. So the Science curriculum should address issues and concerns related to environment such as climate change, acid rain, growth of water eutrophication and varions types of pollution etc though teaching-learning of science at all stages.

Learner will be attracted towards science when they realise its significance to society and relevance to their lives. They should be engaged to construct the knowledge of science though an interdisciplinary approach appreciating its relation and impact on the social and natural environment.

The significance of Chemical Science to society can be high lighted by discussing the chemical components used in products that have altered agriculture, food, health, medicine, electronics, transportation and the natural environment.

Similary importance of physical Science to different areas like agriculture, transportation, household products electronics, define communication, cugineering menufacturing and environment. To understand to relevance to home economics, one can think what happens to the electricity bill if solar cooker solar heater and

compact Fluorescent lamp (CFL). Activities such as use of pressure cooker and greasing the moving parts of a vehicle reduce energy loss. So the role of science education has very much impact on the environment.

Impact of Science on Industrilisation :

Industrialisation means the development of big equipment and application of industrial management methods to Scientific activities them selves. The industrial Revolution was not closely linked to Science at the outset, but rather was produced by craftsmen and engineers, often trained on the job. The most famous example is the steam engine, which was invented almost a century before the principles thermodynamics were understood. It is important to realise that the industrial developments depends on the special condition is that the concept of science should be properly integrated between the scientists and the laboratories into the production process. The impact of science on industrialisation also altered and extended the scientist's role in the different institution. The innovation process in the industrial development has become increasingly dependent on the findings and methodology of science. So the knowledge of science has a great impact on the industrialisation.

1.7 Role of Science for Sustainable Development

Understanding of sustainable development :

Role of the sciences should be to provide information to better enable formulation and selection of environment, it will be essential to enhance scientific understanding, improve long-term scientific assessments, strengthen scientific capacities in all countries and ensure that the sciences are responsive to emerging needs.

Scientists are improving their understanding in areas such as climatic change, growth in rates of resource consumption, demographic trends, and environmental degradation. Changes in those and other areas need to be taken into account in working out long-term strategies for development. A first step towards improving the scientific basis for these strategies is a better understanding of land, oceans, atmosphere and their interlocking water, nutrient and biogeochemical cycles and energy flows which all form part of the Earth system. This is essential if a more accurate estimate is to be provided of the carrying capacity of the planet Earth and of its resilience under the many stresses placed upon it by human activities. The sciences can provide this understanding through increased research into the underlying

ecological processes and through the application of modern, effective and efficient tools that are now available, such as remote-sensing devices, robotic monitoring instruments and computing and modelling capabilities. The sciences are playing an important role in linking the fundamental significance of the Earth system as life support to appropriate strategies for development which build on its continued functioning. The sciences should continue to play an increasing role in providing for an improvement in the efficiency of resource utilization and in finding new development practices, resources, and alternatives. There is a need for the sciences constantly to reassess and promote less intensive trends in resource utilization, including less intensive utilization of energy in industry, agriculture, and transportation. Thus, the sciences are increasingly being understood as an essential component in the search for feasible pathways towards sustainable development.

Scientific knowledge should be applied to articulate and support the goals of sustainable development, through scientific assessments of current conditions and future prospects for the Earth system. Such assessments, based on existing and emerging innovations within the sciences, should be used in the decision-making process and in the interactive processes between the sciences and policy-making. There needs to be an increased output from the sciences in order to enhance understanding and facilitate interaction between science and society. An increase in the scientific capacity and capability to achieve these goals will also be required, particularly in developing countries. Of crucial importance is the need for scientists in developing countries to participate fully in international scientific research programmes dealing with the global problems of environment and development so as to allow all countries to participate on equal footing in negotiations on global environmental and developmental issues. In the face of threats of irreversible environmental damage, lack of full scientific understanding should not be an excuse for postponing actions which are justified in their own right. The precautionary approach could provide a basis for policies relating to complex systems that are not yet fully understood and whose consequences of disturbances cannot yet be predicted.

Recommendations of the International conference :

The programme areas, which are in harmony with the conclusions and recommendations of the International Conference on an Agenda of Science for Environment and Development into the 21 st Century are categorized as :

(a) Strengthening the scientific basis for sustainable management;

(b) Enhancing scientific understanding;

(c) Improving long-term scientific assessment;

(d) Building up scientific capacity and capability.

Scientific as well as relevant indigenous and local knowledge playa critical role in helping to meet the development challenges of today and tomorrow. Based on progress achieved towards the Millennium Development Goals, the post 2015 agenda should be built in an inclusive manner, so as to take into account not only increased economic wealth but also equitable access to education for all (including in the sciences), reducing the gap in the availability and transfer of sustainable technologies between developing and developed countries, and the need to ensure social inclusion in an era of major social transformation.

Analysis of Science and Sustainable Development

Science is critical to help meet the challenges for sustainable development, as it lays the foundations for new approaches and technologies to identify, clarify and tackle global challenges for the future. Science can thus significantly contribute to sustainable development, but requires to that end a broad understanding of science as such. Basic science and applied science complement each other, they are the two sides of the same coin. Science is universal. It does not only bring about progress on the way towards a more sustainable world; it is also in itself away of crossing national, cultural and mental borders and thus helps lay the foundation for a sustainable world.

Science possesses a strong educational component. Science literacy provides the basis for solutions to everyday problems, generally, in uncontroversial ways. Science education and capacity building in science need to be strengthened to make the most of the transformational power of science. Science is a public good and has to be considered as such. Science can also further democratic practices.

Sustainable Development: Its priority in the Society

The conservation, sustainable use of, and equitable access to natural resources and the sharing of benefits arising thereof, the need to adapt to climate change, the promotion of inclusion on the basis of the universal declaration of human rights and ethical principles constitute the main imperatives guiding the work of UNESCO in the areas of natural, social and human sciences and their contribution to sustainable development. An effective science-policy interface will require a regular and systematic

assessments of scientific and other relevant knowledge in relation to social transformation and intercultural dialogue, climate change, biodiversity and key ecosystems such as fresh water and the ocean.

Through normative and technical assistance for ethically based inclusive public policies, UNESCO will accompany countries' efforts to develop their own innovative solutions to the challenges and opportunities posed by sustainable development and cultural diversity. Hence, the highest priority needs to be given to the promotion of capacity development in the sciences, especially at the national level, and to the enhancement of the capacity of societies to take informed decisions about their future.

Science is part of almost every aspect of our lives. Although we rarely think about it, science makes extraordinary things possible. At the flick of a switch, we have light and electricity. When we are ill, science helps us get better. It tells us about the past, helps us with the present, and creates ways to improve our future. Scientific endeavor is as much about us as it is for us. Its place in society, therefore, is not to unfold quietly at the sidelines but to become a fundamental part of the game. Now more than ever, science must engage with us, and we must engage with science.

There are times when science can seem to lose its connection to society and its needs, and sometimes its objectives are not fully understood, even if they are well intended. The lack of a common language and rapid progress in many areas of research has increased the public's concern or contributed to ambivalence about the role that science and technology play in everyday life. But science cannot work in isolation, and advances in science and technology are not an objective in their own right.

The Science in Society (SIS) Programme addresses societal engagement from many perspectives, such as encouraging dialogue between scientists and other members of the public, by promoting an adherence to ethical standards, and by developing better ways for the results of research to be accessed by all. The SlS Programme also supports new ways to interest young people in science and in research careers, and new ways to achieve greater gender equality in science.

The SIS Programme has also been charged with the responsibility of supporting the following specific research activities: the connection between science, democracy and law; ethics in science and technology; the reciprocal influence of science and culture; the role and image of scientists; gender aspects; science education methods; and science communication.

Significance of science and technology for sustainable development

Sustainable development is probably the most daunting challenge that humanity has ever faced, and achieving it requires that the fundamental issues be addressed immediately at local, regional and global levels. At all scales, the role of science and technology is crucial; scientific knowledge and appropriate technologies are central to resolving the economic, social and environmental problems that make current development paths unsustainable.

Bridging the development gap between the North and the South, and alleviating poverty to provide a more equitable and sustainable future for all, requires novel integrated approaches that fully incorporate existing and new scientific knowledge. The Scientific and Technological (S&T) community can make a leading contribution to tackling major problems identified in the Millennium Declaration - "Freedom from want" and "Sustaining our future". These issues include:

i) fighting against disease;

ii) population growth and urbanization;

iii) the digital/information divide;

iv) coping with climate change;

v) confronting the water crisis;

vi) defending the soil;

vii) preserving forests, fisheries and biodiversity and

viii) building a new ethic of global stewardship.

Whatever the cultural, geographical, socio-economic and environmental setting, a strong partnership between the Science & Technology community and other members of civil society, the private sector and governments is a fundamental prerequisite for sustainable development.

1.8 Let Us Sum Up :

- The process of diligently observing, describing exploring & using the world is science.
- Science is both a body of knowledge & the process of acquiring it.
- It consists of facts, concepts, generalisations, theory & Law.

- It possesses basic skills as well as special skills as predicted by its nature.
- Science is a process as well as a product.
- Science accumulates various values & has significance to the existence of human mankind.

Current levels of investment in S&T for sustainable development are far too low in both developed and developing countries. This is true both with respect to the scope of the problems and with respect to the promising rate of return on S&T investments. Larger investments in S&T should be seen primarily as increased investment in a country's socio-economic development and in preserving natural life-support systems for the present and future generations, rather than simply as research expenditures. For this reason, public sector funding for S&T activities targeted on sustainable development goals should be augmented significantly in both all corners of the world. The private sector should reorient its S&T investments in a manner, which integrates sustainable development objectives and should increase its S&T investments generally. Strategic partnerships should be forged between the public and private S&T sectors at national and regional levels.

1.9 Check Your Progress-1

1. What is science?

   .....

   .....

   .....

2. What is Sustainable development?

   .....

   .....

   .....

3. Delineate the structure of science. Give the points only.

   .....

   .....

   .....

4. Give examples to prove Science as an integrated area of study.

.....

.....

.....

5. What is the importance of Science to the society?

.....

.....

.....

6. Mention any four values of science towards the society.

.....

.....

.....

7. What is the relation between Science & industrialisation.

.....

.....

.....

8. Give the steps of training in the Scientific method.

.....

.....

.....

9. Name any four attributes of development of Scientific attitude among learners.

.....

.....

.....

10. Mention some of the key areas of Science regarded as its scope of study.

.....

.....

.....

1.10 References

Innovative Science Teaching - Radha Mohan, 2003, Prentice Hall of India Publishing

Modern Science Teaching - R.C Sharma, 1999, Dhanpat Publishing

Teaching of Chemistry- M.S Yadav, 2004, Anmol Publishers

http://physics.msuiit.edu.ph/spvmlpapers/2005/iso.pdf

http://www.csun.edulscience/ref/plans/lesson_design _ hunter.html

http://www.ilt.columbia.edu/publications/papers/icon.html

http://www.ltag.education.tas.gov.au/planning/modelsprinc backdesign.html.

http://www .ncpublicschools.org

Unit 2 ◻ Planning for Instruction

Structure :

2.1 Introduction

Good science education is true to the child, true to life and true to science. This simple Observation leads to the following basic criteria of validity of a science curriculum & its teaching-learning perspective there to:

a) Cognitive validity requires that the content, process, language and pedagogical practices of the curriculum are age appropriate, and within the cognitive reach of the child.

b) Content validity requires that the curriculum must convey significant and correct scientific content. Simplification of content, which is necessary to adapt the curriculum to the cognitive level of the learner, must not be so trivialized as to convey something basically flawed and/or meaningless.

c) Process validity requires that the curriculum engage the learner in acquiring the methods and processes that lead to generation and validation of scientific knowledge, and nurture the natural curiosity and creativity of the child in science. Process validity is an important criterion since it helps the student in 'learning to learn' science.

d) Historical validity requires that science curriculum be informed by a historical perspective, enabling the learner to appreciate how the concepts of science evolve with time. It also helps the learner to view science as a social enterprise and to understand how social factors influence the development of science.

e) Environmental validity requires that science be placed in the wider context of the learner's environment, local and global, enabling him/her to appreciate the issues at the interface of science, technology and society and preparing him / her with the requisite knowledge and skills to enter the world of work.

f) Ethical validity requires that the curriculum promote the values of honesty, objectivity, co-operation, freedom from fear and prejudice, and develop in the learner a concern for life and preservation of environment.

Looking at the complex scenario of science education in India, three issues stand out noticeably. First, science education is still far from achieving the goal of equity enshrined in our constitution. Second, science education, even at its best, develops competence but does not encourage inventiveness and creativity. Third, the overpowering examination system is basic to most, if not all, the fundamental problems of science education.

2.2 Objectives

Upon completion, the students will be able to :

1. delineate the aims and objectives of teaching Science in Elementary and Secondary school
2. comprehend Bloom's Taxonomy of Educational objectives
3. explain and design lesson planning and related areas
4. format and demonstrate unit planning
5. gain an understanding of pedagogical analysis & apply skills to design it

2.3 Aims and Objectives of Teaching Science in Elementary and Secondary School.

Many students often say, 'why should I study science'? Then we might ask ourselves, 'why teach science'? The typical answer for these frequent questions is 'Beacuse science is all around us, so we need to know about it. However pupils hardly find its relevance in their day to day life. As a result we observe a declining trend in the enrolment of children opting science at higher levels. To address this issue, first we need to understand the aims and objectives of learning science at the elementary and secondary level, because to reach at the higher studies, the concept about the science should be de developed from the initial stages. Since teachers are the key agents to implement the curriculum, so they need to have a clear vision of the rationals, needs, aims and objectives of learning science to help then plan the stages to specify the proper teaching learning strateges for its effective transaction. The origin of the aims of science follows essentially from the nature and sturucture of science and its interrelation to the society. So the teaching learning process of science education should convey the significant aspects of science content at appropriate level and engage the child in the learning process of scientific knowledge at the elementary level.

Harmonious development of child's personality and social efficiency etc. are the general aims of education. If science teaching is to be made effective, then its aims should be in consonance with the general aims of education. We deal with the following main objectives of science teaching.

A. Knowledge. This aim has received the top priority as compared to other aims.

Pupils studying general science should acquire the knowledge of :

(i) Fundamental principles and concepts useful in daily life.

(ii) Facts for science study.

(iii) Inter-dependence and relationship of different branches of science.

(iv) Knowledge of plants and animals.

(v) Natural phenomena going on.

(vi) Knowledge of general rules of health and human body etc.

B. Skills.

Science students should acquire skills in experimentation, construction, observation, drawing etc. Experimentation and construction skills include handling, arranging, preserving, and repairing scientific instruments.

C. Abilities.

The general science teaching should develop certain abilities such as ability to

(i) Sense a problem

(ii) organize and interpret

(iii) Analyse

(iv) Generalise

(v) Predict

(vi) Organise exhibitions, excursions and fairs

(vii) Discuss, argue and express scientific terminology

(viii) Improvise and manipulate instruments using his acquired knowledge.

D. Attitudes.

Science teaching directly inculcates the scientific attitudes among the students. So the students should be taught directly and systematically and every individual should be paid heed to ascertain that he develops the desired attitudes and practices them. A man with the scientific attitude is

(a) Critical in observation and thought

(b) Open-minded

(c) Respectful of others' view point and is ready to discuss his problems with others and accepts what appears correct.

(d) In search of the answers to 'What's' and 'Whys' and 'How's' of the things he observes and accepts the natural things as such.

(e) Objective in his approach to problems.

(f) Not a believer of superstitions and misbelieves.

(g) Follower of cause and effect relationship.

(h) Truthful in his experimentation and conclusions.

(i) Impartial and unbiased in his judgments.

(j) Adopts planned procedure in solving a problem.

E. Reflective Thinking.

With the above attitudes developed, a science student will handle a problem scientifically. He will sense a problem, define it, collect evidence, organize and interpret the data, formulate the hypothesis, test its validity and finally draw conclusions impartially. The training in the scientific method should be one of the important aims of teaching science. All these attributes leads to reflective thinking.

F. Habits.

Certain socially desirable habits like honesty, truth, tolerance, self-confidence, self-reliance etc. should be inculcated through the science teaching.

G. Interests.

The teaching of science should also aim at developing some interests in reading scientific literature, in scientific hobbies, in activities of clubs, excursions, in natural phenomena; in drawing, in leadership, etc. The motivational techniques like rewards and punishments, praise and blame, rivalry and emulation etc. should be implied by the teacher.

H. Appreciation.

The appreciation of natural beauty, scientific inventions, scientists' endeavour is the outcome of science teaching. For such purpose, the teacher should arrange outings, should relate the life histories of scientist and should keep the students in touch with the new inventions in science.

I. Providing Work for Leisure.

As the empty mind is devil's workshop, a science student should not waste his leisure. He can prepare inks, soaps, boot polishes and other daily useful things or he can keep hobbies of stamp collecting, coin collecting, photography, drawing, gardening, study of plants and animals or of minerals etc. He can learn to improvise certain

instruments, learn to play for musical instruments along with its construction knowledge, etc.

J. Training for Better Living.

A science student should know the ways and means of prevention and eradication of diseases to maintain good health, and should be able to adjust himself with his own domestic, social environment and economic and cultural conditions.

K. Forming Basis for Career.

The attitudes and interests of the students should well be adjudged by the science teachers and they should impart them the knowledge accordingly so that they may prosecute the desired professions. An artist can never be a doctor. So nothing should be forced into the minds of the students. Acceleration should be provided in his own direction to get a suitable vocation and fit himself well in society and prove an asset to it.

Aims & Objectives of Teaching Science

Primary Level

The aims and objectives of Teaching Science at Primary School level should be:

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

2. Middle School Level

In addition to the above, the following aims and objectives are suitable for inculcation at the Middle School, level.

1. Acquisition of a kind of information concerning nature and science which may also serve as the basis for a late General Science Course.
2. Developing the ability to reach generalisation and to apply them for solving every problem.

3. Understanding the impact of science upon one way of life.
4. Developing interest in scientific hobbies.
5. Inspiring children by stories about scientists and their discoveries.

3. Higher Secondary Levels

At the higher secondary stage, the aims of General Science teaching 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 adjust himself to his environment.
2. To acquaint him with the 'scientific method' and to enable him to develop proper scientific attitude.
3. To give the pupil a historical perspective, so that he may understand the evolution of the scientific development.

The Indian Education Commission (1964-66) has suggested the aims and objectives of teaching science at various levels:

1. Lower Primary Stage

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

(ii) In classes I and II, the accent should be on cleanliness and formation of healthy habits.

(iii) Development of power of observation.

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

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

(vi) Developing proper understanding of the main facts, concepts, principles and processes in the physical and biological environment.

2. Upper Primary Stage

(i) At this stage 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, 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.

3. Secondary stage

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

(ii) At the lower secondary class physics, chemistry, biology and earth sciences should be taught as compulsory subjects.

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

2.4 Bloom's Taxonomy of Educational Objectives & Writing Objectives in behavioral terms.

Bloom's Revised Taxonomy

Taxonomy of Cognitive Objectives-1950s-developed by Benjamin Bloom is a means of expressing qualitatively different kinds of thinking. It was adapted for classroom use as a planning tools continues to be one of the most universally applied models to organize thinking skills into six levels, from the most basic to the more complex levels of thinking. Lorin Anderson (former student of Bloom) revisited the taxonomy, as a result, a number of changes were made.

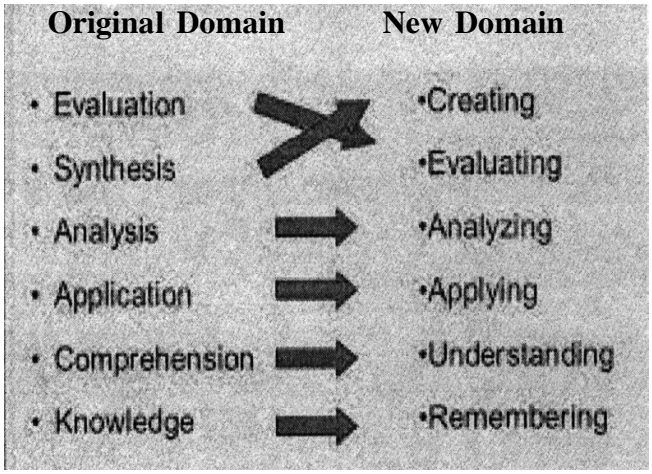


Fig: 1. Revised Bloom's Taxonomy of Educational Objectives

Source : tip¦uark.edu

Revised Bloom's Taxonomy of Educational objectives

The names of six major categories were changed from noun to verb forms.

- As the taxonomy reflects different forms of thinking and thinking is an active process, verbs were used rather than nouns.
- The subcategories of the six major categories were also replaced by verbs and some subcategories were reorganized.
- The knowledge category was renamed. Knowledge is an outcome or product of thinking and not a form of thinking per se. Consequently, the word knowledge was inappropriate to describe a category of thinking and was replaced with the word remembering instead.
- Comprehension and synthesis were renamed to understanding and creating respectively, in order to better reflect the nature of the thinking defined in each category.

The Cognitive Dimension Process

LEVEL 1

Categories & Cognitive Processes	**Alternative Names**	**Definition**
Remember		**Retrieve knowledge from long-term memory**
Recognizing	Identifying	Locating knowledge in long-term memory that is consistent with presented material
Recalling	Retrieving	Retrieving relevant knowledge from long-terrn memory

LEVEL 2

Categories & Coqnitive Processes	Alternative Names	Definition
Understand		**Construct meaning from instructional messages, including oral, written, and graphic communication**
Interpreting	Clarifying Paraphrasing Representing Translatinq	Changing from one form of representation to another
Exemplifying	Illustrating Instantiating	Finding a specific example or illustration of a concept or principle
Classifying	Categorizing Subsuminq	Determining that something belongs to a cateqory
Summarizing	Abstracting Generalizing	Abstracting a general theme or major point(s)
Inferring	Concluding Extrapolating Interpolating Predicting	Drawing a logical conclusion from presented information
Comparing	Contrasting Mapping Matching	Detecting correspondences between two ideas, objects, and the like
Explaining	Constructing models	Constructing a cause and effect model of a system

LEVEL 3

Categories & Cognitive Processes	Alternative Names	Definition
Create		**Put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure**
Generating	Hypothesizing	Coming up with alternative hypotheses based on criteria
Planning	Designing	Devising a procedure for accomplishing some task
Producing	Constructing	Inventing a product

Source : Anderson, Lorin W. & Krathwohl, David R. (2001). *A Taxonomy for Learnmg, Teaching and Assessing: A Revision of Bloom's Taxonomy.* New York. Longman Publishing.

BEHAVIORAL OBJECTIVES

An objective

- Is an intent communicated by a statement describing a proposed change in a learner.
- Is a statement of what the learner is to be like when he/she has successfully completed a learning experience.

A behavioural or instructional objective describes an intended outcome. A usefully stated objective is stated in behavioral, or performance, terms that describe what the learner will be doing when demonstrating his/her achievement of the objective. An instructional objective must.

- Describe what the learner will be doing when demonstrating that he/she has reached the objective; i.e.,

  What should the learner be able to do? **(Performance)**

- Describe the important conditions under which the learner will demonstrate his/her competence; i.e.,

  Under what conditions do you want the learner to be able to do it? **(Conditions)**

- Indicate how the learner will be evaluated, or what constitutes acceptable performance; i.e.,

  How well must it be done? ***(Criterion)***

A behavioral objective, or an Instructional objectives, which is student-oriented, places the emphasis upon what the student is expected to do, not upon what the teacher will do. Sometimes teachers use instructional goals which emphasize what they are expected to do rather than what they expect of their students.

Instructional objectives may also be called performance **objectives**, behavioral **objectives,** or simply objectives. All of these terms are used interchangeably. **Objectives** are specific, outcome based, measurable, and describe the learner's behavior after **instruction.**

Behavioral objectives that are useful in the classroom must meet certain criteria. The four essential elements of a well-written behavioral objective are outlined below. When writing a behavioral objective, evaluate it using these criteria.

1. **Good behavioral objectives are student-oriented.** A behavioral objective, which is student-oriented, places the emphasis upon what the student is expected to do, not upon what the teacher will do.

   Sometimes teachers use instructional goals which emphasize what they are expected to do rather than what they expect of their students. Such teacher-oriented objectives only have the value to the extent that they direct the teacher to do something, which ultimately leads to student learning.

2. **Good behavioral objectives describe learning outcomes.**The important thing to keep in mind here is that we are interested in what the students will learn to do. In other words, it is the learning outcome that is important, not the learning activities that should lead to that outcome.

   It may be helpful to you as a teacher to determine what kind of learning activities you may want your students to carry out. However, determining which learning experiences and activities are most appropriate for your students can only be made afteryou have decided what it is you want your students to

accomplish. Once learning outcomes are identified and described, then activities that are appropriate for attaining those outcomes can be determined.

3. **Good behavioral objectives are clear and understandable.**The first prerequisite for a clear and understandable objective is explicitness. It should contain a clearly stated verb that describes a definite action or behavior and, in most cases, should refer to an object of that action.

4. **Good behavioral objectives are observable.** The evaluation of learning outcomes hinges on the ability to observe those outcomes. The key to an observable objective is an observable verb. Consequently, when selecting behavioral objectives for use in your teaching, watch the verbs! The verb must describe an observable action or an action that results in an observable products.

Course objective:

- What a successful learner is able to do at the end of the course.
- Is a description of a product, of what the learner is supposed to be like as a result of the process.

The statement of objectives of a course/programe must denote *measurable* attributes *observable* in the graduate of the program; otherwise it is impossible to determine whether or not the program is meeting the objectives.

Undesirable words	Desirable words
(open to many interpretations)	(open to fewer interpretations)
To KNOW	To WRITE
To UNDERSTAND	To RECITE
To ENJOY	To IDENTIFY
To APPRECIATE	To DIFFERENTIATE
To GRASP THE SIGNIFICANCE OF	To SOLVE
To COMPREHEND	To CONSTRUCT
To BELIEVE	To LIST
	To COMPARE

Steps to Write Behavioural Objectives :

Steps to write objectives that will describe the desired behavior of the learner:

1. Identify the terminal behavior or performance by name; i.e., specify the kind of behavior that will be accepted as evidence that the learner has achieved the objective.
2. Define the desired behavior further by describing the important conditions under which the behavior will be expected to occur.
3. Specify the criteria of acceptable performance by describing how well the learner must perform to be considered acceptable.

Performances may be visible, like writing, repairing, or painting; or invisible, like adding, solving, or identifying. If a statement does not include a visible performance, it isn't yet an objective.

An Example:

Stated in behavioral terms	Stated in performance terms
"To develop an appreciation for music"	"The learner correctly answers 95 multiple choice questions on the vibration mechanism in music"
"To be able to recall various factors of environmental degradation"	To be able to write a summary of the factors leading to the environmental degradation"

To state an objective that will successfully communicate your educational intent, you will sometimes have to define terminal behavior further by stating the conditions you will impose upon the learner when he/she is demonstrating his/her mastery of the objective.

2.5 Lesson Planning, importance and basic steps

Lesson plan is an out line of important points of a lesson arranged in a order in which they are to be presented. It includs objectives, points to be presented, question to be asked, references, assignments etc.

Importance for planning a lesson :

- Lesson planning makes the teaching regular, well organised, and systematic.
- It enhanes the Self-confidence and self-reliance of the teacher.
- It facilitates appropriate use of aids of apprepriate places.
- It is economical in terms of time, as every step has been planned with fore thought. Repetition is hence avoided.

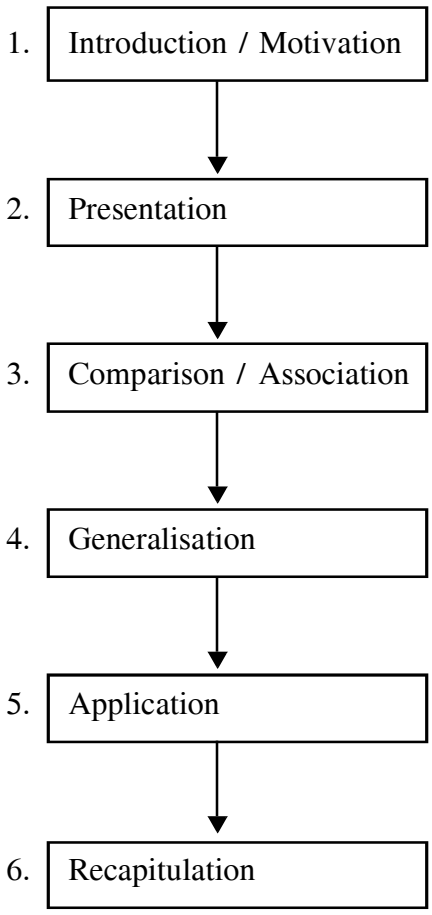
- It establishes proper connection between different lessons of study, the teaching learning process to be continued in a proper way.
- Student's interest can be retained by planning suitable activities and assignments, according to the mental level of the students.

A good lesson plan must contain three components :

1. Objectives : (Why should this lesson be taught?)
2. Content : (What should be taught?)
3. Method : (How should be taught?)

Steps :

According to J.F. Herbart, six formal steps should be followed during the development of a lesson plan.



Diffrences between Unit Plan & Lesson Plan

	Unit Plan	Lesson Plan
Time :	The time span of planning is relatively long.	Time Span is relatively short.
Objective :	It includes relatively more general objectives.	It includes specific objectives
Activity :	Teacher's activity and pupils expected activities are not written	In this plan, both activities are written briefly.
Model :	Here, we just write about model and demonstration, where and when used it any.	Here we should prepare the experiment if any used
Examples :	Examples and Illustration, are not included with content in planning	Illustrations and examples are included with content in planning
Flexibility :	Unit plan is mere flexible than lesson plan.	Lesson plan is comparatively less flexible than unit plan.

How to prepare a good lesson?

Step-I Consider your overall objectives.

Step-II Consider the group.

Step-III Consider the time available.

Step-IV Consider the Resources available.

Step-V Plan and Schedule the subject matter.

Lesson Plan format

Name of the student teacher : ————————

Name of the School : ————————

Class : ———————— Date :

Subject : ———————— Period :

Topic : ———————— Lesson No.–

Entry Behaviour :

Objectives :

Method :

Media :

Introduction

Presentation :

Teaching Point	Instructional objectives	Teachers Activity	Students Activity	Evaluation
1.				
2.				
3.				

Recapitulation :

Home Assignment :

Summary of Black Board work :

2.6 Unit Planning : Format of a Unit Plan

According to Samford, 'a unit is an outline of carefully selected subject matter which has been isolated because of its relationship to pupil's needs and interests.''

The unit plan gives an idea about how to go about instructional or daily lesson plan. It is an overview of number of lessons or periods required, audio-visual aids to be used, objectives to be achieved, methods or strategies to be adopted, reference books for further studies for the teachers and students. Every unit is a substantial part of text book and every unit is a set of several concepts and related skills and can be taken up in subsequent days.

Criteria for a good unit plan :

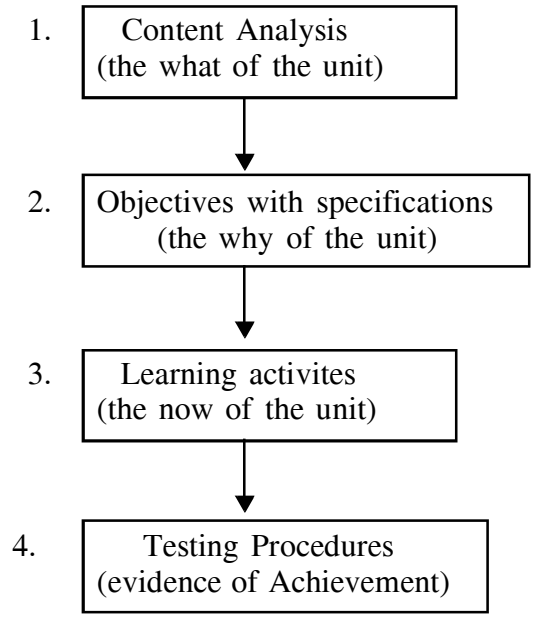
During preparing of a unit plan, the following points should be kept in mind :

- It should be related to the social and physical environments, of the students.
- It should be based on the need, capabilities and interest of the students.
- It should be as a result of co-operative planning between teacher and pupil.
- It should provide project work, excursions, film viewing, demonstration etc.

- Students should be provided with enough time to plan, organise and work on their own.
- Provision should be there for evaluation and follow up.
- It should be flexible so as to allow the above average pupils to go beyond the limits of the units.
- It should help in anticipating and satisfying the future needs of the students.

Steps of Unit Planning :

During planning of a unit the following factors should be kept in mind.



Format of a unit plan :

Subject : Class :

Name of the Unit : Date :

No. of Classes :

1.	Content Analysis.		1. 2. 3.
2.	Objectives with specification.		1. 2. 3.
3.	Learning activities.	Student activities Teaching Strategies	
4.	Evaluation and testing Procedures.		

Example of Unit Planning :

Subject : Chemistry — Name of the Unit : Chemical Componds

Class : IX — No. of classes : 08

1. Content Analysis : * Washing Soda
   * Baking Soda
   * Bleaching Powder
   * Cement
2. Learning Objectives :

The students will :

- develops an awareness of various chemical componds.
- recalls the formulae for washing soda, baking soda, bleaching powder and cement.
- recognises the properties of the above mentioned salts.
- describes with a clearly labeled diagram of solvey process.
- interprets the bleaching effect of bleaching powder.
- illustrates the manufacture of port land cement.

3. **Learning activities**

Students activities :

The students will

- Perform experiment to find out the reaction of Na_2Co_3 with acid.
- Sketches the diagram of solvey process with reactions.
- Develops skill in using washing soda, bleaching powder etc.

Teaching strategies :

- Demonsration on a) reaction of Na_2Co_2 with acid.
  b) bleaching action of bleaching powder.
  c) application of chosen salt in daily life.

- Drawing on the Black Board : Solvey Process Manufacture of Portland cement Visit to a neighbour cement factory.

Valuation and Testing Procedures :

- Problems at the end of the chapter in Prescribed Text Book.
- Test framed with questions in relation to content mentioned on the basis of their learning objectives.
- Excercises to evaluate whether the student can :—
  - i) balance equations
  - ii) Identify the different salts.
  - iii) List the composition of cement.

2.7 Pedagogical Analysis : Meaning and need, Guidelines for conducting Pedagogical analysis

Previously, pedagogy was defined as a study of the methods of teaching a subject or methods of instructions given to the students to change their behaviour. But at present pedagogy is perceived not merely as a science of instruction, but also as a culture or set of cultures which reflect different context and different teaching behaviours-inside and outside the classroom.

Using culture-sensitive pedagogy would mean incorporating different aspects of students' cultural background into the teaching-leamig Process. In the National Curriculum Framework of Teacher Education (NCFTE, 2009), it was pointed out :

> *Pedagogical analysis of school teaching subjects has been thought of as an essential component of practice teaching. By way of pedagogical analysis, a pupil-teacher becomes conversant with the objectives of teaching a unit, the entry behaviour of students, classroom management and evaluation strategies. With this background of having looked into the pedagogical aspects of school teaching subjects, the pupil-teacher is likely to become more effective and confident in the classroom.*

1. Pre-active stage
2. Interactive stage

3. Post-active stage

The basic element of the model is pedagogical analysis, sometimes referred to as 'task analysis', which is a major part of pre-active (planning) stage. It emphasizes the need to undertake separate but linked investigations of the learners' and teachers' tasks, and proposes helpful procedures for affecting both of these. The analysis of the teaching task hinges the teacher's ability to identify the 'type of learning' involved in the learning task. This requires sound knowledge and understanding of the learning theories. With the employment of procedures stipulated in the model, knowledge can be gained through a reasoned inquiry into the relevance and usefulness of such theories. The interactive (implementation) stage is subsequently directly assisted by -this analysis because it has 'classroom reality'.

Major Steps in Pedagogical Analysis

While performing pedagogical analysis of a unit, topic or content, we proceed with the help of the following steps :

Step 1 : Identification of major concepts and their inclusive concepts, i.e. sub-concepts.

Step 2 : Translate them into behavioural objectives.

Step 3 : Teaching methods to be used.

Step 4 : Learning experiences to be given.

Step 5 : Type of learning which will take place.

Step 6 : Pupil's response pattern.

Step 7 : Evaluation strategies to be adopted.

Example of Pedagogical Analysis

Pedagogical analysis of the topic 'Flower'

Step 1: Identification of major concepts and their inclusive concepts or sub-concepts :

1. The meaning of flower

2. Different types of flower
3. Parts of flower
   (a) Calyx (sepals)
   (b) Corolla (petals)
   (c) Androecium (stamens)
   (d) Gynoecium (carpels)
4. Functions of a flower and its various parts
5. Floral symmetry
   (a) Actinomorphic or regular flower
   (b) Zygomorphic or irregular flower
   (c) Assymetrical flower
6. Position of floral whorl on the thalamus

Step 2: Objectives specification in behavioural terms

After the class is over, the students should be able to :

- Recall the definition of flower.
- Recognize different types of flowers.
- Discriminate between different parts of a flower, such as calyx, corolla, androecium, and gynoecium.
- Draw a labelled diagram of a flower.
- Dissect the flower easily and classify the parts on the basis of floral symmetry.
- Illustrate the position of floral whorl on the thalamus.
- Show interest in knowing about parts and functions of flowers grown in the school botanical garden.

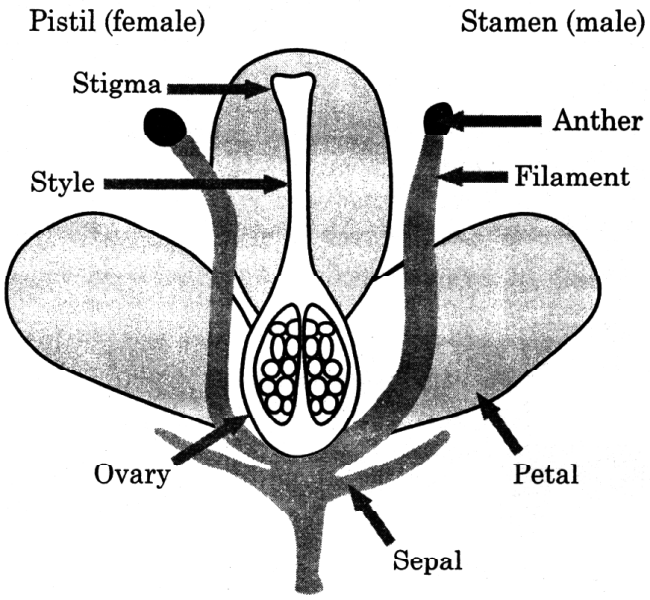
Step 3: Teaching method to be used

- Lecture-cum-demonstration
- Group activity with the samples of flowers
- Constructive approach

Step 4: Learning experiences to be given

Discussion and activity-based 1eaming experiences will be given, which are briefly described here:

1. Discussion will be supported with:
   (a) Demonstration of an actual flower
   (b) Group activity with flowers
   (c) Sketching and drawing on blackboard
   (d) Charts and pictures of different kinds of flowers, see Figure 6.1.



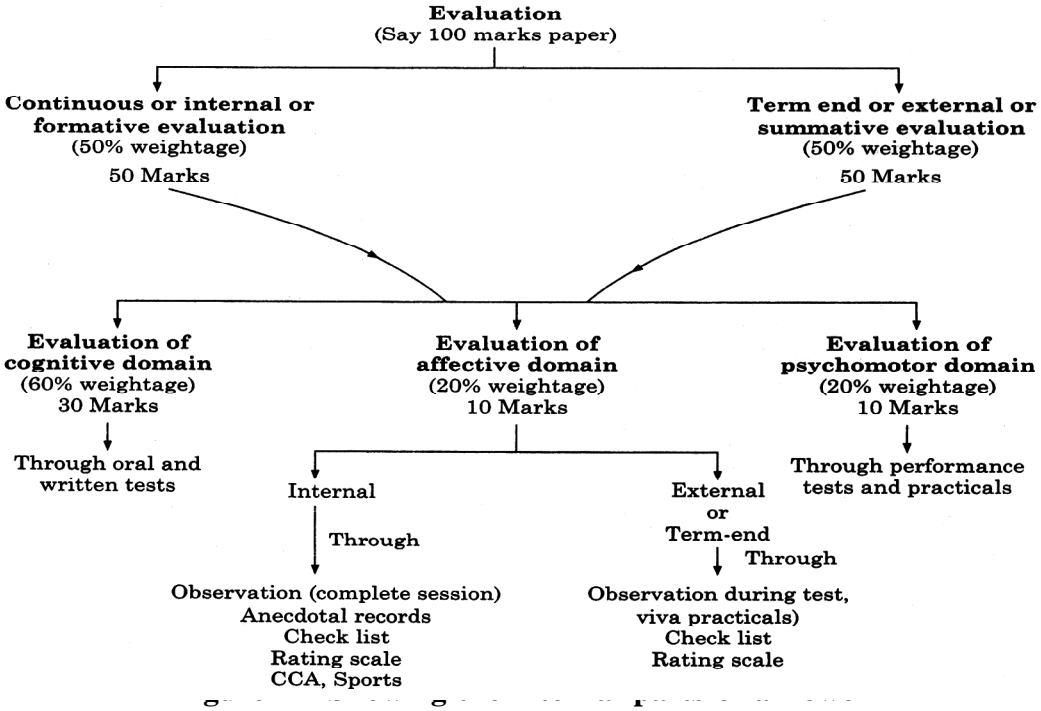
Figur parts.

2. The main points will be highlighted and concepts explained properly with suitable support system such as:

(a) Definition of flower, its structure and functions

(b) Providing diagram, pictures, models to show internal parts of flower (see Figure 7.2)

(c) Providing points of differences between different types of flowers



Through this diagram the students will be able to understand parts and functions of a flower.

3. Different types of flowers will be discussed and demonstrated properly, as given here:

   (a) Dioecious, e.g. mulberry

   (b) Complete flower, e.g. rose

   (c) Incomplete flower, e.g. rasberry, strawberry

   (d) Bisexual flower, e.g. mustard, china rose

   (e) Unisexual flower, e.g. papaya

   (f) Sessile flower, e.g. Ficus, *Trillium*

4. Flowers will be, distributed to all the students to help them understand floral symmetry and they will be instructed to observe and dissect them to analyse the features.

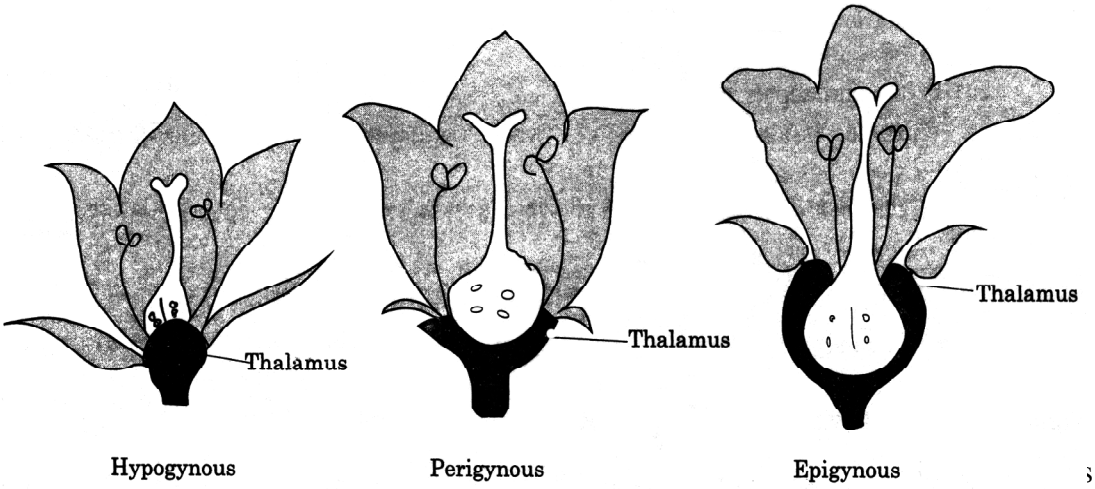
   (a) Actinomorphic, e.g. mustard. The flower can be divided into two equal

halves by any plane.

(b) Zygomorphic, e.g. pea. The flower can be divided into two equal halves by one plane only.

(c) Assymetrical, e.g. canna. The flower can not be divided into two equal halves along any plane.

5. The position of floral whorl on thalamus. After the students dissected the flower, diagram will be made and pictures used for their understanding (Figure 6.3). The students will be asked to write their observation and give examples of hypogynous, perigynous and epigynous flowers.



by dissecting them. They will be told to note down the specific characteristics found in the flowers and compare them with the flowers of other students.

Step 5: Type of learning which will take place

Activity-based constructive learning will occur. Students will dissect their flowers and form knowledge by exploring parts of flowers, floral symmetry, position of the floral whorl on thalamus as shown in Figure 6.3.

Step 6: Students response pattern

Students will listen to the lecture, participate in discussion and activities. They will observe and 'dissect the given flowers and try to analyse their structure and functions. The pupils will then draw diagrams and compare various flowers with regard to their structures and functions of different parts.

Step 7: Evaluation strategies to be adopted

Evaluation will be based on objective and short answer-type questions. For example:

1. Give answers in one word for the following:
   (a) A modified shoot having condensed nodes and internodes with leaves modified into floral parts.
   (b) Male and female parts in the same flower.
   (c) Part of flower which receives pollen grains.
   (d) A flower in which ovary occupies the highest position, and all whorls arise below it.
2. Complete the following sentences :
   (a) When a flower is divided into two equal halves in one plane, the flower is said to be .....
   (b) Petals and sepals are collectively called as
   (c) Thalamus is also known as
   (d) Flowers lacking stalks are called
   (e) Part of flower which protects essential whorl during bud stage is called
3. See Figure 7.4 and give answers to the following questions:

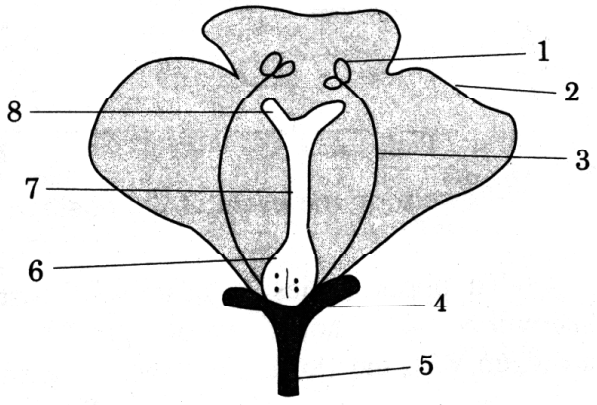


Figure 7.4 **ım 1 to 8.**

(a) Label tl

(b) Name the floral symmetry of the flower shown in Figure 6.4.

(c) Name the position of floral whorl on thalamus.

(d) List one function of any two parts from the above diagram.

2.8 Let us sum up

The general aims of science education follow directly from the six criteria of validity : cognitive, content, process, historical, environmental and ethical. To summarize, science education should enable the learner to :

- know the facts and principles of science and its applications, consistent with the stage of cognitive development,
- acquire the skills and understand the methods and processes that lead to generation and validation of scientific knowledge,
- develop a historical and developmental perspective of science and to enable her to view science as a social enterprise,
- relate to the environment (natural environment, arti facts and people), local as well as global, and appreciate the issues at the interface of science, technology and society,
- acquire the requisite theoretical knowledge and practical technological skills to enter the world of work,
- nurture the natural curiosity, aesthetic sense and creativity in science and technology,
- imbibe the values of honesty, integrity, cooperation, concern for life and preservation of environment, and
- cultivate 'scientific temper' -objectivity, critical thinking and freedom from fear and prejudice.

Within the frame of reference of general aims, the objectives, content, pedagogy and assessment would differ across different stages on the scope and gradation of the school curriculum. While deciding on gradation of science curriculum, it must be borne in mind that a majority of students learning science as a compulsory subject up to Class X are not going to train as professional scientists or technologists in their

later careers; yet they need to become 'scientifically literate', since several of the social, political and ethical issues put forward by contemporary society increasingly revolve around science and technology. As a result, the science curriculum up to Class X should be oriented more towards developing awareness among the learners about the interface of science, technology and society & especially to the issues of environment and health, and enabling them to acquire practical knowledge and skills to enter the world of work. It should stress not only the content of science, but, more importantly, the process skills of science, that is, the methods and techniques of learning science. This is necessary since the process skills are more enduring and enable the learner to cope with the ever changing and expanding field of science and technology. This does not mean that the content can be ignored. Facts, principles, theories and their applications to understand various phenomena are at the core of science and the science curriculum must obviously engage the learner with them appropriately. However, science up to Class X should be learnt as a composite subject and not as separate disciplines such as physics, chemistry and biology. At the higher secondary stage, however, the requirements of different disciplines of science become important and they need to be learnt in depth and with rigor appropriate at that stage.

2.9 Check Your Progress

1. What is the difference between aims & objectives?

   .....

   .....

   .....

2. Define behavioural objectives.

   .....

   .....

   .....

3. Mention the revised Bloom's Taxonomy of Educational objectives by help of a schematic diagram.

.....

.....

.....

4. Define lesson plan & unit plan & state any 3 differences between the two concepts.

.....

.....

.....

5. State the importance of lesson planning.

.....

.....

.....

6. What is meant by action verb?

.....

.....

.....

7. Define Pedagogical analysis according to NCFTE 2009.

.....

.....

.....

8. Mention the major steps of pedagogical analysis.

.....

.....

.....

9. Enumerate the basic steps of unit planning.

.....

.....

.....

10. What is the need of pedagogical analysis of a content in science teaching.

.....

.....

.....

2.10 References

Innovative Science Teaching - Radha Mohan, 2003, Prentice Hall of India Publishing

Modern Science Teaching - R.C Sharma, 1999, Dhanpat Publishing

Teaching of Chemistry-M.S Yadav, 2004, Anmol Publishers

Teaching of Chemistry- Anjali Khirwadkar, Swaroop & Sons Publishers.

Teaching of Biological sciences- Jashim Ahmed,

http://www.ilt.columbia.edulpublications/papers/icon.html

http://www.ltag.education.tas.gov.au/planning/modelsprincbackdesign.htm.

http://www.ncpublicschools.org/

www.etsu.edu/uged/etsul OOO/documents/Daies _cone _ oC experience. pdf

Instructional Media: Selection and Use Craig 1. Scanlan, EdD, RRT, FAARC

www.umdnj.edu/idsweb/idst5330Iinstructional_media.htm.

http://etc.usf.edulbroward/mod2/module2.html

http://knol.google.com/k/low-cost-teaching -aids- for-rural-schoo ls- in- india

Unit 3 ❑ Approaches & Methods of Teaching Science

Structure :

3.1 Introduction

About 3000 BC, with the advent of *writing*, education became more conscious or self-reflecting, with specialized occupations such as scribe and astronomer requiring particular skills and knowledge. Philosophy in ancient Greece led to questions of educational method entering national discourse.

In his literary work, *'The Republic'*, Plato described a system of instruction that he felt would lead to an ideal state. In his dialogues, Plato described the Socratic method, a form of inquiry and debate intended to stimulate critical thinking and illuminate ideas.

Comenius, in Bohemia, wanted all children to learn. In his *'The World in Pictures'*, he created an illustrated textbook of things children would be familiar with in everyday life and used it to teach children

Much later, Jean-Jacques Rousseau in his *'Emile'*, presented methodology to teach children the elements of science and other subjects. During Napoleonic warfare, the teaching methodology of Johann Heinrich Pestalozzi of Switzerland enabled refugee children, of a class believed to be unteachable, to learn.

The Prussian education system was a system of mandatory education dating to the early 19th century. Parts of the Prussian education system have served as models for the education systems in a number of other countries, including Japan and the United States. The Prussian model required classroom management skills to be incorporated into the teaching process.

Newer teaching methods may incorporate television, radio, internet, multimedia and other modern devices. Some educators believe that the use of technology, while facilitating learning to some degree, is not a substitute for educational methods that encourage critical thinking and a desire to learn. Inquiry learning is another modern teaching method. A popular teaching method that is being used by a vast majority of teachers is hands on activities. Hands-on activities are activities that require movement, talking, and listening, it activates multiple areas of the brain.

School science programs are traditionally designed to give children lots of information, have them memorize that information, and then ask them to recall the information on written tests. That approach may be a significant reason for students' less-than-enthusiastic response to science, because that type of instruction does not allow for the active involvement of students in their own learning, nor does it allow children's opportunity to think creatively about what they are learning.

Yet, teachers and parents intuitively know that when students, no matter what their abilities or interests, are provided with opportunities to manipulate information in productive ways, learning becomes much more meaningful. This is a process approach to learning - an approach which provides students with an abundance of projects, activities, and instructional designs that allow them to make decisions and solve problems. Through this approach students get a sense that learning is much more than the commission of facts to memory. Rather, it is what ch i Idren do with that knowledge that determines its impact on their attitudes and aptitudes.

A teaching method comprises the principles and methods used for instruction to be implemented by teachers to achieve the desired learning in students. These strategies are determined partly on subject matter to be taught and partly by the nature of the learner. For a particular teaching method to be appropriate and efficient it has to be in relation with the characteristic of the learner and the type of learning it is supposed to bring about. Davis (1997) suggests that the design and selection of teaching methods must take into account not only the nature of the subject matter but also how students learn. In today's school the trend is that it encourages a lot of creativity. It is a known fact that human advancement comes through reasoning. This reasoning

and original thought enhances creativity. The approaches for teaching can be broadly classified into teacher centered and student centered. In Teacher-Centered Approach to Learning, Teachers are the main authority figure in this model. Students are viewed as "empty vessels" whose primary role is to passively receive information (via lectures and direct instruction) with an end goal of testing and assessment. It is the primary role of teachers to pass knowledge and information onto their students. In this model, teaching and assessment are viewed as two separate entities. Student learning is measured through objectively scored tests and assessments. In Student-Centered Approach to Learning, while teachers are an authority figure in this model, teachers and students play an equally active role in the learning process. The teacher's primary role is to coach and facilitate student learning and overall comprehension of material. Student learning is measured through both formal and informal forms of assessment, including group projects, student portfolios, and class participation. Teaching and assessments are connected; student learning is continuously measured during teacher instruction. Commonly used teaching methods may include class participation, demonstration, recitation, memorization, or combinations of these.

Science teachers have an exciting opportunity to teach kids about how science makes the world work. Unfortunately, reduced teaching budgets and apathy on the part of students sometimes makes it difficult to get students interested in topics like biology, earth science, anatomy, physics, and chemistry. Some teachers are now using techniques such as peer learning, role-playing, and incorporating current events in science lesson plans. These techniques help engage students and help them understand the importance of science. They also make it fun to teach scientific concepts and help students understand common topics in the scientific world.

3.2 Objectives

Upon completion of the subunit, the students will be able to-

1) Know the various approaches and methods of teaching sciences

2) Understand the different strategies of teaching sciences

3) Create different situations of learning engagement

3.3 Different approaches & methods

Process approach

Educators' emphasis to improve students' learning experience, to enrich such experience has led them to search for more effective instructional strategies, strategies that can be described as student centered and that students are the main focus of the learning process, especially those processes that enable the student to use and practice higher level thinking skills and to train him to obtain knowledge, use critical thinking skills in assessing this knowledge and to implement the acquired knowledge in the different life situations. Educators emphasized that one of the goals of science education is to teach students how to think and not to memorize the learning material without understanding it or how to employ it in their daily life. To achieve such an objective, science instruction must focus on assisting students acquire scientific thinking skills, focus on science methods and processes. Students' acquisition of science processes is a priority in science instruction where, if students are fully trained how to use them, enable students to be more practical in their thinking. Therefore; science teachers have the responsibility of providing students with scientific opportunities and effective learning situations, activities leading to the practice of higher order thinking skills such as the use of problem solving skills, using science processes.

A process approach to science is one in which children do something with the concepts and generalizations they learn. It implies that students can manipulate, decide, solve, predict, and structure the knowledge of science in ways that are meaningful to them. When teachers and parents provide opportunities for students to actively process information - particularly information related to nature, then learning becomes more child-centered. This results in attitudes, perceptions, and beliefs that the natural world can be actively explored and personally investigated - and that the environment, both near and far, is full of incredible learning possibilities along with a whole lot of fun.

Science processes are divided into :

- Basic science processes :

Simple processes relatively and include observation, classification, measurement, communication, prediction, using space and time relationships and using figures and inferences.

- Integrated science processes :

These are advanced processes and more progressive than basic science processes in the scientific processes hierarchy and include data interpretation and procedural definitions, variables control, testing hypotheses and experimentation.

The objective of science teaching are constantly changing, developing and they arise from the science attributes, society needs and its characteristics. The most important objectives of science teaching include.

- Help students functionally acquire concepts, facts and scientific thinking skills.
- Help students functionally acquire and develop science processes.
- To develop students' skills in scientific thinking and problem solving.
- To help students develop and promote their science attitudes and tendencies.

The great challenge in modern instructional methods has become to give learners a greater part in the learning- teaching process to acquire the different experiences and develop his thinking skills as this contributes in raising individuals' sense of responsibility for self -learning and not just a recipient of information.

Process Approach based science teaching method is one of the teaching method that can help in achieving as this approach help on providing the individual learner with the necessary skills helping him make solutions and make the suitable decisions for the problem he faces at present and in the future. In light of this, the main objective of this approach is to provide the learner with the adequate competencies in science methods and scientific skills. This approach enables the learner develop a desire to learn.

Direct Experience Approach

Direct Experience approach has its roots in Experiential Education that paved the way for progressive Education. Experiential education is a philosophy of education that describes the process that occurs between a teacher and student that infuses direct experience with the learning environment and content. The term is not interchangeable with experiential learning; however experiential learning is a sub-field and operates under the methodologies of experiential education. The Association for Experiential Education regards experiential education as "a philosophy that informs many methodologies in which educators purposefully engage with learners in direct experience and focused reflection in order to increase knowledge, develop skills, clarify values, and develop people's capacity to contribute to their communities Johnn Dewey was the most famous proponent of experiential education, compiling

Experience and Education (1938). Dewey advocated that education be based upon the quality of experience.

The methodologies reflected in experiential education have evolved since the time of Hahn and Dewey. For experiential education to become efficient Pedagogy, physical experience must be combined with reflection.

Direct Experience approach in Science Education informs many educational practices underway in schools (formal education) and out-of-school (informal education) programs. Many teaching methods rely on experiential education to provide context and frameworks for learning through action and reflection. They can be listed as follows :

- Outdoor education uses organized learning activities that occur in the outdoors, and uses environmental experiences as a learning tool.
- Service learning is a combination of community service with stated learning goals, relying on experience as the foundation for meaning.
- Cooperative learning alters homogeneous groupings in order to support diverse learning styles and needs within a group.
- Active learning, a term popular in US education circles in the 1980s, encourages learners to take responsibility for their learning, requiring their experience in education to inform their process of learning.
- Environmental education is based in educating learners about relationships within the natural environment and how those relationships are interdependent. Students participate in outdoor activities as part of their learning experience.

Direct Experience serves as an umbrella for linking many diverse practices into a coherent whole. Its philosophy is closely linked to numerous other educational theories, but it should not be conflated with progressive education, critical pedagogy, youth empowerment, feminist-based education, and constructivism.

Inductive-Deductive Approach

Two very distinct and opposing instructional approaches are inductive and deductive. Both approaches can offer certain advantages, but the biggest difference is the role of the teacher. In a deductive classroom, the teacher conducts lessons by introducing and explaining concepts to students, and then expecting students to complete tasks to practice the concepts; this approach is very teacher-centred.

Conversely, inductive instruction is a much more student-centred approach and makes use of a strategy known as 'noticing'.

What is deductive instruction

This method is just opposite of Inductive method. In this method, facts are being deduced by application of established formula or experimentation. In this method, one proceed from general to particular principles, from unknown to known and from abstract to concrete facts.

A deductive approach to instruction is a more teacher-centered approach. This means that the teacher gives the students a new concept, explains it, and then has the students practice using the concept. For example, when teaching a new Science concept, the teacher will introduce the concept, explain the rules related to its use, and finally the students will practice using the concept in a variety of different ways.

According to Bob Adamson, "The deductive method is often criticized because: a) it teaches concept in an isolated way; b) little attention is paid to meaning; c) practice is often mechanical." This method can, however, be a viable option in certain situations; for example, when dealing with highly motivated students, teaching a particularly difficult concept, or for preparing students to write exams.

What is inductive instruction

Inductive method is an important procedure to prove a universal law. In this method, this is done by showing that if the law is true in a particular condition, then it will also prove to be true in other similar condition at any place of the world. This method proceeds from concrete to abstract and from a specific example to the universal law.

As all the scientific principles and conclusions are result of induction, thus this method is considered to be one of the most important methods of teaching science.

In contrast with the deductive method, inductive instruction makes use of student "noticing". Instead of explaining a given concept and following this explanation with examples, the teacher presents students with many examples showing how the concept is used.

Generalization (or Rule) — — — — — → Specific Examples or Activities

Specific Examples or Activities — — — — — → Generalization (or Rule)

Source : www.sasked.gov.policy.in

Using any learning situation from above, the teacher would present the students with a variety of examples for a given concept without giving any preamble about how the concept is used rule as a final check that they understand the concept.

Both deductive and inductive sequences are valuable for teaching concepts, generalizations, processes, and skills. When choosing, the teacher should consider a number of factors:

- How personalized should the learning be? Students will usually be more involved in the learning experience and tend to participate more actively when an inductive approach is used. If a deductive approach is chosen, it is important to structure the learning experience in order to draw on students' prior experiences and learning, and to provide for their active involvement.
- Should learning experiences be predictable? The deductive approach is more predictable because the teacher selects the information and the sequence of presentation.
- What depth of understanding and rate of retention is desired? Students tend to understand and remember more when learning occurs inductively.
- How much time is available to teach the material? The deductive approach is faster and can be an efficient way to teach large numbers of facts and concrete concepts.

Merits of Inductive Method

By making use of this method, following merits get accrue to the students as well as to teacher:

a. As this is a scientific method, thus it helps to considerable extent in developing scientific outlook among the students.

b. This method helps to develop scientific attitude among the students.

c. With the help of this method, teacher can develop qualities of critical thinking and habit of keen observation among the students properly and accurately.

d. This is a very logical and psychological approach of teaching science.

e. By this method, students get various opportunities to play an active role in learning process.

Demerits of Inductive Method

This method has certain limitations, some of which are as follows:

a. The results or conclusions drawn from such method are not found to be final in case where the amount of data is very large in number.

b. All the topics of science cannot be dealt with this method properly.

c. This method can only be used when teacher have much time for teaching process.

Merits of Deductive Method

This method has following merits:

a. As students of lower classes are being provided with established scientific principles, thus this method can prove to be effective for them.

b. This method is quite time saving as students are not required to analyse the universal principles.

c. Teacher's duty or burden gets lessen to some extent by making use of this method as a result of which teachers find themselves in a comfortable and secured position.

d. Through this method, a teacher can cover the lengthy syllabi of class in shortest period of time.

Demerits of Deductive Method

This method suffers from the following demerits:

a. As the approach of this method is non-conform and non-explanatory, because of which it is considered to' be an unscientific method of teaching.

b. Through this method, it becomes difficult for the teacher to develop scientific attitude among the students.

c. As in this method, students do not get any opportunity to play active role in learning process, thus, some experts consider it as unpsychological in nature.

d. Rote memory is being encouraged by this method among the students as a result of which they do not become self-independent.

3.4 Lecture, Demonstration, Discussion & other teaching Methods

A lecture (from the French 'lecture', meaning 'reading' is an oral presentation intended to present information or teach people about a particular subject, for example by a university or college teacher. Lectures are used to convey critical information, history, background, theories and equations. A politician's speech, a minister's sermon, or even a businessman's sales presentation may be similar in form to a lecture. Usually the lecturer will stand at the front of the room and recite information relevant to the lecture's content.

Lecture method of teaching is the oldest teaching method applied in educational institution. This teaching method is one way channel of communication of information. Students' involvement in this teaching method is just to listen and sometimes pen down some notes if necessary during the lecture, combine the information and organize it. One of the problems in this method is to grab the attention of students in class room. Another big problem is that many students in the class cannot follow the theme. Learning has a strong influence on method of teaching.

The literature on teaching and learning contains other examples of techniques to maintain students' attention in a lecture setting:

- Avoid direct repetition of material in a textbook so that it remains a useful alternative resource.
- Make connections to current events and everyday phenomena.
- Begin each class with something familiar and important to students.
- End each class by summarizing the main points you have made.
- Adopt a reasonable and adjustable pace that balances content coverage and student understanding.
- Consider using slides, videos, films, CD-ROMs, and computer simulations to enhance presentations, but remember that :

Students cannot take notes in darkened rooms.

- The text needs to be large enough to read from the back of the room.
- Students need time to summarize their observations and to draw and note conclusions.

Pay attention to delivery:-

- Maintain eye contact with students in all parts of the room.
- Step out from behind the lecture bench when feasible.
- Move around, but not so much that it is distracting.
- Talk to the students, not the blackboard.
- If using the board, avoid blocking it with A V projectors or screens.
- Shift the mood and intensity.
- Vary presentation techniques.

Advantages of Lecture Method of Teaching :

1. In this teaching method a large amount the topics can be covered in a single class period.
2. Using of this method exclude the use of any equipment or Lab.
3. Learning material is not required.
4. Student listening skills develops.
5. Logical arrangement of the material in order to present it orally.
6. Help to learn languages.

Disadvantages of Lecture Method of Teaching :

1. Psychologically this method is acceptable because individuals are not alike. Teacher delivers the same lecture to both students without recognizing the individual differences.
2. Learning is an active process thus study should encourage to actively participate in the class room instead of just listening the teacher.
3. If the language used in the lecture is above the standard of the students, they are not able to get full advantage of the lecture.
4. Lectures are often forgotten by the students soon after, while learning is retained if activities are experienced.
5. Attention level is not the same while listening the lecture.

Demonstration Method

Demonstration involves showing by reason or proof, explaining or making clear by use of examples or experiments. Put more simply, demonstration means 'to clearly show'. In teaching through demonstration, students are set up to potentially conceptualize class material more effectively. Demonstrations often occur when students have a hard time connecting theories to actual practice or when students are unable to understand application of theories.

Criteria for good demonstration:

- Identify the intended learning outcomes of the demonstration, so that you can communicate them to your students.
- Consider the various steps involved in the demonstration, listing the equipment and other materials that you will need to collect together before the lesson.
- Check whether you require teaching aids such as charts, pictures, posters and models to complement the demonstration. The board may be used to highlight key words and important points.
- Check that the classroom seating arrangements provide your students with a clear view of the demonstration.
- Rehearse the demonstration so that you are sure of the order in which to do things and can address any possible problems.
- List the questions that you can ask your students before, during and after the demonstration to engage them and focus the attention.
- Identify as many opportunities as possible to develop scientific enquiry. Allow your students to predict what will happen, observe any perceptible changes, record their observations and draw their own conclusions.

A good classroom demonstration should capture your students' interest from the start, with an appropriate introduction to the topic, reference to the intended learning outcomes and some exploratory questions to establish their current knowledge and understanding.

It is important to carry out the demonstration neatly and systematically. The intention is to provide a good example to your students if they later carry out the activity themselves.

Advantages

1. This method of teaching serves as model laboratory instruction.
2. Experiment shown as demonstration points out this matter of observation and indicates this inference.
3. It makes the pupils familiar with the nature and use of apparatus.
4. Experiments requiring special skill will merely be shown by the teacher. In this method no time is wasted.
5. Teacher's time is properly utilized in watching the students doing experiments.
6. While doing practical, there remains no necessity for explaining except educating precautions.
7. This method proves more useful if the pupils are told beforehand that they are going to do practical in the laboratory.

Disadvantages

1. There is danger of students being dishonest when teacher has to play the main role in the discussion and demonstration of the topic.
2. Teachers may be tempted to lecture rather than to teach.
3. Teachers do not try for more experiments than those given in the text book prescribed.
4. Oral discussion may not be encouraged, since it will go to restrict the demonstration experiment.
5. Practical as required may not go hand in hand with demonstration work.

DISCUSSION AS A METHOD

Small group discussion sessions often are used in large-enrollment courses to complement the lectures. In courses with small enrollments, they can substitute for the lecture, or both lecture and discussion formats can be used in the same class period. The main distinction between lecture and discussion is the level of student participation that is expected, and a whole continuum exists. Discussions can be instructor-centered (students answer the instructor's questions) or student- centered (students address one another, and the instructor mainly guides the discussion toward important points). In any case, discussion sessions are more productive when students are expected to prepare in advance.

Focused discussion is an effective way for many students to develop their conceptual frameworks and to learn problem solving skills as they tryout their own ideas on other students and the instructor. The give and take of technical discussion also sharpens critical and quantitative thinking skills.

- Decide on the goals of your class discussion. Keep in mind that the goals may change as you progress through the material during the course.
- Explain to the students how discussions will be structured. Will the discussion involve the whole class or will students work in smaller groups?
- If you want students to discuss questions and concepts in small groups, explain to students how the groups will form.
- Do not allow a few students to dominate the discussion. Some students will naturally respond more quickly, but they must be encouraged to let others have a chance. Be sure that all students participate at an acceptable level
- Look for opportunities for you or your students to bring to class mini-demonstrations illustrating important points of the day's topic.
- Be willing to adjust to the needs of your students and to take advantage of your own strengths as a teacher.

Advantages :

- emphasis on learning instead of teaching.
- participation by everyone in the class.
- development of democratic way of th inking.
- training in reflective thinking.
- traning in self-expression.
- spirit of tolerance is inculcated.
- learning is made interesting.

Limitations:

- discussion method is not appropriate for all the topics.
- it can be used only to students who have some basic knowledge in the topic.
- some of the students may feel shy or reluctant to take part while others may try to dominate.
- teacher may lose control over the students and they may end up in quarelling.

PROBLEM-SOLVING METHOD

Problem-solving is a process-an ongoing activity in which we take what we know to discover & what we don't know. It involves overcoming obstacles by generating hypo theses, testing those predictions, and arriving at satisfactory solutions. Problem-based learning is a method of educating adult learners that combines theoretical knowledge with practical application. The process engages participants in considering complex and challenging issues and encourage them to work collaboratively towards finding an appropriate Solution.

Problem-solving involves three basic functions:

1. Seeking information
2. Generating new knowledge
3. Making decisions

Problem-solving is, and should be, a very real part of the curriculum. It presupposes that students can take on some of the responsibility for their own learning and can take personal action to solve problems, resolve conflicts, discuss alternatives, and focus on thinking as a vital element of the curriculum. It provides students with opportunities to use their newly acquired knowledge in meaningful, real-life activities and assists them in working at higher levels of thinking.

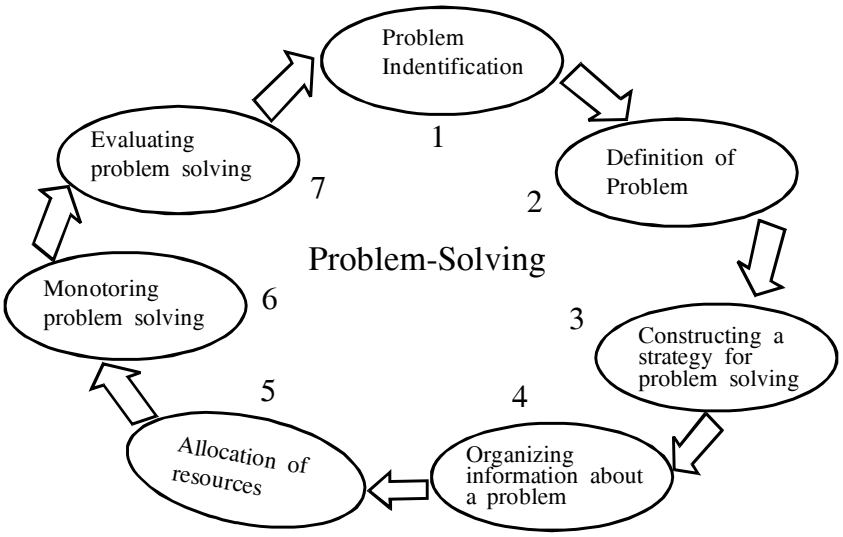


Fig : A Problem–Solving cycle

Here is a five-stage model that most students can easily memorize and put into action and which has direct applications to many areas of the curriculum as well as everyday life:

Here are some techniques that will help students understand the nature of a problem and the conditions that surround it:

- List all related relevant facts.
- Make a list of all the given information.
- Restate the problem in their own words.
- List the conditions that surround a problem.
- Describe related known problems.

For younger students, illustrations are helpful in organizing data, manipulating information, and outlining the limits of a problem and its possible solution(s). Students can use drawings to help them look at a problem from many different perspectives.

1. Understand the problem It is important that students understand the nature of a problem and its related goals. Encourage students to frame a problem in their own words.
2. Describe any barriers Students need to be aware of any barriers or constraints that may be preventing them from achieving their goal
3. Identify various solutions. After the nature and parameters of a problem are understood, students will need to select one or more appropriate strategies to help resolve the problem. Students need to understand that they have many strategies available to them and that no single strategy will work for all problems. Here are some problem-solving possibilities:
    - Create visual images.Many problem-solvers find it useful to create "mind pictures" of a problem and its potential solutions prior to working on the problem.
    - Guesstimate. Give students opportunities to engage in some trial-and-error approaches to problem-solving.
    - Create a table. A table is an orderly arrangement of data.
    - Use manipulatives. By moving objects around on a table or desk, students can develop patterns and organize elements of a problem into recognizable and visually satisfying components.
    - Look for a pattern. Looking for patterns is an important problem-solving

strategy because many problems are similar and fall into predictable patterns.

- Create a systematic list. Recording information in list form is a process used quite frequently to map out a plan of attack for defining and solving problems. Encourage students to record their ideas in lists to determine regularities, patterns, or similarities between problem elements.

4. Tryout a solution. When working through a strategy or combination of strateg.ies, it will be important for students to try out & monitor strategies.
5. Evaluate the results. It's vitally important that students have multiple opportunities to assess their own problem-solving skills and the solutions they generate from using those skills.

CONCEPT-MAPPING

A concept map is a way of representing relationships between ideas, images, or words in the same way that a sentence diagram represents the grammar of a sentence, a road map represents the locations of highways and towns, and a circuit diagram represents the workings of an electrical appliance. In a concept map, each word or phrase connects to another, and links back to the original idea, word, or phrase. Concept maps are a way to develop logical thinking and study skills by revealing connections and helping students see how individual ideas form a larger whole.

Concept-mapping as a teaching method to promote critical thinking is based on the theoretical foundation laid down by educational psychologists (Ausubel 1963; Ausubel, Novak & Hanesian 1978). The fundamental idea is to determine how learning occurs and how thinking develops.

Steps in Developing a Concept Map

The process of concept mapping involves three major steps :

- **Step 1 :** List key concepts/terms related to the topic
- **Step 2 :** Build up concepts to elaborate key concepts
- **Step 3 :** Identify links between concepts

Step I : List key concepts related to the topic

List all the concepts related to the topic which you consider essential to understanding the topic. for example, for the topic "cooperative learning," Jose determined the key concepts to be:

- Team Responsibilities
- Individual Responsibilities
- Characteristics
- Roles
- Basic Elements
- Expected Behaviors

Step 2 : Build up concepts to elaborate key concepts

After defining the key concepts, you then expand on those concepts. Ask yourself the question:

"What are the important concepts, facts, ideas, terms, etc. that explain the key concept?"

Step 3 : Identify links between concepts

It is important to show how or why certain concepts relate to one another. This is called linking explaining the connection between two separate parts of your concept map.

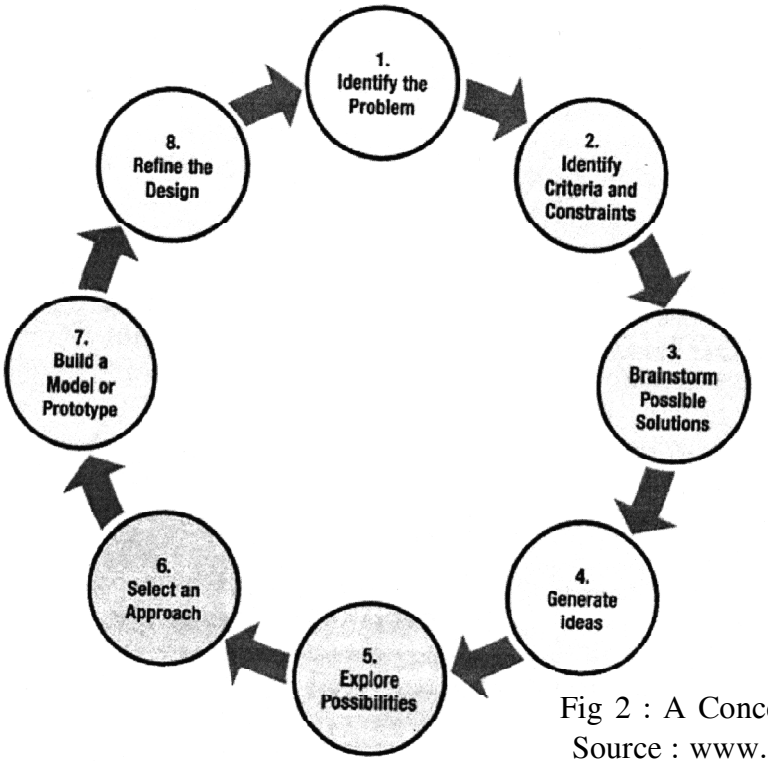


Fig 2 : A Concept mapping cycle
Source : www.scienceedu.gov.in

Characteristics of Concept Maps

- Focus question - clearly specifies the problem or issue the concept map should help to resolve.
- Propositions - a concept map consists of a graphical representation of a set of propositions about a topic.
- Hierarchical structure - the most general concepts are at the top of the map and the more specific, less general concepts are arranged hierarchically below.
- Cross-Links - relationships or links between concepts in different segments or domains or the concept map. Cross-links often represent new insights on the part of the knowledge producer.

PROGRAMMED INSTRUCTION

Programmed learning (or programmed instruction) is a research-based system which helps learners work successfully. The method is guided by research done by a variety of applied psychologists and educators.

Programmed instruction is an instructional method where learning content is broken down into small sections or short chunks. The behavioural principles devised by Skinner, the famous researcher in behaviourism, are used in many classrooms around the world today.

Characteristics of Programmed Instruction/learning:

1. The aims of the course are stated in terms which are objective, and can be measured.
2. A pre-test is given, or the initial behaviour is stated.
3. A post-test is provided.
4. The materials have been tried out and revised according to results (developmental testing).
5. The materials are constructed according to a predetermined scheme (stimulus control).
6. The material is arranged in appropriate steps.
7. The learner has to respond actively (not necessarily overtly).
8. Arrangements are made for responses to be confirmed (knowledge of results).

9. The teaching medium is appropriate for the subject-matter and the students.
10. The materials are self-paced or presented in a manner which suits the learner.

Learning or training?

The terms "programmed learning" and "programmed training" are interchangeable, because the principles and methods were almost identical. If the target audience is industrial or military, researchers used the term programmed training, because training budgets supported the work. But in schools and colleges, the work is often described as programmed learning.

Many accounts used either or both terms according to which interest was paying for the work. Sometimes researchers used both terms as explicit alternatives. Some surveys standardised on using just one of the terms.

Types of Programme Instruction:

Linear programme :

Skinner's approach has been called linear in nature and involves the following features:

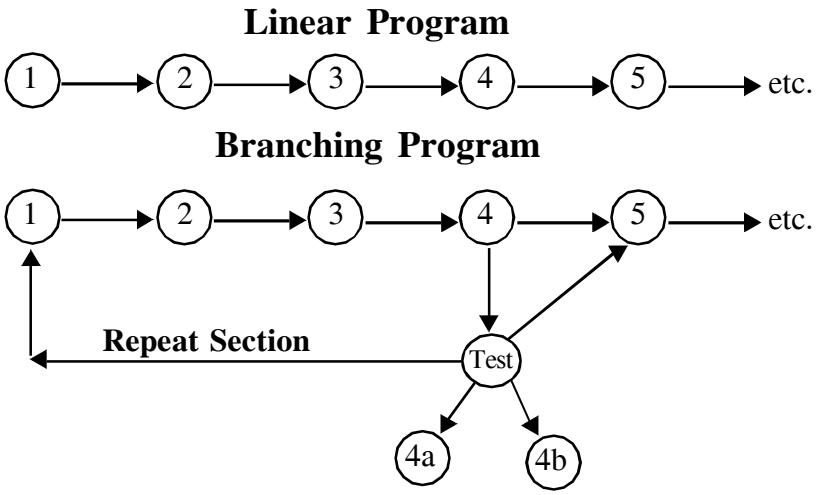
- Learners are exposed to small amounts of information and proceed from one frame or one item of information, to the next in an orderly fashion (this is what is meant by linear)
- Learners respond overtly so that their correct responses can be rewarded and their incorrect responses can be corrected.
- Learners are informed immediately about whether or not their response is correct (feedback)
- Learners proceed at their own pace (self-pacing)

Branching programme:

Branching programmed learning is similar to linear programmed learning except that it is more complicated because it attempts to diagnose the learner's response. It usually involves a multi- choice format.

After the learners have been presented a certain amount of information, they are given a multiple- choice question. If they answer correctly they branch to the next body of information. If they are incorrect, they are directed to additional information, depending on the mistake they made.

Fig : Types of Program



Advantages of Programmed Instruction.

1. Learners will work individually.
2. Students can proceed at their own pace and at time convenient to them. A slow learner is not embarrassed.
3. This offers a method of teaching project leaders and others in local communities.
4. Those who setup programmed instruction units may be motivated to plan their efforts more deliberately and more thoroughly than with traditional teaching.
5. It may be less complicated to keep materials in current Programmed Instruction unit than it is to update in a textbook.
6. Programmed Materials can be prepared for and adapted to fit almost any local situation related to nationality, economic or cultural variations in a community.
7. Material can be exchanged from country to country and from state to state, giving flexibility and variety to extension offering.

Disadvantages of Programmed Instruction.

Programmed Instruction has disadvantage too, among them are-

1. The preparation of Programmed Instruction material is time demanding, many hours are usually required to produce a unit.

2. Motivation is necessary for students, whether they're staff members or layman, to complete units of programmed instruction. It may be that job promotion in their own organization would be sufficient enticement. Possibly an item in the individual personnel record would motivate him to complete a unit.
3. The extension teacher must keep in touch with their students working on units and let them know he's interested in progress and keeping in touch. This may be difficult to do in some cases, like in case of high rate of competition.
4. The technique may be new to the particular students and they may not complete units satisfactorily because they don't adequately understand Programmed Instruction.
5. Programmed Instruction done on an individual basis at student's home or offices would likely have to be limited to the linear type. While this could be effective, it may not have the potential that more sophisticated computers would have.
6. The problem of teacher motivation, one of the human factors is missing here.

TEAM TEACHING :

In *team teaching* a group of *teachers*, working together, plan, conduct, and evaluate the learning activities for the same group of students. In practice, *team teaching* has many different formats but in general it is a means of organising staff into groups to enhance *teaching*.

Team teaching involves a group of instructors working purposefully, regularly, and cooperatively to help a group of students of any age learn. Teachers together set goals for a course, design a syllabus, prepare individual lesson plans, teach students, and evaluate the results. They share insights, argue with one another, and perhaps even challenge students to decide which approach is better.

The team-teaching approach allows for more interaction between teachers and students. Faculty evaluate students on their achievement of the learning goals; students evaluate faculty members on their teaching proficiency. Emphasis is on student and faculty growth, balancing initiative and shared responsibility, specialization and broadening horizons, the clear and interesting presentation of content and student development, democratic participation and common expectations, and cognitive, affective, and behavioral outcomes. This combination of analysis, synthesis, critical

thinking, and practical applications can be done on all levels of education. from kindergarten through graduate school.

Working as a team, teachers model respect for differences, interdependence, and conflict-resolution skills. Team members together set the course goals and content, select common materials such as texts and films, and develop tests and final examinations for all students. They set the sequence of topics and supplemental materials. They also give their own interpretations of the materials and use their own teaching styles. The greater the agreement on common objectives and interests, the more likely that teaching will be interdependent and coordinated.

Teaching periods can be scheduled side by side or consecutively. For example, teachers of two similar classes may team up during the same or adjacent periods so that each teacher may focus on that phase of the course that he or she can best handle. Students can sometimes meet all together, sometimes in small groups supervised by individual teachers or teaching assistants, or they can work singly or together on projects in the library, laboratory, or fieldwork. Teachers can be at different sites, linked by video-conferencing, satellites, or the Internet.

Breaking out of the taken-for-granted single-subject, single-course, single-teacher pattern encourages other innovations and experiments. For example, students can be split along or across lines of sex, age, culture, or other interests, then recombined to stimulate reflection. Remedial programs and honors sections provide other attractive opportunities to make available appropriate and effective curricula for students with special needs or interests. They can address different study skills and learning techniques. Team teaching can also offset the danger of imposing ideas, values, and mindsets on minorities or less powerful ethnic groups. Teachers of different backgrounds can culturally enrich one another and students.

SEMINAR :

A seminar is a form of academic instruction, either at an academic institution or offered by a commercial or professional organization. It has the function of bringing together small groups for recurring meetings, focusing each time on some particular subject, in which everyone present is requested to actively participate. This is often accomplished through an ongoing Socratic dialogue with a seminar leader or instructor, or through a more formal presentation of research. It is essentially a place where assigned readings are discussed, questions can be raised and debates can be conducted. It is relatively informal, at least compared to the lecture system of academic instruction.

Advantages :

1. A wealth of knowledge usually, presented by many speakers at one time in one place. A lot of "learning" at one clip, with most material compressed into two or three days' worth of time.
2. A sense of camaraderie, where individuals can meet others with the same interests/problems/concerns that they may have in their chosen field.
3. A sense of renewed hope and inspiration (this is especially true for Internet marketing seminars), as sometimes business concerns are lessened by sharing experiences with others. Being with others that "understand" individual's problems or concerns, is usually a great morale booster!
4. A great way for those that don't like to read, or attend classes, to improve their knowledge of a specific subject.

Disadvantages:

1. Cost, of course, as all attendees must absorb their own costs. The seminars themselves sometimes also have an entry fee that can be quite high. All travel costs, food costs, hotel costs, and other miscellaneous costs must be absorbed by the attendees.
2. The chance that the speakers may be sharing incorrect knowledge, or not at all knowledgeable themselves (it pays to make your own assessments of presented topics, not just blindly "follow the pack"). Tips, tricks, and strategies need to be weighed as to "worth" and "accuracy" before using these. Careful thought rules here.
4. The chance that the topics may not actively help your learning or your concerns, and that the seminar will be a waste of time, where nothing you learn is of any use to you.
5. The chance that attendees will expect too much from a seminar and thus be disappointed. Realism must rule here. These are not "instant answers" to anything.

COMPUTER ASSISTED LEARNING (CAL) :

Computer-assisted instruction (CAI) refers to instruction or remediation presented on a computer. Computer programs can allow students to progress at their own pace

and work individually or problem solve in a group. Computers provide immediate feedback, letting students know whether their answer is correct.

Computers being a graphic user interface, provide a wide range of additional features that can prove to be more effective for self-learning material. Though, CAI and self-learning books pertain to individualized learning, instructions through computers differ from SLM (Self learning material). Characteristics ofCAI can be listed as follows:

1) Interactivity:

Asking the learner to perform tasks during the package, keeps him alert and attentive. It prevents from getting bored. Immediate feedback is given. The learner is asked to select the correct answer.

As soon as he responds, he is given feedback. The correct and wrong answers are shown. The wrong answer is in a faded colour whereas the correct answer is in bold colours and also some additional information about the question asked is supplied. This helps the learner to from a pictorial image of the answer in his mind. If the response of the learner is incorrect then he is asked to try again, till he gives the correct answer. Encouraging words such as "Very good!" or "You did it correctly" are used to increase the morale of the learner and also to motivate him to learn further.

2) Language:

The learner is usually alone during while using the package. Isolated learning can tend to boring and the learner may eventually lose interest in the package. Hence it is necessary that the language be very interesting that would attract the attention of the learner and encourage him to learn further Conversational language is used, due to which the learner feels as if the narrator is speaking to him. This motivates the learner.

3) Use of a narrator:

Many a times, a graphic narrator is shown which does the job of narrating the topic or the content and usually guides the learner through the entire package. Narrators directly converse with the learner and explain how to use the package. It may sometimes appear as if the graphic narrator is teaching the learner or he is learning along with the learner. This narrator gives a sense of some virtual guide, helping the learner through the process of learning.

4) Content Treatment:

The content is structured. It is broken into small chunks, sections, subsections, units etc. The learner thus gets a whole picture of the content that he is going to learn in the package. The programmer beforehand decides upon the inter-relation and inter-dependence of the components and accordingly places the material in a sequential order or non-linear manner.

5) Multimedia:

Multimedia includes the use of sounds, graphics, animations, motion to any animations,film clips and various other features. All such features have made the CAI packages very interesting. The eye catches any motion and it is easier to grasp attention. It is very interesting to watch a graphic animation performing the unexciting chemical equations or drawing some tedious geometrical figures. If there are any funny sounds in the background then all such boring lessons become fun and frolic. Thus apart from learning, such activities become amusement games for the learner. This keeps the learner motivated and he does not feel as if he is studying some difficult chapter. When there is some definition to be learnt, sounds clip can be added to the text, which would make a double impact on the brain and the learner is able to remember the definition by visual as well as auditory mode. Another advantage of multimedia is that real film clips can be inserted in the packages. Say for example, in a package for Universe, real film clips of the moon or now even the Mars, can be inserted which would create a better impression on the minds of learners.

6) User-friendly Layout:

The package first introduces the topic to learner. The introduction may be based upon some previously known events or some situations that are familiar to the learner. The introduction through familiar topics leads to the main subject to be learned. After the introduction, the user comes to the first page or the homepage. This page contains link to all subunits and subsections. When the components are independent of each other, the learner may opt for any sub unit of his choice. For example, if the package is about different types of fruits and vegetables, he may select fruits or vegetables according to his wish and then learn further about them. Fruits and vegetables are not interdependent on each other. The learner can study these topics individually. Thus he has the freedom of choice in such a situation.

Unique Features of CAI:

There are many unique features of CAI which make it an exciting field of study :

One of the most useful is its adaptability for distance learning. Before the dominance of microcomputers, distance learning was mostly accomplished through PI or the US mail system supplemented by telephone contact. On the contrary, CAI provides regular and timely interaction with the instructor and current feedback.

Students can repeat tutorials as often as needed and work at their own pace. CAI also can be used with greater numbers of students than a traditional classroom would hold. CAI and web-based instruction have opened avenues of access to individuals with disabilities that were not possible before.

Intelligent computer-assisted instruction (lCAI) is programmed so that the CAI adapts to the student's individual needs. It acquires information about the student's current knowledge of a subject and his/her goals in learning the subject and then creates a user profile based on this knowledge. It can then adjust itself to the individual student.

Web-based instruction is unique in that students and/or instructors can communicate with each other anywhere in the world within seconds via the Internet. Feedback from the instructor can be obtained immediately.

3.5 Project Method & Heusistic Method

The project method is a medium of instruction which was introduced during the 18th century into the schools of architecture and engineering in Europe when graduating students had to apply thc skills and knowledge they had learned in the course of their studies to problems they had to solve as practicians of their trade, for example, designing a monument, building a steam engine. In the early 20th Century, William Heard Kilpatrick expanded the project method into a philosophy of education. His device is child-centred and based in progressive education. Both approaches are used by teachers worldwide to this day. Unlike traditional education, proponents of the project method attempt to allow the student to solve problems with as little teacher direction as possible. The teacher is seen more as a facilitator than a deliver of knowledge and information.

The term project is no longer reserved for the planned undertaking calling for the constructive thought and action. Project means almost any undertaking. It is activity oriented but it is more than the simple activity. It advocates that the education should be related to the life situation. The main focus of this strategy is socializing the child and developing the problem solving ability.

DEFINITION OF PROJECT

- ''A project is a whole-hearted purposeful activity proceeding in a social environment'' - W. H. Kilpatrick.
- ''A project is a problematic act carried to completion in its natural selection''- R. L. Stevenson.

TYPES OF PROJECTS

According to Kilpatrick there are four types of projects. They are:

1. Constructive project:

Practical or physical tasks such as construction of article, making a model, digging the well and playing drama are done in this type of projects.

2. Aesthetic project:

Appreciation powers of the students are developed in this type of project through the musical programs, beautification of something, appreciation of poems and so on.

3. Problematic project:

In this type of project develops the problem solving capacity of the students through their experiences. It is based on the cognitive domain. For instance, how to operate a bank account? or how to send a thing at distant place?

4. Drill project:

It is for the mastery of the skill and knowledge of the students. It increases the work efficacy and capacity of the students. For instance, this type of project may be taken up to give drill in singing or swimming.

Other types

- *Individual and Social (Group) projects :*

In individual projects, every student solve the problem in their own according to their interest, capacity, attitude and needs. It develops the problem solving qualities individually and not the social qualities.

In Group projects, the problem is solved by the group of pupils in the class. Here the social, citizenship qualities and synergism are developed.

- Simple and Complex project:

In the simple projects, the students complete only one work at a time. They also focus the work in one subject or one area only. It gives the deep information about the project in one angle. The students get deeper and broader knowledge about the problem.

In the complex projects, the students carry out more than one work at a time. They focus on the work in various subject and angles. Here the students get the knowledge about the work in various activities and dimensions.

PRINCIPLES OF PROJECT METHOD

1. Principle of Purposefulness

The project should be purposeful, and that should have some main objective. The objective should give the enthusiasm and work to the students, otherwise that will be a wastage of time and energy.

2. Principle of Utility

The project should be useful to the students and the society. It should be of some value to the students. From a good project, the students as well as the society may get the benefit a lot.

3. Principle of Freedom

The students should be free to select the topic and execute the work according to their will and wish, interest, attitude and capacity. The teacher should only be a "guide on the side" and give guidelines to execute that.

4. Principle of Activity

Project means the purposeful activity so at the end of the project the students must gain knowledge through their activity. 1t is also a demand of the principle of learning by doing.

5. *Principle of Reality*

Project should be real and related to the life situation of the students and the society. Only then they would be able to complete the project naturally and really. Imaginary problems must not be taken up in the project.

6. *Principle of Social Development*

A good project focuses society needs, social development, and usefulness to the society. A single project solves the problem of the thousands of the people or the society.

7. *Principle of Planning*

The students plan in advance about the project. They find solutions for - How? When? What? Where? Why? So, good project develops the problem solving capacity and prior planning for the execution.

PARADIGM OF PROJECT METHOD

Project method has the following steps:

1. *Creating Situation*

In the first step teacher creates the proper situation to the students in the class. He shares the knowledge about the project method procedure, steps, and uses with the students. After that he provides proper motivation through conversation about the day to day life problems to the students.

2. *Selection of the problem*

Then the teacher helps the students to select the problem and guide them. Here the students are having freedom to choose the topic or problem based on their interest and ability. Before choosing the topic the principles should be taken in to an account.

3. *Planning*

The teacher discuss with the students about the problem through various angles and points. He should create the situation of the discussion with the students and they are allowed to talk freely and openly. After the free expression of the students' opinion about the problem, the teacher writes down the whole program of action stepwise on the blackboard. The grouping is made by the teacher based on the interest and ability of the students.

4. *Execution*

The students start their work in this step. They collect the relevant information/ data and materials at first. The teacher should give time to the students according to their own speed, interest and ability. Ifneed arises, he may provide the necessary help and guidelines to the students. He demands the groups to complete the project in the particular time.

5. *Evaluation*

Here the students evaluate their task. They determine whether the objectives have been achieved or not. After that they criticize and express their feeling about the task freely. The planning, selecting the task, and execution are discussed in the class. All these things are collectively reported to the teacher.

6. *Reporting and Recording*

It is the last step of the project method in which each and every step of the work are reported. The reported things are recorded in a certain order in a book form. The record is useful for the further use and future reference about the project. It reveals many ideas about the concerned project. The book formatted report is submitted to the teacher at the end.

ADVANTAGES OF PROJECT METHOD

1. It is students centered, activity based method.
2. Students involves whole-heartedly in the learning process according to their needs, attitude, interest and ability.
3. This method is related to the life situation of the students.
4. This method develops the problem solving ability to the students.
5. It makes the students independent and confident.
6. It gives the real work experience to the students.
7. It develops the social qualities and synergism in the students' heart.
8. It develops the responsibility realization of the students.

LIMITATIONS OF PROJECT METHOD

1. It is a time consuming method.

2. It is difficult to complete the prescribed syllabus in a particular time.
3. It is a very costly method.
4. It is not applicable for the lower classes.
5. All topics cannot be through this method.
6. It is not applicable for the all schools.
7. It needs so much material for the execution.

HEURISTIC METHOD :

A heuristic method (a Greek word means to "find" or "discover"), often called simply a heuristic, is any approach to problem solving, learning, or discovery that employs a practical method not guaranteed to be optimal or perfect, but sufficient for the immediate goals.

Meaning of Heuristic Method of Teaching :

A problem is placed before the learners and they are asked to find the solution of the problem through various literacy means, like library, laboratory, and workshops etc. Teacher's role is to initiate the learning and pupils are active throughout the learning process. By using their creative thinking and imaginative power, they try to find out the relevant solutions based on some logic.

They learn by self-experience. This teaching strategy is focused on:

1. To develop problem
2. Solving attitude
3. To develop scientific attitudes towards the problem
4. To develop power of self-expression

Its basic principles are:

1. To each as little as possible at one time
2. To encourage learner to learn himself as much as possible.

Advantages :

1. Students are put into the situation to learn by self-experience. It certainly develops self-confidence and self-reliance in the learners.

2. It helps in developing scientific attitude and creativity in the learners.
3. Teacher encourages the learners to explore the environment in search of the solution of the problems. By doing so, some new knowledge is discovered by them.
4. Teacher is always ready to provide individual guidance regarding the solution of the problem. Thus interaction between the teacher and the learner takes place in a cooperative, conducive environment.

Disadvantages of Heuristic Teaching Method

1. It cannot be used at primary level of education.
2. Higher intelligence and divergent thinking is required in the learners. But, there are some students who are below average and fail to succeed in discovering the solutions of the problems. It frustrates them.
3. In true sense, none of the teachers have patience for providing individual guidance to the learner:
4. And learners, too, feel hesitation to approach the teacher for seeking his help.

Suggestions

There can be number of solutions for a problem. So, it is the teacher's duty to provide guidance to the learners to select the most relevant solution of the problem.

1. Problem should be related to the course and curriculum and a definite time period should be allotted to the learners to finish their research work.
2. Students' abilities capabilities, interest and choice of the subject should be taken into consideration in allotting the problems.
3. There should be an eligibility criteria for providing. the problems.

3.6 Creating Different Situations of Learning Engagement

Three Main Types of Cooperative Learning in Science are :

● Cooperative Learning, ● Group Learning ● Small group Learning

Collaborative or Cooperative learning "is an umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together". Cooperative learning, a form of collaborative learning, is an

instructional technique in which students work in groups to achieve a common goal, to which they each contribute:

- out-of-class study groups
- in-class discussion groups
- project groups (in and/or out of class)
- groups in which roles (leader, timekeeper, technician, spokesperson, and so forth) are assigned and rotated.

Cooperative learning is the most commonly used group work teaching strategy by all science teachers. Johnson & Johnson, two well-known pioneers in modern methods of cooperative learning have identified the three main types of cooperative learning: cooperative base groups, informal cooperative learning groups and formal cooperative learning groups (Johnson, Johnson, 1994).

I. *Cooperative Base Groups*

Cooperative base groups are long-term, heterogeneous cooperative learning groups (lasting for at least one semester or year) with a stable membership, whose primary responsibility is to give each member the support, encouragement, and assistance he or she needs to progress academically and develop cognitively and socially in healthy ways.

II. *Informal Cooperative Learning Groups*

An informal cooperative learning group is one in which students work together in temporary, ad hoc groups that last for only one discussion or class period to achieve joint learning goals. In formal cooperative learning groups are used to focus student attention on the material to be learned, create an expectation set and mood conducive to learning, ensure students cognitively process the material being taught, and provide closure to an instructional session. The one-period long group work activity designed for conducting any laboratory work in small groups (usually of 3-4 students) is an example of an informal cooperative learning group.

Group work is appropriate for laboratory work in science lessons because it is not always possible to provide material for individual manipulation.

III. *Formal Cooperative Learning Groups*

The formal cooperative learning group is the most widely used method as almost

all teaching examples provided in the on-line seminar were classified under this method. A formal cooperative learning group is when students work together for one or several class sessions to achieve shared learning goals and jointly complete specific tasks and assignments. These groups provide the foundation for all other cooperative learning procedures. They are structured through pre- instructional decisions, setting the task and the cooperative structure, monitoring the groups while they work, intervening to improve task-work and teamwork, evaluating student learning, and processing group functioning.

Peer- Tutoring :

Peer tutoring is an intervention in which students work in pairs to master academic skills or content. Peer tutoring can involve partners who are the same age or different ages (cross-age). Cross-age peer tutoring involves older students serving as tutors for younger, lower-functioning students. Cross-age tutoring occursfor example, when students in a high school child development class spend regularly scheduled time each week reading with struggling students in a fourth grade class. In this instance, the tutors might be expected to gain less from the content being tutored but may be expected to gain more in social responsibility or understanding of learning as a process. In same-age tutoring, in which students of the same age tutor each other, more skilled students may be paired with less skilled students. In this case, students with stronger skills may provide the first responses, providing a model for the less skilled partner. In other cases, the teacher may decide to pair students of similar ability and have them alternate tutoring roles, which is sometimes referred to as reciprocal peer tutoring. Class-wide Peer Tutoring (CWPT) occurs when the teacher creates highly structured tutoring materials for use during the tutoring session. Peer tutoring is differentiated from tutoring between adults, such as community volunteers, and students. It is also distinguished from cooperative learning, in which students work collaboratively in groups.

Clearly, peer tutoring is a general term that encompasses many tutoring models. All methods are designed to increase practice, responding, and feedback For students, and they often result in increased student motivation and achievement. These models differ, however, in how tutoring pairs are assigned, how tutoring content is developed, and how extensively the tutoring is employed. For example, in cross-age tutoring the expert tutor is typically the older student, while in reciprocal peer tutoring and CWPT the paired students are the same age and can take turns assuming the expert role. In cross-age and reciprocal tutoring, the student tutor is typically responsible For learning the content and then teaching the information to the tutee, while in CWPT the teacher is more responsible.

The instructional components of the peer tutoring approach include

(a) explicit teaching of students in how to be tutoring experts,

(b) purposeful partner assignment,

(c) careful preparation of tutoring materials,

(d) highly structured tutoring procedures that include specific Feedback For tutors to provide tutees,

(e) expert role reversal, and

(f) active teacher monitoring. Also, some type of systematic performance is typically included.

Jigsaw :

Jigsaws are particularly relevant to science because they model the way in which science, engineering, and medicine work in the real world. Groups of experts often collaborate in multi- disciplinary teams to accomplish goals and complete projects. Jigsaw lessons provide unique opportunities for students to learn from each other and practice the 21st century skills of collaboration and communication in an authentic setting. By using the jigsaw method in our classes, we are preparing our students for the careers that await them.

How to Set Up Jigsaw Activities:

- Carefully arrange both sets of groups (the first "expert" ones and the second "multi-disciplinary" ones) to ensure diversity of skill levels and leadership ability.
- Assess students individually (not as a group) to make sure that their marks truly represent their own level of mastery (and not what the group overachiever knows).
- Give students lots of guidance about what they should be doing in each group.
- Choose a captivating, authentic experience for them. If you teach the human body, let them become specialists in a body system. If you are studying fossils, assign your students to become experts on different time periods. Later, give the mixed groups mysteries to solve, like unidentified bones or undiagnosed medical conditions.

Learning with reference to children with Disabilities :

One of the four guiding principles of the National Science Education Standards is simply "science for all students" (NRC 1996). This principle underscores the belief that all students, regardless of race, gender, or disability, should have the opportunity to learn and understand the essential science content described in the Standards. Because of increasingly widespread inclusion practices and more thorough identification procedures, students with documented learning disabilities (LD) are becoming a larger percentage of the science classroom.

Because many practicing science teachers have little training or experience in identifying and meeting the needs of students with disabilities basic educational principles that support the unique learning needs of these students have been formulated. Each principle is accompanied by examples of how a science instructor might put that principle into practice.

Principle1: Learning is enhanced when teachers recognize and teach to diverse learning styles and strengths.

Learners have diverse ways of making meaning, constructing knowledge, and expressing understanding; using this perception as a starting point in our science teaching is particularly important for students with disabilities. These students-who show deficits in certain aspects of' their learning such as organization, reading, memory, and writing-have benefited when instructors accommodate and teach to a variety of learning styles (Carbo and Hodges 1988).

Teachers interested in reaching the broadest range of students can offer multiple means of representing the content in their classroom and provide students with multiple means of' expressing their mastery of that content. This universal design approach to education is strongly advocated by organizations that work to expand learning opportunities for those with disabilities, such as the Center for Applied Special Technology.

Principle-to-practice examples

Although this principle may require more time to implement, the field of science lends itself well to teaching to a diversity of learning styles. Teachers can apply the following approaches.

- Provide instruction that reaches the full spectrum of diverse learners. Example: Students can see or perform a demonstration of osmosis (real or computer-based), view and/or construct a diagrammatic depiction of diffusion versus osmosis, read a text-based description of cell transport mechanisms, and enact a role play that shows active transport kinesthetically.
- Provide various means of assessment that capitalizes on students' learning strengths or preferences.

Example: Students can choose from-or the teacher can alternate among-varied-format tests, graphic organizers, oral interviews, three-dimensional models, written summaries, PowerPoint slide presentations, or posters. The teacher could also have a set order to cycle through.

Principle 2: Content learning is supported by explicit instruction in skills and strategies.

The science curriculum is embedded with an ever-increasing array of thinking, study, and organizational skills that are predictors of future academic success.

Principle 3: Learning is facilitated when instruction and assessment are clearly organized.

Although explicit organizational schemes are useful for all students, they are particularly important for CWSN (children with special needs) who are most successful when provided with high structure (Minskoff and Allsopp 2003). Explicit organization of instruction and assessment can positively affect student planning, prioritizing, and goal-setting, all typical areas of difficulty these students (Raskind et at. 1999). Teachers should pay special attention to organizing routines and pacing, which are frequently difficult for these students.

Principle 4: Learning is maximized when instruction and assessment are based on explicit objectives.

In the *Guide to Teaching Science to Students with Special Needs in the Inclusive Setting*, Mastropicri and Scruggs (1993) emphasize clearly stated objectives as a hallmark of effective instruction for such students. Certainly, understanding the purpose of a lesson or an assessment will enhance the learning of any student, but this understanding is particularly salient for such students, whose memory capabilities

are likely to be compromised as a part of their diagnosis (Hulme and Mackenzie 1992), clearly articulated objectives, which are easily available and frequently referred to, can be an important reference point, allowing such students to access and re-access information that is likely to provide both clarification and motivation.

The following points provide strategies for making learning objectives explicit during instruction and assessment.

- Make a direct connection, orally and in writing, between each class task and its associated learning objective.

  Example: When facilitating a role-playing demonstration of active transport, the teacher must make explicit at the outset the purpose of the demonstration and provide an opportunity at the end for students to articulate the main idea of the demonstration.

- Provide scoring rubrics that describe the qualities of excellent work for the various components of each assignment.

  Example: If assigning a lab report on some aspect of cell transport from an inquiry-based investigation, the teacher can give students a rubric that describes the qualities of an excellent, adequate, partial, or poor hypotheses statement. Each component of the assignment (e.g., data table, graph) would include similar descriptors of quality.

- Provide (or assign) some form of study guide for students to review before any quiz or exam. Example: The instructor can generate a study guide for early units in the course and eventually assign it to students.

Principle 5: Learning is improved when teachers provide consistent feedback.

In addition to providing important self-assessment information, frequent feedback enhances motivation, which is important to academic achievement. The benefits of feedback, while important to all students, some ways to offer consistent and helpful feedback for students in science exist.

Principle 6: Learning is sustained when students develop self-knowledge.

By increasing their own understanding of learning styles and disabilities, science teachers can help impart this information to their students, thus increasing students' metacognition and their ability to begin advocating for themselves as learners.

3.7 Constructivist Approach and its use in Teaching Science

Constructivist teaching is based on constructivist learning theory. Constructivist teaching is based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information. Learners are the makers of meaning and knowledge. Constructivist teaching fosters critical thinking, and creates motivated and independent learners.

Characteristics of Constructivist Teaching

According to Audrey Gray, the characteristics of a constructivist classroom are:

- the learners are actively involved
- the environment is democratic
- the activities are interactive and student-centered
- the teacher facilitates a process of learning in which students are encouraged to be responsible and autonomous

Role of teachers in a constructivist classroom:

In the constructivist classroom, the teacher's role is to prompt and facilitate discussion. Thus, the teacher's main focus should be on guiding students by asking questions that will lead them to develop their own conclusions on the subject. It is unanimously suggested that good teachers join self, subject, and students in the fabric of life because they teach from an integral and undivided self, they manifest in their own lives, and evoke in their students, a capacity for connectedness".

There are three major roles for facilitators or teachers to support students in constructivist learning environments (CLE):

● Modeling - Modeling is the most commonly used instructional strategy in CLEs. Two types of modeling exist: behavioural modeling of the overt performance and cognitive modeling of the covert cognitive processes. Behavioural modeling in CLE demonstrates how to perform the activities identified in the activity structure. Cognitive modeling articulates the reasoning that learners should use while engaged in the activities.

● Coaching - the role of coach is complex. She acknowledges that a good coach motivates learners, analyzes their performance, provides feedback and advice on the performance and how to learn about how to perform, and provokes reflection and

articulation of what was learned. Moreover, she posits that coaching may be solicited by the learner.

- Scaffolding - Scaffolding is a more systemic approach to supporting the learner, focusing on the task, the environment, the teacher, and the learner. Scaffolding provides temporary frameworks to support learning and student performance beyond their capacities. The concept of scaffolding represents any kind of support for cognitive activity that is provided by an adult when the child and adult are performing the task together.

Constructivist Learning Environments (CLEs)

In CLEs, learning is driven by the problem to be solved; students learn content and theory in order to solve the problem. This is different from traditional objectivist teaching where the theory would be presented first and problems would be used afterwards to practice theory.

Depending on students' prior experiences, related cases and scaffolding may be necessary for support. Instructors also need to provide an authentic context for tasks, plus information resources, cognitive tools, and collaborative tools.

Constructivist assessment

Traditionally, assessment in the classrooms is based on testing. In this style, it is important for the student to produce the correct answers. However, in constructivist teaching, the process or gaining knowledge is viewed as being just as important as the product. Thus, assessment is based not only on tests, but also on observation of the student, the student's work, and the student's points of view. Some assessment strategies include:

- Oral discussions. The teacher presents students with a "focus" question and allows an open discussion on the topic.
- KWL(H) Chart (What we know, What we want to know, What we have learned, How we know it). This technique can be used throughout the course of study for a particular topic, but is also a good assessment technique as it shows the teacher the progress of the student throughout the course of study.
- Mind Mapping. In this activity, students list and categorize the concepts and ideas relating to a topic.
- Hands-on activities. These encourage students to manipulate their environments or a particular learning tool. Teachers can use a checklist and observation to assess student success with the particular material.

- Pre-testing. This allows a teacher to determine what knowledge students bring to a new topic and thus will be helpful in directing the course of study of findings.

Significance of Teacher in a constructivistic Science classroom:

In constructivists' view, teachers in science classrooms as authority figures play two essential roles. One is to introduce new ideas or cultural tools where necessary and to provide the support and guidance for students to make sense of these for themselves. The other is to listen and diagnose the ways in which the instructional activities are being interpreted to inform further action. The essential role of the teacher is controlling the 'flow of discourse' (Mortimer & Scott, 2000) in the classroom. The ability to guide the classroom discourse as ideas are explored and explanations are introduced, is central to the science teacher's skill and is critical in influencing students' learning. Teacher's role may be summarized as;

- develop key ideas relating to the new concepts being introduced;
- introduce points relating to epistemological features of the new way of knowing;
- promote shared meaning amongst all of the students in the class, making key ideas availab Ie to all;
- check student's understanding of newly introduced concepts.

3.8 Let Us Sum Up

Whether in lecture, discussion, laboratories, or individual encounters, questioning is an important part of guiding students' learning. When students ask questions, they are often seeking to shortcut the learning process by getting the right answer from an authority figure. 1 lowcvcr, it is t:1C processes of arriving at an answer and assessing the validity of an answer that are usually more important, particularly if the student can apply these processes to the next question. Both of these processes are obscured if the teacher simply gives the requested answer. Often, the Socratic method- meeting a student's question with another (perhaps leading) question-forces students (while often frustrating them) to offer possible answers, supporting reasons, and assessments. In fact, posing questions can be an effective teaching technique. Here are some tips for the effective use of questions:

- Wait long enough to indicate that you expect students to think before answering. Some students know that if they are silent the professor will give the answer (Rowe, 1974).

- Solicit the answer from a volunteer or a selected student.
- Determine the student's confidence level as you listen to the answer.
- Solicit alternative answers or elaboration to provide material for comparison, contrast, and assessment.
- Solicit additional responses from the same students with a leading question or follow-up observation.

It is often seen, that questionning on the part of the learners provide an actual learning, if they are directed properly in the path of learning.

3.9 Check Your Progress

1. What is the meaning of method & approaches in teaching–hearning situation?

   .....

   .....

   .....

   .....

2. Give the Characteristics of discussion method.

   .....

   .....

   .....

   .....

3. What are the basic tenets of concepts mapping?

   .....

   .....

   .....

   .....

4. How Good lecture can be delivered in a science classroom.

.....

.....

.....

.....

5. Mention the determinants a controlled cooperative learning in a Science classroom.

.....

.....

.....

.....

6. What is meant by CAI? Write its components.

.....

.....

.....

.....

7. Define a project.

.....

.....

.....

.....

8. Mention 4 attributes of constructivististic hearing environment (CLE).

.....

.....

.....

.....

9. What are Peer-tutoring & jigsaw.

.....

.....

.....

.....

10. What are the roles played by a Science teacher to cater to the needs of CWSN.

.....

.....

.....

.....

3.10 References

We demeyer, C.A, hearning at the Backdoor : Reflections on the Non-traditional hearning in the life Span. Madision, WI : University of Wisconsm Press, 1991.

Saba, F, Distance Education theory, methodology & epistemology : A Pramatic Paradigm in M. G. Moore & W.G Anderson (Eds). Lawrence Erlbalam Associates, 2003.

Ahmed. J. Teaching of Biological Sciences : computers & Education Pergamon, Oxford, UK, 2005.

Basker, PG (1989), Multimedia Computer Assisted hearing, kogan Page, London.

Joshi, A.N & Salunke, K.S., Content based methodology, Prentice Hall of India, New Delhi.

Kalra, R. M, Science Education for teacher trainees & In-Serience Teachers, Prentice Hall of India, New Delhi.

Munger, R.L, changing children's Bahaviour by, changing the people, places & Activities in their lines, Prentice Hall of India, New Delhi.

Mangal S. K & Mangal, U, Essentials of Educational Technology, Prentice Hall of India, New Delhi.

Unit 4 ❐ Learning Resources with References to Children with Disabilities for Teaching Science

Structure :

4.1 Introduction

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

Our day to day life experiences have three aspect cognition, affection and conation. None of these can be experienced independently. Montessori Stressed the import of human senses. At the first step stimulation of sense produces in him or her just a sensation but later his Sensation became a meaning to it and at the end it visit convert to perception. Perception leads to ideas or conceps. The pupils interested to see concrete objects. They want to handle, manipulate and the teacher should provide a situation for the pupils to satisfy their curisitys of doing thing.

According to Burton, ''Teaching learning aids are those sensor objects or images which initiate or stimulate and re-inforce learning.''

4.2 Objectives

After going through this unit, the learners will be able to:

- Understand the need & importance of teaching-learning aids.
- Signify & delineate different co-curricular activities Plan & interpret science lab with reference to children with disabilities.
- Explain & demonstrate aquarium, museum, botanical & zoological garden.

4.3 Needs for Teaching learning aids for Science Teaching

The use of Teaching learning aids is necessary for the following reason :

1. The aids help in drawing the attention of students.
2. These help in arousing interest and motivating force for the students activity.
3. These help in providing direct experience as the objects are presented in concrete form.
4. These are helpful to the students to have clear understanding of the concept.
5. Teaching learning aids break monotomy and provide variety of learning situations.
6. These help in making the students remain active all together.
7. These stress on the principles of learning by observing and doing.
8. They help teacher for in creasing classroom interaction style.
9. They help in catering to the needs of all kinds of students in the classroom.
10. Teaching aids help developing scientific attitude and train the teacher for applying scientific method in the class room.

Importance of teaching learning aids :

There is an old saying which reads.

I Hear, I Forget : The traditional teacher depended to much on verbal exposition, pupil hears and forget.

I See, I Remember : As a sensory organ, the eye is very highly developed when compare to the other sensory organs. So, what one sees, one remembers.

I do, I Understand : When one is engaged in any Practical activity, involving physical more all the Senses are used to perceive. Hence flow of knowledge is quick, complete and more accurate.

So importance of teaching learning aids can be given for the following reasons :

i) It reduces verbalism or meaning less use of words and phrases and contributes towards the clearness of percept and accuracy in learning.

ii) It extends first hand experience when students see a demonstration, handle the aparatus, perform experience themselves and prepare chart model etc.

iii) It is the most natural and easiest way of learning. Image is the greatest instrument of instruction. When a Pupil sees an object, he/she forms an image of the object.

iv) Some type of freedom prevails in the classroom. Pupil can talk, ask, comment and discuss and they are motivated to do work and they work freely in the classroom situation.

v) The large number of pupils can learn though proper teaching learning aids used by the teacher.

vi) New curricula have broadened and extended the field of Education which can be satisfactory covered only with the help of teaching aids.

Principles for Selection of Teaching learning aids

1. The aids Should be integrated with learning. It should be an integral part of educative process and appropriate to the curriculum of the class. It should not be merely recreational but should accomplish some significant end and co-ordination with day-to-day lessons. *For example*, while teaching about a scientist, the taperecorded speech may be reproduced in the classroom. This will provide life-like situations and the pupils will feel interested.

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

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

4. It should be truthful, accurate and realistic and should be a substitute for reality. *For example*, a model of red-rose should represent a true flower in its

proportion, colour, symmetry etc, If the aid used is just a rnisrepresentatic of the actual thing the whole aim of the aid or teaching is defeated for tl children will learn wrong things.

5. It should be motivational and highly informative, The aid used shou attract and capture the attention of pupils.
6. It should be available where and when required.
7. It should have desirable utility and should be according to loc conditions and needs. The aid selected should satisfy the purpose with which it is used.

Principles for the Use

1. The teacher should be well skilled in the use of aid. Aid should I actually taught and not merely displayed, It should not substitute b supplement the teacher's work.
2. While using the aid active participation of students should be sougl There should be adequate preparation on the part of pupils, They should I told what they should look for. The pupils should ask questions, answ questions, comment and discuss.
3. The aid should be properly protected and preserved for nothi discourages or mars the interest of the studctnts more than a spoiled pictui broken model or a cracked slide.
4. It should he located convenientlvso that it is eas ilv ava ilahle when need arises.
5. The aids should be evaluated at regular intervals in order to know their use and effect on learning.

Types of Teaching-learning aids on the basis of experiences :

All the experiences that human beings derive are mainly from three sources :

(i) Direct sensory contact which involves doing.

(ii) Pictures or some other forms of representation of objects by observing.

(iii) Oral or printed words which involve symbolising.

All the learning experiences which can be utilised for class room teaching are shown by Edgar Dale in a pictorial device—''Pinnacle form which he called ''Core of experiences.''

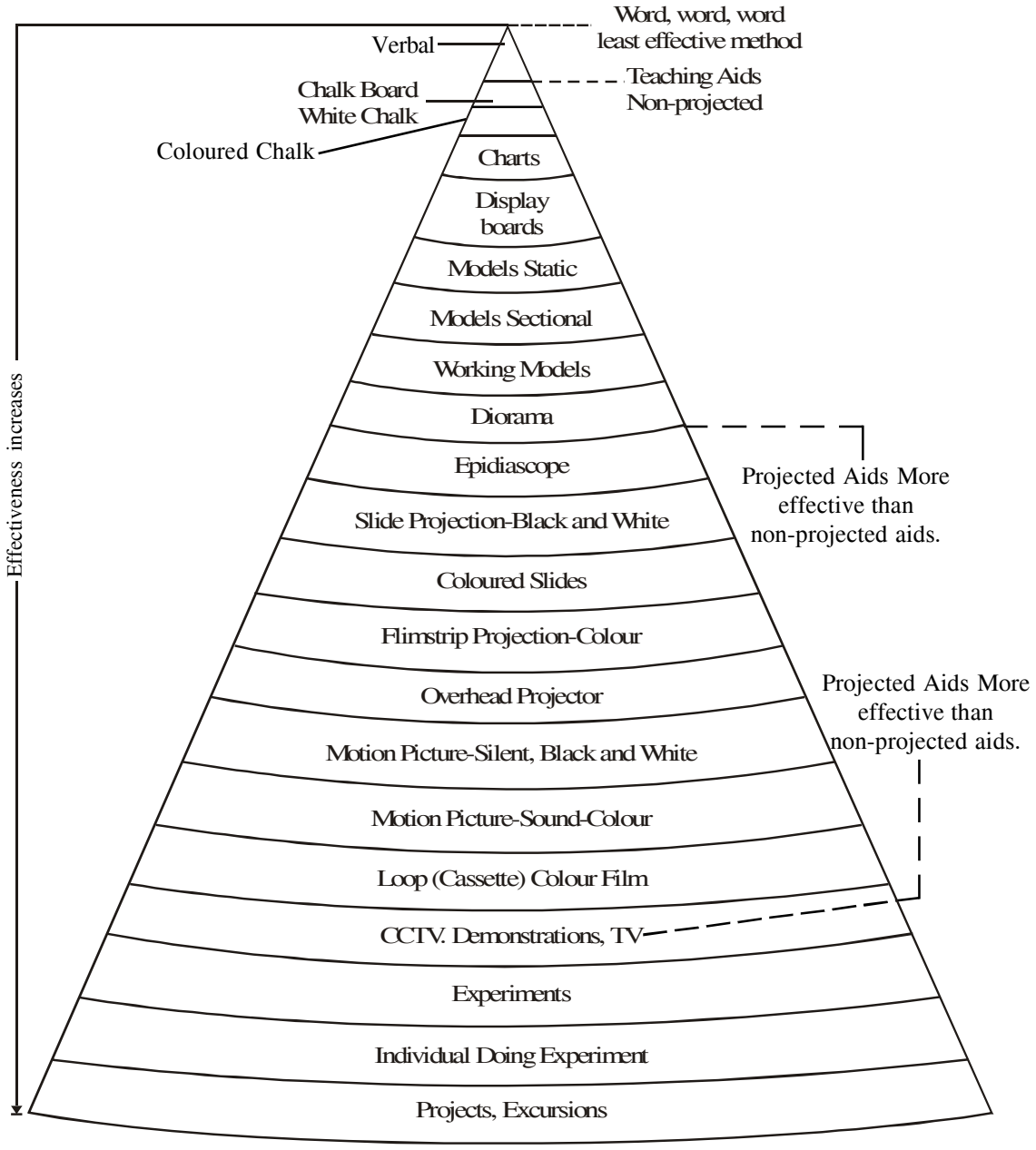


Figure 2.1 Relative Effectiveness of Teaching Aids

Source : Sampath *et al*

Classification of Teaching learning aids

Visual

i) Chalk-Board

ii)Charls, Diagrams Sketches, models, graphs

iii) Motion pictures film strips and slides

iv) Flannel graph, Bulletin Board and scrap book etc.

Auditory

i) Radio

ii) Gramophone

iii) Tape-recorder etc.

Audio–Visual

i) Films (Sound motion pictures)

ii) Television

iii) Video etc.

Information Technology

1. CD/DVD

2. Multimedia etc.

Teaching learning Aids to Promote Effective Learning—Comparative Study

Sl. No.	Tool Hardware	How to use	Features and Utilisation	Conditions for Use	Accesories available	Software needed	How many	Maintenance
1	2	3	4	5	6	7	8	9
	2×2 slide viewer	Individual or small group instruction depend on type of viewer	Student can use alone in classroom or industrial an resource centres Ideal for students in make up work	With proper screen little or no darkening of the laboratory is necessary	Some models built-in-screens in covers, slide carries, slide trays, manual or automatic changers, automatic timers, remote control changers, adapters for single-frame vertical filmstrips	Information available from manufacturers. Teachers can themselves make slides	One in each laboratory, one in resource centre	Low
2	TV receiver (C.C.T.V.)	Small or large group instruction	Useful in areas where space or safety limitations prevent students from clearly	School plant must be specially equipped	Auxiliary speakers, glare shields, coaxial cable with impedance	Commercial TV stations often broadcast many programmes. But teachers.	Considering cost one is usually enough if a planning room or	Normal Mainten

1	2	3	4	5	6	7	8	9
			viewing demonstrations		matching transformer for connecllting 300 ohm actenna or camera system	must develop own TV films for use in regular lessons possible.	resource centre is available	
3	Audio-tape recorder (Listening station)	Used with individual or small group instruction, can be used with other audio-visual equipment	Ideal for mock up lectures or dictated tests	Needs carphones and jacks. Students use the equipment independently. Need not disturb teacher or classmatches	Earphones, Jacks sound proof individual desk units	Teachers may record own tapes to suit lessons	One per lab or resouce centre	Specialised maintenance needed
4	Portable Video-tape machine	Entire class viewing	Instructors and students can programme tape to be used for classroom demonstrations Avoid crowding around machines where safety problems could arise	Can tape teacher's demonstrations, allowing him freedom to work with students	Portable video monitor special effects generators empty reels, wide angle lens, telephoto lens, vidicon camera	Both sending and receiving equipment is necessary (see TV Receiver)	One in a resource centre	Requires specialised maintenance
5	Tape-recorder and record player	Small or large group instruction replaying recorded educational broadcass	Lectures may be given during teacher's absence Students may review lecture as they wish or listen to recordings	None	Additional speakers, microphones, stereo head phones, earphones	Spare reels, 2 track tape, check cata-logues/ disc records (33, 45, 78, r.p.m. Discs)	One per department	Spectalise maintenance may be sometimes needed
6	Trans-parency equipment	To make transparency for us with overhead projector	Can be used to make transparencies	None	Carrying case, dust cover	Light Sensitive transparency blanks, laminates	One per department	Spectalise maintenance

1	2	3	4	5	6	7	8	9
7	Wall charts and posters	Small or large group instruction	Can be used for a variety or purposes				As may as available	No maintenance problem
8	Filmstrip Projector or Slide projector	Small or large g roup instruction	Can be used for 2×2" slides or 35 mm filmstrip, teacher may stop and discuss any time Student can assist by reading or operating the projector during class	A darkened room may be necessary	Dust cover, carrying case lenses, automatic timer, remote control film advance, rewind take-up self-contained unit with screen, PA system in some models	Many commercially available 35 mm film-strips, check film and audio-visual catalogues	One for each area in the department, one for the resource centre is ideal	Low, but specialised work may have to be done
9	8mm sound projector	Small or large group instruction	Through commercially available films, more up-to-date information can be brought into the classroom to assis t the industrial arts teacher in clarifying lessons	Same as 16 mm motion picture projector	Loudspeaker 20 mm to 32 mm f/1 Projection zoom lens, universal splicer, remote control microphone, variable speed control, automatic a nd semi-automatic threading devices, stop motion devices	Check catalogues for film listings	One per department	Specialised maintenance
10	16 mm sound projector	Small or large group instruction	Can be used in classroom or laboratory	Darken room except for newly developed day-light screen	Speakers 10 and 25 hours 1000 watt lamps, protective covers, automatic threading devices remote control, wide angle lenses	Commercial films available, consult film catalogues for lists of films for rent or free. Some teachers can make their own films	One per department is usually enough	Specialised maintenance may be necessary

1	2	3	4	5	6	7	8	9
11	Continuous loop film projector	Individual or small group instruction ideal but can also be viewed by a large group	Continuous loop enables students to review materials as they wish	Some darkening of the room may be necessary	Carrying case, screen, automatic cartridges, zoom lens, auxiliary speaker, listening centre (head phones)	Empty cartridges film splicers, make use of the filmstrip projector one of the newest and best audio-visual aids in the market	Two or three would be ideal but one per deparment is usually enough	Low
12	Overhead projector (Trans-parency parency Projector	Whole class instruction	Can be used in a lighted room or laboratory with teacher facing students during presentation	None	Roll feed attachment build-in projection pointer, heat filter carrying case light flash shield copy trays plastic dust cover	Much software available but trans-parenncies can easily be made by the teacher	One per department enough, two or three optimum	Low
13	Opaque projector	Individual or small group instruction	Use of this machine can replace overhead	Darkened classroom	Roll feed attachment glass pressure plate dust	Teachers can make own	Depending upon size of the department two or three	Low

Source : Sampath *et al*

4.4 Importance of Co-curricular Activities

In the 21century, the pure academic type of education that students are introduced to, is steadily paving way to a whole new type of education with a special focus to incorporate three major genres of education: reasoning, psychomotor and emotional learning.

Education is a pretty broad concept that surpasses the four walls of a classroom. The core aim of education is to foster all round development of a child. All round development essentially means intellectual, physical, moral, sensible and social development. All round development can be achieved only through education.

Education plays a fundamental role in the making of a man and his development as a culturally well developed social animal. To fulfil these objectives, there is a prime need of striking a balance between syllabus, curriculum, books and also co-curricular activities beyond that.

They actually complement the curricular activities and groom the students in the "Art of living and working together." They are the true and practical experiences gained by students by their own learnings.

Children herald a new tomorrow and education plays an influencing role in shaping the worldview of children by creating a society that is inclusive and without barriers. It is in this context that schools are acknowledged as a crucial sphere for developing a tolerant and plural community by means of imparting education and developing equal opportunities for all. Schools adopting inclusive means are the beacons to an inclusive world that is tolerant to the differences.

SCIENCE CLUB :

A science club is an out-of-school-hours club that offers children the chance to do science-related activities that extend and enhance the science they experience in the classroom. Each science club is different, as the club programme reflects the interests of the children, the club organiser and the facilities available. Most clubs use the opportunity to explore areas of science not covered by the curriculum and to give the club members plenty of opportunities to do practical science. A science club can be run in a lunch break or after school. Some organisations are able to offer special Saturday clubs. A science club session typically lasts for about 45 minutes. In this time, the members might complete a challenge, plan a science project or have a special scientific visitor.

Guiding Principles :

There are many guiding Principles that govern the activities of children. They are :

- solve a relevant, science-based problem, set within a scenario.
- work in pairs or small groups, independently of adults.
- take part in practical, hands-on science activities.
- think and talk about science, during the activity and when sharing their results

- share their results using a variety of media.
- solve increasingly complex problems, from a wider range of contexts
- make more decisions themselves about how to carry out, record and interpret the activity
- the increase in the length of the activities.
- reflect on, discuss and share the ideas about increasingly complex ideas
- share the results more widely, and in more diverse media.

SCIENCE EXHIBITION :

In order to develop scientific instinct among the youth, the National Curriculum Framework (NCF)- 2005 encourages implementation of various curricular activities viz. organization of "Science Exhibition" at school, block, tehsil, district, region and state levels. The vision of this activity is the exploration of the surrounding's resources to enable children to express themselves. The science instinct among the children begins at the unit (school) in the form of student projects; materials and activities.The following objectives could be illustrated :

Objectives :

To provide a forum to nurture science and inventive interest from the surrounding environment and connecting new ideas to their existing ideas from materials and activities.

To explore and encourage scientific and technological talent and creative thinking among children and inculcate in them a sense of pride in their talent;

To developed an understanding about the role of science and technology to meet the needs of the society;

To analyse how science and technology have affected individuals, cultures and societies;

To motivate the youth that science and technology are instrument for achieving self-reliance in socio-economic development; and

To encourage them as an architect of the nation and visualize future of the nation;

Significance :

In an exhibition, students get a chance to apply or do the practical aspect of the things that they have learned from the classroom. These are real opportunities for the kids to easily implement the things that they have learn from schools. It helps in being Creative.

The school exhibition that is held in most of the schools is a great platform for the kids to do things. This is really a great chance for the kids to speak well. In most cases, the students need to explain to the faculties, their fellow students, judges and may also need to explain to people who come from outside to see the exhibition. This can help in boosting in their skills in speaking and thus their *confidence*.

Here is teacher's different role. He can act as a motivator. Teacher has a great opportunity to develop student's creativity by preparing science kits or models involving students directly (teacher as a facilitator). The great way is teacher play a role as a facilitator in learning.

SCIENCE TEXTBOOKS :

In the teaching-learning process, the text-book occupies an important place. There is a saying "As is the text-book, so is the teaching and learning". A good text-book can even replace class-room teaching. The science text-book should aim at aiding the pupils in the development of their personalities, in developing open mindedness, developing appreciation and understanding of nature and not merely stuffing their minds with facts.

Characteristics of a good science text-book

1. The author: A good text-book is judged, at face, by the author, his qualification and experience.
2. Mechanical features of the text-book:
   (a) The print and paper used and the binding of the text-book should be attractive. It should be hard and durable.
   (b) The printing should be clear, legible and appropriately spaced.
   (c) The book should be well-illustrated with diagrams, sketches and pictures.
   (d) The size of the print, the language and experiments discussed should suit the age ofthe child and standard of the child.

3. The subject matter-its nature and organisation :

   (a) The subject-matter should be developed as far as possible in psychological sequence. Care must be taken of the mental growth and interest of pupils.

   (b) There should be consistency of the subject-matter and the text-book should satisfy the objectives of science teaching.

   (c) Each chapter should begin with a brief introduction and end with a summary.

   (d) Subject-matter should lead to the inculcation of scientific attitudes, disciplinary and cultural values.

   (e) Each chapter should contain assignments at the end.

   (f) During treatment of subject-matter, numerical examples should find place where necessary.

   (g) Headings and sub-headings are given in bold letters.

   (h) Each text-book should contain detailed table of Contents and an index.

   (i) The language of the book should be simple, clear, lucid, scientific and precise. The English equivalents of the terms should be always given in brackets.

   (j) The text-book should give suggestions for improving scientific apparatus.

   (k) Examples in the text-book should be given from local environment and from life experience.

   (l) During the treatment of science subject in the text-book, care should be taken to see that it is correlated with other subjects like craft, social environment and physical environment.

   (m) Each text-book should be accompanied by a laboratory manual. Besides these characteristics, the UNESCO Planning Mission has given some principles of writing text-books. They are as follows:

      (i) It should be first of all according to the requirements of the syllabus. It should also help in the improvement of the syllabus.

      (ii) The facts, concepts etc., should be modern and within the comprehension of the pupils.

      (iii) The contents should contain not only the established facts but also

the problems which are being researched and thereby, arousing the interest in the pupils in these problems.

(iv) It should help in linking up science with life and practice. The pupils should be equipped with 'know-how' utilizing the knowledge in everyday life.

(v) The whole content of the text-book should be aimed at shaping the integrated modern scientific outlook which ensures success in mastering scientific knowledge and solution of the problems of vital issues. The content should be simple, brief, exact, definite and accessible.

4.5 Science Laboratory with Reference to Children with Disabilities

Individuals with physical disabilities often encounter barriers to one of modern society's most important rites of passage. It is that crucial process of obtaining a good education, so natural and uncomplicated for most people-that opens the door to productive employment and full participation in society. Today's barriers are rarely physical or architectural. More often, they involve perceptions and misperceptions of not just disability but also ability. One misperception is that a physical disability somehow disqualifies a person from a career in science, engineering, or mathematics. Well-intentioned but misinformed adults still discourage students with disabilities from pursuing careers in these fields. Often it occurs indirectly and implicitly, when adults withhold the mentoring and encouragement that can nudge young people toward science careers and sustain their interest. In addition, adults may set artificial limits on what the student with disabilities should attempt. These limits may be based not on reality but on the adults' own low expectations for the student or sincere concerns that the student may fail and not cope well with failure. In reality, students with disabilities benefit from the freedom to establish their own horizons, cope very well with the process, and learn from it.

Application of universal design to a science lab :—

Students with disabilities face access and challenges to typical science labs in educational settings. Access barriers may prevent a student from :

- gaining knowledge,

- demonstrating knowledge, and
- fully participating in lab activities.

There are two approaches to making academic activities accessible to students with disabilities- accommodations and universal design (UD). Accommodations are alternate formats, assistive technology, and other adjustments for specific students once they are enrolled in a class.

Universal Design (UD)

The Center for Universal Design defines universal design as "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design." Applications of UD in education take proactive steps to create academic products and environments that are accessible to students with a wide range of characteristics, including disabilities, thereby minimizing the need for future accommodations. For example, if a science lab contains an adjustable-height workstation, an accommodation will not be needed for a future student who uses a wheelchair that is too high for standard-height workstations. This workstation may also be comfortable for a student who needs to remain seated because or a health impairment or someone who is very tall or short in stature. In a science lab, UD can be applied to :

- lab climate;
- physical access, usability, and safety;
- delivery methods;
- information resources;
- interaction;
- Feedback;
- assessment; and
- plans for accommodations.

Making accommodations is reactive, whereas universal design is proactive.

Accommodations

Following are examples of accommodations that might benefit a student with a disability.

- Use wheelchair-accessible labs and field sites.

- Talk to a student about special learning needs and accommodation alternatives.
- Provide a lab partner.
- Use plastic instead of glass.
- Allow extra time for set up and completion of lab work.
- Address safety procedures for students with a variety of sensory and mobility abilities.
- Use institutional resources for students with disabilities.
- Typical science lab accommodations for students with specific disabilities include those in the following lists.

Blindness

- Verbal descriptions of demonstrations and visual aids.
- Braille text and raised-line images.
- Braille or tactile ruler, compass, angles, protractor,
- Braille equipment labels, notches, staples, fabric paint, and Braille at regular increments on tactile ruler, glassware, syringe, beam balance, stove, other science equipment.
- Different textures (e.g., sand paper) to label areas on items.

Low Vision

- verbal descriptions of demonstrations and visual aids
- preferential seating to assure visual access to demonstrations
- large print, high contrast instructions and illustrations
- raised-line drawings or tactile models for illustrations
- large print laboratory signs and equipment labels
- video camera, computer or TV monitor to enlarge microscope images
- hand-held magnifier, binoculars
- large print calculator

Mobility Impairments

- wheelchair-accessible field site
- uncluttered lab; clear, wide aisles
- preferential seating to avoid physical barriers and assure visual access to demonstrations
- mirrors above the instructor giving a demonstration
- an enlarged screen
- wheelchair-accessible, adjustable-height work surface
- non-slip mat
- utility and equipment controls within easy reach from seated position
- electric stirrer, container filler
- support stand, beaker and object clamp; test tube rack
- handles on beakers, objects, and equipment
- surgical gloves to handle wet or slippery items
- modified procedures to use larger weights and volumes
- extended eyepieces so students who use wheelchairs can use microscopes
- flexible connections to electrical, water, and gas lines
- single-action lever controls in place of knobs
- alternate lab storage methods (e.g.,"Lazy Susan/ storage cabinet on casters)

Deaf and Hard of Hearing

- preferential seating to view demos and watch instructor captioning for video presentations
- written instructions prior to lab
- visual lab warning signals

Learning and Attention Disabilities

- combination of written, verbal, and pictorial instructions with scaffolding
- repeated demonstration of procedure and support practice

- frequent, brief breaks
- preferential seating to avoid distractions and minimize extraneous stimuli
- scanning and speaking "pen"

Health Impairments

- avoid chemical materials to which student is allergic or provide alternate assignment
- flexible schedule and time allocation

Universal Design Considerations

Some of the accommodation suggestions listed above could be implemented within a lab now, anticipating that at some point a student with a disability may need access to the lab and that some changes may benefit all students. Here are some strategies that could be implemented in a science lab as a part of universal design efforts:

- Provide both written and verbal instructions.
- Give verbal and visual descriptions of demonstrations and visual aids.
- Use plastic instead of glass.
- Allow extra time for set up and completion of lab work.
- Address safety procedures for students with a variety of sensory and mobility abilities, including the provision of visual lab warning signals.
- Make laboratory signs and equipment labels in large print, with high contrast.
- Ensure that field sites are wheelchair accessible.
- Maintain wide aisles and keep the lab uncluttered.
- Incorporate an adjustable-height work surface for at least one workstation.
- Install a mirror above the location where demonstrations are typically given.
- Use lever controls instead of knobs.
- Install flexible connections to water, gas, and electricity.
- Buy lab products that can be used by students with a variety of abilities (e.g., plastic lab products instead of glass, tactile models, large-print diagrams, non-

slip mats, support stands, beaker and object clamps, handles on beakers and equipment, surgical gloves to handle slippery items, video camera with computer or TV monitor to enlarge microscope image).

- Ensure that utility and equipment controls are within easy reach from a standing or seated position.
- Provide surgical gloves for handling wet or slippery items.

Treat people with disabilities with the same respect and consideration with which you treat others. There are no strict rules when it comes to relating to people with disabilities. However, here are some helpful hints.

General

- Ask a person with a disability if he or she needs help before providing assistance.
- Talk directly to the person with a disability, not through the person's companion or interpreter.
- Refer to a person's disability only if it is relevant to the conversation. If so, mention the person first and then the disability. "A man who is blind" is better than "a blind man" because it puts the person first.
- Avoid negative descriptions of a person's disability. For example, "a person who uses a wheelchair" is more appropriate than "a person confined to a wheelchair." A wheelchair is not confining-it's liberating.

Blind or Low Vision

- Be descriptive. Say, "The computer is about three feet to your left," rather than "The computer is over there."
- Speak all of the content presented with overhead projections and other visuals.
- When guiding people with visual impairments, offer them your arm rather than grabbing or pushing them.

Learning Disabilities

- Offer directions or instructions both orally and in writing. If asked, read instructions to individuals who have specific learning disabilities.

Mobility Impairments

- Sit or otherwise position yourself at the approximate height of people sitting in wheelchairs whcr. you interact.

Speech Impairments

- Listen carefully. Repeat what you think you understand and then ask the person with a speech impairment to clarify or repeat the portion that you did not understand.

Deaf or Hard of Hearing

- Face people with hearing impairments so they can see your lips. Avoid talking while chewing gum or eating.
- Speak clearly at a normal volume. Speak louder only if requested.
- Use paper and pencil if the person who is deaf does not read lips or if more accurate communication is needed.
- In groups raise hands to be recognized so the person who is deaf knows who is speaking. Repeat questions from audience members.
- When using an interpreter, speak directly to the person who is deaf; when an interpreter voices what a person who is deaf signs, look at the person who is deaf, not the interpreter.

Psychiatric Impairments

- Provide information in clear, calm, respectful tones.
- Allow opportunities for addressing specific questions.

4.6 Aquarium, vivarium–Role in Teaching with Setting & Mainfaiming

AQUARIUM :

An aquarium (plural: aquariums or aquaria) is a vivarium of any size having at least one transparent side in which water-dwelling plants or animals are kept and displayed. Fishkeepers use aquaria to keep fish, invertebrates, amphibians, aquatic reptiles such as turtles, and aquatic plants. The term, coined by English naturalist Philip Henry Gosse, combines the Latin root aqua, meaning water, with the suffix -arium, meaning "a place for relating to". The aquarium principle was fully developed in 1850 by the chemist Robert Warington, who explained that plants added to water in a container would give off enough oxygen to support animals, so long as their numbers do not grow too large.

Educational Benefits of Aquariums

Reading

Reading is an essential part of our everyday lives. Students will enjoy researching topics such as fish species, plants, or reefs to learn more about aquarium keeping. Who has not heard of the "selective" reading habits of children who only read books on topics of interest to them? The wide variety of aquarium-related topics can help foster good reading habits in children who may not otherwise be interested in reading.

Writing

Students can be asked to write reports or daily journal entries about the classroom aquarium. Students can also write letters to fish or aquatic experts with their questions. Both are great ways to help sharpen grammar and writing skills.

Developing Critical Thinking & Problem-solving Skills

Students collect data from an aquarium by measuring and recording water temperature, pH, ammonia, and nitrate levels. Chart or graph the information and look for trends that coincide with events in the aquarium. Any event, even the loss of a fish, is an opportunity to discuss possible causes and their effects, preventions, and ways to improve existing conditions. The teaching and learning opportunities are endless.

Science

Biology, chemistry, ecology, and physics are just a few of the sciences involved in aquarium keeping. A classroom aquarium can be used to teach students about specific topics such as fish anatomy or more complex topics such as the food chain, the water cycle, or the nitrogen cycle.

Bringing Children & Parents Together

An aquarium is a fun, educational tool that parents and children can enjoy together. Students not only develop learning skills but because they get excited about their aquarium, arc eager to share what they learned with family members and friends. Involved parents are more likely to participate in other school activities with their child.

Setting up a teaching aquarium is a great way for students of all ages to learn about a variety of topics and gain valuable life lessons. However, the decision to set up an aquarium should never be done on a whim. Carefully evaluate the amount of time, effort, and finances you will be able to commit to the aquarium and its inhabitants.

Patience and proper research are key to a successful aquanum.

VIVARIUM :

The Vivarium program began in 1986, and is overseen by its principal designer, Alan Kay. Alan, in addition to being a computer scientist, is a musician, mathematician, biologist, physicist, philosopher, cognitive scientist ... and as such is able to bring a wide range of thought and influences to bear on the many issues inherent in such a grand goal, or grand direction, as Alan might prefer to phrase it. Alan is fond of pointing out that really good research simply cannot have a well stated goal, it can only have a useful direction. If you could state at the outset that you were going to now invent the flying buttress or vaulted arch, then you'd already have vour goal so well defined that you'd have no need to perform the research. The literal definition of a "Vivarium" is an enclosure or reserve for keeping plants and animals alive in their natural habitat in order to observe and study them.

A vivarium is an enclosure, container, or structure adapted or prepared for keeping animals under semi natural conditions for observations or study or as pets; an aquarium or terrarium. Impact on student learning is higher than expected because it plays an important role in teaching them about the conservation of plants and animals. A vivarium is a portion of an ecosystem.

1. a vivarium for smaller land animals, especially reptiles, amphibians, or terrestrial invertebrates, typically in the form of a glass-fronted case.
2. a sealed transparent globe or similar container in which plants are grown.

There are many ways to bring classmates together and learning at the same time. Many times this is done with a class pet or aquarium. There is, however, a less expensive and just as fun alternative! Classroom terrariums are a great learning tool, can be created in any setting, and can be big or small. They are usually used for learning about habitats, ecosystems, biology, etc. Children can get their hands in the dirt and play around while learning valuable lessons about the Earth. Here are just a few examples of what students can learn from terrariums:

- life Cycle of Plants

The life cycle of plants is easy to learn, and what better way to learn it than to witness it yourself? The students can observe the plants they grew themselves go from seed, to root, to bud, and then create new seeds! This is a standard life cycle that applies to other things as well, like humans and animals.

- Care of The Earth

Terrariums can also teach children how important it is to care for the Earth. Even if their terrariums are small (a bean seed in a cup for example) it's a little living thing kids can take care of. Caring for those little beans can teach responsibility in a way that kids will respond well to. Their small terrarium can be considered in scale to the Earth because all the basic resources are represented (sun, water, nutrients). Their small demonstration shows that the Earth needs people to care for it too.

- Systems Interacting

Terrariums teach how plants, animals, and insects interact similar to the real world. You can include small animals, like turtles, in addition to the plants, soil and water provided. It shows that all living things have the same resources and need to learn to share and keep everything in balance.

Overall they help raise children's awareness of the Earth and how important maintaining harmony is, while having tons of fun! For information on the kinds of projects we do and how they align with our philosophy.

4.7 Museum, Botanical & Zoological Garden : Role in Teaching

MUSEUM :

A museum is an institution that cares for (conserves) a collection of artifacts and other objects of artistic, cultural, historical, or scientific importance and makes them available for public viewing through exhibits that may be permanent or temporary.l' Most large museums are located in major cities throughout the world and more local ones exist in smaller cities, towns and even the countryside. Museums have varying aims, ranging from serving researchers and specialists to serving the general public.

The purpose of modern museums is to collect, preserve, interpret, and display items of artistic, cultural, or scientific significance for the education of the public. The purpose can also depend on one's point of view. To a family looking for entertainment on a Sunday afternoon, a trip to a local history museum or large city art museum could be a fun, and enlightening way to spend the day. To city leaders, a healthy museum community can be seen as a gauge of the economic health of a city, and a way to increase the sophistication of its inhabitants. To a museum professional, a museum might be seen as a way to educate the public about the museum's mission, such as civil rights or environmentalism. Museums are, above all, storehouses of knowledge.

While there is an ongoing debate about the purposes of interpretation of a museum's collection, there has been a consistent mission to protect and preserve artifacts for future generations. Much care, expertise, and expense is invested in preservation efforts to retard decomposition in aging documents, artifacts, artworks, and buildings. All museums display objects that are important to a culture. As historian Steven Conn writes, "To see the thing itself, with one's own eyes and in a public place, surrounded by other people having some version of the same experience can be enchanting"

BOTANICAL GARDEN :

A **botanical garden or botanic garden** is a garden dedicated to the collection, cultivation and display of a wide range of plants labelled with their botanical names. It may contain special ist plant collections such as cacti and succulent plants, herb gardens, plants from particular parts of the world, and so on; there may be greenhouses, shadehouses, again with special collections such as tropical plants, alpine plants, or other exotic plants. Visitor services at a botanical garden might include tours, educational displays, art exhibitions, book rooms, open-air theatrical and musical performances, and other entertainment.

Botanical gardens are often run by universities or other scientific research organizations, and often have associated herbaria and research programmes in plant taxonomy or some other aspect of botanical science. In principle, their role is to maintain documented collections of living plants for the purposes of scientific research, conservation, display, and education, although this will depend on the resources available and the special interests pursued at each particular garden.

Over the years, botanical gardens, as cultural and scientific organisations, have responded to the interests of botany and horticulture. Nowadays, most botanical gardens display a mix of the themes mentioned and more; having a strong connection with the general public. There is the opportunity to provide visitors with information relating to the environmental issues being faced at the start of the 21 st century, especially those relating to plant conservation and sustainability.

Roles & Fuctions :

- Availability of plants for scientific research
- display of plant diversity in form and use
- display of plants of particular regions (including local)

- plants sometimes grown within their particular families
- plants grown for their seed or rarity
- major timber trees
- plants of economic significance
- glasshouse plants of different climates
- all plants accurately labelled
- records kept of plants and their performance
- catalogues of holdings published periodically
- research facilities utilising the living collections
- studies in plant taxonomy
- examples of different vegetation types
- student ed ucation
- a herbarium
- selection and introduction of ornamental and other plants to commerce
- studies of plant chemistry
- report on the effects of plants on livestock
- at least one collector maintained doing field work

ZOOLOGICAL GARDEN :

The term zoological garden refers to zoology, the study of animals, a term deriving from the Greek z$\overline{o}$ion ("animal") and logos ("study"). The abbreviation "zoo" was first used of the *London Zoological Gardens*, which opened for scientific study in 1825 and to the public in 1857. The number of major animal collections open to the public around the world now exceeds 1,000, around 80 percent of them in cities.

In India there are more than 150 zoos. On the basis of the area, number of animals and variety, exhibited as well as the number of visitors, zoos are classified into large, medium and small. They attract as many as 50 million visitors annually. We have urban, rural, literate and illiterate people who visit zoos. India too has

recognised the importance of zoos as a site for education and learning.

Significance

- Scope of Education and Interpretation in Zoos, are like large classrooms where a number of activities, specifically for children, teachers and school groups can be conducted.
- Zoos displaying live animals can capture the attention and affection of the public for wildlife and nature like no other institution.
- Living animals clearly have an enormous power of attraction and are the great and unique feature of zoos and form the very basis of zoo education.
- People visiting zoos are interested in learning about the animals, their habitat, behaviour and conservation status.
- Zoos are therefore appropriate places to impart to the visitor information about animals, their habitats, biology and threats to their existence.
- An array of biological and other themes can be explained through zoo education. These include themes such as animal adaptations, behaviour, reproduction, and nutrition, and also complex subjects such as evolution and ecology.
- Zoo programmes can explain how easily the subtle balances in natural habitats and ecosystems are disturbed by human interference and the connections between human consumption and life style and the survival of species and biological systems.
- Zoos provide a range of opportunities to educate a great variety of people and groups of all ages and levels.
- Many people of diverse groups visit zoos including different age and educational levels and different social, ethnic and cultural backgrounds.
- Providing education, communication and information relevant to all these groups is a challenge. Several educational and interpretive facilities could be provided in zoos to enhance, sensitize, educate and enrich the visitors' experience.
- In zoos, such programmes help visitors understand the uniqueness of each animal and its relationship to its surrounding.
- Interpretation is defined as an educational activity which aims to reveal meaning

and relationships through the use of original objects, by first-hand experience, and by illustrative media rather than communicating factual information.

4.8 Let Us Sum Up

Co-Curricular activities are those which are undertaken side by side with the curricular activities. Aco-curricular activity essentially takes place outside a typical pen and pencil classroom experience. It gives the students an opportunity to develop particular skills and exhibit their non-academic abilities. These activities might be compulsory, such as music, art or drama classes that take place during the day. Others generally are voluntary, such as participating in school sports team, school debating team or student newsletters. In either case, participation can assist students in more than one ways.

In Science education Co-curriculum takes a variety of forms like science clubs, exhibitions, visit to museums, botanical and zoological garden etc. Also maintainence & nurturing of aquariums & vivariums, their significance as an aid to learning. Another aspect in the purview of science education includes two pertiment aspects : science text books & laboratory set up that have been dealt in this unit very elaborately. While discussing on laboratory, stress is given on universal design for to accomodate children with special needs.

4.9 Check Your Progress

1. Why are teaching aids essential in our science teaching?

   .....

   .....

   .....

2. Mention different types of teaching learning aids used in science teaching.

   .....

   .....

   .....

3. What are the principles for selection of teaching learning aids in our science teaching.

.....

.....

.....

4. Mention the significance of Co-curricular activities.

.....

.....

.....

5. What is meant by UDL.

.....

.....

.....

6. How an aquarium is maintained?

.....

.....

.....

7. Define vivarium.

.....

.....

.....

8. Hist the functions of botanical garden.

.....

.....

.....

9. Give the importance of museum in Science teaching.

.....

.....

.....

10. What are the characteristics of a good science text books?

.....

.....

.....

4.10 References

Ahmed, J. 2006, Teaching of Biological Sciences, Prentice Hall of India, New Delhi.

Sharma, R.C, 1999 Modern Science Teaching, Mohan, R, 2003, Innovative Science Teaching, Prentice Hall of India, New Delhi.

Jadav, M.S, 2004, Teaching of Chemistry, Anmol publishers.

http://www.ncpublicschools.org.

http://www.scienceteacher.org.

Unit - 5 ❐ Evaluation

Structure

5.1 Introduction

Evaluation is a continuous appraisal of the achievement of the aims of education as well as the method of teaching learning process. It is a wider concept than testing and measurement and is supposed to judge the worth of all educational outcomes brought about as a result of Teaching and learning. If also involves the self appraisal by the students of their sucess and failure from time to time. As a result the students come to know of their own draw backs and try to improve. On the basis of day to day records of the pupils it becomes easy to know the present status of the students. So evaluation provides essential information for an effective guidance of the teaching learnig programme.

5.2 Objectives

After completing this unit the student teacher will be able to :

i) Know about the concept of evaluation.

ii) Understand the nature and need of evaluation.

iii) Explain NRT, CRT & CCE

iv) Construct or form tools and techniques of formative and summative assessment.
v) Prepare Diagnostic test and Achievement test.
vi) Prepare various types of tests and questions.
vii) Differentiate between 'tool' and 'technique' of evaluation.

5.3 Evaluation - concept, nature & need

According to Dandekar (1971), ''Evaluation may be defined as a systematic process of determining the extent to which educational objectives are achieved by pupils.''

According to Kothari commission (1964-66), ''Evaluation is a continuous process, it forms an integral part of the total system of Education, and is intimately related to educational objectives. It exercises a great influence on the pupil's study habits and teachers' methods of instruction and thus helps not only to measure educational achievement but also to improve it the techniques of evaluation are means of collecting evidences about the students development in desirable directions.''

Nature of Evaluation :

Evaluation may work as a connecting bridge between the objectives of teaching science and the ways and means of attaining these objectives in the form of learning experience learning methods and learning environment.

A pupil's learning is evaluated in terms of the exteni.....of achievement and them behavioural objectives speciefied for a course of suudy in science. A close relationship that exists between objectives, learning experiences and evaluation can be formed a follows.

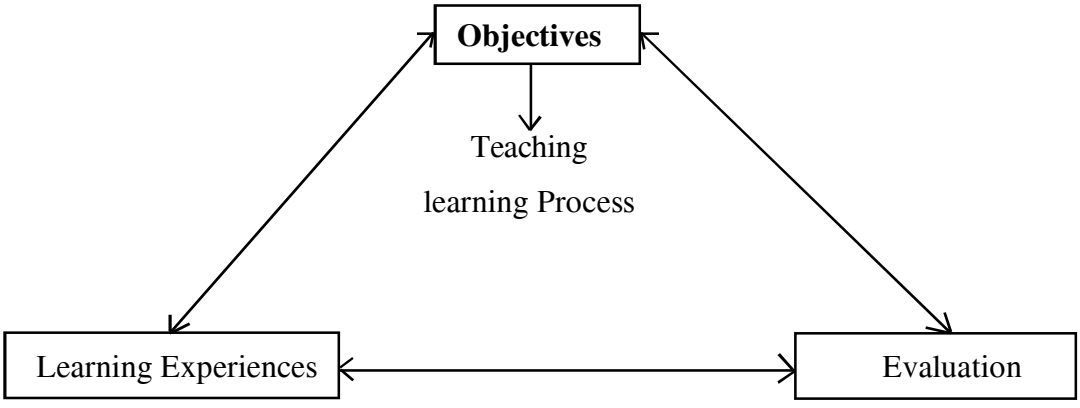


Fig : Evaluation triangle

Evaluation is a term which has overtones that distinguish it from measurement.

Measurement	Evaluation
1. It focus on a single aspect or subject matter achievement.	1. It emphasis on overall growth of pupil.
2. Measurement is not based on pre-determined objectives.	2. It based on wide range of objectives.
3. It has limited in scope	3. It concerned total personality of the pupils
4. It is done as and when required.	4. It is a continuous process.
5. It used a limited set of techniques	5. It uses variety of techniques.

Needs of Evaluation :

Evaluation process is very much necessary in the major two kind of processes :

i) Educational

ii) Administrative

The educational needs of evaluation are primarily concerned in our teaching learning process.

i) **Learning :** This includes such functions as monitoring student progress, diagnozing student weakness, determining the need of remedial work and improving the quality of the learning environment.

2) **Teaching :** This is concerned with assessing the affectiveness of teaching structure and techniques.

3) **Curriculum :** This includes improving courses and curricular, texts, students and teaching materials.

Administritive Needs of Evaluation Include :

a) **Society :** This includes accountibility to society in terms of the demands and requirements of the employment market.

b) **Parents :** This mainly mamfests itself in a perceived need for regular reporting to parents.

c) **Education System :** This includes the requirements of education system itself for purpose of selection, such as for entroduced to a higher grade or tertiary level.

However is a broader perspectives, the need of evaluation can be studied at the following six levels.

i) learning level.

ii) Teaching level

iii) Guidance and counselling level

iv) Curricular Development level

v) School administration level

vi) Classroom research level.

Types of Evaluation

Evaluation Process may be classified broadly into four categories :

i) **Placement Evaluation :** It determine Pupil performance at the begining of instruction.

ii) **Formative Evaluation :** It monitor learning progress during instruction

iii) **Diagnostic Evaluation :** It diagnose learning difficulties during instruction.

iv) **Summative Evaluation :** It evaluate achievement at the end of the instruction.

5.4 NRT & CRT, CCE : Concept & Significance, Scholastic & Co. Scholastic Assessment.

The learning experiences of the students are lively to bring about behavioural changes in the learner as specified through differenet behavioural objectives Evaluation of Student's performance is generally done interms of marks or grades. Sometimes students may be compared with some absolute performance standard instead of making comparism with other students of a given group.

There are two types of Evaluation : i) Norm references Test (NRT) and ii) Criterion Reference Test (CRT)

NRT : It assessess the students performance relative to other students of the group. Students are awarded marks and relative rank is this method of Evalution.

CRT : It assesses the students performance is terms of specified performanced standard or criterion without any mention of the performance levels of the other students of the group. This evaluation method is related to mastery learning and developmental tests of the students.

Comprehensive and Continuous Evaluation : (CCE)

It is a process to provide holistic profile of the learner through regular assessment of scholastic and co-scholastic domains of development. It aims at making evaluation an integral part of teaching learning process. It focuses on all round development of personality of the learners. It improves on going teaching-learning processes by diagnosing the learning gaps and offering corrective and enrichment input. It brings about a paradigm shift from examination to effective pedagogy.

Scholastic and Co-scholastic Assessment :

The assessment procedure of different aspects of learners, which are related to intellect or the brain is called scholastic Assessment. It includes assessment of learners in curricular subjects, assignments, project work, practical and oral work etc.

On the other hand the assessment procedure of different aspects of learners, which are related to hand and heart. The include psychomotor skills, physical development, life skills, attitude, values, interests and participation in co-curricular activities.

5.5 Tools and Techniques for Formative and summative Assessment

Since Evaluation of students' learning out comes is one of the most important functions of teaching learning process. Student's learning out comes are evaluated with the help of different tools and techniques. These learning outcomes are generally. devided into cognitive and non-cognitive learning outcomes.

Cognitive learning out comes are related to scholastic areas of students' performance where as non-cognitive learning out comes are concerned with non-scholastic areas. Evaluation of cognitive out comes is done with the help of certain tools and techniques whereas some other tools and techniques are used for the assessment of students performance in non-cognitive areas.

Basic techiques of Evaluation :

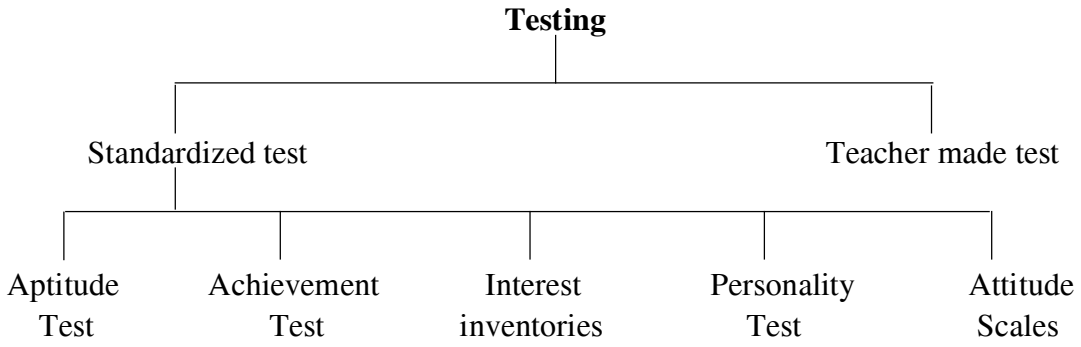
i) Testing

ii) Observation

iii) Inquiry

iv) Content Analysis

Testing : The Tests are broadly classified as follows :



ii) **Observation**

An assessment for which the primary data source is viewing or listening in the teaching-learning environment is a classroom observation. Observation is a techniques of evaluation which requires an observe to record the activities, experience and expressions of individual pupil either seperately or in a group.

Observation may be two types :

(a) **Direct Observation :**

When observation is restricted to selected aspects of pupils behaviour and when records are made systematically and as objectively as possible. This is known as an direct observation.

e.g. situations where tasks like drawing, painting, clay modelling are given the teacher can observe certain set of behaviours (Pre-planned) like accuracy, heatness, orginality, initation, precision, design etc

(b) **Indirect Observation :**

When a classroom teacher can observe and note pupils' performance either in the classroom or outside the classroom. The teacher can observe informally the pupils conduct, social adjustment or their personal and emotional adjustment. This iis called indirect observation.

iii) **Inquiry :**

Certain details about the students can be obtaind by inquiring and securing information from the students themselve parents, school teachers and administon, peer group and so on.

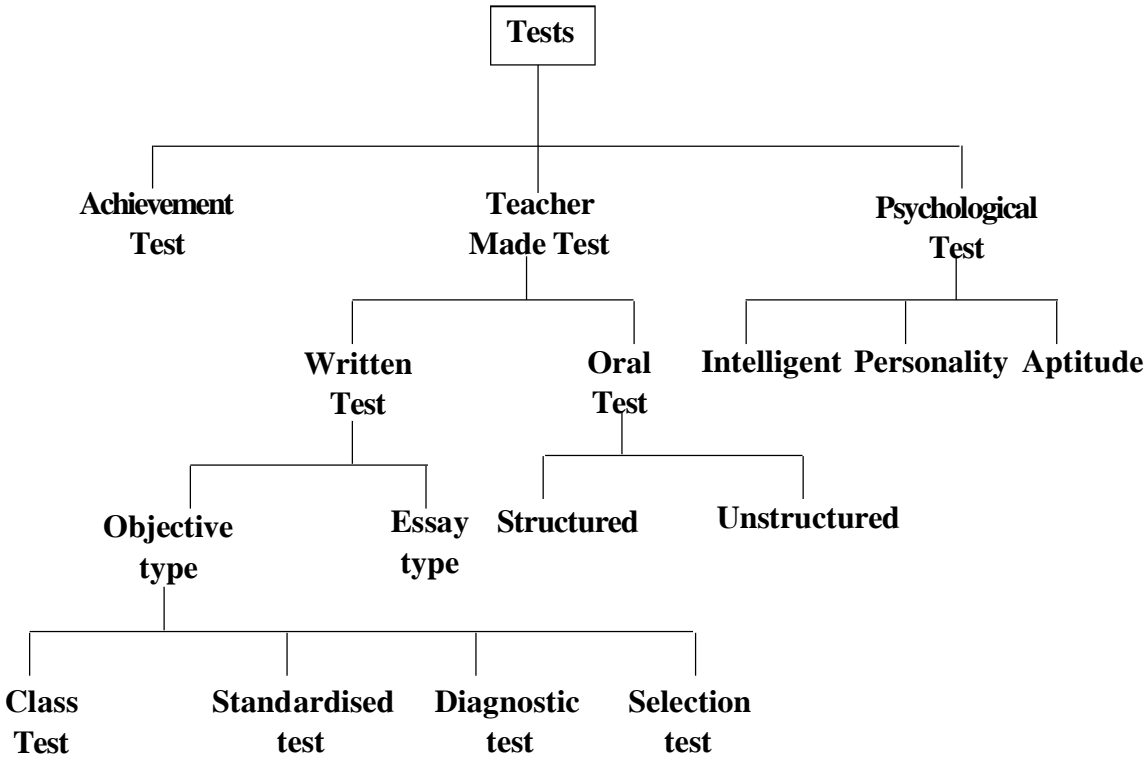
e.g. Assessment of the success of a course can be obtained by securing the opinion of students on a questionnaire.

iv) Content Analysis :

Analysis means where a given qualitative material is ....mented into its constituent parts which is studied in detail for its characteristics or attributes. The content analysis is a mostly used method for analysing the materials. It is also termed as information analysis since it deals with classification, generalisation, evaluation and comparison e.g. The content of open-ended Questionnaire, interviews and focus .....discussions that is observed and are communicated qualitatively may be analysed.

Different tools of Evaluation :

Generally experimental techniques are used for the collection of different information from the students. The most common tools used for applying experimental techniques are Tests. The different types of test can be used as a tools of Evaluation. These are given below:



5.6 Preparation of Diagnostic Tests & Achievement leas

Diagnostic Tests are generally used to find out the learning difficulties and deficiencies of the students. The process of determining the causes of educational diagnosis is called educational diagnosis. The scope of educational diagnosis is much larger than the use of tests and examinations. An adequate diagnosis may involve the use of intelligence tests, rating scales, controlled observations, questionnaires, interviews etc. etc. A satisfactory level of diagnosis can be reached when the teacher has gained sufficient insight into the nature of the pupil's problem.

Major aspects of diagnostic tests:

1. To determine the extent through which the desirable educational objectives are achieved.
2. To identify the factors that may be interfering with the optimum growth of the individual.
3. To understand the learning difficulties faced by the students.

Characteristics of Diagnostic Tests:

1. **Objectives:** The essence of educational diagnosis is the identification of some of the causes of learning difficulty and some of the potential educational assets.
2. **Validity :** It refers to the evidence of casual factors to the attainment of the objectives. The methods of diagnosis may be valid for discovering certain factors which create different difficulties among the students.
3. **Reliability:** The increase in reliability is related to the decrease in the fluctuation in conclusion that can be secured by providing a more adequate and representative sample of pupil reaction upon which the conclu sions are drawn.
4. **Comparability:** Diagnostic procedures that give comparable results are basics for intelligent interpretation.
5. **Exactness:** The exactness may be increased by analyzing the characteristics of the progress in learning more minutely and utilizing the symptoms.

Diagnostic Test: A diagnostic test is a test used to diagnose or reveal an individual's weakness and strengths in a certain course of study.

Steps involved in the diagnostic testing:

1. Identifying the students who are having learning difficulties.
2. Locating the errors of learning difficulties ..
3. Discover the casual factors which are responsible for learning difficulties.

Functions of diagnostic test:

1. Direction of curriculum which is emphasized by any important objectives of education.
2. Provision of educational guidance of the pupils
3. Stimulation of learning activities of pupils.
4. Motivation of administrative and supervisory efforts.

Steps for preparation of diagnostic test:

1. Planning
2. Writing items
3. Assembling the test
4. Providing dirction
5. Preparing scoring key and marking scheme
6. Administering the test
7. Making interpretation.

Criteria for administration of Diagnostic Test:

1. The teacher is to win the confidence of the students and reassure them that test is to help them in the improvement of their learning rather than for declaring pass or fail.
2. It should be administered in a released environment.
3. Students should be seated comfortably.
4. Students should be asked not to consult each other while taking the test.
5. If any student is not able to follow something, he should be allowed to seek clarification from the teacher.
6. The teacher may ensure that the students taking the test attempt all questions.
7. Time schedule should not be enforced strictly. If any student takes a little more time, he should be allowed to do so.

Role of Computers in Diagnostic Testing:

Computers can be used for diagnostic testing in education. Several commercial test publishers have developed programmes for interpreting scoring of available diagnostic tests and for combining test scores and other data in the prescriptive formulation of individual used instructional programmes.

Preparation of Achievement Test:

Achievement Tests are used to find out how much a student has learnt from a given course of study taken by him or her in a particular time. The tests are expected to yield information on the performance of individual students who are tested as well as the performance of group of students as a whole.

Considerations for constructing a achievement test:

1. Deciding the purpose of the testing programme.

   The testing of students may be i) in a class or within a class ii) in a board examination iii) in an achievement survey

2. Assess the objectives to be covered. It should cover the cognitive level of educational objectives, i.e. Knowledge, Understanding, Application, Analysis, Synthesis, Evaluation.

3. Coverage the prescribed syllabus. It should determine the weightings in terms of marks to be assigned in each content area, large number of such questions which can be answered in short time in better coverage and limit the number of essay type questions.

Type of questions;

The common selection type questions are:

1. MCQ
2. True-False
3. Matching Type
4. Essay Type
5. Short Answer Type
6. Completion type

Factors which decide time to be allowed for answering questions:

- Availability of resources.
- Course content to be covered.
- Class for which testing is to be done.
- Number and type of questions to be included.

Table : Assigning weightage to Objectives and difficulty level.

Objectives	**Knowledge**	**Understanding**	**Application**
%	40	30	30
Difficulty Level	Easy	Average	Difficulty
%	25	50	25

Table : Preparation of Blue Print of the Question Paper:

Sample Blue print :

Objectives	Knowledge			Understanding			Application			Total
Types of Question	MCQ	VSA	SA	MCQ	VSA	SA	MCQ	VSΛ	SA	
Subunit-I	1(1)						3(1)	1(1)		
Subunit-II		2(1)		1(2)						
Subunit-III	1(2)				2(1)				3(1)	
Subtotal										

N. B: Figures outside the bracket indicate marks allotted for question and figures within the brackets indicate number of questions.

After preparing blue print, the question paper should be framed and marking scheme should be prepared. Then the question paper should be reviewed, moderated and finalized for administration.

Hence achievement test can be constructed for both school examinations and achievement surveys. The question paper should be well balanced combining all types of questions e.g. Multiple Choice Questions, Short Answer Type and ,very Short Answer Type Questions. The type of questions should be included in the question paper as per the

particular percentage ratios. After developing the question paper it should be reviewed by one or experts to ensure the quality of constructed questions. Moderation of question papers should be done to ensure that no question is out of syllabus and the difficulty level of the question is according to plan. Questions that are too easy or too difficult may be replaced with those that are neither too easy nor too difficult.

5.7 Adaptations of Evaluation procedure with reference to Children with disabilities

Introduction to Assessment and Overview

An assessment in special education is the process used to determine a child's specific learning strengths and needs, and to determine whether or not a child is eligible for special education services. Assessment in special education is a process that involves collecting information about a student for the purpose of making decisions. Assessment, also known as evaluation, can be seen as a problem-solving process (Swanson & Watson, 1989) that involves many ways of collecting information about the student. According to Gearheart and Gearheart, 1990; Pierangelo and Giuliani, 2006, assessment is "a process that involves the systematic collection and interpretation of a wide variety of information on which to base instructional/intervention decisions and, when appropriate, classification and placement decisions. Assessment is primarily a problem-solving process".

Importance of Assessment

The importance of assessment should never be underestimated. In special education, you will work with many professionals from different fields. You are part of a team, often referred to as a multidisciplinary team,that tries to determine what, if any, disability is present in a student. The team's role is crucial because it helps determine the extent and direction of a child's personal journey through the special education experience (Pierangelo and Giuliani, 2006). Consequently, the skills you must possess in order to offer a child the most global, accurate, and practical evaluation should be fully understood. The development of these skills should include a good working knowledge ofthe following components of the assessment process in order to determine the presence of a suspected disability:

- **Collection:** The process of tracing and gathering information from the many sources of background information on a child such as school records, observation, parent intakes, and teacher reports.

- **Analysis:** The processing and understanding of patterns in a child's educational, social, developmental, environmental, medical, and emotional history
- **Evaluation:** The evaluation of a child's academic, intellectual, psychological, emotional, perceptual, language, cognitive, and medical development in order to determine areas of strength and weakness
- **Determination:** The determination of the presence of a suspected disability and the knowledge of the criteria that constitute each category
- **Recommendation:** The recommendations concerning educational placement and program that need to be made to the school, teachers, and parents

Purpose of Assessment

Assessment in educational settings serves five primary purposes:

- **screening and identification:** to screen children and identify those who may be experiencing delays or learning problems
- **eligibility and diagnosis:** to determine whether a child has a disability and is eligible for special education services, and to diagnose the specific nature of the student's problems or disability
- **IEP development and placement:** to provide detailed information so that an Individualized Education Program (IEP) may be developed and appropriate decisions may be made about the child's educational placement
- **instructional planning:** to develop and plan instruction appropriate to the child's special needs
- **evaluation:** to evaluate student progress. (Pierangelo and Giuliani, 2006)

The Difference Between Testing and Assessment

There is sometimes confusion regarding the terms "assessment" and "testing." While they are related, they are not synonymous. Testing is the administration of specifically designed and often standardized educational and psychological measures of behavior and is a part of the assessment process. Testing is just one piece ofthe assessment process. Assessment encompasses many different methods of evaluation, one of which is using tests.

Role of the Education Professional in the Special Education Process

The professional involved in special education in today's schools plays a very critical role in the overall education of students with all types of disabilities. The special

educator's position is unique in that he or she can play many different roles in the educational environment. Whatever their role, special educators encounter a variety of situations that require practical decisions and relevant suggestions. No matter which type of professional you become in the field of special education, it is always necessary to fully understand the assessment process and to be able to clearly communicate vital information to professionals, parents, and students (Pierangelo and Giuliani, 2006).

Assessment Law:

The Individuals with Disabilities Education Act (IDEA), lists 13 separate categories of disabilities under which children may be eligible for special education and related services. These are:

- **autism:** a developmental disability significantly affecting verbal and nonverbal communication and social interaction, generally evident before age 3
- **deafness:** a hearing impairment that is so severe that the child is impaired in processing linguistic information, with or without amplification
- **deaf-blindness :** simultaneous hearing and visual impairments
- **hearing impairment :** an impairment in hearing, whether permanent or fluctuating
- **mental retardation :** significantly sub average general intellectual functioning existing concurrently with deficits in adaptive behavior
- **multiple disabilities :** the manifestation of two or more disabilities (such as mental retardation- blindness), the combination of which requires special accommodation for maximal learning
- **orthopedic impairment :** physical disabilities, including congenital impairments, impairments caused dy disease,and impairments from other causes
- **other health impairment :** having limited strength, vitality, or alertness due to chronic or acute health problems
- **serious emotional disturbance:** a disability where a child of typical intelligence has difficulty, over time and to a marked degree, building satisfactory interpersonal relationships; responds inappropriately behaviorally or emotionally under normal circumstances; demonstrates a pervasive mood of unhappiness; or has a tendency to develop physical symptoms or fears
- **specific learning disability:** a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations

- **speech or language impairment :** a communication disorder such as stuttering, impaired articulation, a language impairment, or a voice impairment
- **traumatic brain injury:** an acquired injury to the brain caused by an external physical force, resulting in total or partial functional disability or psychosocial impairment, or both
- **visual impairment:** a visual difficulty (including blindness) that, even with correction, adversely affects a child educational performance.

Types of Tests Used in Special Education

- Developmental assessments
- Screening tests
- Individual intelligence tests
- Individual academic achievement tests.
- Adaptive behavior scales
- Behavior rating scales
- Curriculum-based assessments
- End-of-grade, end-of-course, and alternate assessments

Developmental Assessments

Developmental assessments are norm-referenced scales designed to assess the development of infants, toddlers, and preschoolers in key areas. These areas include fine- and gross-motor, communication and language, social, cognitive, and self-help skills. If a very young child is thought to be experiencing delays, and especially if the child is going to be served in an infant- toddler program, professionals will use developmental assessment scales to identify strengths and weaknesses. The scales are administered through direct observations of the young child and parent questionnaires. From the results of the assessment, the evaluator can determine how delayed or advanced the child is in the key areas mentioned above.

Screening Tests

Schools often use screening tests to help find children who might be below the norm in different areas. Screening instruments are very easy to administer, contain relatively few items, and can be completed in a relatively brief time, often requiring only a few minutes per child. They may be pencil-and-paper tests, rating scales or checklists used

to document certain behaviors, or direct observations of skills or abilities. Their purpose is to alert the school to a potential problem so that more in-depth assessments can be conducted.

Individual Intelligence Tests .

Only a psychologist or diagnostician trained and certified in the administration of specific intelligence tests, often called IQ (intelligence quotient) tests, can administer them. This is because, in order for the test to be considered reliable and valid, it must be administered and scored in a very precise manner.

Most intelligence tests report an overall or general IQ score as well as subscores in areas such as verbal skills, motor performance, and visual reasoning. Intelligence tests commonly used in the public schools are the Wechsler Intelligence Scale for Children (3rd ed.) (WISC-III) (Wechsler, 1991), the Stanford-Binet Intelligence Scale (4th ed.) (Thorndike, Hagen, & Sattler, 1986), and the Woodcock-Johnson III Tests of Cognitive Abilities (WJ III) (Woodcock, McGrew, & Mather, 2001).

Individual Academic Achievement Tests

Most students in special education, and those referred for special education consideration, will be weak in one or more academic areas. In order to determine most precisely which academic areas are of concern, a psychologist or educational evaluator will administer at least one broad ranging, multiple-skill academic achievement test to the child. The results of the test will tell how the child stands in key academic skills such as reading, written expression, arithmetic, general information, and specific school subjects.

Traditionally, professionals have used norm-referenced academic achievement tests for formal evaluations to help determine a student's special education eligibility, placement, and IEP goals. These tests will also be useful for documenting the academic progress of students over a long period of time.

Adaptive Behavior Scales

A student with mental retardation (or intellectual disabilities) must exhibit a deficit in adaptive behavior. Adaptive behavior skills are those that are especially useful for daily functioning. Typical items on adaptive behavior scales include daily living skills; community participation skills; and functioning in specific ability areas such as demonstrating appropriate social behaviors, communication, motor abilities, and applying basic academic skills.

Among the most commonly used scales are the second edition of the AAMR Adaptive Behavior Scales (ABS), including the Residential-Community versions (ABS-RC:2) (Nihira, Leland, & Lambert, 1993) and the School version (ABS-S:2) (Lambert, Nihira, & Leland, 1993). Other useful scales are the Vineland Adaptive Behavior Scales (2nd ed.) (Vineland-If) (Sparrow, Cicchetti, & Balla, 2005) and the Scales of Independent Behavior-Revised (Bruininks, Woodcock, Weatherman, & Hill, 1996).

Behavior Rating Scales

Like adaptive behavior scales, a parent or a teacher may complete the scale or an evaluator can obtain the relevant information from someone else who knows the child. After rating different behaviors, the evaluator can then calculate summary scores; and because the scales are norm- referenced, the scores for the child can be used to determine his or her behavioral status compared to others.

Rating scales that are frequently used in schools are the Devereux Behavior Rating Scale- School Form (Naglieri, LeBuffe, & Pfeiffer, 1993) and the Social Skills Rating System (Gresham & Elliot, 1990).

Curriculum- Based Assessment

Curriculum-based assessments are often made by the teacher to determine the student's skill level in specific curriculum areas at a certain point in time. For example, if a student has an IEP goal to learn to read on the fifth-grade level, the teacher is not likely to regularly administer a standardized reading test to see if the goal is being achieved. Instead, the teacher might ask the student to read aloud two or three times a week from a fifth-grade reader and answer comprehension questions abut the material. At each session, the teacher would record and chart the number of words read correctly, the number misread, and the number of comprehension questions answered. By using this form of curriculum-based assessment, the teacher could determine if the student was making progress toward the goal.

Curriculum-based assessment provides a viable approach for evaluating how well a student responds to intervention (Fuchs et al., 2003). For this reason, teachers are likely to use it very often when evaluating students who are participating in early intervening activities. By using the curriculum-based assessment, teachers and other professionals will be able to determine if a particular intervention is succeeding.

End-of-Grade, End-of-Course, and Alternate Assessments

The purpose of the No Child Left Behind Act (NCLB) was to close the achievement gap between students with high and low levels of performance. Schools are required to

demonstrate adequate yearly progress for all students or make significant changes in the way schools are run. In order to show if schools are making adequate progress, students are tested at the end of each grade. Currently, this testing applies to children between the third and eighth grades. Besides NCLB, many also have educational accountability laws that operate in a similar way.

Students in special education are not exempt from these tests; in fact, IDEA 2004 requires their participation. If students with special needs are unable to participate in the general education mandated assessment, there are two possibilities. First, they may take the test with accommodations that allow them to participate. Second, they may participate through an alternate assessment procedure. Most students with academic special needs and with sensory or physical impairments are provided with accommodations, whereas students with more severe intellectul special needs are evaluated using an alternate assessment.In ease, the students

IEP must indicate how the end-of-grade or end-of-course test is to be given (Browder & Spooner, 2003).

10 Basic Steps in Special Education

When a child is having trouble in school, it's important to find out why. The child may have a disability. By law, schools must provide special help to eligible children with disabilities. This help is called special education and related services. Following are the 10 basic steps:

Step 1. Child is identified as possibly needing special education and related services.

There are two primary ways in which children are identified as possibly needing special education and related services: the system known as Child Find, and by referral of a parent or school personnel.

When a child is identified by Child Find as possibly having a disability and as needing special education, parents may be asked for permission to evaluate their child. Parents can also call the Child Find office and ask that their child be evaluated.

Referral or request for evaluation. A school professional may ask that a child be evaluated to see ifhe or she has a disability. Parents may also contact the child's teacher or other school professional to ask that their child be evaluated. This request may be verbal, but it's best to put it in writing.

Parental consent is needed before a child may be evaluated. Under the IDEA regulations, evaluation needs to be completed within 60 days after the parent gives consent.

Step 2. Child is evaluated.

Evaluation is an essential early step in the special education process for a child. It's intended to answer these questions:

- Does the child have a disability that requires the provision of special education and related services?
- What are the child's specific educational needs?
- What special education services and related services, then, are appropriate for addressing those needs?

By law, the initial evaluation of the child must be "full and individual"-which is to say, focused on that child and that child alone. The evaluation must assess the child in all areas related to the child's suspected disability.

The evaluation results will be used to decide the child's eligibility for special education and related services and to make decisions about an appropriate educational program for the child.

If the parents disagree with the evaluation, they have the right to take their child for an Independent Educational Evaluation (lEE). They can ask that the school system pay for this IEE.

Step 3. Eligibility is decided.

A group of qualified professionals and the parents look at the child's evaluation results. Together, they decide if the child is a "child with a disability," as defined by IDEA. lfthe parents do not agree with the eligibility decision, they may ask for a hearing to challenge the decision.

Step 4. Child is found eligible for services.

lfthe child is found to be a child with a disability, as defined by IDEA, he or she eligiblefor special education and related services. Within 30 calendar days after a child is determined eligible, a team of school professionals and the parents must meet to write an individualized education program (lEP) for the child.

Step 5. IEP meeting is scheduled.

- The school system schedules and conducts the IEP meeting. School staff must:
- contact the participants, including the parents;
- notify parents early enough to make sure they have an opportunity to attend;
- schedule the meeting at a time and place agreeable to parents and the school;

- tell the parents the purpose, time, and location of the meeting;
- tell the parents who will be attending; and
- tell the parents that they may invite people to the meeting who have knowledge or special expertise about the child.

Step 6. IEP meeting is held and the IEP is written.

The IEP team gathers to talk about the child's needs and write the student's IEP. Parents and the student (when appropriate) are full participating members of the team. If the child's placement (meaning, where the child will receive his or her special education and related services) is decided by a different group, the parents must be part of that group as well.

Step 7. After the IEP is written, services are provided.

The school makes sure that the child's IEP is carried out as it was written. Parents are given a copy of the IEP. Each of the child's teachers and service providers has access to the IEP and knows his or her specific responsibilities for carrying out the IEP. This includes the accommodations, modifications, and supports that must be provided to the child, in keeping with the IEP.

Step 8. Progress is measured and reported to parents.

The child's progress toward the annual goals is measured, as stated in the IEP. His or her parents are regularly informed of their child's progress and whether that progress is enough for the child to achieve the goals by the end ofthe year. These progress reports must be given to parents at least as often as parents are informed of their nondisabled children's progress.

Step 9. IEP is reviewed.

The child's IEP is reviewed by the IEP team at least once a year, or more often if the parents or school ask for a review. If necessary, the IEP is revised. Parents, as team members, must be invited to participate in these meetings. Parents can _make suggestions for changes, can agree or disagree with the IEP, and agree or disagree with the placement.

If parents do not agree with the IEP and placement, they may discuss their concerns with other members of the IEP team and try to work out an agreement. There are several options, including additional testing, an independent evaluation, or asking for mediation, or a due process hearing. They may also file a complaint with the state education agency.

Step 10. Child is re-evaluated.

At least every three years the child must be reevaluated. This evaluation is sometimes called a "triennial." Its purpose is to find out if the child continues to be a child with a disability, as defined by IDEA, and what the child's educational needs are. However, the child must be reevaluated more often if conditions warrant or if the child's parent or teacher asks for a new evaluation.

5.8 Let us sum up

As discussed so far there are fifferent types of evaluation tools and techniques. Norm-referenced test, Criterion refereuced tests & c ontinuous and comprehensive evaluation are a pre-requisite of to days evaluation system in education.

To determine if a child is eligible for classification under one of the 13 areas of exceptionality, an individualized evaluation, or assessment, of the child must be conducted. The focus of evaluation is to take the educator, step-by-step through the assessment process in special education. A referral to Special Education can be made by teachers, parents, doctors, or anyone involved in a student's education. Before a child is placed in Special Education an assessment must be completed to determine their academic level, cognitive ability, adaptive behavior, motor skills, or language processing abilities. The design of the assessment varies according to the suspected area of disability. Assessments are only appropriate when all other classroom interventions are tried. The assessment results are presented at the Individual Educational Plan (IEP) meeting to the IEP team, which is usually composed of the child's parents, a general education teacher, an administrator, and the assessment team. The goal is to understand the student's strengths and weaknesses, to understand the root causes of their learning difficulties, and to determine their eligibility for Special Education services. When the individual pieces of the assessment are put together, they compose a complete picture of the child and their educational needs. If the child qualifies for Special Education, the assessment information is used to develop an IEP.

5.9 Check Your Progress.

1. Define Evaluation. Mention Defferences between reaqurement and Evaluation.

   .....

   .....

   .....

2. Discuss in brief defferent types of Evaluation.

   .....

   .....

   .....

3. Explain with suitable example, the difference between NRT and CRT.

   .....

   .....

   .....

4. Why evaluation process are necessary in our teacher learning system.

   .....

   .....

   .....

5. Explain in brief about CCE and scholastic and non scholastic assessment in Evaluation process.

   .....

   .....

   .....

6. Mention different types of tests used in our teaching learning system.

   .....

   .....

   .....

7. Classify different types of tools used in Evaluation.

.....

.....

.....

8. Explain about the basic technique of Evaluation implemented in our teaching learning
process.

.....

.....

.....

5.10 References

Ahmad. J, Teaching of Biological Sciences, Prentice Hall of India, New Delhi.

Singh A. K. Tests, Measurement & Evaluation in Education.

Agarwal J. C. Evaluation in Education, Vikas Publishing House, New Delhi.

Mangal, S. K. Essentials of Educational Technology, Prentice Hall of India, New Delhi.

Notes

Notes