PEDAGOGY OF SCIENCE

ELECTIVE COURSE 1 (EC 1)

GREY NOTES

B.Ed. F.Y./S.Y. SEM – 2 / 3

Dnyan Ganga Education Trust's College of Education (B.Ed.)

Thane (w)

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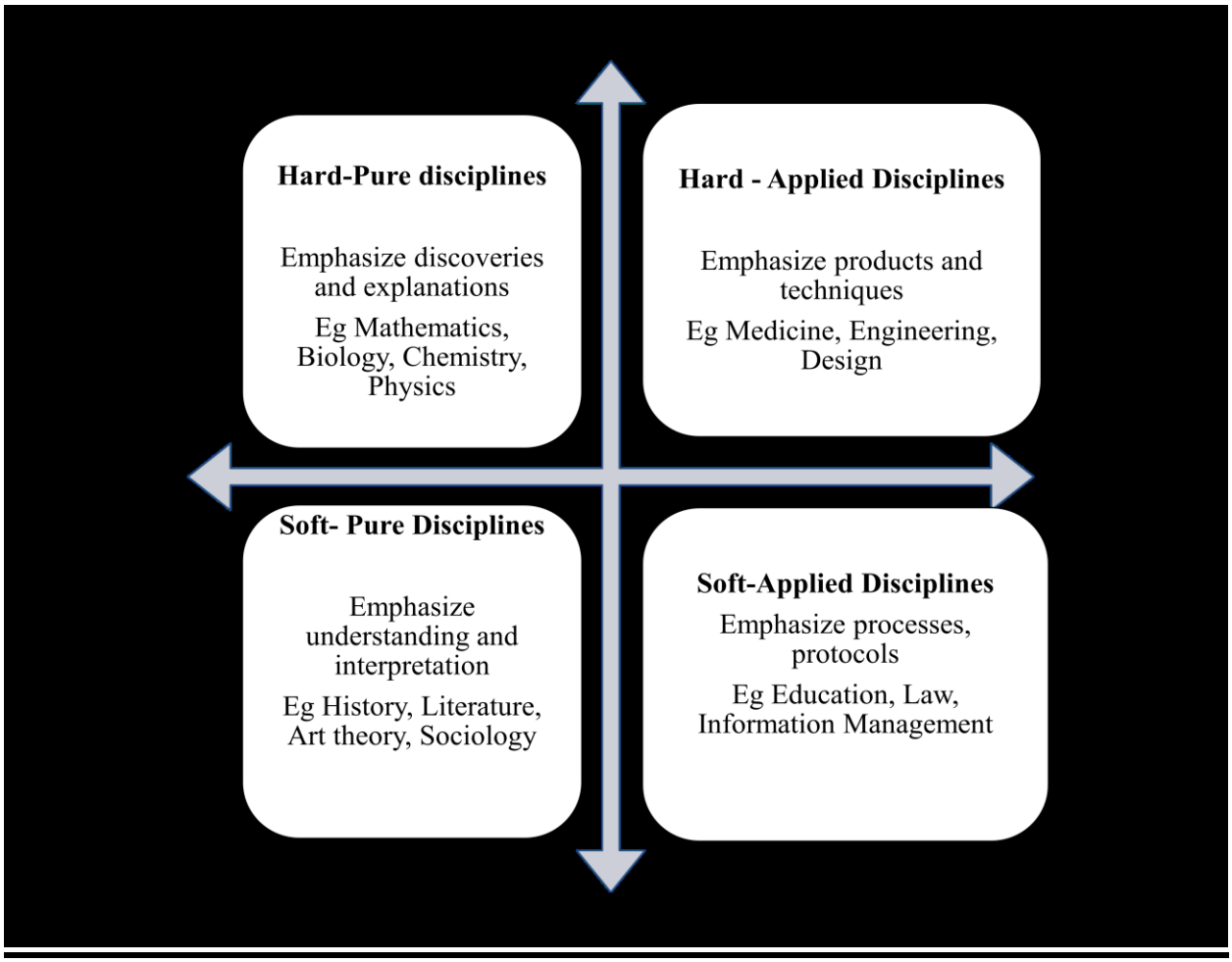
Unit 1

1A]. Meaning of Academic Disciplines
1B]. Classification of Academic Disciplines

1 a) Meaning of Academic Disciplines



Hard-Pure disciplines involve general areas of human understanding and are clustered around limited number of problems. The nature of knowledge in these disciplines is cumulative and concerned with universal phenomena. The result of such knowledge is discovery of something new or expansion of already existing knowledge. Just like a crystal grows as more and more molecules add on to it, so is it in case of this group of disciplines. As new knowledge keeps adding, the older form of knowledge is enhanced. For example, consider the knowledge about an atom. As research on the atom progressed, our knowledge about atoms made incremental progress. The relationship between the knowledge seeker and knowledge is unbiased and very objective. There are very definite criteria to verify knowledge in such disciplines. There is a high degree of consensus over significant questions. For example if two scientists are studying the effect of temperature on the states of matter, their results will be similar no matter which

parts of the world they perform their experiments in. Academic communities in hard-pure disciplines are well organized, their work is quite competitive and publication rates are high.

Hard-Applied Disciplines are involved in purposive work. The emphasis is on application of theories resulting in creating techniques and products. These disciplines are practical in nature and are concerned with solving problems, addressing challenges and mastering the environment around us. The focus is on application and hence heuristic approaches find more importance in such disciplines. They use both quantitative and qualitative approaches. The criteria for judging the product of such disciplines are functional. Such disciplines result in new techniques and products being created. Engineering, for example, is a hard-applied discipline which draws from Mathematics, Physics and Chemistry. Clinical Medicine is a hard-applied discipline dependent upon Biology and Chemistry. The ethos in such disciplines is entrepreneurial and dominated by professional values. Patents are submitted for publication.

Soft-Pure Disciplines stress on understanding and interpretation of phenomena. Knowledge in these disciplines is reiterative which means there may be repetition of knowledge when examined in different situations. These disciplines are concerned with particular happenings rather than general occurrences. Unlike hard sciences, here data is qualitative. The researcher and knowledge share a personal relationship. There can be different views regarding what verification of data. Subjectivity can be high when interpretations are made. There is no definiteness as to what significant questions are to be answered. Anthropology and History are some examples of disciplines in this type. The academic communities of such disciplines tend to be less structured compared to those from hard-pure disciplines. Publication rate is also lower.

It is interesting to note that while a discipline like Sociology is a soft-pure discipline, Sociometrics, a subfield of Sociology, is hard-pure.

Soft-Applied Disciplines emphasize processes and protocols. These are functional and utilitarian in nature. They are concerned with the enhancement of professional practice. Often their status is uncertain. They also appear to be dominated by intellectual fashions. They use a mix of qualitative and quantitative data for their growth. Case studies form an important tool in such disciplines. Law and Education are examples of soft-applied disciplines. Education depends upon other soft disciplines like Psychology, Sociology, Philosophy. Publication rates in these disciplines are low.

A brief summary of the above discussion is given below

Discipline Types	**Nature of knowledge**	**Objects of Inquiry in the discipline type**	**Enquiry procedures**	**Results of Research**	**Culture of the discipline type**	**Disciplinary areas**
Hard-Pure	Cumulative and concerned with phenomena	Concerned with universal things and quantities	Clear criteria for knowledge verification	Discovery and theories	Competitive, high number of publications, task oriented	Natural Sciences
Hard-Applied	Purposive and pragmatic	Concerned with mastery Of physical environment	Qualitative and quantitative approaches, use of Heuristic methods	Patents, products	Entrepreneurial, Dominated by professional values, role oriented culture	Science based Professions

Soft-Pure	Reiterative, holistic knowledge	Concerned with particular events	Qualitative methods, there is dispute over criteria For knowledge verification	Results in understanding and interpretation	Individualistic, loosely cohesive communities, low publication rates	Humanities and Social Sciences

Soft - Applied	Functional and utilitarian knowledge	Concerned with enhancement of professional practice	Use of case studies	Results in protocol and procedures	Outward looking, dominated by intellectual fashions, power oriented,	Social Professions

Thus the understanding of Biglan-Becher typology gives an overview of how different disciplines are similar and how they differ. One also sees how a particular group of disciplineshas somewhat similar characteristics with respect to research carried out or publications made.The Biglan - Becher groupings can be a tool to promote intra- as well as interdisciplinarydialogue through recognition of the differences and similarities present in the various groups.
Research in Education must take this typology into consideration as Education (from the soft applied type) often relies on disciplines like Psychology and Sociology (soft-pure). A good understanding of the typology of disciplines will result in better quality of research.
Interdisciplinary studies too need to look at this typology carefully.

Interdisciplinary and multidisciplinary teaching and learning: meaning, significance and role of the institution

Interdisciplinary and multidisciplinary approaches make educational experiences authentic.
Curricula that reflect real life are more meaningful to students. Students are able to see natural and logical connections that cut across content areas. The traditional approach to learning organizes content into compartments based on subject matter boundaries. In interdisciplinary and multidisciplinary approaches, content revolves around questions, themes, problems and projects.

Meaning of Interdisciplinary teaching and learning

Heidi Jacobs defines interdisciplinary learning as "a knowledge view and curriculum approach that consciously applies methodology and language from more than one discipline to examine a central theme, issue, problem, topic, or experience"
Keith Barton and Lynn Smith suggest that interdisciplinary learning is especially important in the early grades so as to "provide authentic experiences in more than one content area, offer a range of learning experiences for students, and give students choices in the projects they pursue and the ways they demonstrate their learning."
Barton and Smith explain that interdisciplinary units enable teachers to use classroom time more efficiently and address content in depth, while giving students the opportunity to see the relationship between content areas and engage in authentic tasks.

- Classification of academic disciplines**:** Becher -Biglan typology (pure-hard, pure-soft, applied- hard, applied-soft types) with emphasis on nature of knowledge in eachtype.

There is no definite system with respect to classification of disciplines. Some experts classify disciplines based on the focus of their content as Arts and Humanities, Socials Sciences, Natural Sciences, Mathematics and Business Studies. In the early 1970s Anthony Biglan carried out a study to investigate the faculty's judgment about similarities and differences between several academic fields.

These perceptions were classified as

i. Pure vsapplied
ii. Hard vs soft (or paradigmatic vs non paradigmaticdisciplines)
iii. Concerned with life systems vs those not concerned with lifesystems.

Let us examine the meaning of these terms

UNIT –1b) Classification of Academic Disciplines

Classification on basis of research undertaken

Pure Disciplines: Pure disciplines refer to those disciplines that tend towards fundamental research. There is systematic observation of phenomena solely for the purpose of discovering unknown facts which may develop into theories. The product of these disciplines is some kind of new knowledge. Simply put a pure discipline is a discipline that involves study purely for the sake of knowledge and not for its application. Some examples are Pure Mathematics, Pure Physics, Pure Chemistry, Pure History. To elaborate, Pure Mathematics solves problems, finds facts and answers questions that don't depend on the world around us, but on the rules of Mathematics itself.

Applied Disciplines: Applied disciplines relate existing knowledge to real world situations. These disciplines make significant contributions to the world by articulating the theoretical foundations in their field of study. For example Human Resource Development is an applied discipline that draws heavily from pure disciplines like Psychology and Sociology. Engineering is an applied science dependent on the pure sciences of Mathematics andPhysics.

Classification on basis of data involved

Hard disciplines: Disciplines that tend to use quantitative data, tend to be predictive and use experimental methods are classified as a hard disciplines. Eg: Physics, Chemistry, Engineering, Computing are all examples of hard disciplines as they deal with quantitative data. They use experimental methods to build their repository of knowledge. Braxton (1995) represents the hard disciplines as being characterized by greater concern for career development and cognitive goals (such as the learning of facts and concepts)

Soft Disciplines: Soft disciplines are those disciplines that rely on qualitative data. They generally do not use experimental methods and hence cannot make conclusive predictions concerning the future. Examples of soft disciplines are Languages, Law, Anthropology and Education. The soft disciplines as being characterized by greater concern for general education development, character development, critical thinking and 'scholarly' activities (such as the reading of research articles).

Disciplines are also classified as those dealing with life systems or living beings as against those that deal with inanimate objects. Examples of the former are Biology, Psychology and those of the latter type are Physics, Mathematics, Geology.

A study by Smart and Ethington (1995) reports the opinions on the goals of undergraduate education from over 4000 university faculty members who regularly taught undergraduate students. The conclusions were that soft and applied disciplines place greater emphasis on knowledge acquisition, and hard disciplines have more concern for knowledge application. Knowledge integration and

application were both perceived to be more important in the applied disciplines than in the pure.

While Biglan's work concentrated on the cognitive dimension of disciplines, Becher in 1989 called attention to the social dimensions of academic disciplines. From this emerged the Biglan- Becher typology of academic disciplines. According to this typology, four main types of groups are possible

1. Hard and Puredisciplines
2. Hard and Applieddisciplines
3. Soft and Puredisciplines
4. Soft and Applieddisciplines

UNIT –1C)Importance of Science education as a School Subject

Science, as a subject is universal and knows no boundaries. The claims of Science for inclusion in the school curriculum came to be recognized after years of active and persistent efforts. Science almost revolutionaries human life and proved indispensable for existence of man.

Now, supremacy of Science has been established in every field. In fact, so great is its importance for man and society that the present day people live in an "age of science". No one perhaps needs an explanation at present to include science in the school curriculum, Canon, Wilson, a famous educationist in 1867, in support of inclusion of science as a School subject wrote", "Science teaches what evidence is, what proof is.

English, History, Geography, Classics etc. are taught because they provide a liberal education. The main object of imparting education is to turn out intelligent citizens able to appreciate and enjoy the beauty and wonder of Nature.

They should be efficient in all walks of life and should take delight in the wealth of culture of past generations and civilizations. Hence, Science should form an essential part of the curriculum as it is the only subject which affords knowledge of certain facts and laws and helps in achieving the main object of education."

The following are the arguments in favor of General Science to be placed in School Curriculum:

1. Science provides unique training in observation and reasoning. Science students reason from definitely ascertained facts and form clear concepts. It makes one systematic and enables him to form an objective judgment.

2. The discoveries have added to the prosperity of human race with vast increase of knowledge. Herbert Spencer in his, "What Knowledge is of Most Worth" gives information which study of Science furnishes. According to him, Science learning is incomparably more useful for our guidance in life. Other chief subjects too provide an intellectual training not inferior to that of Science. Practically, we live in a world of scientific discoveries. So science education cannot be neglected.

3. Prof. H.E. Armstrong says that Science is taught to provide training in and knowledge of Scientific method, which is useful in the life pursuits. So this needs a School base of Science education.

4. Science has its cultural value. It has a literature of its own. The Scientific discoveries of Galileo, Newton, Faraday, Darwin, Pasteur, Kelvin, Bose, Armstrong and others are treasures of mankind. So, Science has won the first rank of humanistic studies.

5. Science has utilitarian value. It trains child to use his leisure properly. These are clearly illustrated in scientific hobbies.

6. Modern knowledge of Science provides great intellectual pleasure. An educated person is under very great disadvantage if he is not familiar with that knowledge.

7. Knowledge of the methods of observation and experiment in the different branches of Science helps pupils to develop a logical mind, a critical judgment and a capacity for methodical organization.

8. Science is useful in that it remedies some of the defects of the ordinary school education. It is found to be the most valuable element in the education of those who show special aptitude. Science provides discipline of mind.

Unit 2 Place of Science in the Curriculum and Life

a) Meaning and Nature (Product & Process) of Science , Science Process skills – Basic and Integrated

b) Aims and Objectives of teaching science at upper primary, secondary and higher secondary level (NCF 2005)

c) Values of teaching science in socio-cultural context

UNIT –2 a) MEANING AND NATURE OF SCIENCE

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

Definition:

Science is a systematic and organized body of knowledge.

Science is not only mass of knowledge but ultimate source of such accumulated knowledge.

Science can be defined as a systematic attempt to discover, by means of observation and reasoning, particular facts about the world, and to establish laws connecting facts with one another and, in some cases, to make it possible to predict future occurrences.

Science is a body of empirical, theoretical, and practical knowledge about the natural world, produced by scientists who emphasize the observation, explanation, and prediction of real world phenomena.

In its broadest sense science refers to the systematic acquisition of knowledge or a prescribed practice that is capable of prediction in a controlled environment.

In this sense science may refer to a highly skilled technique or practice.

Science **Investigation and exploration of facts :Process**

Building of a systematic and organized body of facts : Product

Science as a Product Facts, principles, concepts, laws, relationships

Science as Process – observation, quantification, classification, measurement, inferring, predicting.

In modern use, "science" more often refers to a way of pursuing knowledge, not only the knowledge itself.

Experimentation - It is a process in the sense it helps to explore the truth and involves certain systematic procedures and mental faculties as reasoning, analysis and synthesis.

The **process** of science is the scientific method.

This is the process of constructing an accurate, reliable, repeatable model of the real world, by scientists collectively working towards this goal over time.

Scientific ideas are developed through reasoning. The process of science is not predetermined.

Science is a Process as well asProduct

It is a process in the sense it helps to explore the truth and involves certain systematic procedures and mental faculties as reasoning, analysis and synthesis.

It is a product because it results in an organized body of systematic knowledge.

Science helps to makedescriptions

It answers questions like how , where, when, under what circumstances.

Science makespredictions

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

Science is based on observation

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

Science is concerned with past, present andfuture

Science answers questions about the past.eg why could the dinosaurs have become extinct? It is involved with the present.eg search for remedies to diseases.

It also dwells in the future.eg what fuels can be used in the future?

Scientific ideas are subject tochange

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

Science in its nature is dynamic.

UNIT –2 b) AIMS AND OBJECTIVES OF TEACHING SCIENCE AT UPPER PRIMARY, SECONDARY AND HIGHER SECONDARY LEVEL (NCF 2005).

NCF-2005 states that good science education is true to the child, true to life and true to science.

In the context of NCF- 2005 .

True to child - means that the science we teach should be understandable to the child and be able to engage the child in meaningful and joyful learning.

True to life - means that the science we teach should relate to the environment of the child, prepare her for the world of work and promote in her concerns for life and preservation of the environment.

True to science - means the science we teach should convey significant aspects of science content at appropriate level and engage the child in learning the processes of acquiring and validating scientific knowledge.

OBJECTIVES at UPPER PRIMARY STAGE

1. At the upper primary stage, the child should be engaged in learning the principles of science through familiar experiences, working with hands to design simple technological units and modules (e.g. designing and making a working model of a windmill to liftweights)

2. The students should continue to learn more about the environment and health, including reproductive and sexual health, through activities andsurveys.

3. Scientific concepts are to be arrived at mainly from activities and experiments. Science content at this stage is not to be regarded as a diluted version of secondary schoolscience.

4. Group activities, discussions with peers and teachers, surveys, organisation of data and their display through exhibitions, etc. in schools and the neighbourhood should be important components ofpedagogy.

Objectives at Secondary stage

1. The students should be engaged in learning science as a compositediscipline.
2. The students should be engaged in working with hands and tools to design more advanced technological modules than at the upper primarystage.

3. The students should be involved in activities and analysis on issues concerning the environment and health, including reproductive and sexualhealth.

4. The students should be engaged in systematic experimentation as a tool to discover/verify theoreticalprinciples.

5. The students should work on locally significant projects involving science andtechnology.

OBJECTIVES at HIGHER SECONDARY STAGE

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

Unit 2 –C)

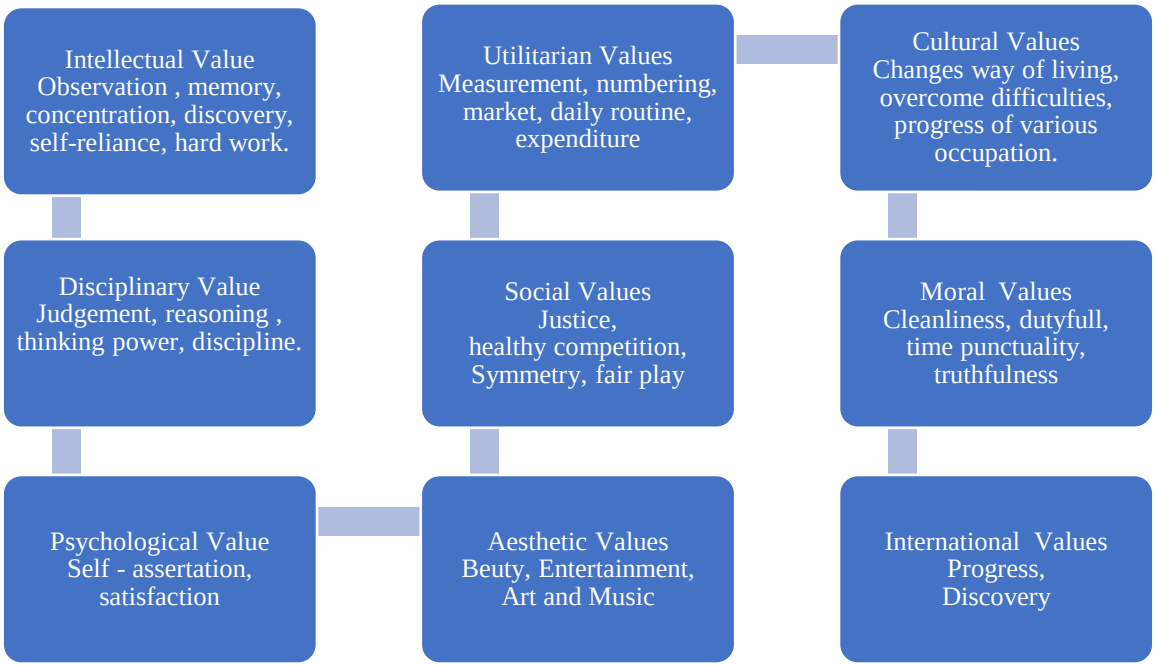
Values of teaching Science – (Ref: Dr. A.K. Kulshrestha)

Introduction:

Values give meaning and strength to a person's character by occupying a central place in his life.

Values are guiding principles of life which are conducive to all round development.

Therefore values reflect one's personal attitudes, judgments, decisions, choices, behavior, relationships, dreams and vision. Thereforescience plays an important role in progress of society.



1. **Intellectual value :**

There is no other subject in curriculum like science which makes student's brain active. Problem solving help us in developmental of mental faculties, each problem of science possesses such a sequence which is necessary for constructive and creative process. In this way, all mental abilities of a child are developed through Science.

2. **Utilitarian or Practical Value :**

We use science knowledge in our daily routine, house, outside, market, income—expenditure etc.

In the absence of scientific knowledge a person can neither treat his family well nor can he face his social duties.

3. **Disciplinary Value :**

Science develop child personality with qualities like concentration, truthfulness, seriousness etc. mathematics is the only subject whose knowledge develops the habit of hard work, concentration, well organized and clarity in the students.

4. **Moral Value :**

Through science study child develops qualities of cleanliness, reality, punctuality, truthfulness, honesty, self-control, self-reliance, patience, listens to others and respect them etc.

5. Social Value :

In order to live a social life, its knowledge is needed because the give and take process, business and industry depend upon the knowledge of science.

6. Cultural Value :

The history of science presents the image of culture of different nations. The person becomes cultured, critical observer, logical thinker and proper knowledge of science changes the mind of the person.

7. Aesthetic Value :

Scientist discovers something new with the help of scientific laws, facts, theorems and principles, a sense of joy is developed in his mind, he realizes the aesthetic aspect of his findings or research.

8. Vocational Value :

The aim of education is to learn living and make learner self-dependent. All vocations like engineering, technology, information technology, management are prestigious and important. The knowledge and training of this vocation is possible only through science. Almost every vocation needs knowledge of science.

9. Psychological Value :

Scientific education is also useful from the point of view of psychological aspects. Science fulfills the psychological needs of the children. In science emphasis is given on operations and experiments so that its knowledge becomes more solid as well as durable.

10. Scientific Attitude :

The knowledge of science trains the children in attempting the problems according to a definite and distinct procedure which may be called as the scientific method. Training which a child receives in studying science can be applied to solve the problem arising in new situations.

Unit 3 Organisation of Science Curriculum

a) Maxims of teaching science
b) Co-relation of Science in the Curriculum: Internal & External
c) i. Infusing Global Perspective in Science Curriculum
ii. Curriculum Organization- Concentric and Topical approach

UNIT –3 a) Maxims of Teaching In Education

Maxims of Teaching are the universally facts found out by the teacher on the basis of experience. They are of universal significance and are trustworthy.The knowledge of different maxims helps the teacher to proceed systematically. It also help to find out his way of teaching, especially at the early stages of teaching.

The different maxims of teaching are briefly explained below. ***(Give own examples of Science)**

Known to Unknown:

This maxim is based on the assumption that the student knows something. We are to increase his knowledge and widen his outlook. We have to interpret all new knowledge' in terms of the old. It is said that old knowledge serves as a hook on which the new one can be hung. Known is trustworthy and unknown cannot be trusted. So while teaching we should proceed from known and go towards unknown. For example, while teaching any lesson, the teacher can link the previous experiences of the child with the new lesson that is to be taught Teaching of science.

Simple to Complex:

Class-room teaching is formal where the teacher tries to teach and the students try to learn things. In this process of teaching-learning, the teacher should see that simple things are presented first to the students. That way they will start taking interest. Once they become interested, thou gradually complex type of things can also be learnt by them. By learning simple things, they feel encouraged and they also gain confidence. On this basis, they become further receptive to the complex matter. On the other hand, if complex types of things are presented to the learner first, he become, upset, feels bored and finds himself in a challenging situation lot which he is not yet ready being immature and unripe.

Gradually more difficult items of learning may be presented to the students. It will smoothen teaching being done by the teacher and make learning convenient and interesting for the students.

For example, while teaching sentences of English simple sentences should be taught first and complex type of sentences may be taken afterwards.

Concrete things are solid things and they can be touched with five senses. But abstract things can only be imagined. So it is rather difficult to teach the children about abstract things. The students are likely to forget them soon. On the other hand, if we teach the students with the help of concrete objects, they will never forget the subject matter.

For example when we teach counting to the students we should first examine concrete nouns like, laptop, book, Pen etc. and then proceed to digits and numbers. The stars, the moon, the sun etc. being taught first whereas the abstract thing:, like planet, satellites etc. should be taught afterwards.

Analysis of synthesis.

Analysis means breaking a problem into its convenient parts while synthesis means grouping of these separated parts into one complete whole. A complex problem can be made simple and easy by dividing into different parts.

"Analysis is the approach for understanding and synthesis is for fixation." Analysis of a sentence' is taught to students, that helps the students to understand the different parts of a sentence. Later on, synthesis of sentences should be taught.

Particular to General:

While teaching, the teacher should first of all take particular statements and then on the basis of those particular cases, generalization should be made. Suppose the teacher is teaching Present Continuous Tense while Teaching English, he should first of all give a few examples and then on the basis of those make them generalize is that this tense is used to denote an action that is going on at the time of speaking.

Empirical to Rational.

Empirical knowledge is based on observation and firsthand experience. II is particular concrete and simple. We can see, feel and experience it on the other hand; rational is based on our arguments, and explanation. The stage of arguments is the last whereas seeing things or feeling them is the first stage. Empiric.il is less general statements whereas rational is more general statements. So the safe approach in teaching is that we should proceed from empirical to rational. It is a journey from less mental maturity to more mental maturity.

Induction to Deduction

Induction means drawing a conclusion from a set of examples whereas deduction is its opposite. The teacher should proceed from induction to deduction. For example, in English while teaching conversion of active voice into passive voice, the teacher should first convert a few sentences of active into the passive voice and on the basis of those conclude the general rule for conversation of active voice into passive voice.

Psychological to Logical.

While teaching, the teacher should first keep in mind the interest, aptitudes, capacities, development level etc. of the children during selection of subject matter and then on to its logical arrangement.

In teaching English, the structures are selected as per needs and requirements of the students and then arranged in a logical way. The psychological appeal of the thing is more important at the early stages. Then the' logic behind it should be seen.

Whole to Part.

In teaching, the teacher should try to acquaint the child with the whole lesson first and then the different portions of it may be analyzed and studied intensively. This principle holds good while teaching a thing to the small children. At the early stages, the child loves to speak full sentences because in daily life situations, full sentences are used. The child should be given a full sentence. Then he may have full familiarity with the different words contained in that sentence. Later he may have the knowledge of words. Then he will have the knowledge of different letters forming the words.

Suppose a poem is to he taught to the students. They should be acquainted with the full poem first. Gradually they may be asked to grasp the poem stanza by stanza In the case of average students, their first attempt may be on full stanza, taking it as a whole and then to the different lines con I. lined in the stanza as parts. It will help the teacher to teach better and the learners to learn things conveniently.

Definite to Indefinite.

In teaching, definite things should be taught first because the learner can easily have faith in them. Then afterwards he should give the knowledge of indefinite things. Definite things, definite rules of grammar help the learner to have good knowledge. Gradually he can be taught about indefinite things.

The above given maxims are only hints and guidelines for the teacher, especially at the initial stages. He may use them if he finds some of them useful in his teaching situations. In some situations of class-room teaching, he may not use them if he feels so. The teacher should keep the maxims in his hand and he should remain their master. Then only the different maxims will remain tools and yield better result.

Simple to complex-

It is well known maxims of teaching & this is the natural process of mind. It is also psychologically successful methods for imparting the knowledge of abiotic and biotic resources like sea &ocean . A science teacher can show a pond or a tank to his students. Similarly a model of mountain can be used to explain various things about a mountain its role in giving shelter to various flora and fauna..

for example

a teacher may give flower of hibiscus specimen to observe and learn. while learning the simple five whorls of the flower the students may learn initially only the simple structures or parts, its description and their immediate functions.

it is only when the student leans the topic on sexual reproduction in flowering plants will they learn about the stages of pollination and fertilization, followed by theory of reduction division and formation of gametes. thus the topic evolves as the purpose of flowering is understood from simple to complex and also the maxim from whole to parts are also seen in this example.

Known to unknown-

It is always better to proceed from known to unknown. It demands that the teacher should make efforts to establish some association with the previous knowledge of the students while imparting them any knew knowledge. For ex: while teaching about forests & their qualities the science or environmental education teacher can establish association with gardens that the students have seen. Due to this the

regional science as well as geographyy is quite important.

Concrete to abstract –

Though it is desirable to proceed from concrete to abstract but it is difficult in teaching of geography. Geographical factors, that are abstract in nature, cannot be displayed in concrete form. Now ever teacher should try his best to act according to this maxims the teacher sketches & diagrams

& try to establish the abstract facts in the minds of students.

Particular to general –

It is always better to cite some specific examples before proceeding to general principles of a phenomenon. It helps the students to follow things easily & properly. The geography teacher should

proceed from the geography of region and then go over to the geography of the general principles of the whole world.

UNIT –3 b) CORRELATION OF SCIENCE WITH INTERNAL AND EXTERNAL SUBJECTS

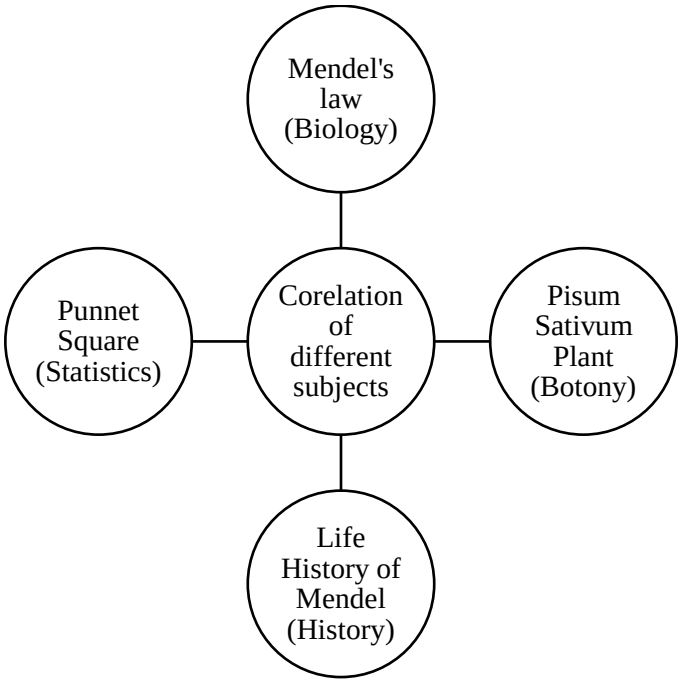
1. CORELATION OF SCIENCE IN CURRICULUM :

1. Correlation is reciprocal relationship with Various subjects of curriculum.
2. Knowledge does not work in isolation and also do not work in isolation.
3. Therefore correlation of different subjects is very essential for achieving whole knowledge this makes learning interesting and natural.

4. Correlation of subjects has important position in educational scheme.
5. Educational scheme emphasis on correlation of different school subjects within themselves and also correlation with life.
6. The principle of correlation demands that various subjects contribute child education and helps him to understand environment better and carry out activities which are meaningful.

Advantages of Correlation

1. Integration of knowledge.
2. Science cannot be studied in isolation.
3. Co-relation of science with other subjects help in expanding the knowledge of science.
4. MOTIVATION – Through co relation teacher can emphasis on application of one subject in another subject or situation therefore student understands importance of particular subject , feels it interesting, gets career opportunity and all this factors motivates him/her to learn the subject.
5. Mental Horizon – Corelation is usefull in widening mental horizon of student. It helps in development of reasoning ability and logical thinking.
6. Effective Learning – Corelation helps in effective learning as same topic dealt in variety of situations.
7. TRANSFER OF LEARNING – Students are able to transfer learning from one situation to another, if a particular concept is learned and correlated in two or three different situations.
8. DECREASES EFFORTS – Corelation can simplify the syllabus by placing one particular topic in one particular subject but corelationg with various subjects.
9. CORALTION OF LIFE – Corelation of subjects with parallel topics makes subjects interesting and students are able to correlate with real life.



2. CORELATION OF SCIENCE WITH EXTERNAL SUBJECTS :

1. **Science and language**:

To explain and to write and to propagate scientific knowledge science needs help of language to express, explain law, principles, definition of science there should be appropriate use of words, science teacher should have fluency of language so that they can write articles or research paper on scientific studies.

Teacher should inculcate reading skills of language among students so that they will read science fiction stories or biography of scientist which will arouse their interest in science.

2. **Science and History** :

In science if student is studying life history of any scientist or story of any discovery or invention science has to take help of history subject.

Evolution of man can be easily and simply expressed in form of story to students i.e. science through history similarly through group historical evidences many time chemical tests are done.

e g. Carbon dating etc... which are related to science subjects.

3. **Science and Civics** :

While teaching about hygiene teacher can correlate science with civics by discussing hygiene in community.

e g. Swash Bharat Abhiyan.

While teacher is teaching about first aid to students teacher can correlate about first aid and duty of good citizen to provide help during any disaster.

4. **Science and Geography** :

Geography is much related to science and now it is also regarded as branch of science.

In geography on studies topic like pressure, temperature, humidity of particular place this concepts are from science.

We learn about water cycle in geography as well as science, but in water cycle there are scientific concept like evaporation, condensation and precipitation.

5. **Science and Mathematics** :

Subject like physics can not proceed without mathematics,

eg. Physics have derivations, formulas etc.

In chemistry while writing chemical equations, we may use of numbers to balance equations.

In Biology while solving problem related to genetics.

Eg. Mendel's law related problem, he make use of Punnet square to which is related to maths.

6. **Science and Drawing** :

While drawing diagrams in science we make use of drawing, in science drawing becomes simple, technical specific and labelled now this drawing is called as diagram. Thus science is correlated to drawing.

e.g. In Biology - Animal or Plant cell diagram, In Chemistry - Carbon Atom structure diagram,In Physics – Circuit diagram.

7. **Science and Craft** :

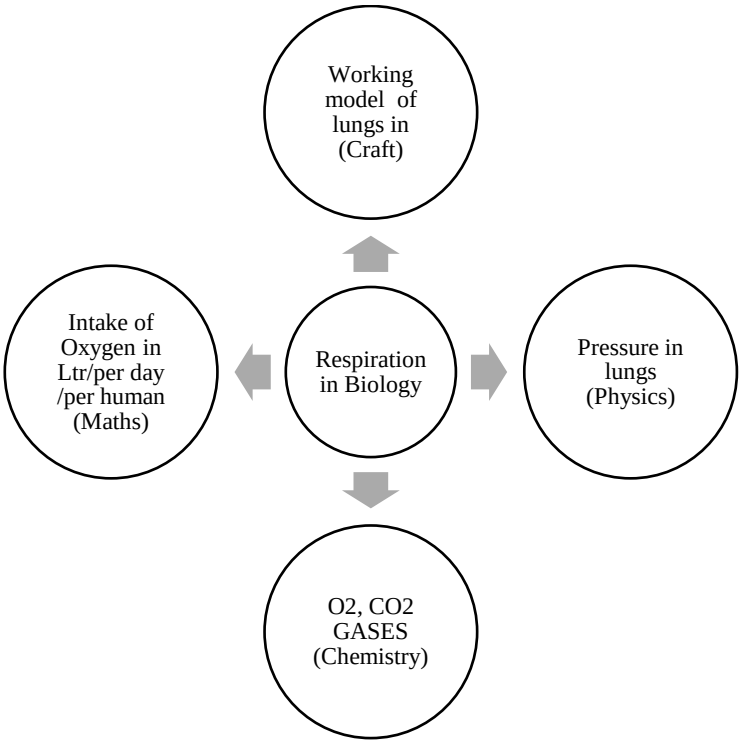
To explain scientific concept there are different models, this models are made through craft by student by teacher or by manufacturer.

This scientific models are crafted(made) from materials like clay, fibre and wood.

We can make models of different scientific concept by reuse of plastic, newspaper etc.

e.g. DNA model made by ice-cream sticks, Model of human respiratory system made by fibre

3. CORELATION OF SCIENCE WITH INTERNAL SUBJECTS :



1. **PHYSICS AND CHEMISTRY** :

While learning Chemistry – thermodynamics we come across like heat, temperature, energy, pressure which are related to Physics.

While learning Astrophysics we learn about planets, stars, astronoids etc and also we learn about their chemical composition which is related to chemistry.

While learning concept like dry cell or voltaic cell we should have knowledge about both physics and chemistry.

2. **CHEMISTRY AND BIOLOGY** :

In Cell every second thousands of chemical reactions takesplace cell is biology and chemical reactions is chemistry.

In Biology we learned about Nutrition, nutrients, carbohydrates, proteins etc is Chemistry.

Concept of genetics, DNA is Biology, molecular structure of DNA is chemistry.

3. **PHYSICS AND BIOLOGY** :

When we learned about blood circulation it is biology but when we learned about blood pressure in this chapter we are learning physics.

When we are studying structure of eye so it is biology but when we are studying focal length of eyes related to lenses it is physics.

UNIT –3 c i)Global Perspectives in science teaching (Meaning and Infusing global perspectives in the science curriculum)

DEVELOPMENTAL EDUCATION

PUTTING GLOBAL DIMENTION IN THE CURRICULUM

↓↓

Developmental education is an approach to the curriculum, which promotes equity and social justice, both locally and globally and enables pupils to develop skills and attitudes and values needed for a sustainable future.

It is a process of challenging negative assumptions about other countries and people and promoting positive attitude to diversity and differences.

Meaning-

An attitude that develops a sense of shared humanity towards the overall goal of world harmony.

Awareness that we live in an interdependent world and that we cannot ignore the problems faced by mankind.

It involves taking a broader and more critical view of experiences, learning and knowledge and includes seeking to understand the links between our own lives and those of people throughout the world.

Through issues like pollution, global warming, depletion of natural resources, energy crisis, extinction of some species Science can highlight the aspect of global perspective in more natural way to learners.

Global Perspectives aim at:

Encouraging empathy and mutual understanding by exposing students to different worldviews.

Developing skills and attitudes among students to bring about effective change leading to more just and peaceful world.

Preparing students to live in the world of increasing interdependence.

Developing students' ability to think critically and have independence of mind in order to undertake whatever constructive action is appropriate.

Infusing GP in the science curriculum

I. Incorporating a range of key concepts asappropriate

- citizenship
- socialjustice
- interdependence
- sustainabledevelopment
- humanrights
- values andperceptions
- diversity
- conflictresolution

II. Incorporating a range of perspectives from differentcountries/communities:

- Feel for 'real worldproblems'
- Increasing students' sensitivity to local needs and problems and putting them inthe global concerns, constraints and opportunities. Examples of solutions arrived at in differentcontexts.
- Eg. Nile Purification Project successfully carried out in Egypt can be related to Ganga PurificationProject.

III. Including action forchange

- Small actions to bring aboutchange.
- Personal → local →→global
- Strategies used for sensitization: games, role-play, stories, scientific inquiries orsimple activities.

IV. Developing sustainable practices

- encourage those practices that areenduring
- incorporate into thecurriculum
- focus on exposing the students to socio-cultural realities of life, bringing in a new dimension of socialrelevance.

STEPS TO INTRODUCE GP THROUGH THE SCIENCE CURRICULUM: (with example)

- Identify two to three keyconcepts
- Locate plug points in the sciencecurriculum
- Collect data/ information (both local andglobal)
- Design participatorymethods/approaches
- Use appropriate strategies to further sensitize students to theissue
- Decide on small action- studentinitiative.

UNIT –3 c ii) Curriculum Organization – Topical, Concentric.

Concentric Approach

In this approach the topics will find a place in different classes of different years of a course in a progressive manner. The content will be included from simple to complex as the pupils understand the content according to capabilities that present in chronological and mental ages.

The concentric approach is a way of organizing a curriculum by laying out basic concepts, covering other related material, and then circling back around to the basic concept and filling in more complexity and depth.

Instead of life science, earth science, physics, biology and chemistry being separated and studied in sequence, each year's curriculum revisits the sciences studied earlier.

It's believed that starting with fundamentals that are then regularly revisited, built on, deepened and broadened each time leads to a better understanding of a subject's interconnections.

The organization of curriculum using concentric approach is useful in primary and secondary school levels.

Merits-

1. It proceeds from ‘simple to complex ‘and ‘whole to part’.
2. Greater opportunity for revision of topic.
3. It takes into consideration mental growth of the pupil.
4. Continuity can be maintained.

Limitations-

1. Repetition is sometimes cumbersome. Some facts are repeated again and again.

2. The presentation lacks novelty and freshness.

3. Less appealing and fails to arouse interest.

4. Pupil develops a sense of familiarity without the fullness of knowledge.

Topical Approach:

Topical arrangement means that a topic should be finished entirely at one stage. It takes the topic as a unit. Topical arrangement requires that easy and difficult portions of a topic should be dealt with at one stage only which is psychological.

In topical approach all relevant material is covered in linear fashion and concepts are not revisited.

In this system the topic which is dealt with earlier receives no attention later and so there is every likelihood of its being forgotten

They are introduced with a view to make the teaching of the topic complete and thorough. Hence topical method demands that a topic once taken should be finished entirely.

This is not much useful for lower classes.

Merits-

1. Integrated knowledge is imparted to the pupils.

2. In-depth , thorough knowledge of the topic.
3. Pupil's interest and motivation is sustained.

4. Correlation of subjects.

5. This approach can be adopted according to the age, ability of the students.

Limitations-

The main defect in the topical method is that it introduces in the curriculum a largeness of irrelevant material for which the pupil finds no time and no immediate need or the use of which cannot be appreciated by the pupil at that stage.

Module2:TRANSACTING SCIENCE CURRICULUM

Unit 4 Science Teaching: Methods, Approaches and Tools

a) Methods of Teaching - Lecture cum demonstration method, Project method, Problem Solving

b) Approach :Inducto-deductive Approach

c) Concept Mapping – Meaning, Steps and Significance, PEOR (i.e. Predict,Explain, Observe & React)

UNIT – 4 a) Methods of Teaching

Lecture cum Demonstration method

Introduction

- This method includes demonstration of certain experiment by teacher along with proper explanation of that experiment.
- This method is devised to overcome demerits of lecture method.
- This method is according to maxim of teaching from concrete to abstract.
- Students see actual apparatus and experiment. Therefore, they feel interested in learning.

Steps involved in Lecture cum Demonstration method

1) Planning and preparation
   - Teacher should plan lesson properly i.e. lesson plan.
   - Teacher should collect and arrange all apparatus required for demonstration.
   - Do the rehearsal of demonstration.

2) Introduction of lesson
   - Teacher should introduce lesson before starting demonstration.
   - Teacher may use previous knowledge of student related to experiment.

3) Presentation of subject matter
   - While demonstration of experiment the teacher should explain laws, principle or theory related to experiment.
   - Language of experiment should be simple and clear yet scientific.

4) Experimentation
   - Demonstration should be properly placed so that all students are able to observe it.
   - Time management should be kept in mind.

5) Black Board work
   - Teacher should make use of black board to summarize principles of experiment, to draw diagram, write difficult scientific words etc.

Advantages

1) This method includes theoretical and practical knowledge.
2) It gives clear, undoubted and permanent knowledge.
3) There is semi-active participation of students if teacher asks students to perform some part of demonstration.
4) Multisensory communication is used which leads to interesting successful teaching-learning process.
5) It leads to better understanding of subject as concrete things are shown to students.
6) This method is useful in explaining experiments which are costly or which includes corrosive reagents.
7) It is time saving.
8) This method is suitable for all types of students.
9) This method helps teacher to gain student's attention.
10) It develops reasoning ability and critical thinking ability of students.

Disadvantages

1) This method is majorly teacher dominating. Students are passive and observing demonstration.
2) Students do not get practical experience.
3) Students are not able to develop their practical skills as they are not involved in doing experiment.
4) This method is not psychologically sound for students as 'learning by doing' is not followed.
5) Students do not get opportunity to do planning, construction, innovation etc. as whole experiment is demonstrated by teacher.
6) On teacher's part lot of preparation is required. Teachers have to invest more time in this method.
7) If students are large in number this method is not that effective as all students will not be able to observe demonstration.
8) This method demands well- experienced and well trained teacher.
9) Students sitting in last benches can be inattentive if they are not able to observe demonstration.

Suggestions

1) Students should be made to stand in semi- circular manner so that each one gets opportunity to observe demonstration.
2) Small groups of students should be made and then experiments should be conducted.
3) Mirror should be placed behind the demonstration table so that all students are able to observe the demonstration.
4) Rooms should be well ventilated and properly lighted.
5) Apparatus should be arranged in proper manner i.e. left to right or right to left.
6) Chemicals which are to be used in demonstration should be properly checked.
7) Experiment set up should be according to level of student. It should not be too lengthy.
8) Experiments should be properly connected or related to the theory, principle or law.
9) Teacher should have good control over class.

Project method

**********Explain steps, advantages and limitations of project method. Add a note on role of teacher in project method along with criteria of a good project. **********

Introduction:

- Project method accomplishes main objective of education i.e. learning by doing.
- In this method students are involved in some purposeful activity.
- Project method was propounded by Sir John Dewey.
- According to Stevenson- project method is problematic act which is completed in natural setting.
- Ballard states that project is a bit of (piece) real life which is experienced in school.
- Kilpatrik defies project as a whole hearted purposeful activity done in a social setting.

Criteria of a good project:

- Project should be purposeful and related to life.
- Experience gained from project should be fruitful i.e. objectives of the project should be achieved.
- Freedom should be given to students to work on their own.
- Teacher should just supervise and guide the project.
- Project should be economical.
- It should be adequately challenging- neither too complex nor too simple.

- It should be feasible to students; they should be able to do it without the help of their parents.

Steps involved in Project method:

1. Providing a situation.

   Teacher should provide a situation which may create some appropriate problem for students that they may find challenging and interesting to solve.

2. Selecting and proposing.
   - Students should be allowed to select a project.
   - Project should be acceptable to all.
   - It should be related to syllabus.
   - It should be manageable by students.

3. Planning.
   - Planning is important for success of the project.
   - Detailed planning of the project should be done under the guidance of the teacher by the students.
   - During planning, duties of project should be assigned to every group member.

4. Execution of project.
   - Student should collect information regarding different aspect of their project.
   - There should be good co-ordination among group members.
   - Teacher should supervise the project.
   - This is the longest step in the project.

5. Evaluation.
   - Project is reviewed by teacher and student from time to time.
   - Check whether objectives of projects were achieved or not.
   - See the positive and negative points after completion of project.

6. Recording.
   - Students should keep complete record of their work i.e. topic, minutes of meeting, duties assigned, problem occurred and their solutions, evaluation reports.

Advantages:

- Project method is a psychologically sound method as it is based on learning by doing, law of exercise, law of readiness.
- It helps in developing critical thinking and reasoning ability.
- It is possible to correlate different subjects through project method. Eg: Preparing model of digestive system- correlation of science and arts.
- Students can work at their own speed, place and execute their project.
- This method develops problem solving and scientific attitude among students.
- It inculcates dignity of labour among students.
- This enhances social relationships and co-operation among students.
- They get a chance to experience a piece of real life through this method.
- It is democratic as the students have full freedom to select their own project.
- Since students do the project on their own, the knowledge is retained for a longer time.

Limitations:

- This method is time consuming as the whole syllabus cannot be completed by this method.
- It could be expensive as it can add financial burden on students and their parents.
- Lot of expectation re kept from the teachers; they are expected to be an encyclopaedia, which is not possible at all times.
- Due to project method practical knowledge is clear but theoretical knowledge is not focussed.
- All projects are practically not possible in classroom or school environment.
- It is also not possible if teacher-student ratio is high.
- This method demands ell trained, experienced and knowledgeable teachers.
- If curriculum is very vast there is no scope for project method.
- Current examination systems do not have place for project method.

Role of teacher:

- Teacher should be a guide and active partner.
- Teacher should provide opportunity to slow and shy students to contribute in the project.
- Teacher should create democratic environment during project.
- Teacher should have thorough knowledge of students and their projects.
- They should be good and impartial supervisors.

Problem solving method

Introduction

- Scientific method involves reflective thinking, logical reasoning, scientific enquiry, practical skills and scientific attitude.
- Scientific method is basically problem solving method.
- According to James, problem solving is an educational device when teacher and students cautiously, with planning, purposefully attempt to explain or solve some educationally (scientifically) significant difficulty (problem).
- According to Risk, problem solving may be defined as planed attack upon a difficulty (problem) for purpose of finding proper solution.

Problem "Problem solving" Solution

Characteristics

- Problem should be according to the capacity of students.
- Problem should be related to previous knowledge of the student.
- Problem should have practical and educational value.
- Language of problem should be simple and clear.
- Problem should neither be too difficult nor too easy.
- It should be related to the syllabus.
- Problem should be challenging to students.
- It should fit within the administrative time table of the school.

Steps of problem solving method

1) Sensing the problem
    - A situation should be provided to student wherein students can feel to inquire about something and feel to ask a question.
    - Teacher can also give problem to student and stimulate student to find out the solution.

2) Defining the problem
    - Problem should be defined in clear, simple and scientific language.
    - Teacher should help students in framing the statement of the problem.

3) Analysing the problem
    - Student will now study words and phrases in detail, understand the whole problem properly and then start solving the problem systematically.

4) Collection of data
    - After analysing problem, students should refer different books, internet etc for collecting data.
    - They should also collect data from field related to the problem.

5) Interpretation of data
    - After collecting data, data should be organised on the basis of similarities and differences.
    - Collected data can be well organised with the help of tale and graph.
    - Teachers should help students in organising and interpreting data.

6) Formulation of hypothesis
    - Students are asked to form tentative hypothesis.
    - Hypothesis is probable solution for the problem.

7) Selection and testing of hypothesis
    - Students, after experimentation reject one hypothesis and accept another.

8) Drawing conclusion
    - On the basis of results and selected hypothesis, conclusion can be made.

9) Application of generalization (conclusion) to new situation
    - After solving problem, the conclusion or generalization can be applied by the student in his or her real life or a classroom situation.

Advantages

- By problem solving method, children get trained to solve problems of real life.
- This method stimulates critical thinking, logical thinking and reasoning ability of students.
- It helps in making students self reliable and resourceful.
- Students develop confidence.
- It motivates students to gather data and information independently.
- Students gradually develop ability of analysing problem.
- They develop patience and tolerance.
- It is based on the principle of "learning by doing".
- IT gives a break from boredom due to traditional teaching- learning process.
- Students develop skill of observation.

Disadvantages

- It is lengthy and time consuming method.
- All topics cannot be covered.
- It is applicable only for higher standard classes.
- It is difficult part for the teachers to organize content based on this method.
- It is not suitable for slow learners.
- Text books do not always contain problems related to real life.
- Students have to give independent effort to find put a solution which is not possible in case of every student.
- Organizing data, finding hypothesis and interpreting data is at times difficult at school level.
- This method demands well trained and experienced teachers.
- It requires proper infrastructure, apparatus etc to carry out experimentation which can be expensive.

Conclusion

- Problem solving method is a progressive method and an innovative teaching- learning process.
- Though it has certain demerits it can be overcome by selecting appropriate content which can fir into problem solving method.

UNIT – 4 b)Inducto-Deductive approach

The Inductive method

Inductive method is the method of constructing a formula with the help of a sufficient number of concrete examples. With the help of these examples students are helped to arrive at certain conclusion or principles.

Merits of Inductive Method

1. It promotes mental activity on the part of the pupils and makes them active participants in the learning process.

2. It is based on actual observation, thinking and experimentation.

3. This method provides opportunities to the students to be self-dependent and develops self-confidence.

4. The student's curiosity is well kept till the end when generalisation is arrived at.

5. The method is based on sound psychological principles. Learning by doing is the basis of this method.

De-merits of Inductive Method

1.There is every possibility that the students may draw conclusion very hastily and these may b based on insufficient data and therefore may be wrong.

2.The method is very slow and lengthy.

3.It is not very useful in the teaching of subjects in which there is more stress on

the teaching of facts.

4.Inductive reasoning is not absolutely conclusive because the generalisation

made with the help of few specific examples may not hold good in all cases.

The Deductive Method

In this method the rules, generalisation and principles are provided to the students and then they are asked to verify them with the help of particular examples.

This method is mainly used in Algebra, Geometry and Trigonometry because different relations , laws and formulae are used in these sub branches of mathematics.

Merits of Deductive Method

1. The teachers' work is simplified. He gives general principles and the students verify them.

2. This method is very economical. It saves time and energy both of the students and the teachers .

3. It is very suitable for small children who cannot discover truths for themselves. They get ready-made material.

De-merits of Deductive Method

1. The child is deprived of the pleasure of self-activity and self- effort as ready-made formulae, principles and rules are given to him.

2. It encourages memorization of facts which are soon forgotten and therefore, knowledge is rendered useless.

3. It fails to develop motivation and interest in learning.

4. It fails to develop self-confidence and initiative in the students.

5. It is very difficult for a beginner to understand an abstract formulae if it is not preceded by a no. of concrete examples.

Conclusion

There can be no induction without deduction and no deduction without induction.

Induction approach is a method of establishing rules and generalisation and also deriving formulae.

Deductive approach is a method of applying the deduced results and for improving skill and efficiency in solving problems.

Hence a combination of both inductive and deductive approach is known as Inducto- deductive approach .

UNIT –4 c) Concept Mapping

Introduction

- Concept map is a two dimensional hierarchical, node link, diagram that depicts the structure of knowledge as viewed by student.
- It is a technique to visualize the relationship between concepts and related information.
- Concept map is composed of concept labels, each enclosed in nodes which are circular, oval, square, triangular, cloud shape etc.
- These nodes are connected to each other by linking lines. Linking lines may have linking phrase like types, are, is etc. which articulates relationship between two nodes.
- Concept map is usually from general to specific or broad to narrow which helps students to comprehend the topic in scientific way.

Steps in Concept Mapping

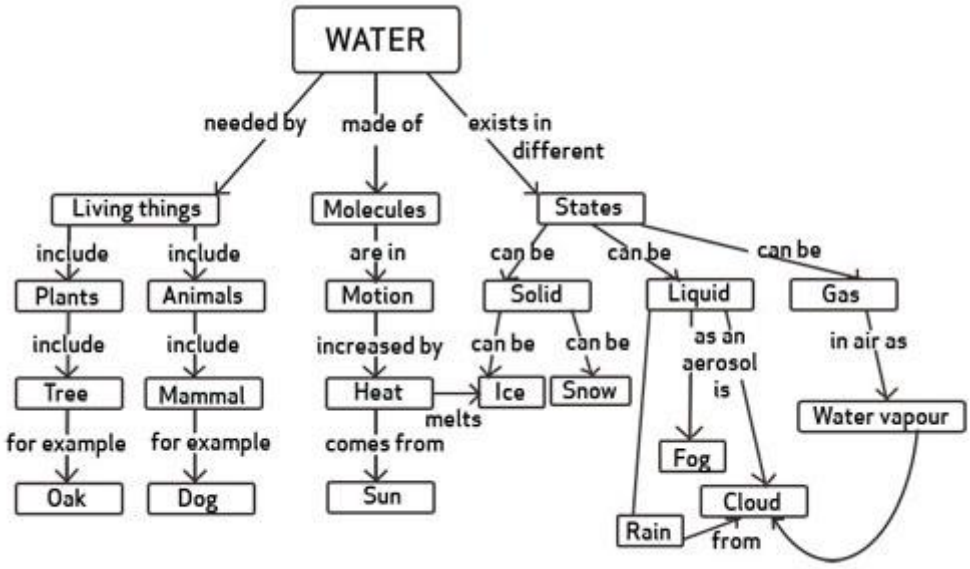
1) Place the main topic or idea at the top or centre of the page.
2) Organize the subtopics in order from the most general to the most specific.
3) Use the linking word in the form of a preposition, verb, or short statement to connect the relationship of one concept or term to another.
4) If applicable, add crossing links to show connections and relationships between different words on the map.

Significance

1) Concept map helps to organize information in well-connected schemas.
2) Interpret new information and novice features in meaningful pattern of information.
3) As students gain mastery of concept maps, they develop an understanding of relationships among elements of a concept.
4) By constructing concept maps, students enhance a meta-cognitive approach to learning.

5) Students control their own learning and monitor their progress.
6) Learner physically draws connection between two sub topics (sub concepts) and he/she reinforces same connection between concepts mentally (cognitive level).
7) This method enables teachers to engage their students and increase their motivation for learning.
8) Helps students to build/connect new knowledge with previous knowledge.
9) Students understand concept rather than memorizing the concept.

Example of concept map on WATER



Unit 5 Learning Resources and Activity

a) Science Text book: Characteristics of good Science textbook

b) Science Club and Science Field Visit – Concept, Organisation and Significance

c) Improvised Apparatus and E- resources (Virtual lab and Simulation)

UNIT –5a) Essential Characteristics of a good science text-book :

Introduction:

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:**

- The print and paper used and the binding of the text-book should be attractive. It should be hard and durable.
- The printing should be clear, legible and appropriately spaced.
- The book should be well-illustrated with diagrams, sketches and pictures.
- The size of the print, the language and experiments discussed should suit the age of the child and standard of the child.

***3.*The subject matter-its nature and organisation:**

- 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.
- There should be consistency of the subject-matter and the text-book should satisfy the objectives of science teaching.
- Each chapter should begin with a brief introduction and end with a summary.

- Subject-matter should lead to the inculcation of scientific attitudes, disciplinary and cultural values.
- Each chapter should contain assignments at the end.
- During treatment of subject-matter, numerical examples should find place where necessary.
- Headings and sub-headings are given in bold letters.
- Each text-book should contain detailed Table of Contents and an index.
- 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.
- The text-book should give suggestions for improving scientific apparatus.
- Examples in the text-book should be given from local environment and from life experience.
- 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.
- Each text-book should be accompanied by a laboratory manual.

UNIT –5 b) Science Field Trip

Explain steps , advantages and limitation of science field trip add a note on

Role of teacher.

Introduction

A field visit is a journey by a group of people to place away from their normal environment. The purpose of the visit is usually non experimental research or to provide students with experiences outside their every day activities, such as going camping with teachers and their classmates. Field trips are also used to produce civilised young men and women who appreciate culture and arts.

Criteria of good field visit

Popular field trip sites include zoos, nature centres, community agencies, local business, amusement parks, science museum and factories.

Steps involved in field visit

- Field visits are most often done in 3 steps :

- 1)Preparation, activities and follow up activity. Preparation apply to both the student as we as teacher.
- 2) Activities include lectures, tour, worksheets, videos and demonstration.
- 3) Follow up activities are generally discussions that occur in classroom once the trip is over.

Planning

- Proper planning should be made to ensure the safety of students as well teachers.
- Make sure that every child has a signed permission form. Obtain emergency contact number.
- First aid box should be handy. Time and destination should be informed to parents.

Advantages

- Students get opportunity to observe their chosen subject outside classroom setting .
- They can collect samples to conduct research.
- It can provide educational opportunities in many disciplines including , botany, geology, geography, archaeology and others who study natural or human world.

Limitations

- They take incredible amount of safety.
- Inclement weather if the trip is outdoor.
- Field visit bring up a wide array of legal issues.
- If the student gets injured ona nature hike, school is liable to pay medical fees.
- Parents may be nervous about the safety of the child.
- Other liabilities include exposure issues.

Role of teacher

- Teacher should first inform students when and where the visit is.
- Massage should be send to parents through note or mail.
- Consent form should be collected from students.
- Proper count should be maintained through out the visit.
- Ensure students safety.
- During the visit proper guidance and information should be provided. This will create interest among students to learn.

SCIENCECLUB

The science club is the place for students who are interested in science to learn about all scopes of science from medicine to chemistry to physics to the environment. We discuss how to use

this conceptual basis for applications in the real world.Trips are taken to museum , aquarium, and state parks.

Science clubs channelize the energies of students and make use of their skills and talents , which satisfy their instincts and urges and helps in their overall personality development . Through activities of a science club, learning of science become joyful.

ORGANIZATION OF SCIENCE CLUB

A properly organized science club will be a valuable aid to teaching science and also means of motivating the children for learning science.

- Science club is run by the students for the students the science teacher is the pivot of all the activities.
- Science teacher can explain the importance and benefit of organizing science club and can arouse enthusiasm among students .
- Science club should have its own constitution.
- Principal should be the patron and science teacher should be the sponsors.

Objectives of Science club.

- To develop a general interest in science.
- To inculcate scientific attitude and provide opportunities for training.
- To develop interest in scientific hobbies.
- To develop habits of exploration and creative faculties.
- To encourage individual and group activities.
- To develop in children a sense of healthy competition.
- To make the students and public science minded.
- To keep students in touch with the recent advances in o.
- To provide challenging opportunities to the gifted.

Activities of science club:-

1. Organizing lectures , debates , seminars, symposia etc.
2. Holding science exhibition and fairs.
3. Celebrating birth days of eminent scientists.
4. Conducting visual programmes of science interest.
5. Arrange visits to places of science interest
6. Preparing charts,postures , models etc.
7. Developing school garden
8. Displaying science news
9. General reading of science literature.

Conclusion:-

Science club gives great importance to science learning.

Science club is a place where the people can engage in their individual interests.It gives an opportunity to express the creative abilities in the field of science and pupil are free to choose their activities. In a science club people work not to satisfy their teacher, but themselves. A science club provides freedom , where as in a class the pupil have to conform to a strict system

Field Visit

1) Every thing cannot be learnt in classroom setting .

2)Excursion and visits to places of scientific interest provide students opportunity of direct experience.

3) Now learning becomes more accurate and meaningful.

4) Field visit is a planned visit which is always outside, classroom.

Definitions

1) A visit to a factory, farm factory or museum made by students and teachers for purpose of first hand observation.
2) A trip by student to gain first hand knowledge away from the classroom , as to a museum, factory , geological area , or environmental of certain plants and animals.
3) A field trip is a visit to a place outside the regular classroom which is designed to achieve certain objectives which cannot be achieved as well by using other means.

So, field visit is a first hand knowledge outside the class.

Steps of organisation of field visit

Planning:

1) Visit or excursion should be planned well in advance.
2) Visit should be to the place of scientific interest.
3) Discuss the place of visit with principal and school management.
4) In advance take permission of visit tentatively from owner, director/curator.
5) Plane for date, time, schedule , travel route arrangement of transport vehicle, expenditure to be born by student etc.

Preparation:

1) Student should be prepared for the visit
2) They should know objective of the visit.
3) Student should know what the should observe type of information they should record.
4) Planning and making small groups and group leader and divide the work among groups.
5) Ask students to bring necessary things prepare the list requires as per priority.

Execution:

1) During visit teacher should act as supervisor .
2) Teacher should continuously provide instruction to students in order to maintain discipline.
3) Avoid any mishap and to accomplish objectives of visit.
4) One can arrange for resource person or guide during field visit.

Making report:

1) Make a report on what things were observed during the visit.
2) What students learned.
3) Attach photographs to the report.
4) Report should be written in formal language-concise and precise.
5) At last attach evaluation report.

Evaluation:

1) After visit, teacher and student should evaluate visit in terms of objectives of field visit.
2) Student and teachers should share thereexperiences(good and bad).
3) They should find out the lackeness in the visit and find the reason behind it.

Importance:

1) Students get first hand and direct information and experience. Example student learns about radio in chapter sound. This can be enriched by visiting radio station.
2) Students are able to co relate school life with outside world. Example students use notebooks so take them to Navneet factory.
3) They create situation which helps to develop spirit of scientific enquiry.
4) Field visit provides actual sources, material for study.
5) Student get traveling experience which itself teaches a lot.
6) People learn planning , cooperation and learn spirit.
7) They learn to take responsibilities and discharge their duties.
8) It helps to gain concrete experience.
9) It helps to inculcate scientific attitude logical reasoning, critical thinking.

UNIT –5 c)
Improvised Apparatus

In developing country like India, Science teachers face problem due to lack of adequate apparatus in laboratory.

One way to overcome this problem is improvisation of apparatus.

Preparation of ordinary simple apparatus from simple articles found at home and other places is called as **improvised apparatus.**

Characteristics of Improvised Apparatus:

1. The materials should be easily available in local environment either free of cost or at low cost.
2. To prepare improvised apparatus, it should not demand any specialized skill from student or teacher.
3. Materials can be easily used by teachers and students.
4. The production of improvised apparatus should not be time consuming.
5. The apparatus should be simple as per the age and level of the pupils.

Advantages or Importance of Improvised Apparatus:

Economic Value: Since preparation of improvised apparatus requires low cost materials, there is hardly any economic burden on students, teachers or school.

Educational and Psychological Value: Students themselves prepare the apparatus from the material which is available around them. Therefore they get deep knowledge about the working of that apparatus and principle of working of that apparatus.

There is development in hand and head co-ordination i.e development of skill.

It gives students sense of achievement because it is created by himself.

It gives students opportunity to apply his knowledge to create something.

Students learns to think critically about his apparatus.

Example: Why is the apparatus not working and how can I improve it work more efficiently?

Students can also make this their creative hobby.

Social Value: Pupils work with their own hand and they put efforts so students learn to respect labours.

Recreational Value: Students can make improvised apparatus during leisure time. Therefore the problem what to do in free time gets solved.

Scientific Value: When children work themselves on Improvised Apparatus, they develop interest in scientific activity due to which they learn science and gain scientific knowledge.

Inspiration: Improvisation of apparatus can inspire young children to improve, to invent new things.

Virtual Lab

- The **Virtual Laboratory** is an interactive environment for creating and conducting simulated experiments: a playground for experimentation. It consists of domain-dependent simulation programs, experimental units called objects that encompass data files, tools that operate on theseobjects.
- The Virtual Laboratory is an interactive environment for creating and conducting simulated experiments: a playground for experimentation. ". (The VirtualLaboratory Environment @ Algorithmic Botany retrieved 11:48, 30 June 2006 (MEST))

Objectives of the Virtual Labs:

- To provide remote-access to Labs in various disciplines of Science and Engineering. These Virtual Labs would cater to students at the undergraduate level, post graduate level as well as to researchscholars.
- To enthuse students to conduct experiments by arousing their curiosity. This would help them in learning basic and advanced concepts through remote experimentation. To enthuse students to conduct experiments by arousing their curiosity. This would help them in learning basic and advanced concepts through remoteexperimentation.
- To provide a complete Learning Management System around the Virtual Labs wherethe students can avail the various tools for learning, including additional web-resources, video-lectures, animated demonstrations and selfevaluation.

- To share costly equipment and resources, which are otherwise available to limited number of users due to constraints on time and geographicaldistances

Uses

- Virtual laboratories can be used to overcome health and safety concerns, time or location constraints, or ethical and legislativeissues
- Likewise, web-centric or computer-centric learning is best delivered using virtual laboratorytools.
- VL provide active, enquiry-based learning rather than passivelearning.
- Enhance learning experiences by enabling experimental manipulations at the click of a mouse.
- VL receive instant onlinefeedback
- Virtual laboratory tools enable students to focus on the underlying scientificconcepts.
- Enabling active engagement in construction ofknowledge
- Making available real-worldsituations
- Providing representations in multiplemodalities
- Drilling students on basic concepts to reachmastery
- Facilitating collaborative activity amongstudents
- Seeing interconnections amongconcepts

Simulation

Meaning

- **‘S**imulation means to imitate conditions of (situation etc.) with a model, for convenience of training’ as defined in the concise oxford dictionary of currentEnglish.
- ‘Simulation is the use of a model to conduct experiments which convey an understanding of the behaviour of the system modeled.’ (Gogg andMott,1993)

Uses of simulation

- Simulations can help students translate among multiple representations.
- Simulations contain physical systems represented in many different ways in two or three-dimensions: pictures, graphs, words, equations, diagrams, data tables, contour maps, etc. The students can make sense of the concepts by seeing the connection between the representations and how one variable affects another.
- Simulations can help students build mental models of physical, chemical or biological systems.
- Simulations allow students to visualize concepts that appear on textbooks or hear from their teachers in lectures. By using the simulation they can see a concrete situation that helps them build a mental model.
- Simulations can help students understand equations as physical relationships among measurements.
- Simulations are great tools to help students recognize how equations relate observations and measurements. Using a simulation where the students are able to vary parameters and see the effect of these variations, the role of equations is powerfully enriched.
- Simulations can serve as a vehicle for collaboration.
- Students working in groups can use a simulation to explain and describe their understandings to each other.
- Simulations can allow students to investigate phenomena that would not be possible to experience in a classroom or laboratory.
- Simulations can give students engaging, hands-on, active learning experiences.
- Simulations give students control when exploring scientific concepts and phenomena.

UNIT – 6 Science Teacher

a) Science teacher – Need and Avenues of Professional growth
b) Science Laboratory - Planning and Maintenance, Laboratory Method
c) Diagnostic testing and Remedial teaching in Science

Need and Avenues of Professional Growth

Meaning of Professional Growth

When a teacher learns new techniques and new knowledge then he/she grows in his/her experience of teaching and subject knowledge. This is known as *professional knowledge.*

A number of programs have been started by different agencies to help professional growth and development of Mathematics teachers. These keep the teachers updated about new developments, researches, concepts and methods of teaching Mathematics.

Numbers of opportunities are provided by the Government in different programs.

AVENUES OF PROFESSIONAL GROWTH FOR SCIENCE TEACHERS

1.Seminars

2.Conference

3.Workshop

4.Refresher Course

5.Study Groups

6.Professional Writing

7.Summer/Winter Institution

1. SEMINAR

A seminar is a meeting where a group of people discuss a problem or topic. A seminar is a class at a college or a university in which the teacher and a small group of students discuss a topic at student level.

Example: A teacher will participate in a seminar like

A) New teaching strategies in Science

b) Issues in Science education

c) Career prospects

2.CONFERENCE

A formal meeting of people with a shared interest, typically one that takes place over several days.

Example: All Science teachers meet in a conference and intensively discuss recent teaching-learning processes of Science or teaching Science for differently abled, enhancing Science school laboratory.

3.WORKSHOP

A meeting at which a group of people engage in intensive discussion and activity on a particular subject or project.

Example: A workshop for Science teachers on Science teaching aid, improvised Science apparatus, software of virtual laboratory and simulation.

4. REFRESHER COURSE

A refresher course is a training course in which people improve their knowledge or skills and learn about new developments that are related to the job they do.

Example: A refresher course on environmental education for Science teachers.

Conduction of Chemistry practicals at higher secondary levels.

5. STUDY GROUPS

Various study groups at district and state level. Teachers can share their experiences on different activities.

Teaching-Learning process and difficulties faced during teaching.

Acquire professional efficiency (experience.)

Follow problem-solving approach.

Participate in refresher courses, acquire latest development in Science field.

Teachers are encouraged to study various publications by NCERT.

6. PROFESSIONAL WRITINGS

This may include writings regarding new methods, techniques of teaching Science or problems faced while teaching.

Instructions regarding conduction of experiments in the laboratory.

7. SUMMER/WINTER INSTITUTE

Refresh and update the knowledge of Science teachers.

A) Unitary Institute

Held once a year to update the teachers in the areas of Science and new technologies.

B) Sequential Institute

Training given to the best 5 teachers about the concepts of methods of Science. They are prepared as resource portions.

C) Specialists

Organize all India level improvement/implementation of textual material for training college.

D) Project Technology Institute

Organized for secondary school teachers on regional basis, provides training in laboratory work, practicals and workshops.

NEED FOR PROFESSIONAL GROWTH

- Teachers should have updated knowledge to answer students' queries
- Should be acquainted with the latest strategy of evaluation
- Learn new technologies and teaching methods
- Develop scientific attitude, temper and inculcate these values in the students
- Need to acquire knowledge, ability, skills to organize Science clubs, Science excursions, etc
- Teachers need competency in motivating students, learning Science and applying knowledge of Science in daily life
- Acquire skills of guiding students for projects and vocational guidance

Teachers should participate and contribute in revision of Science

UNIT – 6 (b)

SCIENCE LABORATORY – PLANNING AND MAINTENANCE, LABORATORY METHOD.

What is Science Laboratory?

As science is a practical subject, it is necessary to conduct various experimental works. Science laboratory is central to scientific instructions and it forms essential component of science education. Without proper and well equipped lab, it is not possible to carry out science teaching effectively.

What is Laboratory method?

Under the laboratory method, the teacher encourages the students to derive various laws and principles on their own by getting personally involved in the experiment work.

For this provision of a well equipped lab is needed. Along with materials and facilities, proper instructions should be provided by the teacher. The students carry out the experiments independently and record the observations. On the basis of which they infer their results or draw conclusions.

Students work is supervised and controlled by the teachers so the probability of accidents reduces and the work is conducted without mistakes.

Some experts have divided this method into various categories:

1. **Inductive Lab Method:** Through this method students get the opportunity to form scientific concepts and principles as they have to take part in various project functions.
2. **Verification and Deductive Method:** Through this method teachers illustrate various scientific concepts, principles and laws in front of the students.
3. **Technical Skill Oriented Method:** This method stresses to acquire various manipulative skills which develop eye-hand coordination.
4. **Science Process Oriented Method:**Through this method teachers develop the science process skills of various students.

   It is necessary to plan and organise the lab activities carefully. Pre-lab instructions should be provided by the science teacher well in advance so that students get prepared for taking active part in the lab activities. Through Pre-lab instructions students will become oriented to the objectives to be attained and the procedures to be followed.

   Necessary directions for the actual lab work should be provided by the teacher, which should highlight the precautions which they are required to observe. Teacher can provide the instructions in written form or orally.

There should be proper provision of black boards and instruction cards in the classroom, as without it this function cannot be performed properly.

Importance of Lab Method:

a. Laboratory Method is based on the principle of learning by doing.
b. It helps in better understanding of concepts of science and construction of knowledge.
c. Firsthand experience is obtained through experiments imprinting permanent impression on young minds.
d. Provides opportunity to the teacher to inculcate various process skill of science in the students.
e. Process skills so acquired help in developing interest, values and spirit of inquiry that constitute scientific attitude.
f. Provides environment to the learner to exhibit qualities such as resourcefulness, imitativeness, orderliness, cooperation and team spirit.

Planning:

- Space
- Provision of elements of flexibility for effective teacher demonstration, for individual and small group work.
- Ample physical and material facility.
- Ample storage facility for chemicals and equipments.
- Good lighting and ventilation.
- Regular supply of water and gas.
- Availability of shelves, cupboards and notice boards.
- Seating arrangement and furniture in laboratory.
- Lecture room, teachers working place and students working place.
- Staffing
- Financing
- Budgeting
- Storage

These factors need to be considered while planning a Laboratory.

Maintenance:

- Storage of scientific material.
- Maintenance of lab registers

- Maintenance of electrical parts.
- Maintenance of glassware.
- Care and maintenance of Lab equipment (apparatus)
- Repairs of electrical parts and equipments.
- Refurbishing, dismantling, cleaning and polishing each component. If done regularly will extend the life of the lab.
- Annual stock taking of chemicals and equipments.

UNIT – 6 (c)

DIAGNOSTIC TESTING AND REMEDIAL TEACHING

A test designed to identify and investigate the difficulties, inadequate and saps of pupils in specific curriculum areas with a view to helping them to overcome those difficulties through remedial instruction is called diagnostic test

The term diagnostic comprises all activities in measurement and interpretation that help to identify the growth lags and their casual favors for individuals or class.

NATURE OF DIAGNOSTIC TESTING

- Thorndike and Hagen (1970) suggested that a diagnostic test should provide a detailed picture of the strengths and Weaknesses of a pupil in a particular area.
- Any test that yields more than a single overall score is diagnostic.
- Diagnosis has become an essential phase of developing plans of adaptation instruction to individual differences.

DEFINITION OF DIAGNOSTIC TESTING

- A diagnostic test is a test designed to locate specific learning deficiencies in case of specific individuals at a specific stage of learning so that specific efforts could be made to overcome those deficiencies.
- It helps the teachers in identifying the status of learner at the end of a particular lesson, unit or course of learning as to what specific teaching or learning points have been properly grasped by the learners.

IMPORTANCE OF DIAGNOSTIC TESTING

1) To find strength and weakness of individual either on an individual level or class level.

2) To analyze the difficulties of the student in a particular phase of work.

3) To find out the causes & nature of adjustment attitudes, interest motives of students through test interviews, and case studies.

4) To provide remedial treatment to the learner.

5) To help in designing curriculum to capabilities of learner.

6) To make students aware of their strengths, abilities and potentials.

7) To give proper guidance to students.

8) To help them to locate faulty learning.

9) To give suitable references for specialized cases.

10) Follow up is done after providing diagnoses.

THE STAGE OF PREPARATION OF DIAGNOSTIC TEST

1. PLANNING :-

The first step in the construction of a diagnostic test is identification of subject matter areas which are really difficult for the pupils. After selecting areas they should be further divided in to simple teaching point and test items may be constructed for each points.

As for as diagnostic test is concerned it is not very necessary to know the importance of various leaning points. All the learning points have to be covered in an unbroken sequence each learning point should have an adequate number of questions help to identify the areas of weakness.

2. WRITING THE ITEMS

All the forms of questions, essay, short answer and objective type can be used for testing different learning points. However it appears that for diagnostic purpose short answer questions involving one or two steps, be used widely.

Whatever be the form of questions they should in general be easy suitable for average students of that age or grade. The questions have to be specifically related to the learning point and should be such as to throw eight on the weakness of students. The questions should be written in simple language. The scope of the expected answer should be clear to the student.

Questions are dubbed around learning point even when they are of different forms, the learning point are arranged sequentially form simple to complex which ensures that students not have to change their mental sets every frequently. The mode of assembling also helps in finding out the weakness of the student.

3. ASSEMBLING THE TEST

Preparation of blue point may at together be avoided. No rigid time limit need to be specified through for administrative purpose of the limit may be set.

4. PROVIDING DIRECTION AND PREPARATION SCORING KEY:-

A set of instructions clear and precise is drafted. It should also be provided with a scoring key and marking scheme.

5. REVIEWING THE TEST:-

Before printing the test, it should be carefully edited and reviewed. This ensures that any in advert ant errors are eliminated. An analysis of the test testing down learning points with corresponding questions may be presented for future reference.

PREPARING THE SCORING KEY AND MARKING SCHEME

Scoring key is prepared the objective type questions and marking schemes made for the essay and short answers.

The paper setter himself prepare this marking scheme includes.

- Number of points or steps expected in the answer.
- Outline of each point or steps.
- The weight age to each of these

REMEDIAL TEACHING

Teaching or instructional work carried out to provide remedial measures for helping the students to overcome their common or specific weakness or learning difficulties diagnosed through diagnostic test.

STRATEGIES FOR REMEDIAL TEACHING

1. CLASS TEACHING

A particular lesson or unit or topic is repeated on the normal classroom by using special aids or strategies the class as a whole is benefited through such type of remedial teaching.

2. GROUP TUTORIAL TEACHING

Students of the class divided in to homogeneous group called tutorial group. On the basis of their common learning difficulties teacher teach then by using various strategies.

3. INDIVIDUAL TUTORIAL TEACHING

Difficulty of each student is attended individually by using special strategies. In this schedule every learner who feels learning difficulty of one or the other nature is attended individually.

4. AUTO INSTRUCTIONAL LEARNING

This responsibility of overcoming difficulties is handed over to the learners. Self learning self corrections are done by the student. Teacher's also supervises the learning process.

5. AUTO INSTRUCTIONAL LEARNING

In this technique the learners provided with auto correct instructional as self learning materials and equipments like programmed learning text books and packages auto learning modules teaching machines and computer assisted programmed instruction.

6. INFORMAL TEACHING

Learning difficulties arise act of lack of interest and non availability of first and experience are overcome by providing informal teaching situations like excursions field trip etc.

DIAGNOSTIC TESTING AND REMEDIAL TEACHING CYCLE

- Diagnostic testing for knowing the child's weakness and learning difficulties.
- Hypothesizing problem causes for weakness and difficulties.
- Applying remedial teaching for removing these weakness and difficulties.
- Containing the repeat above for process to achieve desired success in removing the diagnosed difficulties and weakness.