Unit I: Foundation of science Teaching:

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Values of Science Teaching

1.1 Teaching.Teaching science offers numerous values, encompassing intellectual, practical, and social benefits. It cultivates a scientific mindset, fosters critical thinking, and promotes problem-solving skills. Science education also enhances logical reasoning, creativity, and observational abilities. Furthermore, it provides a foundation for understanding technology and its impact on society, and it can inspire a sense of wonder and curiosity about the natural world.

1. Intellectual Value:

- Science education promotes logical thinking, reasoning, and analytical skills.
- It encourages curiosity and a desire to understand the world through observation and experimentation.
- Students develop the ability to form hypotheses, test them, and draw conclusions based on evidence.

2. Practical Value:

- Science provides knowledge and understanding that are directly applicable to everyday life.
- It helps individuals make informed decisions about their health, environment, and technology.
- Science education can lead to careers in fields like engineering, medicine, and research.

3. Social Value:

- Science encourages collaboration and teamwork through group projects and discussions.
- It fosters a sense of responsibility towards the environment and natural resources.
- Science education can help students understand the impact of technology on society and its potential benefits and challenges.

4. Other Values:

- **Aesthetic Value:**

  Science can inspire a sense of wonder and appreciation for the beauty and complexity of the natural world.

- **Cultural Value:**

  Science provides insight into the historical development of scientific knowledge and the contributions of different cultures to scientific discovery.

- **Psychological Value:**

  Learning science can help students develop a sense of confidence and self-efficacy as they master new concepts and skills.

  In essence, teaching science is valuable because it equips students with the skills and knowledge they need to thrive in a world increasingly shaped by science and technology, while also fostering a sense of curiosity, critical thinking, and responsible citizenship

1.2 Nature, Scope, Importance & Value of Science

Definition of Science :

In the words of J.W.N. Sullivan, ‘‘Science is the activity where truthfulness is obviously an essential condition for success. Its success in fact is measured by its truthfulness. Henri Poincare explains, ‘‘Science is built of facts as a house is built of stones; but an accumulation of facts is no more a science than a heap of stones.’’ In another way it could be said that science is more a verb than it is a noun. Science is an accumulated & systematized learning in general usage restricted to natural phenomenon. The progress of Science is marked not only by an accumulation of fact, but by the emergence of Scientific method & of the Scientific attitude.

Science is a cumulative & endless series of empirical observations which result in the formation of concepts & theories, with both concepts & theories being subjects to modification in the light of further empirical observation. Science is both a body of knowledge & the process of acquiring it.

The Structure of Science: It consists of the following—

Facts are the basis of all knowledge. They are said to be grass-roots for any theory or law. The whole process of the Scientific enterprise is continuously replenished by new facts & discoveries.

Concepts: is a generalized idea suggested to the individual by object, symbol or situation. It is an understanding of almost undefinable something.

Generalization: are very helpful in deriving useful conclusions regarding the scientific facts. Actually, the facts, concepts & generalizations are interrelated & interdependent.

Theory: is based on facts, it is precise & clear & it must be grounded in empirical data. It follows the law of parsimony & open to interpretation & verification. It has applicability & a meaningful structure as well.

How: A scientific law may be defined as a factual statement of what always happens in certain circumstances.

Nature of Science: learning of science is a lengthy & continuous process Knowledge acquired through this is referred to as product. The following are the criteria of nature of Science.

Science is a process: A process involves planning various stages of an activity, establishing steps for gathering information & then retaining it. In Science, gathering information, thinking, solving problems, etc. are called the 'processes of Science.' Two types of skills are acquired through this—basic skills & special skills.

Basic Skills

Observation: It is not merely 'looking' at or 'seeing' something. Through observation they come to know their environment.

Classification: Whatever is observed by the students is grouped on the basis of similarities.

Communication: Students observe & learn many things. This learning is transmitted to others through some means of communication. Communicating the knowledge could be in the form of a name, label, sign, symbol etc.

Measurement: It is recording the precise & accurate observation.

Estimation: are made by the learners whenever accuracy is not required.

Predictions: This skill enables to know the behaviour of a particular object or phenomenon before it happens.

Inferences: On the basis of above mentioned skills, ability to draw inferenced develops, inferences can be made about any process or phenomenon.

Special Skills: Along with basic skills, certain special skills are needed for an experiment or to solve any problem. These skills are as under–

Identification & control of variables : There are dependent independent & extraneous variables in any experimental set us. So, identification & control of there variables, (excepting the constants) are an important parameter.

Hypothesis formation : Science students acquire a basic skill of prediction. If the predictions are tested, they are called hypothesis. They are the guess about the result of an experiment.

Experimentations : Experiments are conducted to test a hyprothesis. The effects of various vareables are studied here. Tabulation: Data collected in the expriments is tabulated is an organized manner.

Interpretation : The analysis of the tabulated data leads to the interpretations & conclusion.

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

Science as a product : The information that is acquired through the process of sciences or the body of knowledge formed is called 'product of science'. Knowledge of any from consists of development of facts, concepts, principles, theory & ultimately law.

Importance & values of Science : Science helps to develop a scientific temper, scientific outlook & a Scientific attitude. There are certain values (Fig 2) attached to science which are as follows :

Intellectual value : The great value of science is that is has introduced us to new ways of thinking & reasoning. The chief part played by Science in helping to develop consciousness of man it to be found in the new thoughts that it has made us think. Science helps us to understand, evaluate & solve the problems of life. It enables the students to became more logical, develop reasoning ability & creativity. Students get various opportunities to develop the power of observation, reasoning, thinking, analysis, synthesis and evaluation.

Utilitarian value : of Science need not be emphasised. Science has entered in our life & daily activities to much that our existence would became impossible without it. Its achievements in almost all spheres are marvellous science has wrested from nature almost all the hidden treasures. If we look around yourself & will see that somehow or the other connected with sciences. No subject can claim to be as utilitarian as science. Modern age is the age of scientific inventions & we are surrounded with electrical gadgets, everything is guided by Science.

Vocational Value : In today's world, many Science based inter disciplinary vocations have come up, eg, poultry, diary, agriculture etc. knowledge of science is needed for research work as well. Amongst all, mobile repair & cyber cafe are the latest vocations which are based on science & technology Disciplinary value

: Science promoter team work, healthy exchange of thoughts, spirit of enquiry & a balanced judgement. Science promotes organized behaviour & systematisation in every work. Study of Science enables an individual to live a confident & disciplined life.

Moral & aesthetic value : Science inculcates moral & aesthetic values in the students. A highly moral person is honest, truthful & has are integrated personality. By studying Science, qualities of punctuality,

patience, Self-control, self-respect & determination are developed in students, making them highly moral individuals. In the words of Keats, ‘‘**Truth is Beauty’’**. In nature everywhere, we come across what Einstein calls ‘Pre-established harmonies’, which is beautiful & the discovery of such harmonies is the concern of Science. So, again there is a compromise between the artist & the man of Science or in others words science & art are basically the same.

Social & cultural value: Science has played are important role in determining the culture & civilization of a country from time to time. It has affected our way of thinking & way of living. The effect of Science is multifarious. It has a direct influence is dispelling many traditional beliefs & the adoptions of others suggested by the success of scientific method. As a result of which the social organizations have been amply changed & hence there is corresponding political changes. Science has its own literatures which makes are appeal is no way less powerful & elevating than the humanistic studies. The cultural & social aspect of science should, be fully appreciated by science students.

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

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

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

Making an accurate survey of the problem. Setting up the method of attacking the problem.

Collecting data regarding the problem. drawing conclusions from the collected data.

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

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

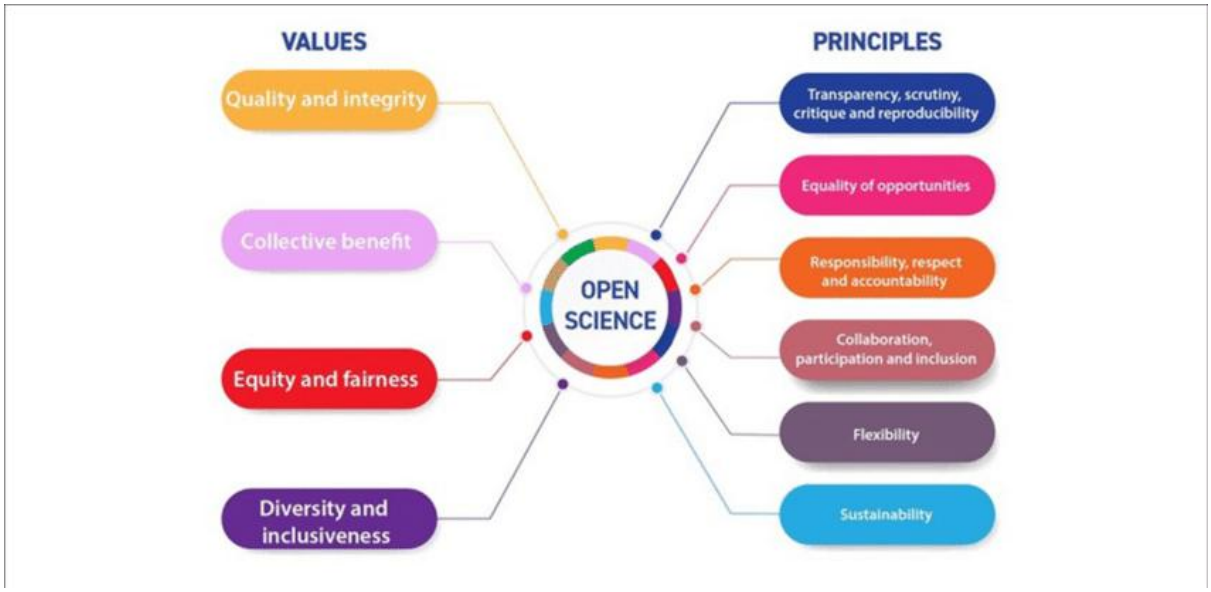

Fig : 1—Values of Science

Inter relationship of various branches of science

1.3 Science as an integrated area of study

Background

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

objects of enquiry and methodologies emanating from the hitherto separate study of both worlds.

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

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

The Science education community expresses different views about how Science education should be organised. The relative merits of integrated versus subject specific Science in compulsory schools are disputed among teachers, scientists and teacher educators. Fensham gives a comprehensive description of a problem area in Science education. First, Fensham points to the social changes of the 1960's that gave Science new groups of learners, with all the difficulties entailed. Arbitrarily, the academic disciplines have developed over the years in response to the expansion of knowledge. However, this nature of disciplines I snot a justification for the destruction or elimination of disciplinary boundaries. Every discipline possesses characteristics that are clearly unique to that discipline. Integrated and thematic curriculum/ instructional approaches ignore the conceptual, procedural, and epistemological differences that exist between the various areas of mathematics and the sciences. For example, problem solving is quite different among the various sciences let alone across mathematics and science in general. Within an interdisciplinary approach, the unique and valuable aspects of the various academic disciplines can be maintained while still developing students' understanding of interconnectedness.

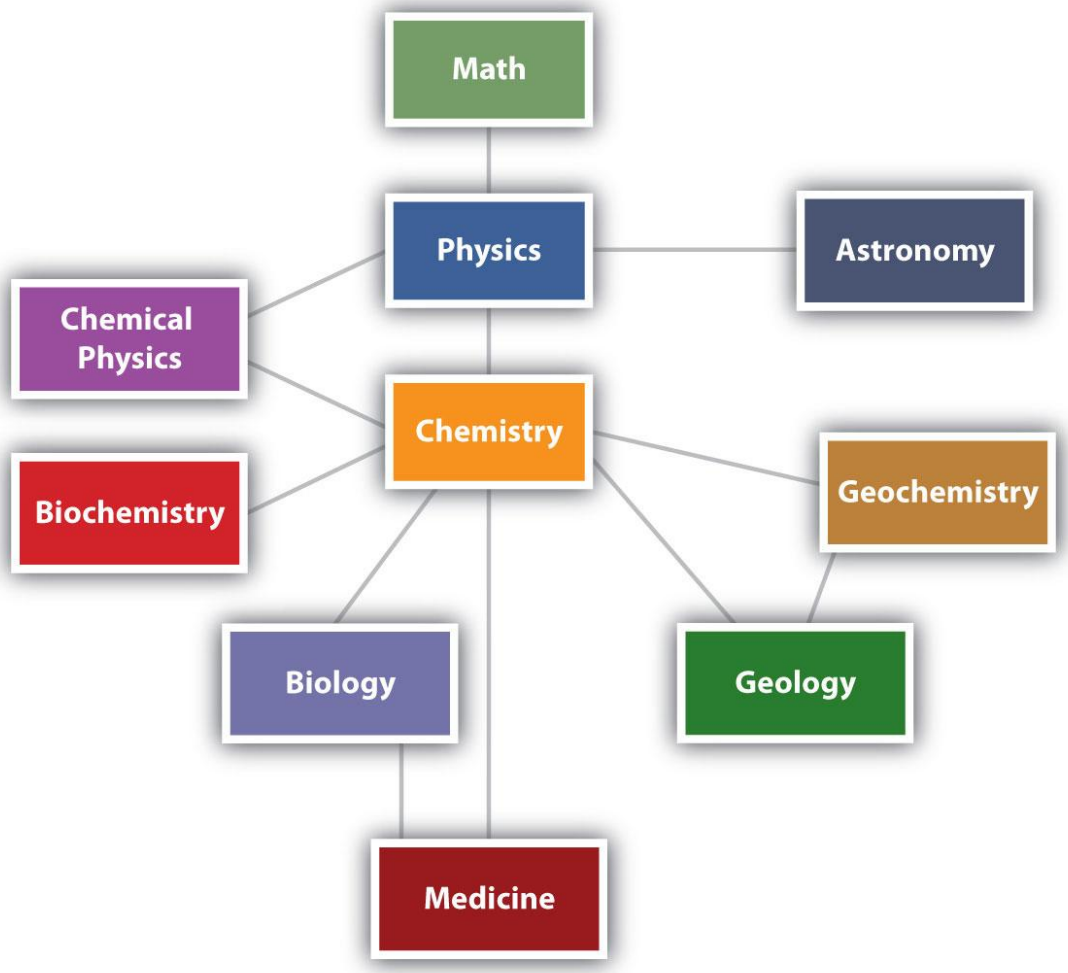

Fig:2- Branches of Science

Inter-relatedness of science & other subjects:

It is always said that science cannot be taught in isolation. All the branches of science are inter- dependent upon each other & there are a number of facts & principles which are common to various science subjects. As a result of this new subjects like physical chemistry, Geo-physics, Bio- Physics, Bio-Chemistry, Soil-Chemistry etc have been introduced. One of the most important factors that is responsible for the ineffectiveness in teaching in teaching science is the lob-sided specialization of teachers.

For e. g, a teacher while teaching the sense organs say, eye, should be able to make a parallelism with a camera, which the students have learnt in Physics.

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

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

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

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

By the help of this, students will find the opportunity to relate the knowledge which they have already gained, with the knowledge which they are gaining. This kind of relation activity leads to development of interest among the students. While imparting knowledge of one subject, teacher gets much help in communicating her ideas if she makes use of examples or reference of concepts covered by other subjects. Although it is not very easy to co-relate various subjects with the complex subject like science, but it is not impossible. This can be done in the following manner: -

Science and Language:

Since science is a practical subject, it is very important for the learners to be able to express their views and ideas in clear and attractive form. For this purpose, it is necessary that they should have thorough knowledge of language which they use.

Student who does not have good control over the language cannot express his views and various scientific laws and principles in front or others and especially in front of teacher.

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

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

assignment designed for them. In this manner, he can correlate science with the language.

Science with Mathematics:

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

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

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

Correlation existing in between one of the subjects of science and mathematics can be understood. Astrology is an advanced branch of science in which it is predicted or enumerated that which planet revolves at which speed and when it will get appeared to the people of earth. This is quite complex area, and no one can enter into this complex area without having a sound mathematical basis. Likewise, mathematical rules and theories are

also applied to considerable extent in physics, in which no one can intend to take even single step without relying on the subject of mathematics. Thus, it can be said that science teacher should make all efforts by which she can establish co-relation in between the subjects of science and mathematics. It will not be improper in any way to consider both of these subjects as complementary to each other, which can be studied simultaneously or at the same time. Hence, it can be said that without making use of examples from mathematics, it is not possible for a science teacher to explain various scientific principles and concepts properly to the students. To make it possible, sincere and deliberate efforts should be made by science as well as mathematics teacher to co-relate both the subjects in accordance with the syllabus.

Science and History:

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

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

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

Science and Geography:

Geography is the subject in which various concepts relating to earth on which we live are dealt with. Everything existing on earth, on different planets of the universe are also main subjects of geography. Which kind of crop should be sown in which kind of soils, how many kinds of rocks are found on the earth are some of the main topics which are covered by Geography. One will be surprise by this fact as these topics are also covered by the subject of Science. In science, various concepts relating to the atmosphere and earth in which living and non-living beings exist are made. For this reason, temperature, wind directions

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

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

Science and Social Studies:

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

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

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

As a result of these machines, our life has become very easy and smooth and now we can accomplish complex functions within short period of time, which were considered to be very time consuming. Not only this, various research works has led to development of various medicines with the help of which physicians have found the remedies of various diseases, which were once considered to be incurable and were responsible for bringing about heavy loss of life in earlier times.

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

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

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

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

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

Science and Civics:

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

They begin to realise a sense of responsibility, which help them in playing important role in development of the nation. Through information of scientific facts, students get to know about various kinds of diseases and the role which they can play in creating a healthy and clean atmosphere around them. Through this kind of information, they become more responsible citizens and play an important role in creating an ideal civic life in the society and nation as a whole.

Science and Art:

It is considered by the majority of people that it is science who has contributed

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

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

An artist should know the principles of light and shade, objects and background for drawing or keeping the colour contrast in attractive condition. Thus, it can be

said that some common features are found in the subjects of science and art, because of which they can be co-related with each other effectively.

Science and Music:

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

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

To make improvements in their voice and manner of singing, various scientific equipments are being used today, which could not come into being without scientific developments. Thus, it is only through the utilization of scientific developments in the real life that led to the development of various apparatuses used in the musical field. Science teacher can relate subject of science with the music by narrating the students that what led to development of various equipments used by the musicians and on which principles do they operate or function.

Science and Craft Works:

Some people will find it quite unsound to relate science and craft works with each other, but various kinds of improvements can be brought about in ability of students to understand various scientific principles and facts. During craft periods, students can be provided with the task of designing various pieces of scientific apparatuses and equipments. Through such step, scientific interest can be developed in the students, which will help in arousing the interest of students in various scientific incidences. An urge will get developed in them to see or observe the equipments or apparatuses designed by them in reality, by which they will be motivated to get more and more information regarding the research functions conducted in the scientific field through various means and sources. Thus, it can be said that if a science teacher can relate science with other subjects of the curriculum, then more justifiable and satisfactory results will be obtained.