

CHAPTER I

CONCEPTUAL FRAMEWORK

1.0.0 INTRODUCTION

Today, we are in the post-industrial era and getting into a knowledge economy. The knowledge economy demands creation of new knowledge and values. The creation of new knowledge is supposed to be developed by our system of education through teaching and learning process. Whether, our education system is doing this function? A recent study at Harvard University by Bainand Ken(2004), discovered the fact that up to the age of four almost all children are at genius level, in terms of multiple frames of intelligence be it mathematical, interpersonal, linguistic, musical, artistic but by the age of twenty, the genius level proportion of the tested population dropped to 2%. This study is quite concerned to our education system. “Whether we are doing justice to our children with the help of our education system or not?” It is a question to all the major stake holders of our system of education. There is a need to think in this area of concern. We need to nurture and develop the multiple frames of intelligence within our children. We need to fuel imagination which Einstein said, is more important than only providing mere knowledge. We have tended to imprison disciplinary studies in opaque walls. This has restricted flights of imagination and limited the creativity of our children. Most instrumentalities of our education harm the potential of the human mind for constructing and creating new knowledge. We have only emphasized delivery of information and rewarding capabilities of reproducing information. This is the core of reform in education that is needed for the 21st century.

In our country also, we offer different subjects at primary, secondary and senior secondary level of schooling to prepare the children to serve themselves and the society utilizing their innate potentials. We have subjects like language, science, mathematics, social sciences, art, culture and many more. Different subjects have different potentials to prepare the child for different purposes in the society. Science is the subject which aims to enhance the thinking process of the child so that the child can contribute something to the society. For contributing to society the child need to learn science in schools. Science is taught as an important subject at primary,

secondary and senior secondary level. At primary and secondary level it is called as general science because it is not divided into various branches. According to Gillespie (2004), "Science connotes both the knowledge contained in such disciplines as astronomy, physics, chemistry, biology, geology and the activities involved in obtaining it". It is generally agreed that although science first arose from the attempts of ancient Greek philosophers, especially Aristotle, to understand the world in rational naturalistic terms rather than in theological terms. Its full development has been largely a product of the past four centuries.

Science at senior secondary level has become specialized to develop scientific aptitude. Biology is a very important partner of science which students can opt who are interested to develop their future career in this field. It aimed at studying various phenomenon of living organism on earth. The subject is taught in school by traditional methods of mug and jug approach. In this approach student are considered as empty mug to be filled with the jug of teacher's knowledge. Teaching biology by traditional approach has failed to bring desired result therefore there is a need to adopt new teaching-learning methodology. The constructivist methodology may be one of them. To adopt this methodology we have to understand the nature, and scope and curriculum of the Biology subject so that we can adopt relevant methodologies of constructivist in this subject.

1.1.0 NATURE AND SCOPE OF BIOLOGY

Biology traces the study of living word from ancient to modern times. Although the concept of biology as a single coherent field arose in the 19th century, the biological sciences emerged from traditions of medicine and natural history reaching back to Ayurveda, ancient Egyptian medicine and the works of Aristotle and Galen in the ancient Greco-Roman world. Over the 18th and 19th centuries, biological sciences such as botany and zoology became increasingly professional scientific disciplines and other physical scientists began to connect the animate and inanimate worlds through physics and chemistry. The end of the 19th century saw the fall of spontaneous generation and the rise of the germ theory of disease, though the mechanism of biological inheritance remained a mystery.

In the early 20th century, the rediscovery of Gregor John Mendel work led to the rapid development of genetics by Thomas Hunt Morgan and his students and by the 1930 the combination of population genetics and natural selection in the modern evolutionary synthesis.

The nature of biology is experimental, explorative, technical, microscopic, behavioral and involve many approaches to study it. By studying it student can develop interest in the subject to increase their curiosity, observation, discussion and technical aspects about various biological process of plant and animals. They will also understand their interaction with the environment and other living member of their surroundings. It helps us to understand in detail about life in general and living organisms in particular. It seeks to advance our understanding of the principles and mechanisms that governs life on earth. Its application in day to day life is very crucial which can be understood by studying its scope.

The scope of biology is very wide. Student who are interested in this branch have endless opportunities to shape their professional growth and carrier. Student of biology can join carrier related with medicine,surgery, horticulture, agronomy, veterinary science, animal husbandry, pharmacy, physiotherapy, nursing, food processing, genetic engineering, biotechnology, bioinformatics,environmental sciences, radiology, forensic science, genetics, botany, zoology, biogeography, paleontology, embryology, evolution, genomics, proteomics, aagronomist, animal behaviour scientist, animal welfare officer, biochemist, cheese production supervisor, conservation biologist, environmental analyst, environmental ecologist, environmental manager, environmental officer, fisheries scientist, food and drink technologist, forestry technician, genetics technician, marine biologist, meat biochemist, medical sciences technician, nursery grower, plant pathologist, plant physiologist, quarantine officer, research manager, secondary school science teacher, zoologist etc.After examining the nature and scope of biology it is needed to examine the objectives of teaching biology.

1.1.1 OBJECTIVES OF BIOLOGY

The principal objective of teaching biology atsenior secondary stage is to explore the variations amongst the living and developing respect for the diversities. It also aims to appreciate that the most complex biological phenomena are also built on essentially

simple processes (NCERT, 2009). Learning biology uncover these elementary aspects and illustrate their linkage to more complex phenomena. It was also felt that the contributions of scientists that led to critical and important discoveries in biology need to be highlighted, not merely through a chronological listing, but through brief biographical discussions. It is an effort to bring out the processes that led to the discovery of principles and ideas in biology. These would stimulate critical and creative thinking. Besides, the course at the senior secondary stage provides substantial orientation to the students to professional and career opportunities available in medicine, agriculture, research, teaching and industry. To develop understanding about the subject methodology student have to complete one investigatory project in class XI. This projects will provide children an exposure to what it means to carry out an investigation, what research methodologies are, how data is analyzed and presented and, how to interpret data and draw conclusions. While doing the project children will get the chance to select their area of interest. The major objective can be summarized topic wise as follow.

➤ **Classification**

- Identify what is necessary for organisms to be considered members of the same species.
- Demonstrate how the major categories of biological classification scheme show that some organisms are more closely related than others.
- Recognize the necessity of scientific names.

➤ **Structure and Function**

- Identify the basic structures and functions that allow organisms to obtain and use energy (Includes: unicellular, multi-cellular, animal and plant).
- Identify the basic structures and functions that allow organisms to exchange basic materials.
- Identify the basic structures and functions that allow organisms to get rid of waste materials.
- Identify the basic structures and functions behind the transport of essential materials in an organism.
- Identify the basic structures and explain the functions that allow an organism to pass on genetic information for the survival of the species.

➤ **Biochemistry**

- Identify reactants and products in biochemical reactions.
- Identify the structure and function of macromolecules.
- Recognize the functions of enzymes.
- Recognize the relationship of photosynthesis and cell respiration to cell energetic.

➤ **Organization of Cells**

- Identify the basics components of cell theory.
- All living things are made of cells.
- Cells are the basic unit of structure and function.
- All cells come from pre-existing cells.
- Compare and contrast eukaryotic with prokaryotic cells.
- Major considerations include, presence of a nucleus, Presence of membranebound organelles, both living, and both have plasma membranes and ribosome.
- Classify cell organelles according to their contribution to overall cell functions including the following functions: Transport (plasma membrane), Energy(chloroplast, mitochondria), Manufacturing of macromolecules (ribosome),Homeostasis (plasma membrane), Structure (cell wall), Compare and contrastplant cells and animal cells, features that distinguish plant from animal cells.
- Recognize the cell processes that regulate the flow of substances in and out of the cell body.
- Distinguish between: diffusion, osmosis, passive transport, active transport.
- Recognize that the cell cycle provides for genetic continuity, cell division, growth, and repair.

➤ **Plant physiology**

- Transportation in plants.
- Mineral nutrition.
- Photosynthesis.
- Respiration.
- Plant growth and development.

➤ **Human Physiology**

- Digestive System.
- Respiratory system.
- Body fluid and Circulatory system.
- Excretory System.
- Nervous system.
- Skeletal System.
- Endocrine System.

1.1.2 BIOLOGY TEACHING AND LEARNING

Traditional biology teaching and learning relied heavily on lectures, reading, and teacher led demonstrations. This has created the habit of rote learning among student. The learning to them is just only passing exams with good marks. It has become the main objective of study. This trend is not suitable for the transformation of our country. The children should be allowed to construct and discover their own knowledge to create something new. It is also supported by Rousseau in his book where he had said that children should not be taught directly but should be allowed to discover things for themselves, especially through play, and that learning how to learn was of much greater importance than teaching factual information. The teacher centered learning need to be converted into child centered learning and ultimately knowledge creation centered learning. Questions need to be explored by the students along with different stakeholders of school. Turmoil need to be created in the mind of students to become active thinker to model their minds. Researcher now explored various methodology how above objectives can be achieved and found that the constructivism can help both teacher and learner. Constructivism means construction of knowledge related to various problem faced by human being. In teaching biology it has wider role to play. Thus there is a possibility of adding constructivist teaching learning approach in our schools particularly in the subjects like biology at senior secondary level. The present study is an attempt in this direction to examine the possibility of adding constructivist teaching and learning approach in the teaching and learning of biology at senior secondary level. For this, it is essential to know about constructivism.

1.1.3 BIOLOGY SYLLABUS OF CLASS-XI (CBSE)

The Biology (class XI) course is a one-year course at the senior secondary level. The course emphasizes a multi-representational approach to biology. The biology course involves the scientific study of living organisms. The course considers the interactions among the vast number of organisms that inhabit planet earth. It presents the basic form and function of these organisms, from cells to organ systems, from simple viruses to complex humans. This syllabus aims also at emphasizing the underlying principles that are common to both animals and plants, as well as highlighting the interrelationships of biology with other areas of knowledge. The format of the syllabus allows a simple, clear, sequential flow of concepts without any jarring jumps. The empirical experience gained and practical exercises carried out during the course would prepare the students to handle biology easily at higher levels in case they opt to continue further studies in this area. The syllabus stresses the connection of the study of biology to real life problems, use of biological discoveries, innovations in everyday life, in environment, industry, medicine, health and agriculture. The importance of illustrations and their use to make the concepts more explicit is stressed. The syllabus also takes up issues pertaining to environment, health and other ethical issues that arise with any interference of human beings in the natural processes, which have great relevance from the societal point of view. The following units are covered in the biology course (Class – XI, NCERT).

Unit I: Diversity in living world: The unit focuses on characteristics of living organism and their classifications.

Unit II: Structural organizations in plants and animals: It aims at morphological and anatomical structures of different plants and animals.

Unit III: Cell: structure and function: This unit describes about structural and functional unit of life, biomolecules and cell division.

Unit IV: Plant physiology: It describes about the various metabolic reactions of plant body and their mechanism.

Unit V: Animal physiology: It focuses on the working mechanisms of different systems of human body.

Considering the nature of biology and content of class XI syllabus, it is essential for the teachers to teach biology in such a way that the student will develop

understanding of contents and further develop insight for divergent thinking and think in a constructive way which is possible through constructivism.

1.2.0 CONSTRUCTIVISM

In past centuries, constructivist ideas were not widely valued due to the perception that children's play was seen as aimless and of little importance. Jean Piaget did not agree with these traditional views. He saw play as an important and necessary part of the student's cognitive development and provided scientific evidence for his views. Today, constructivist theories are influential throughout much of the informal learning sector. The student learn things in different situation which can be analyzed from different perspective of constructivism like philosophical, social, information processing and the psychological.

Some historical figures who influenced constructivism are: Giambattista Vico (1668–1744), Immanuel Kant (1724–1804), John Dewey (1859–1952), Maria Montessori (1870–1952), Wladyslaw Strzemiński (1893–1952), Jean Piaget (1896–1980), Lev Vygotsky (1896–1934), Heinz von Foerster (1911–2002), Jerome Bruner (1915–), Herbert Simon (1916–2001), Paul Watzlawick (1921–2007), Ernst Von Glasersfeld (1917), Edgar Morin (1921) and many more. The work of these researchers had contributed immensely in describing the constructivism which is as follow.

Constructivism is a philosophy of learning founded on the premise that by reflecting on our experiences, we construct our own understanding of the world we live in. Each of us generates our own rules and mental models. We use to make sense of our experiences. Learning therefore, is simply the process of adjusting our mental models to accommodate new experiences.

Constructivism is a set of assumptions about the nature of human learning that guide constructivist learning theories and teaching methods of education. Constructivism values developmentally appropriate teacher-supported learning that is initiated and directed by the student.

In sum, constructivist environments start with observations within a world of authentic artifacts rooted in authentic situations. Students, while accessing various materials, construct ongoing interpretations of their observations, and collaborate with their peers. Finally, students serve as coaches and teachers to each other to show their

mastery of what they learned. On the basis of above foundation let us discuss the theoretical perspectives of constructivism.

1.2.1 CONSTRUCTIVISM THEORETICAL PERSPECTIVES

There are several approaches to constructivism with two major branches, those built on philosophical theories of learning (Von Glaserfeld, 1996) and those built on psychological theories (Fosnot, 1996) of learning. These theories intended to explain constructivism as a theory of human learning. Bentley (1996) a Science educator, believes that social contextual constructivism and radical constructivism are most prominent. Loving (1997) another science educator, sees the varieties of constructivism as including personal to the radical to the social and finally to the critical. For Fosnot (1996) constructivism is either social or cognitive while Stahl and Casteel (1997) advocated it from information constructivist perspective.

Although there are several approaches to constructivism. Phye (1997) said, "Common perspectives include the view that academic knowledge construction on the part of students is basically a learning process that involves change. Thus, knowledge is the desired outcome or effect of the process of learning". Phye (1997) advocated that for implementing a constructivist approach in classroom, teacher must be in a position to:

- Influence or create motivating conditions for students
- Take responsibility for creating problem situations
- Foster acquisition and retrieval of prior knowledge
- Create a social environment that emphasizes the attitude of learning to learn

Phye (1997) said that the learning process, not the product of learning, is the primary focus of constructivism. In facilitating teachers' understanding of constructivism, Brooks (1990), presented an extensive list of constructivist teaching practices. These require the teacher to recognize and encourage student autonomy and leadership. It encourages the use of "Raw data and primary sources, along with manipulative, interactive, and physical materials". It helps in using the vocabulary of cognitive science such as predict, analyze, and classify in developing student activities. It maximizes student thinking and their use of instructional strategies. It questions students to identify their theories about concepts before sharing your understandings of those concepts. It promotes dialogue between students and teachers

among students. It helps students to elaborate their ideas, challenge students' thinking by presenting contradictions to their ideas without demeaning them as persons. Teacher uses wait-time after questioning students, promote inquiry by students through questioning them and having them question one another, provide time for student processing and thinking, encourage student reflection, design curriculum around conceptual clusters of problems, questions, discrepant situations. Teacher uses curriculum at the students' level of development, identify students' conceptions and misconceptions and develop lessons that respond to such immediately for some tasks, group students by intellectual ability.

Although Brooks (1990) does not use the term "Higher-Order Thinking", it is apparent that implementing these practices results in greater critical and creative student thinking such as classifying, analyzing, predicting, presenting theories, engaging in dialogue on issues, elaborating, etc. Contrary to Phye (1997) idea that incorporating constructivist practices into a classroom only requires modification of teaching practices rather than sweeping change. Teachers have to identify student's conceptions and misconceptions and develop lessons that respond to these problems immediately, and, for some tasks, group students by intellectual ability. Airasian and Walsh (1997) also believe that constructivism requires significant change in the classroom, changes that will not be easy. Brook and Brooks (1993) have listed following differences between traditional and constructive classroom.

TABLE 1.1: Difference between Traditional and Constructive Classroom

| SN. | Traditional Classroom | Constructivist Classroom |
|-----|--|--|
| 1 | Curriculum begins with the part of the whole. Emphasizes basic skill. | Curriculum emphasizes big concepts, beginning with the whole and expanding to include the parts. |
| 2 | Strict obedience to fixed curriculum is highly Valued. | Pursuit of student questioning is highly Valued. |
| 3 | Curricular activities rely heavily on Textbooks and workbooks. | Material include primary source of material and manipulative materials. |
| 4 | Learning is based on repetition | Learning is interactive, building on what the student already knows. |
| 5 | Teacher disseminates information to students; students are recipient of knowledge. | Teachers have dialogue with students, helping students construct their own knowledge. |

| SN. | Traditional Classroom | Constructivist Classroom |
|-----|---|---|
| 6 | Teacher's role is directive, rooted in authority. | Teacher's role is interactive, rooted in negotiation. |
| 8 | Knowledge is seen as inert. | Knowledge is seen as dynamic, |
| 9 | Students primarily work alone. | Students primarily work in group. |

After discussing about constructivism and differences between traditional and constructive classroom now it is required to know something about constructive learning designs, characteristics of constructivist classroom, Principles of Constructive Learning Approach (CLA), Constructive Teaching Strategies (CLS) and some activities encouraging the construction of knowledge.

1.2.2 CONSTRUCTIVIST LEARNING DESIGN

The constructive learning design requires creativity, critical thinking and innovative ideas from teachers and learners. The paper "Constructivist Learning Design" by George W. Gagnon, and Michelle Collay have advocated that constructive learning design need lot of collaboration. It is designing for learning not planning for teaching. The constructive learning designs are being used now had been gone through a variety of revisions in the past several years and now emphasize on following six important elements: Situation, Groupings, Bridge, Questions, Exhibit, and Reflections. These elements are designed to provoke teacher planning and reflection about the process of student learning. The constructive learning design are flexible as these vary as per the content of the course. Teachers develop the situation for students to explain, select a process for groupings of materials. The teachers also build a bridge between what students already know and what they want them to learn. They anticipate questions to be asked and answer without giving away an explanation. Teachers encourage students to exhibit a record of their thinking by sharing it with others and solicit students' reflections about their learning. The objectives, outcomes, or results need to be evaluated as per board curriculum or the textbook by the teachers. This brief overview above indicates how each of these six elements can be integrated and work as a whole. The brief discussion about these different components are as follow.

Situation: First of all teacher need to create a situation for learning and this need to be explained to learners properly. Give this situation a title and describe a process of

solving problems, answering questions, creating metaphors, making decisions, drawing conclusions, or setting goals. This situation should include what you expect the students to do and how students will make their own meaning. Fosnot (1996) provides similar examples from writing art.

Groupings: There are two categories of groupings:(A)Grouping of students as a whole class, individuals, thinking teams of two, three, four, five, six or more, and methods for grouping them which may be counting off, choosing a color similar clothing? (B)Groupings of materials that students will use to explain the situation by physical modeling, graphically representing, numerically describing, or individually writing about their collective experience. How many sets of materials you have will often determine the numbers of student groups you will form.

Bridge: During this process teacher need to understand the prior knowledge of student. They need to design the bridge between previous knowledge of student to cross and arrive new conclusions. This might involve such things as giving them a simple problem to solve, having a whole class discussion, playing a game, or making lists. Sometimes this is best done before students are in groups and sometimes after they are grouped. Teachers need to think about what is appropriate.

Questions: Questions need to be put before student to create turmoil in their mind and promote thinking from new dimension. Questioning sessions could take place during each element of the Learning Design. Teachers also need to anticipate questions from students and frame other questions to encourage them to explain their thinking and to support them in continuing to think for themselves.

Exhibit:Teachers need to record their thinking as student were explaining thesituation. This could include writing a description on cards and giving a verbal presentation, making a graph, chart, or other visual representation, acting out or role playing their impressions, constructing a physical representation with models, and making a video tape, photographs, or audio tape for display.

Reflections: It is the product of the whole process in which students explain the situation and then saw the exhibits from others. Students reflects about what they remembered from their thought process, feelings in their spirit, images in their imagination, and languages in their internal dialogue. What attitudes, skills, and concepts will students take out the door? What did students learn today that they won't forget tomorrow? What did they know before; what did they want to know; and

what did they learn? Each of these six elements of constructivist learning design has educational precedents.

While designing constructive framework we have to adopt some principles of constructive learning approach which are discussed as below.

1.2.3 PRINCIPLES OF CONSTRUCTIVE LEARNING APPROACH

What are some guiding principles of constructivist thinking that we must keep in mind when we consider our role as educators? Prof. George E. Hein (1991) has outlined a few ideas, all predicated on the belief that learning consists of individuals' constructed meanings and then indicate how they influence education. Some of the principles are given as below.

- Learning is an active process in which the learner uses sensory input and constructs meaning out of it
- People learn to learn as they learn
- The crucial action of constructing meaning is mental
- Learning involves language
- Learning is a social activity
- Learning is contextual
- One needs knowledge to learn
- It takes time to learn
- Motivation is a key component in learning

By adopting these principles we can develop following characteristics in teaching learning process in classroom.

1.2.4 CHARACTERISTICS OF CONSTRUCTIVIST CLASSROOM

A constructivist teacher and a constructivist classroom exhibit a number of qualities different from a traditional or direct instruction classroom. A constructivist teacher is able to flexibly and creatively incorporate ongoing experiences in the classroom into the negotiation and construction of lessons with small groups and individuals. The environment is democratic. The activities are interactive and student centered. The students are empowered by a teacher who operates as a facilitator/consultant (Audrey Gray, 1997).

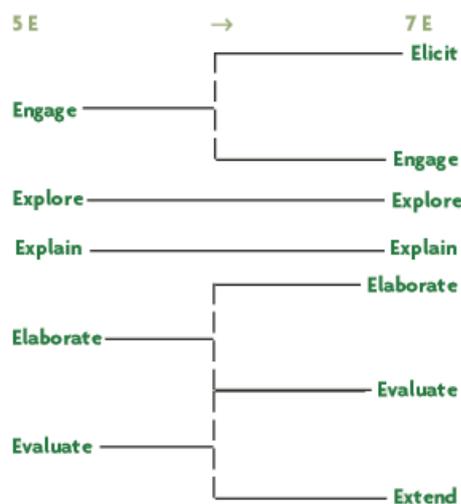
- The learners are actively involved.
- The environment is democratic.
- The activities are interactive and student-centered.
- The teacher facilitates a process of learning in which students are encouraged to be responsible and autonomous.

To achieve above qualities we have to adopt some constructivist teaching strategies, mentioned below.

1.2.5 7E LEARNING MODEL OF CONSTRUCTIVISM IN BIOLOGY CLASSROOM

Sometimes a current model must be amended to maintain its value after new information, insights, and knowledge has been gathered. Such is now the case with the highly successful 5E learning cycle and instructional model (Bybee 1997). Research on how people learn? And the incorporation of that research into lesson plans and curriculum development demands that the 5E model be expanded to a 7E model. The 5E learning cycle model requires instruction to include the following discrete elements: engage, explore, explain, elaborate, and evaluate. The proposed 7E model expands the engage element into two components elicits and engage. Similarly, the 7E model expands the two stages of elaborate and evaluates into three components elaborate, evaluate, and extend. The transition from the 5E model to the 7E model is illustrated in Figure 1.1.

FIGURE 1.1: 7E LEARNING MODEL



These changes are not suggested to add complexity, but rather to ensure instructors do not omit crucial elements for learning from their lessons while under the incorrect assumption they are meeting the requirements of the learning cycle. The various components of 7E can be explained to help instructor how to incorporate these during the teaching and learning sessions.

TABLE No. 1.2: 7E Learning Model: An Example

| S.N. | 7 E component | Example |
|-------------|-----------------------------|---|
| 1. | Elicit prior Understandings | Students are asked to give some example of underground leaf. This requires a few minutes of class time. |
| 2. | Engage | Student are now mentally engaged in thinking. |
| 3. | Explore | Students were asked to explore vegetable market and collect some vegetables. |
| 4. | Explain | Teachers will explain characteristics of leaf and its various modifications. |
| 5. | Elaborate | Student were asked to look into various parts of onion. And identify them. |
| 6. | Evaluate | They develop the deeper level about the concept and ultimately found the answer of the question. |
| 7. | Extend | Students are challenged to explore some new modification of leaves in their surroundings. |

1.2.6 CONSTRUCTIVIST TEACHING STRATEGIES

Constructivist teaching strategies motivate and inspire student to focus their attention in learning with full concentration as they require active involvement of children. These strategies requires following dimensions.

- Use teaching strategies that require students to make a construct. Students must apply, use, or process the information.
- Ensure that all students are participating in making constructs. Holding them accountable for their learning.

- Ensure the tasks require students to process the information at a high level on Bloom's taxonomy: Evaluation, synthesis, analysis etc.
- Require the students to make a product that is used to diagnose learning errors and omissions. e.g. Speaking to a partner, matching cards, written work etc.
- Require students to check for their own, and each other's learning errors and omissions.
- Require students to correct these learning errors and omissions.
- Make the above fun!

Analyzing the requirement of subject the researcher found following teaching strategies most appropriate to the targeted biological contents.

- **Experimentation:** students individually perform an experiment and then come together as a class to discuss the results.
- **Research projects:** students research a topic and can present their findings to the class.
- **Field trips.** This allows students to put the concepts and ideas discussed in class in a real-world context. Field trips would often be followed by class discussions.
- **Films.** These provide visual context and thus bring another sense into the learning experience.
- **Class discussions :** This technique is used in all of the methods described above. It is one of the most important distinctions of constructivist teaching methods.
- **Cooperative Learning:** Cooperative learning is a successful teaching strategy in which small teams, each with students of different levels of ability, use a variety of learning activities to improve their understanding of a subject.

1.3.0 RATIONALE

Teaching biology in traditional method is simply passing bookish knowledge to younger generation. Here the student are considered as empty bottle to be filled with the bookish knowledge of teachers. This approach may not solve the purpose of a subject like Biology. Biology teaching is very complex process as here the learner have to deal with living organism. It is not as simple as teaching of physical sciences.

One mistake in this field may take the life of an organism. It is a very delicate subject which requires deeper understanding of the students. New methodology need to be adopted while teaching this subject. The constructivist approach is one of the promising methodology which can be very helpful. In this approach every learner is very unique person supported by Wertsch (1997).

Biology at secondary level provide scope for the entry in the medical science and therefore the learner need to be very responsible while choosing this subject. In the medical field the doctor can save the life and can spoil it. Hence, as the students of Biology, students need to learn various skills. Biology teaching and learning requires longtime to develop the required skill. The learner need to be self-motivated and confident as said by Von Lagerfeld (1989) sustaining motivation to learn is strongly dependent on the learner's confidence in his or her potential for learning.

Biology incorporates learning about various plant and animals. These also have various social importance. Professionals of this field have different roles in their society. They have to follow some social norms and ethics as per the society and culture of the area. It has been said by social constructivist Wertsch (1997) that the background and culture of the learner throughout the learning process, helps to shape the knowledge and truth that the learner creates, discovers and attains in the learning process.

While teaching biology teacher need to facilitate the learning of the student which is supported by Bauersfeld, (1995) when he said that instructors have to adapt to the role of facilitators and not teachers. This dramatic change of role implies that a facilitator needs to display a totally different set of skills than a teacher said by Brownstein (2001). A teacher mostly gives a monologue, a facilitator is in continuous dialogue with the learners opinioned by Rhodes and Bellamy (1999).

The learning environment should also be designed to support and challenge the learner's thinking Di Vesta, (1987). The role of the facilitator in the social constructivist viewpoint is that the instructor and the learners are equally involved in learning from each other as well Willard and Holt (2000). Learners and instructors should develop an awareness of each other's viewpoints and then look to their own beliefs, standards and values, thus being both subjective and objective at the same time (Savery 1994). Some studies argue for the importance of mentoring in the process of learning Archee and Duin (1995) and Brown et al. (1989).

In biology teaching sharing of knowledge is very crucial which is supported by social constructivists, the process of sharing individual perspectives-called collaborative elaboration results in learners constructing understanding together that wouldn't be possible alone (Greeno et al., 1996). Team work is the key of success in teaching and learning biology which is supported by Kukla (2000) who argues that reality is constructed by our own activities and that people, together as members of a society, invent the properties of the world. Creativity is the bone of learning and teaching biology which is supported by Prawat and Floden (1994) when they said that knowledge is thus a product of humans and is socially and culturally constructed. Biology teaching-learning requires the social understanding among various members which is supported by McMahon (1997) who agrees with the concept of learning in a social process. He further states that learning is not a process that only takes place inside our minds, nor is it a passive development of our behaviors that is shaped by external forces and that meaningful learning occurs when individuals are engaged in social activities. Biology learning and teaching requires the integration of difference sciences and thus it need to be linked with other subjects as biophysics, biochemistry, biostatistics and many more. Biology teaching and learning is very challenging as the living organism are having capacity to adopt and develop variation. Therefore, the learners and teachers are constantly challenged and after overcoming it they develop confidence supported by Brownstein (2001) when he said that previous successes enhance learner confidence. Learners must not only have ownership of the learning or problem-solving process, but of the problem itself Derry (1999).

Lord (1990) in his study of environmental science discovered that students in constructivist classes performed significantly better on exams and rated the course higher and participated more. Lord, T.R. (1997), found that the constructivist treated group out-performed the traditionally taught cohort on identical evaluations. Lunsford et al. (1997), in a their study of Active Learning in Anatomy and Physiology found that inquiry-based strategies, if properly implemented in the classroom, are not a detriment to future Allied Health students when they take licensing exams.

At senior secondary level biology is a preparatory stage to enter into medical, paramedical and allied fields that why at this level student need proper preparation to develop interest in these fields and for this they should have sound knowledge and background to do well, thus need knowledge and thinking process to do something

new and creative. For this, they need different type of teaching learning paradigm which is possible by constructive learning approach; it can help them to have a sound background to enter in medical, paramedical and allied branches.

Class XI and XII both are stages to prepare student for any professional line as class XII is associated with stage end examination (board examination) the researcher has more scope to experiment something new for class XI student. Hence, class XI was selected for the present study. Though this area is having big scope for solving the problems of biology teaching, the area is not much explored in biosciences in India. The demand of 21st century is to adopt innovative teaching method in various field of teaching therefore the researcher is interested in conducting this research.

Many studies have been conducted in the past that attempted to characterize and assess the impact of active learning strategies upon student learning in large lecture settings. Some studies have concentrated upon interactive engagement strategies employing techniques to evoke individual participation in the lecture process, while others have examined the effects of cooperative or peer learning upon student performance. The researcher could not come across researches related to use constructivism strategy in biology teaching in the Indian context. Thus, a need was felt to carry out the present study. For conducting this research following questions were raised in the researcher's mind which needs to be answered.

1.4.0 RESEARCH QUESTIONS

In the process of formulating the present research study and studying the related literature, the following research questions came in the mind of the researcher. The researcher tried to get the answer of these research questions in the process of this research work.

- Whether Constructive Learning Approach (CLA) is feasible in teaching biology?
- Whether CLA enhances achievement of student of biology?
- Whether CLA generates interest in teaching biology?

1.5.0 STATEMENT OF THE PROBLEM

TEACHING BIOLOGY AT SENIOR SECONDARY LEVEL THROUGH
CONSTRUCTIVIST APPROACH

1.6.0 OBJECTIVES OF THE STUDY

The present study was conducted with the following objectives.

1. To develop a Constructivist Learning Strategy (CLS) to teach biology at senior secondary level.
2. To implement the developed Constructivist Learning Strategy to teach biology at senior secondary level.
3. To study the effectiveness of CLS in terms of students achievement in biology.
4. To study the effectiveness of CLS in terms of students reaction towards CLS for teaching biology.

1.7.0 HYPOTHESIS OF THE STUDY

Following null hypothesis was formulated which will be tested at 0.01 level of significance.

There will be no significant difference between the mean biology achievement score of experimental and control group.

1.8.0 OPERATIONAL DEFINITION OF THE TERMS

Achievement in biology: Achievement in biology is the marks secured by the students in biology achievement test constructed by the researcher.

Effectiveness in terms of achievement: Effectiveness is the significant difference in the post test scores of the experimental and control group in biology.

Reaction of Students: The preference (agree or disagree) of the students towards the statements related to the teaching of biology using CLS in a five point reaction scale prepared by the researcher is the reaction of students.

Effectiveness in terms of reaction: Effectiveness in terms of reaction is the overall positive reaction (more than or equal to intensity index of 4) of the students towards the developed CLS in likert type 5 point reaction scale developed by the research.

1.9.0 EXPLANATION OF TERMS

Constructivist Learning Strategy (CLS): In the present study CLS is the teaching plan including the strategies like brainstorming, visit, extensive

laboratory work, jigsaw I &II, and animated film strips using 7 E model of constructivism.

1.10.0 DELIMITATION OF THE PROPOSED STUDY

The present study is delimited to standard XI of English Medium Schools affiliated to CBSE.

1.11.0 SCHEME OF CHAPTERS

Chapter I deal with the conceptual framework of the present research problem, introduction, science at secondary level, biology at secondary level, nature, scope of biology, biology syllabus of class-xi (CBSE), biology teaching, origin of constructivism, definition of constructivism, constructivism theoretical perspectives, constructivist learning design, principles of constructive learning approach, characteristics of constructivist classroom, constructivist teaching strategies, 7e learning model of constructivism in bio-class, rationale, research questions, statement of the problem, objectives of the study, hypothesis of the study, operational definition of the terms, explanation of terms , delimitation of the proposed study.

Chapter II deals with the review of the related literature-introduction, studies on constructivism, studies related to laboratory experiment, studies related with educational videos, studies related to jigsaw, studies related to field work , summary of the review of related literature and implication of review for the present study.

Chapter III deals with the methodology of the study which includes introduction, objectives of the study, hypothesis of the study, method of the study, research design, research design, population, sample, tool for data collection, achievement test, reaction scale, development of constructive learning strategies, validation of constructive learning strategies, pilot study of the developed constructive learning strategies, implementation of the constructive learning strategies, tour to sarthana national park, tour to waghai botanical garden, tour to surat municipal institute of medical education and research (SMIER), arranging jigsaw I & II , puzzles to provide learning situation for student to learn structure cell and function, extensive laboratory experimentation to provide learning condition for the student to develop skill related to morphology and anatomy of plant and animals, presentation of video film to provide learning conditions for the student to develop skill related to plant and

animal physiology, procedure of data collection, step 1: pre testing , step 2: implementation, step 3: post- testing, procedure for the data analysis.

Chapter IV includes introduction, achievement of experimental and control group in biology, reaction of students towards constructive learning strategies, major findings of the study, discussion, suggestions for future research, rationale of the study, research questions, statement of the problem, objectives of the study, hypothesis, explanation of terms, operational definition of the terms, delimitation of the proposed study, method of the study, research design, population, sample, tool for data collection, achievement test, reaction scale, development of constructive learning strategies, procedure of data collection, step 1: pre testing, step 2: implementation, step 3: post- testing, procedure for the data analysis, major findings of the study, suggestions for future research, conclusion.

Chapter V deals with the summary of the whole study.