Chapter – I

THEORETICAL ORIENTATION
CHAPTER-I

"Knowledge is actively constructed by the learner, not passively received from the environment."

- Jean Piaget

1.0 Introduction

The Indian education system is as old as the human civilization. Ancient Indian system was mainly concerned with vocational learning of parental crafts, manual work, physical exercise of yoga, disciplined life, truthfulness, self confidence, respecting elders, helping needy persons and love for nation etc. However Indian education system suffered a great drawback in the later period. Now India is one of the world’s fastest growing countries; its dominance on the various sectors has been acknowledged world over. The education sectors and specifically science education have an important role in achieving this position.

Education is the most important medium in making a change in our life. It is through education that we learn to absorb the processes that define the art of being good human persons. An educated person is one who has the aptitude for even mind, accommodativeness and humility and free from ego, narrowness and obscurantism. Education must also teach us how to live with others in trust, tolerance and togetherness. Education is that great capacity builder that enables the frog in the well to leap out of its comfort zone somnolence and find an exciting open space where opportunities are around. Empowering the students to find the ways and means of livelihood is only a part of education more important than that it prepares us for a life of learning, for expanding horizon of activities.

Education is the only source of human resources and the first step in nation building of which elementary education is the true beginning. With the passage of time and need of the hour various attempts have been made to achieve universal access, universal enrollment, universal retention and universal success of 6-14 years of children at elementary education level. A consistent quantitative expansion of elementary education has resulted in
almost universal access and enrollment of these children but not in their universal retention and success.

While the present scenario seems to be heartening, there are several concerns related to education that seems to have gone unaddressed. "We seem to be passing through crisis of values in all spheres of life which promote incorporation of values into the present system of education it is commonly deplored that violence crime, cruelty, intolerance, indiscipline, indifference to human values and greed has spread to all aspects of our life including the education sector. Altruism, selfness service to follow human beings and idealism are the things of past, sensitivity to the beauty in art, literature and life in general are very much on the decline. Lack of social cohesion and national disintegration has become patent manifest and our democratic social order is under severe stress Social tension, unrest, prejudices and complexes transmitted through social environment vitiate the quality of life Casteism, regionalism, linguistic and communal platforms divide the peoples as never before." (Reddy and Sharma, 2003).

Elementary education is the corner stone of social development and principle means of improving the welfare of individuals. It promotes economic growth thereby reducing poverty and enhances political, economic and scientific institutions. The benefit of elementary education for development stem largely from the improved community skills, it imparts literacy, numeracy, problem solving ability and scientific outlook. What confronts us all is an enormous and unprecedented opportunity to develop the human resources of the nation to a broader and fuller degree than our most optimistic forebears ever dreamed of.

Universalisation of Elementary education (UEE) is the constitutional obligation. Article 21A of the Indian constitution states that "The state shall Endeavour to provide free and compulsory education for all children until they complete the age of fourteen years." "Education for all" is the slogan of all countries. But financial constraints aggravated by population explosion, poverty and illiteracy of masses a large rural habilitation, apathy of parents towards schools, hilly and tribal areas and failure to promote adequate work ethics are many major stumbling blocks in making elementary education free.
and compulsory in Indian context. Very recently in India education has been considered as fundamental Right (86th amendment) but merely making education as a fundamental Right will not serve its purpose unless efforts are made for improving the performance of the schools through a community owned approach and ensuring quality primary education. Further, education as fundamental Right will remain a shallow fundamental right of the children (just for the sake of legislative provision) unless and until there are certain conditions and role and responsibility performed by the school, parents, teachers and community at large. Now, after five decades of independence we have been able to achieve only 65% literacy. It seems impossible to improve quality of education without the active involvement of community in general and parents in particular.

For achieving universalisation of primary education (UPE), after District Primary Education Programme (DPEP), now the Sarva Shiksha Abhiyan (SSA) has come to existence, its guidelines were formulated in 2001 by centrally sponsored scheme seeking to operationalise the National Policy on Education (NPE)- Programme of Action (POA) strategies of achieving universalisation of elementary Education (UEE) by transforming, toning and accelerating the primary education system.

One of the objectives of SSA included “Elementary education of satisfactory quality with emphasis on education for life.” the major component of quality of education could be clustered under three groups, namely the level of material and human input or the characteristics of factors that go into education process; the process useful i.e. action involved in the school functioning; and the output of the process i.e. learner achievement in terms of their performance capabilities. The nature and extent of interaction between two i.e. input and process influence the third, namely learner’s achievement (Govinda and Varghese, 1992).

The quality of a school or educational system should, in real sense, be judged in terms of learner achievement, namely, how much and how well the learners have acquired the intended curriculum Input (Dove, 1991). With this framework of the concept of quality of education, it would be worth examining the effectiveness of primary school. To what extent the objectives of SSA
have been realized? Which type of schools gained more as compared to other schools? What is the relative gain among the learners across their sex, caste and location? Study of this kind is quite essential in the context of universalisation of elementary education.

1.1 Historical Perspective

*Verum esse ipsum factum*, Giambattista Vico

"the norm of the truth is to have made it," or

"the true is precisely what is made"

The philosophy of essentialism believes in using primary concepts, thoughts, and skills. According to essentialism the purpose of education is to teach children the lessons they need to live in the world. Some of the theorists who used and share similar ideals in education are Johann Friedrich Herbart, Herbert Spencer and Maria Montessori.

Johann Friedrich Herbart (1776-1841) was a great Philosopher, Psychologist, and an educator. Also called as the "Father of Scientific pedagogy." He believed the frame work of education should be based upon two systems psychology and ethics, "To Herbart ideas were central to the process. He felt they grouped themselves into what is called "Appreciative masses." By assimilation new ideas could enter the mind through association with similar ideas already present" (BookRags Staff, 2005)

Herbert Spencer (1820-1903) was known as the Philosopher, Scientist Engineer and Political economist (Smith, 1977)."Spencer systematically tried to establish the basis of scientific study of education, psychology, sociology and ethics from an evolutionary point of view" (BookRags Staff 2005). Spencer stated " If they are sufficiently complete to live, they do live and it is well they should live. If they are not sufficiently complete to live, they die, and it is the best they should die." He believed people had natural will to flourish from their environment and learn from it. If they could not well then they could not.

Maria Montessori (1870-1952) she was physician and during her medical practice she studied the behaviors of children. She analyzes their learning by watching them use their surrounding environment to refine their
own skills. She provided the children a stimulating environment to learn in emphasizing self determination and self realization.

Humanism is a philosophy that emphasizes the freedom, dignity, and potential of humans. Humanists commit to helping every person realize and perfect their potentials and view reason and education as a means to that end.

Jean Jacques Rousseau (1712-1778) was a Swiss-French writer and philosopher. His educational ideas were based on his view that children are naturally good and emphasized learning from nature and learning by experience. He stressed the importance of children developing ideas themselves, to make sense of the world in their own way and to draw their own conclusions from their own experiences (Doley & Smith, 2007).

Johann Heinrich Pestalozzi (1746-1827) was a Swiss educator and social reformer whose method resulted in the introduction of an elementary school system in Europe. Pestalozzi believed that the “whole child” not just the mind should be educated, religion should not be an educational guiding principle, and learning occurs by doing. (“Johann Heinrich Pestalozzi,” 1967). He encouraged children to absorb knowledge through own sensory experiences. His technique to bringing physical specimens into the classroom for observation was innovative in teaching of natural sciences.

Friedrich Froebel (1782-1852) was a German educator and psychologist best known for his creation of the Kindergarten system. His educational philosophy is based on his belief of the unity of all things in God. His Kindergarten program encouraged free activity, creativeness, social participation and motor expression (Bourgion, 1998). He encouraged educational environments where children were involved in practical work and directly using materials since he felt understanding unfolds by engaging with the world.

**Major contributors of Constructivist Thought**

Constructivism is not a new concept in education. Early thoughts about student centered methodology in teaching can be traced back to the writings of Greek philosophers such as Plato and Socrates, Later; theorists like Piaget
contributed the idea of child driven investigation to enhance what learning they have already experienced. Other theorists, such as Lev Vygotsky, added new dimensions to constructivism. Vygotsky "social constructivism" credited different aspects of culture and socialization to a child’s construction of knowledge. However among the earlier proponents of some form of constructivism are Budha (560-477 BC), Heraclitus (540-475 BC) the philosopher of endless change.

Some historical figures who influenced constructivism:

- Giambattista Vico (1668-1744)
- Immanuel Kant (1724-1804)
- John Dewey (1859-1952)
- Jean Piaget (1896-1980)
- Lev Vygotsky (1896-1934)
- Jerome Bruner (1915-Present)
- Seymour Papert (1928-Present)
- Ernst von Glasersfeld (1917-present)
- Donald Schon (1930-1977)
- Herbert Simon
- Paul Watzlawick
- Edgar Morin

**Constructivism in the Late 18th and 19th Century**

Giambattista Vico (1668-1744) Vico contended that a human being constructs his own understanding and was the first theorist to put his idea into words with his well known postulation *Verum esse ipsum factum* ("true itself if fact" or "the true itself is made") (SEDL, 1994). His perception of “truth” stems from the process of a person growing and maturing, thereby learning of what is honest and accurate in his own reality (Parkinson, 2004).

Immanuel Kant (1724-1804) Kant supported the notion that humans have the ability to gather information through perception, organize it within
their cognitive structures, reflect on, and analyze what happens to them, and then apply meaning to those situations

Alexander Kapp (1833) He developed the term "andragogy" to define the idea of adult learning (Smith, 1999) This definition was created to in contrast to the term pedagogy, which describes the specific way children learn (Smith, 1999)

Constructivism in the Late 19th and 20th Century

John Dewey (1859-1952) Dewey advocated the idea that learning should pertain to actual life (Educational Broadcasting Corporation, 2004). He also saw the need for learner to reflect on any personal experience that brought about learning.

Jean Piaget (1896-1980) Constructivism is based on the work of Jean Piaget and he is credited for giving constructivism momentum as an active movement in education (SEDL, 1994). He believed that human should be at one with the world around them. When children feel unbalanced to their world, they seek to once again feel adjusted. Uneasy children will have found that balance through investigation and by engaging with the world around them. He thought such an experience, also known as "learning by doing" contributed to knowing (Lunenburg, 1998) A classroom today allow the students to perform experiments to learn science concepts is using Piaget's idea of Constructivism (Fogarty, 1999).

As the name suggests, in constructivist theory; meaning is constructed based on experience. Even though we hear and receive information, it does not necessarily mean that we have learned that information. New learning is assimilated into learner's mental schemas by connecting with knowledge that is already present. New learning must be reflected upon and connected with old experience. Learners must reflect upon learning to make it connect to the old learning and to construct it's meaning. Learning is done by asking questions, exploring, and evaluating what is known.

Jean Piaget, after the creation in 1955 of the International Centre for Genetic Epistemology in Geneva, first uses the expression "constructivist's epistemologies". According to Ernst von Glasersfeld, Jean Piaget is "the great
pioneer of the constructivist theory of knowing” (in An Exposition of Constructivism: Why some Like it Radical, 1990) and "the most prolific constructivist in our century" (in Aspects of Radical Constructivism, 1996).

Lev Vygotsky (1896-1934) Vygotsky’s constructivism labeled specifically "Social Constructivism". He had believed that a child needed adult assistance to build knowledge. As knowledge is constructed, the additional support can be decreased and the child could think their own (Krechmar, 2008). Therefore, any instructor in the twenty-first century who had concluded a whole group discussion, then allowed students to work independently on the concepts presented has applied Vygotsky practice (Fogarty, 77).

20th Century Constructivist Thought

Jerome Bruner (1915-Present) Bruner postulated that students come into the educational system with their own beliefs and ideas (Educational Broadcasting Corporation, 2004). He acknowledged that children need assistance with their learning to build on what they already know (Boulware&Crow, 2008; Caldwell, 2008). Bruner reasoned that children should understand the skills and knowledge that go into understanding a concept rather than focusing on categorizing a concept by name. In other words, the How and why are more important than the who or what (Boulware & Crow, 2008).

Ernst Von Glasersfeld (1917-Present) He believed that the new knowledge acquired by a person does not have a definite correct or incorrect answer that is absolute. Instead, he contended that since experience is combined with perception, then someone can only use his or her ideas to ask questions that will formulate new thinking. Ernst von Glasersfeld, who has promoted since the end of the 70s radical constructivism, Edgar Morin and his book La Méthode (1977-2004, six volumes). Mioara Mugur-Schächter who is also a quantum mechanics specialist. Jean-Louis Le Moigne for his encyclopedic work on constructivist epistemology and his General Systems theory ("Le Moigne's Defense of Constructivism" by Ernst von Glasersfeld).

Seymour Papert (1928-Present) he centered his constructivist theory around the idea of "learning by doing" (or "playing") and incorporating
technology to improve student learning and enhance creativity. He is best known for his Logo software, which is used in math programs. Papert, contended that technology, and should be used far more extensively in education to prey on students’ inherent motivation to play.

Donald Schon (1930-1997) Schon studied internal processing and wrote about the capability of people to think about themselves and believed that if people thought about the things they have done, then they could modify their behavior and, therefore, their lives (Kinsella, 2007)

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, however. He saw play as an important and necessary part of the student's cognitive development and has provided scientific evidence for his views. Today, constructivist theories are influential throughout much of the so-called informal learning sector. One example is the Investigate Centre at the Natural History Museum, London. Here visitors can engage in open ended investigations of real natural history specimens reaching towards self selected goals.

The history of research on ‘teaching effectiveness’ reveals that there has been increasing shift from ‘teacher centered’ teaching methods to ‘learner centered’ classroom procedures. Until the 1950’s, researchers on ‘teaching’ focused on two themes – firstly, the ‘methods experiments’ where researchers compared the relative merits of using one method of teaching a particular subject with another method and secondly, exploring the personal characteristics of the ‘good teacher’. By the 1960s, it was increasingly recognized that teaching could not be described or prescribed in terms of standardized methods. It was also accepted that good teachers could not be distinguished by any kind of distinctive personality profile alone. It was realized that to understand teaching one needs to study ‘what happens in the classrooms’.

In 1978, Driver and Easley published an article which state that Interventions provided in the classroom can help children to construct their
own concepts. They believed that learners construct knowledge on the basis of their prior knowledge and personal experience.

Driver and Easley's article is taken as the beginning of the constructivist movement for improvement of teaching learning processes. A number of educators have been investigating instructional strategies which are effective in facilitating student's conceptual changes (Posner, strike, Hewson & Gertzog, Novak, Driver). The new constructivist paradigm provides teachers with an alternative way of viewing their teaching.

By the 1980s, it was recognized that in classroom processes, learner's craft, that is, learning strategies, prior knowledge, skill and context of the learner are as important teacher craft. During the 1980s and 1990s, the constructivist movement gained momentum and researchers like Posner (1982). Driver (1983) and Novak (1984) conducted knowledge and how teachers can provide interventions to help children construct their concepts. These researcher also emphasis the active role of the learner in the teaching learning process.

Constructivism as general philosophy has long history (Hawkins, 1994) and major theorists such as Dewey, Montessari, Piaget and Vygotsky are constructivists at root. These theories, however failed to support significant reforms in education because these could not translate constructivist perspectives in to educational practice.

In recent years the quality of education in schools and especially the effectiveness of teaching and learning have drawn the attention of educational policy planners and practitioner. Researches conducted by NCERT and other research institutes in the context of minimum levels of learning (MLL), District Primary Education Programme (DPEP) midterm Assessment surveys and achievement surveys indicate the attainment of students is much below the desired levels.

1.3 Theories on Constructivism

Constructivism may be considered an epistemology (a philosophical framework or theory of learning) which argues humans construct meaning from current knowledge structures. These arguments about the nature of
human learning guide constructivist learning theories and teaching methods of education. Constructivism values developmentally-appropriate and facilitator-supported learning that is initiated and directed by the learner. This is the path through which educators (facilitators) wish to approach students in constructing meaning of new concepts.

Under the theory of constructivism, educators focus on making connections between facts and fostering new understanding in students. Instructors tailor their teaching strategies to student responses and encourage students to analyze, interpret, and predict information. Teachers also rely heavily on open-ended questions and promote extensive dialogue among students. (Jacqueline and Martin Brooks)

It is important to note that constructivism itself does not suggest one particular pedagogy. In fact, constructivism describes how learning should happen, regardless of whether learners are using their experiences to understand a lecture or attempting to design a model airplane. In both cases, the theory of constructivism suggests that learners construct knowledge. Constructivism as a description of human cognition is often associated with pedagogic approaches that promote active learning by doing.

1.3.1 Bruner’s Theory on Constructivism

Bruner’s theory on constructivism encompasses the idea of learning as an active process wherein those learning are able to form new ideas based on what their current knowledge is as well as their past knowledge. A cognitive structure is defined as the mental processes which offer the learner the ability to organize experiences and derive meaning from them. These cognitive structures allow the learner to push past the given information in constructing their new concepts. The learner, often a child, will take pieces of their past knowledge and experiences and organize them to make sense of what they know, then base further concepts and solve additional problems based upon a combination of what they already processed and what they think should be processed next.

The teacher resources used should be focused on that of encouragement, aiding and allowing the student to uncover the main
principles on their own. Communication between the learner and teacher is the key concept. Socratic learning is suggested as the best method of communication in this theoretical framework, as it allows the teacher to actively note any study skills the learner verbalizes, their progression, their frustrations, and form a rubric of their current learning state based on the dialogue. Seeing as this theory takes known information and expounds upon it, any teacher lesson plans, teacher worksheets, or resources should in fact be constantly building the learner's knowledge in a spiral manner.

The four major principles of Bruner's theory on constructivism encompass 1) a predilection toward learning. The second, how a grouping of knowledge is able to be constructed to best be understood by the learner. The third is effective manners for the teacher to present said material to the learner, with the fourth and final aspect being the progression of rewards as well as punishments.

1.3.2 Discovery Learning (Bruner)

Discovery learning is an inquiry-based, constructivist learning theory that takes place in problem solving situations where the learner draws on his or her own past experience and existing knowledge to discover facts and relationships and new truths to be learned. Students interact with the world by exploring and manipulating objects, wresting with questions and controversies, or performing experiments. As a result, students may be more likely to remember concepts and knowledge discovered on their own (in contrast to a transmissionist model). Models that are based upon discovery learning model include: guided discovery, problem-based learning, simulation-based learning, case-based learning, incidental learning, among others. Proponents of this theory believe that discovery learning has many advantages such as (i) encourages active engagement(ii) promotes motivation(iii) promotes autonomy, responsibility, independence (iv) the development of creativity and problem solving skills.(v) a tailored learning experience.
1.3.3 Vygotsky’s Social Development Theory

Vygotsky’s Social Development Theory is the work of Russian psychologist Lev Vygotsky (1896-1934), who lived during Russian Revolution. Vygotsky’s work was largely unknown to the West until it was published in 1962. Vygotsky’s theory is one of the foundations of constructivism. It asserts three major themes:

Major themes: (i) Social interaction plays a fundamental role in the process of cognitive development. In contrast to Jean Piaget’s understanding of child development (in which development necessarily precedes learning), Vygotsky felt social learning precedes development. He states: “Every function in the child’s cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological).” (Vygotsky, 1978). (ii) The More Knowledgeable Other (MKO). The MKO refers to anyone who has a better understanding or a higher ability level than the learner, with respect to a particular task, process, or concept. The MKO is normally thought of as being a teacher, coach, or older adult, but the MKO could also be peers, a younger person, or even computers. (iii) The Zone of Proximal Development (ZPD). The ZPD is the distance between a student’s ability to perform a task under adult guidance and/or with peer collaboration and the student’s ability solving the problem independently. According to Vygotsky, learning occurred in this zone.

He focused on the connections between people and the sociocultural context in which they act and interact in shared experiences (Crawford, 1996). According to Vygotsky, humans use tools that develop from a culture, such as speech and writing, to mediate their social environments. Initially children develop these tools to serve solely as social functions, ways to communicate needs. Vygotsky believed that the internalization of these tools led to higher thinking skills.

Applications of the Vygotsky’s Social Development Theory

This theory is applicable to many schools who have traditionally held a transmissionist or instructionist model in which a teacher or lecturer ‘transmits’
information to students. In contrast, Vygotsky’s theory promotes learning contexts in which students play an active role in learning. Roles of the teacher and student are therefore shifted, as a teacher should collaborate with his or her students in order to help facilitate meaning construction in students. Learning therefore becomes a reciprocal experience for the students and teacher.

1.3.4 Piaget’s Stage Theory of Cognitive Development

Swiss biologist and psychologist Jean Piaget (1896-1980) observed his children (and their process of making sense of the world around them) and eventually developed a four-stage model of how the mind processes new information encountered. He posited that children progress through 4 stages and that they all do so in the same order. These four stages are:

(i) Sensorimotor stage (Birth to 2 years old). The infant builds an understanding of himself or herself and reality (and how things work) through interactions with the environment. It is able to differentiate between itself and other objects. Learning takes place via assimilation (the organization of information and absorbing it into existing schema) and accommodation (when an object cannot be assimilated and the schemata have to be modified to include the object).

(ii) Pre-operational stage (ages 2 to 4). The child is not yet able to conceptualize abstractly and needs concrete physical situations. Objects are classified in simple ways, especially by important features.

(iii) Concrete operations (ages 7 to 11). As physical experience accumulates, accommodation is increased. The child begins to think abstractly and conceptualize, creating logical structures that explain his or her physical experiences.

(iv) Formal operations (beginning at ages 11 to 15). Cognition reaches its final form. By this stage, the person no longer requires concrete objects to make rational judgments. He or she is capable of deductive and hypothetical reasoning. His or her ability for abstract thinking is very similar to an adult.
1.4 **Bases of Constructivism**

1.4.1 **Philosophical Bases**

Constructivism is not a new concept. It has its roots in philosophy and has been applied to sociology and anthropology, as well as cognitive psychology and education. Constructivism is comparatively a modern philosophy. Perhaps the first recognized constructivist philosopher, Giambatista Vico commented in a treatise, “one only knows something if one can explain it” Yager (1991). Immanuel Kant further elaborated this idea by asserting that human beings are not passive recipients of information. Learners actively take knowledge, connect it to previously assimilated knowledge and make it theirs by constructing their own interpretation (Cheek, 1992).

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,” which we use to make sense of our experiences. Learning, therefore, is simply the process of adjusting our mental models to accommodate new experiences. Known as the Constructivist approach. (Jacqueline and Martin Brooks)

1.4.2 **Psychological Bases**

Constructivism is also a psychological theory of knowledge which argues that humans construct knowledge and meaning from their experiences. Constructivism is a set of beliefs about knowledge that begins with the assumption that reality exists but cannot be known as a set of truth (Tobin et al., 1993). Constructivism is not accepting what you are told but your prior knowledge about what you are taught and your perceptions about it. Constructivism is a theory, a tool; a lens for examining educational practices (Dougiamas, 1998)

1.5 **Models of Learning**

Currently, three learning models are practiced by the teachers in the classroom. The first model is knowledge transmission by the teacher and its reception by the students passively. It describes learning as a simple
recording mechanism, carried out by the brain, with a notion, that the acquisition of the knowledge is the direct result of transmission. It is not true. This model has its implications for teaching. Knowledge cannot simply be transferred by words and knowledge is not acquired passively.

The second model; the behaviouristic learning model, focuses on overt behaviour rather than what occurs in the mind. In this model desired behavior is defined, simple stimulus–response approach is practiced and reinforced and individuals get rewarded for correct responses. Behaviorism has failed to explain the phenomenon such as language learning, problem solving and creative thinking. This theory is teacher centered, teacher directed and teacher controlled.

The third model is based on cognitive learning theory which assumes that learners are active in their attempts to understand the world, new understandings depends on prior learning, learners construct understanding. Learning is a change in people’s mental structures instead of change in observable behavior. Jean Piaget has promoted cognitive learning which focuses on what occurs within child’s mind in the process of learning. It supports information processing theories and constructivist theories. A constructivist classroom is student centered, activity based, interactive and knowledge is constructed by joining previous knowledge with new experience. The learner is actively engaged in his own dialogue with students, facilitating construction of knowledge.

1.6. Constructivist Teaching Models

From behaviorism to constructivism is known as paradigm shift in education.

The major models of constructivist teaching are:

1.6.1 Problem Learning Centred Model

Wheatley (1991) proposed a model of constructivist teaching using problem-centred learning approach. Wheatley (1991) quotes Kozmetsky (1980) stating that “each student must be encouraged to build his/her own conceptual constructs that will permit the ordering of knowledge into useful problem solving schema” (p.152) This problem – centered learning approach has three components: tasks, groups, and sharing. Wheatley (1991) goes into
further detail on the selection of the tasks based upon student prior knowledge and that the tasks should contain the following 10 attributes: 1) be accessible to everyone at the start; 2) invite students to make decisions; 3) encourage “what if” questions; 4) encourage students to use their own methods; 5) promote discussions and communication; 6) be replete with patterns; 7) lead somewhere; 8) have an element of surprise; 9) be enjoyable, and 10) be extensible.

Wheatley’s (1991) problem-centre approach to learning is a simple and open-ended approach that many teachers already use or could adapt their current learning activities to fit within.

1.6.2. Constructivist Teaching Sequence Model

Scott, Dyson, and Gater (1987) suggested that a constructivist teaching sequence could consist of three phases as follows:

Phase 1: Elicitation of ideas from students

The teaching commences with orientation or question (involving exploring student ideas, discussing the differences among ideas of students, carrying out experiments, and trying to explain the observed phenomenon). Students usually become aware of their own and others’ point of view. This really sets the scene for the work to come by introducing the context of the study and hopefully raising interest in what is to follow.

Phase 2: Reconstructing and application of ideas

During the restructuring phase, students’ ideas can be clarified, challenged, and exchanged through discussion with others, or the teacher can promote conceptual conflict through the use of disconfirming experiment or demonstration. Consequently this phase, students are given the opportunity to consolidate and reinforce new conceptions by using them both familiar and novel situations.

Phase 3: Review of change in ideas.

The students are invited to reflect on how their ideas have changed by drawing comparisons between their new thinking and their initial thinking at the start of the unit.
1.6.3. The Learning Cycle Model.

The learning cycle approach has been proposed as a means to enhance conceptual change (Atepans, Dyche, & Veiswenger, 1988). There are three phases in this model, namely, Exploration, term introduction, and concept application. Gallos, Treagust, and Berg (2001) have created six steps of teaching in science classes relevant to the learning cycle model as follows:

1) Review, Check previous day’s work and reteach if necessary,
2) Present new academic content or skills,
3) Provide initial but guided student practice and check for understanding,
4) Provide continual feedback and correctives,
5) Provide students with opportunities for independent practice and,
6) Conduct weekly and monthly reviews

1.6.4. Five Guiding Principles of Constructivism

Another model for constructivist teaching in science was created by Brooks and Brooks (1999), have stated five guiding principles of constructivism in his book “A Case for the Constructivist Classrooms.” The first is to use the problems of relevance to student instruction. The second is that learning be structured around primary concepts. The third is to value the students’ point of view, the fourth is to adapt curriculum to address students’ suppositions and the fifth is to assess students’ learning in the context of teaching.

1.6.5. Constructivist Learning Model

Yager (1991) also proposed a “Constructivist Learning Model” for use in science teaching. He suggested the following constructivist procedures for science teachers:

1) Seek out and use student questions and ideas to guide lessons and whole instructional units.
2) Accept and encourage student initiation of ideas.
3) Promote student leadership, collaboration, location of information and taking actions as a result of their learning process.
4) Use student thinking, experiences and interests to drive lessons.
5) Encourage the use of alternative sources for information both from written materials and experts.
6) Use open ended questions and encouraging students to expand on their questions and their responses.
7) Encourage students to suggest causes for event and situations and encourage them to predict consequences.
8) Encourage students to test their own ideas.
9) Seek out students' ideas before presenting teacher ideas or before studying ideas from textbooks or other sources.
10) Encourage students to challenge each other's conceptualizations and ideas.
11) Use cooperating learning strategies that emphasizes collaboration, respect individually, and use division of labour tactics.
12) Encourage adequate time for reflection and analysis, respect and use all ideas that students generate.
13) Encourage self analysis, collection of real evidences to support ideas and reformulation of ideas in the light of new knowledge.

1.6.5.1 5 E Model of Instruction

Rodger W Bybee (1997) developed a model for constructivism called as 5E's. This model consists of 5 phases as follows.

1. Engagement

This phase of the model initiates the learning task. The activity should make connections between past and present learning experiences, anticipate activities, and focus students' thinking on learning outcomes of current activities. The student should become mentally engaged in the concept, process, or skill to be explored.

2. Exploration

This phase of teaching model provides students with common base of experiences within which they identify and develop current concepts, processes, and skills. During this phase, students' actively explore their environment and manipulate materials.
3. **Explanation**

This phase of instructional model focuses students’ attention on a particular aspect of their engagement, exploration, experiences and provides opportunities for them to verbalize their conceptual understanding, or demonstrate their skill or behaviors. This phase also provides opportunities for teachers to introduce a formal label or definition for a concept, process, skill, or behavior.

4. **Elaboration**

This phase of the teaching model challenges and extends students’ conceptual understanding and allow further opportunity for students to practice desired skills and behaviors through new experiences, the students develop deeper and broader understanding, more information, and adequate skills.

5. **Evaluation**

This phase of teaching model encourages students to access their understanding and abilities and provides opportunities for teachers to evaluate student progress toward achieving the educational objectives.

### 1.7 Principles of Constructivism:

1. Learning is a search for meaning. Therefore, learning must start with the issues around which students are actively trying to construct meaning.

2. Meaning requires understanding wholes as well as parts. And parts must be understood in the context of wholes. Therefore, the learning process focuses on primary concepts, not isolated facts.

3. In order to teach well, we must understand the mental models that students use to perceive the world and the assumptions they make to support those models.

4. The purpose of learning is for an individual to construct his or her own meaning, not just memorize the "right" answers and regurgitate
someone else’s meaning. Since education is inherently interdisciplinary, the only valuable way to measure learning is to make the assessment part of the learning process, ensuring it provides students with information on the quality of their learning. (Jacqueline and Martin Brooks)

1.8 Concept of Constructivism

“Experience is the child of Thought, and Thought is the Child of Action—We cannot learn men from books.”

-Benjamin Disraeli-1826

Constructivism is an epistemology, learning or meaning-making theory, that offers an explanation of the nature of knowledge and how human beings learn. Constructivism basically a theory-based on observation and scientific study—about how people learn. The meaning of Constructivism varies according to one’s perspective. Constructivism is a relatively new paradigm which takes into account the subjective, contextual and pluralistic nature of knowledge. It is one of the new theories, which has much influenced the teaching learning process. The basic idea of the constructivism is that the learner must construct knowledge; the teacher cannot supply it (Bringuier, 1980), the constructivism paradigm as advocated by Piaget (1960/1981) and Bruner (1990), stresses that whatever gets into the mind has to be constructed by the individuals through knowledge discovery. In other words this theory hold the view that the learning is an active process in which learner construct new ideas or concepts based upon their current or post knowledge. Constructivism has initiated learner centered approach in education.

The verb “to construct” comes from the Latin word ‘Construere’, which means to arrange or give structure. Ongoing structuring processes are the conceptual heart of constructivism. Constructivist believe that the process of actively engaging in building new knowledge structures is how new knowledge is created.

According to Simsons (1993), Constructivism is an approach in which the learner is building internal illustrations of knowledge, personal interpretations of experience.
In a Constructivist classroom, teachers use active techniques to learning. Students learn primarily through experiments, real world problem solving, reflection and discussion. In constructivist classroom, the teacher guides the students in their learning. The teacher encourages the students to ask question and to access their learning. By asking questions, the students work through their learning and not only learn new information, but they learn how to learn. Students are encouraged to evaluate their learning and reflect on their learning progress. Hands on learning are the basis of a constructivist classroom. Students learn by doing “They become engaged by applying their existing knowledge and real-world experience, learning to hypothesize, testing their theories, and ultimately drawing conclusions from their findings”.

In objectivist paradigm, teacher transmits authoritative knowledge to passive students whereas in constructivist paradigm students construct knowledge in a particular context in which the cognizing individual is operating (Von Glaserfeld 1989). Most of the time, teacher teach by the lecture method and sometimes take up activities to verify the factual knowledge given in the text books. Objectivism is based on the assumption that knowledge is objective, universal and complete and it can be imported by those who have it, to those who do not have it. Constructivism on the other hand is based on the assumption that knowledge is subjective, contextual and inherently partial. Hence it focuses on the resilience of the learner’s beliefs and the social construction of reality.

The traditional methods of teaching are based on objectivist view of knowledge. In objectivist paradigm, the teacher transmits knowledge to the learners who are considered as passive receivers of knowledge. It is believed that the teacher has all the knowledge and the teacher is the source of right knowledge and correct answers. In contrast, the constructivist paradigm is based on the assumption that knowledge is subjective and learners construct knowledge in the social and cultural environment in which they are embedded.

Constructivism proposes new definitions for knowledge and truth that forms a new paradigm, based on inter-subjectivity instead of the classical
objectivity and viability instead of truth. The constructivist point of view is pragmatic as Vico said "the truth is to have made it".

Active involvement of students is emphasized in constructivism, hence knowledge gained last long in their memory. Five basic themes pervade the diversity of theories expressing constructivism. These themes are (1) active agency, (2) order, (3) self, (4) social-symbolic relatedness, and (5) lifespan development. With different language and terminological preferences, constructivists have proposed, first, that human experiencing involves continuous active agency.

1.9 Constructivism in Education

Constructivism is associated with cognitive psychology. Constructivist learning is a knowledge construction based on the assumption that learners actively create and restructure knowledge in highly individualized ways, through experiences. Constructivism emphasizes the importance of knowledge, beliefs and skills an individual brings to experience of learning. It recognizes the construction of new understanding as a combination of prior learning, new information and readiness to learn. Fosnot (1996) defines constructivism by reference to four principles. Learning is an important way, depends on what we already know, new ideas occur as we adapt new change our old ideas; learning involves inventing ideas rather mechanically accumulating facts, meaningful learning occurs through rethinking old ideas and coming to new conclusions about new ideas which conflict with our old ideas.

"Knowledge is constructed in the mind of the learner" (Bodner et al., 2001) Constructivism is an approach to education that has long been embraced by such infamous thinkers as Frobel, Freud, Erikson and its greatest contributors, Jean Piaget and John Dewey. (Devnes et al 1992) It has been studied, implemented and found to be successful by educators for many years and has shown its staying power by the many schools and learning facilities that have changed their curriculum to embody the constructivist perspective. While some critics note that there is always a new fad, or latest trend when discussing education, they have yet to brand
constructivism with this label. Its importance can be witnessed as its discussion made the cover of the November 1999 issue of the Educational Leadership Journal. As well, the numerous articles (200+ found on the ERIC database) published on the topic show the wide range of support or disapproval from other academics in the field of education. (Bird et al. 2001). Defining constructivism is a task that is not easily completed.

1.10 The Scope of Constructivism

The range of constructivist concerns can be seen in the subheadings of a recent science education article, where we are informed of ‘A constructivist view of learning’, ‘A constructivist view of teaching’, ‘A view of science’, ‘Aims of science education’, ‘A constructivist view of curriculum’ and ‘A constructivist view of curriculum development’ (Beil 1991). The expanded purview of constructivism is also apparent in the remarks of another constructivist that: ‘this approach [constructivism] holds promise for the pursuit of educational objectives other than those associated exclusively with cognitive development … the constructivist point of view makes it possible to develop a vision of the whole educational phenomena which is comprehensive and penetrating’ (Pépin 1998, p. 173). Another author writes ‘Constructivism is a postmodern theory of knowledge with the potential to transform educational theory’ (Fleury 1998, p. 156). It is not surprising then that, ‘For several years now, across the country [USA], preservice and in-service teachers have been considering constructivism as a referent for their philosophies of education’ (Bentley 1998, p. 244). And constructivism is not just a theory about education; it is a theory about one of culture’s greatest and most enduring achievements, namely science. As Bentley says ‘Indeed as an epistemology, constructivism speaks to the nature of science’ (Bentley p 243).

Constructivism spreads to still further fields. It increasingly presents itself as an ethical and political theory, as well as learning, a teaching and an epistemological theory. As a recent paper says ‘There is also a sense in which constructivism implies caring – caring for ideas, personal theories, self image, human development, professional esteem, people – it is not a take-it-or-leave-it epistemology’ (Watts 1994, p. 52). This ethical dimension is
manifest in the frequency with which notions of emancipation and empowerment occur in constructivist writing. Constructivism is thought to be a morally superior position to its rivals in learning theory and pedagogy. It offers teachers 'a moral imperative for deconstructing traditional objectivist conceptions of the nature of science, mathematics and knowledge, and for reconstructing their personal epistemologies, teaching practices and educative relationships with students' (Hardy & Taylor 1997, p 148).

There is also a political dimension to much constructivist writing. Two constructivist writers say that they are committed to the philosophy and principles of composite groups and mixed-ability groupings (Brass & Duke 1994, p 100). Another writer has identified the Progressive Education tradition as constructivist, and the British Plowden Report of the mid-1960s as the embodiment of constructivist school organisation (Hawkins 1994).

Thus one problem posed for the appraisal of constructivism for determining whether it has been a help or hindrance in educational reform, is being clear about what aspect of constructivism is being appraised: the learning theory, theory of knowledge, pedagogical theory, and theory of science, educational theory or more all-encompassing worldview. Frequently the different aspects are treated as a package deal, whereby being a constructivist in learning theory is deemed to flow on to being a constructivist in all the other areas, and being a constructivist in pedagogy is deemed to imply a constructivist epistemology and educational theory. But these aspects can all be separated and each can stand alone. Thomas Kuhn, for instance, held a constructivist theory of science yet was an advocate of anti-constructivist pedagogy (Kuhn 1959). Socrates might be seen to be a constructivist in pedagogy, yet he was an anti-constructivist in his theory of knowledge. On the other hand, Ernst Mach was a most vigorous champion of instrumentalist (constructivist?) views of science, yet was quite didactic in his pedagogy.

Thus at least the following dimensions, or fields, of constructivism need to be separated:

1. Constructivism as a theory of learning.
2. Constructivism as a theory of teaching.
3. Constructivism as a theory of education.
4. Constructivism as a theory of cognition.
5. Constructivism as a theory of personal knowledge.
6. Constructivism as a theory of scientific knowledge.
7. Constructivism as a theory of educational ethics and politics.
8. Constructivism as a worldview.

1.11 Concept of Constructivist Approach

The National Curriculum Framework (NCF-2005) also recommends that curriculum should help the learners to become constructors of knowledge and emphasizes the active role of teachers in relation to the process of knowledge construction.

According to the constructivist approach learning is an interaction between the learner and learning environment. During this interaction, prior knowledge is used as a basis to interpret and construct new understanding. In other words, learning occurs if a student can construct his or her knowledge and apply or generalize its meaning to new situations. The constructivist approach opens new avenues for learning as well as challenges for the teacher trying to implement it. In a learner centered situation, the constructivist teacher becomes one of many resources a student may learn from, and not the primary source of information. The teacher act as a facilitator, co-learner, democratic leader, and a diagnostician.

The constructivist thinking has been considered important to achieve the objectives of learning to live together, learning to learn, learning to know and learning to be.

Education is a process of acquiring information and knowledge. How one perceives knowledge and what is the process of coming to know are pertinent question of education. The traditional methods in which the learners receive the information passively appear outdated. Constructivist approach believes that the learners actively construct knowledge in their attempts to
make sense of their world. Hence learning should emphasize the development of meaning and understanding. Students should be able to acquire experiences and learn by themselves, and apply what they learn to various and unpredictable situations that they might encounter over the course of their worldly lives.

National Curriculum Framework-2005 (NCERT) proposed a paradigm shift to Constructivism in schooling. NCF-2005 has given impetus to the constructivist approach to teaching-learning as constructivism started assuming greater importance in contemporary psychology and epistemology as growing relevance in pedagogy and schooling. However, constructivism as an all-encompassing approach used by philosophers, psychologists, curriculum designers, educators, and pedagogues to meaning making needs to be probed in order to develop awareness among actual classroom practitioners.

The Constructivist teaching is based on the belief that learners actively create, interpret, and recognize knowledge. Then, the instructional strategy should be such in which students should participate in experiences that accommodate these ways of learning. Such experiences include inquiry activities, discovery, problem solving, discussion with peers and teachers, collecting and interpreting information from different sources, and expressing their understanding in diverse ways. Effective instruction depends on the teacher's ability to understand how students make sense of the stimuli rather than how teachers make sense of those stimuli by themselves.

According to Driver (1989), if it is accepted that learning involves the reconstructing of students' conceptions, then not only do educators need to appreciate the ideas that children bring to the learning situation, but they need to understand the processes by which conceptual change occurs in order that this can be taken into account in the design of learning programmes. The key feature of constructivism epistemology is that the human beings construct mental models of their world, and new experiences are interpreted and understood in relation to existing mental models. A constructivist classroom transforms the student from a passive recipient of information to an active participant in the learning process.
In a constructivist setting, knowledge is not objective, mathematics and science are viewed as systems with models that describe how the world might be rather than how it is. These models derive their validity not from their accuracy in describing the real world, but from the accuracy of any predictions which might be based on them (Postlewaite, 1993). The role of the teacher is to organize information around conceptual clusters of problems, questions and discrepant situations in order to engage the student’s interest. Teachers assist the students in developing new insights and connecting them with their previous learning. Ideas are presented holistically as broad concepts and then broken down into parts. The activities are student-centered and students are encouraged to ask their own questions, carry out their own experiments, make their own analogies and come to their own conclusions.

1.12 Constructivist Trends

Cultural Constructivism

Cultural constructivism asserts that knowledge and reality are a product of their cultural context, meaning that two independent cultures will likely form different observational methodologies. For instance, Western cultures generally rely on objects for scientific descriptions; by contrast, Native American culture relies on events for descriptions. These are two distinct ways of constructing reality based on external artifacts.

Communal Constructivism

In Communal constructivism students and teachers are not simply engaged in developing their own information. Rather, they are actively involved in creating knowledge that will benefit other students. "In this model students will not simply pass through a course like water through a sieve but instead leave their own imprint in the development of the course, their school or university, and ideally the discipline." Holmes, B., Tangney, B., Fitzgibbon, A., Savage, T, & Mehan, S. (2001).

Radical constructivism

The notion "radical constructivism" (RC) was coined by Ernst von Glasersfeld in 1974 in order to emphasize that from an epistemological
perspective any constructivism has to be complete (or "radical") in order not to relapse into some kind of fancy realism. The basic tenet of RC is that any kind of knowledge is constructed rather than perceived through senses. As such, RC does not present a metaphysics in the strict sense as it does not make statements about an outside reality ("No statement" means neither confirming nor denying reality. The subject of much criticism, RC equals solipsism, doesn’t therefore apply) Forerunners of the RC movement in the 18th century were Giambatista Vico, whose dictum "verum ipsum factum" already pointed in the direction of knowledge construction, and George Berkeley whose claim "esse est percipi" challenged metaphysics

Critical Constructivism

A series of articles published in the journal Critical Inquiry (1991) served as a manifesto for the movement of critical constructivism in various disciplines, including the natural sciences. Not only truth and reality, but also "evidence", "document", "experience", "fact", "proof", and other central categories of empirical research (in physics, biology, statistics, history, law, etc) reveal their contingent character as a social and ideological construction. Thus, a "realist" or "rationalist" interpretation is subjected to criticism.

While recognizing the constructedness of reality, many representatives of this critical paradigm deny philosophy the task of the creative construction of reality. They eagerly criticize realistic judgments, but they do not move beyond analytic procedures based on subtle tautologies.

Trivial Constructivism

This is also known as the personal Constructivism. This is the simplest idea in Constructivism what Giaserfeld (1990) calls trivial constructivism. According to this thought: "Knowledge is, actively constructed by the learner, not passively received from the environment".

Social Constructivism

Social constructivism is a sociological theory of knowledge that applies the general philosophical constructionism into social settings, wherein groups construct knowledge for one another, collaboratively creating a small culture.
of shared artifacts with shared meanings. When one is immersed within a culture of this sort, one is learning all the time about how to be a part of that culture on many levels. Its origins are largely attributed to Lev Vygotsky. Social constructivism has been studied by many educational psychologists, who are concerned with its implications for teaching and learning. Constructivism forms one of the major theories (behaviourism, social learning, constructivism and social constructivism) of child development, arising from the work of Jean Piaget's theory of cognitive development. Piaget's stage theory (describing four successive stages of development) also became known as constructivism, because he believed children needed to construct an understanding of the world for themselves. Social constructivism extends constructivism by incorporating the role of other actors and culture in development. In this sense it can also be contrasted with social learning theory by stressing interaction over observation.

**Psychological Constructivism**

Psychological constructivism is based on Jean Piaget's model of development of the individual. The process focuses learning as a personal individual, intellectual construction based on experiences of one in the world. To Piaget, the child mind is self-organized by a constant antagonism between internal, subjective mental states and external reality.

**1.13 Science Education**

**Introduction**

"Every effort will be made to extend science education to vast numbers who remained outside the pale of formal education."


Gagne (1965)” Science is what the scientist does. It is a process by which we increase and refine our understanding of the universe through continuous observation, experimentation, application and verification”

According to Kothari Commission” Science and Mathematics should be taught on compulsory basis to all the pupils as a part of general education during the first 10 years of schooling.”
Development of science and technology is vital for the progress of any country. It is a major vehicle for enhancing the quality of human life. The developments in science and technology, particularly in information technology and computer science are occurring so fast that it is difficult to portray the world of 2020. The emergence of globalization and the intellectual property rights regime have made ‘knowledge’ a big resource and it is believed that in the 21st century only those countries would excel which possess a wealth of knowledge. Under such a scenario it has become all the more important that we should have a strong science base in our country, particularly in children. A vast infrastructure for education, including science education, has been created in the country. It comprises hundred thousand schools, over 860 colleges, more than 200 universities, several institutes of specialized learning like Indian Institutes of Technology (IITs), Indian Institute of Science (IISc), Tata Institute of Fundamental Research (TIFR), about 40 scientific laboratories of the Council of Scientific and Industrial Research with an equal number of institutes of defence Research and Development Organization. All this had a positive impact and we could produce renowned scientists, researchers and academicians. Curriculum development, textbooks production and teachers’ training. Many scholars 1-5 have shown concern for the decline of enrolment in science courses in higher education over the years. No attempt, however, seems to have been done to ascertain the situation of enrolment in science at school/college level.

Science education in Indian schools have deviated much from imparting in depth knowledge in science because it is merely bookish and theoretical. The shift in emphasis from conventional approaches in teaching to that of reconceptualization technique of instruction and evaluation is relatively new and developing at a faster rate. It requires a number of ways to create the right environment for learning. Effective learning occurs when the students are actively involved in organizing and finding the relationships in the information they encounter rather than being the passive recipients of the teacher delivered quantum of knowledge. The young inquisitive minds may have questions about all sorts of things and these questions are being suppressed in a conventional classroom. And the students are not able to
apply or correlate their information and knowledge to the various day to day life situations outside the classroom.

A consequence of this one-way of transmitting knowledge (from the teacher to the students) induces a high level of dry memorization by the students. The reason behind it consists in the lack of development of quantitative and analytical skills that comes with the traditional lecturing. As side effects, sciences (and in particular the physical sciences) are perceived as cryptic, difficult and requires a student to be "very smart".

National Curriculum Framework for Teacher Education (2009)!, NCTE which observes that the quality and extent to learner achievement are determined primarily by teacher competency sensitivity and teacher motivation.

Glynn Yeany and Britton (1991) stated that school science curriculum are commonly placed on a continuum from "textbook-centered" to "teacher-centered" and that the textbook is the vehicle that drives the teaching. The textbook is usually accompanied by a large bulk of resource materials such as additional information, overhead transparencies, wall charts, cassette tapes, teaching kits, worksheets, exercises, suggested activities and experiments, and the activity cards. Besides this, there are also "very useful" teachers' handbooks prepared by the publishers which prescribe precisely how a concept should be taught (So Tang & Ng 2000).

The problem of the heavy reliance on textbooks during science lessons was addressed in the American Association for the Advancement of Science Report (1989) noting that the present science textbooks and methods of instruction emphasized the learning of answers more than the exploration of questions, memory at the expense of critical thoughts, bits and pieces of information instead of understanding in context, recitation over argument reading in lieu of doing.

Morns (1995) in discussing the pedagogy in classrooms claimed that the major resource used by teachers and pupils in Hong Kong is the textbook. It often provides the content of the lesson and many of its learning activities. Further to this, in examining the nature of the more pupil-centered tasks used
in the classrooms, such as group work, problem solving and discovery learning, Morris found that these tasks are often characterized by a high degree of teacher control and a low level of pupil involvement.

It is well known fact that children are curious. Their curiosity motivates them to discover new ways to use this powerful key for unlocking the mysteries of their world. Science education will be strengthened so as to develop the child well defined abilities and values such as spirit of inquiry, creativity, objectivity, the courage of question, and aesthetic sensitivity. Science education programme will be designed to enable the learner to acquire problem solving and decision making skills and to discover the relationship of science and health, agriculture, industry and other aspects of daily life.

There are a plethora of methods which are useful in evaluating student achievement in science. Mandated testing stresses the use of multiple-choice test items to appraise learner progress. These are emphasized as being objective in that all students.

**Science Education in Independent India**

Before independence, entire education system of India was traditional and conservative. Negligence of British rulers was reflected in all spheres of education including science education. In 1943, Norwood Report was published where a chapter on science teaching was included. In 1945, Education Act of 1944 came into force where recommendations to increase science teaching in Indian schools were incorporated. In spite of all the efforts it took about six years when a definite directive was issued in 1953 by the Secondary Education Commission to teach ‘General Science’ as a compulsory subject in high school. In 1956, First National Seminar on “Teaching Of Science” was held at Tara Devi, Shimla Himachal Pradesh, the participants discussed the various issues like syllabus, Text books, Laboratory equipments, Teaching methods etc. to analyze the merits and demerits of the existing system. The policy makers of our Government had positive thinking towards improvement of science teaching was evidenced by the following vital steps taken:
In 1957, National Science Policy was adopted by the central Government.

During 1961-62 Indian Parliamentary and Scientific Committee was constituted.

In early Sixties a proposal was initiated to deal with different issues of teaching science like curriculum development, methods of teaching creativity in teaching by the NCERT, New Delhi.

1964-66 Recommendation of Kothari Commission to improve the science education from primary to research level.

1968 National Policy on Education was framed and science and Mathematics were declared as compulsory components of the syllabi.

Involvement of international bodies like UNESCO and UNICEF in the upliftment of standards of science education.

According to the 42nd amendment of the Constitution of India-Part IV A fundamental duties of citizen o 51A(h), it shall be the duty of every citizen of India to develop scientific temper, humanism and the spirit of enquiry and reform(1976)

Again, the period 1972-77 was a watershed for the school science education policy in our country. Entirely new approaches of teaching science emerged in schools.

During the last phase of 20th Century educationists and policy makers shifted their focus for educational planning from routine traditional framework to a more dynamic multidimensional pattern to fulfill the needs of 21st century Education Policy of 1986 and its Programme of Action (1992) also highlighted the science education.

The NCF-2005 provides wide scope for utilization of personal experiences of learners in day-to-day school activities. Expressing concern over lack of opportunities for students in present system to share their personal experiences, the NCF-(2005) strongly recommends “the curriculum must enable children to find their voices, nurture their curiosity to do things, to ask question and to pursue investigations, sharing and integrating their
experiences with school knowledge rather than their ability to reproduce external knowledge (p. 13)."

**Science Education of Today**

In spite of all efforts of our policy makers, national leaders and educationists, science education and science teaching learning process as a whole appears a bit gloomy even after sixty years of independence. Starting from the Indian school education in science, under graduate/post graduate and research, level of quality in basic science is not very encouraging in comparison to global standard. Even in the different states of India uniformity is lacking in all aspects. Quantitative growth has been achieved as evidenced by existing more than million primary and secondary schools, around 2000 professional institutes, around 2000 training institutes, more than 20,000 general colleges and 400 universities which are ready to accommodate eligible candidates at suitable stages. Infrastructural facilities available for science teaching are not uniform in the schools where three distinct categories can be identified. The categories are government aided, government administered and under total private management. Of these three, the third one .i.e. the private schools provide best facilities for science teaching learning system in the form of qualified teachers, well equipped laboratories, libraries, computer facilities etc. other schools i.e.governement and aided somehow manage their systems because of limitations of varied nature.

**Constructivist teaching in science**

"The most conspicuous psychological influence on curriculum thinking in science since 1980 has been the constructivist view of learning." (Fensham, 1992, p.801) Tobin (1993) remarked that as "constructivism has become increasingly popular... in the past ten years.... it represents a paradigm change in science education." (p.ix) Yeany (1991) also argued that "an unification of thinking, research, curriculum development, and teacher education appears to now be occurring under the theme of constructivism." (p.1) their views were echoed by the words of Scott, Asoko, Driver and
Emberton (1994) "science learning, viewed from a constructivist perspective, involves epistemological as well as conceptual development." (p.219)

This emergence of science education as a scientific domain is usually associated with the establishment of what Novak (1988) called an 'emergent consensus' about constructivist positions, considered by Gruender and Tobin (1991) to be the most important contribution to the last decades in science education. A contribution which the American Association for the Advancement of Science has described as a real 'paradigm change' (Tobin 1993, cited by Jenkins 2000). However, some voices have begun to question constructivist positions in science education, speaking, for example, of 'Constructivism Deconstructed' (Suchting 1992) or of 'Rise and Fall of Constructivism' (Solomon 1994). These very different appraisals make Jenkins (2000) ask: 'Constructivism in School Science Education: Powerful Model or the Most Dangerous Intellectual Tendency?'

Constructivist views also emphasize generative learning, questioning or inquiry strategies (Slavin, 1994). An emphasis on constructivism and hands-on inquiry-oriented instruction to promote children's conceptual knowledge by building on prior understanding, active engagement with the subject content, and applications to real world situations has been advocated in science lessons (Stofflett & Stoddart, 1994). And constructivist views emphasizing discovery, experimentation, and open-ended problems have been successfully applied in science (Neale & Smith, 1990). Wildy and Wallace (1995) believed that good science teachers are those who teach for deep understanding: "They use students' ideas about science to guide lessons, providing experiences to test and challenge those ideas to help students arrive at more sophisticated understanding. The classrooms of such teachers are learner-centered places where group discussion, exploration and problem solving are common place." (p.143)

**Role of Constructivist Approach in Science classroom**

Constructivism is not a new concept. It is learning or meaning making theory. The term 'constructivism' encompasses a variety of theoretical positions (Geelan, 1997) and has mainly been applied to learning theories,
focusing on learning as a conceptual change (Driver & Oldham, 1986) and to curriculum development and teaching, mainly in science (Osborne & Wittrock, 1985).

A Constructivist learning settings differs from the one based on the traditional model. In constructivist classroom, learning outcomes not only depend on the learning environment but also on the prior knowledge of the learner. Learning involves construction of meaning by the students from what they see or hear. It is a continuous and active process which is influenced to a large extent by existing knowledge.

In the Constructivist classroom, the focus trend is shift from the teacher to students. The classroom is no longer the place where the teacher pours knowledge into passive students, who wait like empty vessel to be filled.

<table>
<thead>
<tr>
<th>Traditional classroom</th>
<th>Constructivist classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum begins with the parts of the whole. Emphasizing basic skills</td>
<td>Curriculum emphasizes big concepts, beginning with whole and expanding to include the parts.</td>
</tr>
<tr>
<td>Learning is based on repetition</td>
<td>Learning is based interactive, building on what the student already knows.</td>
</tr>
<tr>
<td>Teacher's role is directive, rooted in authority.</td>
<td>Teacher's role is interactive, rooted in negotiation.</td>
</tr>
<tr>
<td>Assessment is through testing, correct answers.</td>
<td>Assessment includes student works, observations, and points of view, as well as tests. Process is an important as product.</td>
</tr>
<tr>
<td>Knowledge is seen as inert.</td>
<td>Knowledge is seen as dynamic, ever changing with our experiences.</td>
</tr>
<tr>
<td>Students works primarily alone.</td>
<td>Students' works primarily in groups.</td>
</tr>
<tr>
<td>Teachers disseminate information to students; students are recipients of knowledge.</td>
<td>Teachers have a dialogue with students, helping students to construct their own knowledge.</td>
</tr>
</tbody>
</table>
It also provides some clear pointers towards teaching strategies that might assist students in conceptual reconstruction (Hodson & Hodson, 1998), such as:

a. identifying students' views and ideas;

b. creating opportunities for students to explore their ideas and to test their robustness in explaining phenomena, accounting for events and making prediction;

c. providing stimuli for students to develop, modify and where necessary change their ideas and views, and;

d. Supporting their attempts to re-think and reconstruct their ideas and views.

Though Wilson (2000) suggested science educators need to look beyond the confines of cognitive psychology in developing pupils’ understanding of scientific concepts, the four immediate accessible points she suggested for practicing teachers to consider in teaching concepts to pupils are also rooted with constructivist teaching. These were:

1. recognizing what pupils already know;
2. teach fewer concepts;
3. improve continuity across key stages and progression of the development of concepts. Pupils are exposed to scientific concepts at a much earlier stage in their education, and;
4. Acknowledge the diversity of learners.

1.14 ACHIEVEMENT

Academic achievement may be defined as the degree or level of proficiency attained in scholastic or academic work.

Academic achievement has been considered as an important factor in life. In the rapidly changing world and with the growing advancement in science and technology, the place of education has become vital.

Academic achievement has always been a crucial area and the main centre of educational research. It refers to the skills developed in the school
subjects that are evaluated by the school authorities with the help of achievement tests that may be either standardized or teacher made. In other words academic achievement is the competency that is really revealed in school in which they have received instructions. It is the core of educational growth. It makes the student more confident and self reliant in the field of education. Higher achievement in education facilitates better adjustment of the individual.

Academic achievement is the major concern of the educational policy makers of every country. To a great extent the achievement of the students affects their future success and performance, underachievement in their various subjects surely influence their social life as a good citizens. So, care should be taken to increase the rate of achievement and find out the hindrances that decrease the achievement rate.

It has been accepted that environment both inside and outside the school in which the child grows has a great influence on the academic achievement of the student. Among them, socioeconomic status, social phobia, anxiety, learning disabilities, pertaining styles, learning styles, teaching methodology, classroom climate etc are such variables. Achievement is the case of the wider term educational growth which includes growth in all subjects. The importance of achievement lies on the fact that it sets an emotional tonic in one’s life. In fact achievement refers to the pupil’s knowledge attainment as skills developed with the help of achievement test in the form of examinations or tests. According to Crow and Crow (1963). “Achievement means the extent to which the learners are profiting from instruction in a given area of learning”.

Kater V. Good (1941) in his “Dictionary of education” has defined the achievement as “Knowledge attained or skills developed in school subjects”.

Trow (1950) defines socialistic achievement as “the attained ability or degree of competency in school takes usually as measured by standardized test and expressed in grades or with based on norms derived from a wide sampling of pupil’s performance”.

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In General, achievement is the knowledge and skills developed by the pupils in school subjects and it can be assessed by the examinations, test score or grades assigned to the students to determine the status of pupil’s.

Factors Affecting the Achievement

There are several factors which are responsible for high and low achievement of the students and these factors can be grow into two broad classes:-

Subjective factors: - These factors are related to the individual himself while influencing only achievement. Some of important subjective factors are:-

1. Motivation
2. Aptitude.
3. Intelligence.
4. Learning ability
5. Study method or approach.
6. Attitude towards education.
7. Level of Aspiration.
8. Perception of the self
10. Interest curricular and co-curricular.

Objective factors: The factors which confirm the performance of the individual. These are

1. Socio-economic factors.
2. Education system.
3. Teacher efficiency.
4. Value system comprising the family trait and company.
5. School situation and performance.

The effectiveness of any educational or academic achievement depends on different factors like social, economic, status, personality,
intelligence, motivation and interest etc. Thus, these variables are generally referred to as correlates of achievement. Heads of institutions, curriculum planners, teacher and other who are involved in task of helping students to achieve better would like to have the knowledge of the extent of influence these correlates exerts on achievement, thus academic achievements, of the students shows the performance of the students in different subjects.

The present study gives the effectiveness of constructivist methods in the learning process of the students and how these methods effects the achievement of the pupil’s in their learning styles in the schools in Himachal Pradesh.

1.15 Statement of the Problem

The problem under investigation is entitled as follows:-

“Effect of Constructivist Approach on the 6th Grade Students Achievement in Science”

1.16 Significance of the Study

The aims and objectives of science education at elementary level spelt out were unfortunately not implemented properly. In spite of many efforts made by the various committees and commissions as listed earlier, the quality of science education is not satisfactory. The textbooks are activity-based inclusion of learner-centered teaching learning process and increased utilization of community resources. But still, the change is not up to the mark. Science is being taught in the schools as a body of established facts obtained by individuals using infallible methods. The present classroom practices emphasize on the product side of science rather than the method of acquiring the knowledge, which is the scientific method that forms the process side of science.

In the Conventional classroom, the classes are usually driven by “teacher talk” and depend heavily on textbooks for the structure of the course. Teachers serve as pipelines and seek to transfer their thoughts and meanings to the passive students. Obviously, the traditional teacher-as-information-giver, textbook guided classroom has failed to bring about the desired outcomes of science education. An alternate is to change the focus of the
classroom from teacher dominated to student-centered using a constructivist approach. Studies have proved that Constructivist approach is effective to enhance the academic performance, attitude and interest of the students by using various methods and strategies.

An attempt was made by the investigator to study the effect of Constructivist Approach in the Indian context at elementary level schools to find out whether this method would be able to enhance the academic performance of the students, understanding of basic concepts, and better use and understanding of basic processes of science and can apply science concepts, processes and principles in various new day to day life situations. This study will be able to put emphasis on the learner centered or activity method.

The importance of the present study is to prepare students to become good adaptive learners i.e. students should be able to apply what they learn in school to the various unpredictable situations that they might encounter in the course of their work lives. Obviously, the traditional teacher as information giver and text book guided classroom has failed to bring about the desired outcome of producing thinking students.

Results of this study offer information about constructivist teaching approaches effectiveness in teaching science at the classroom levels and thus provide a vital guide for teachers, administrators, students, as well as instructional system builders. These groups will be guided accordingly as to design, methods, and arrangement of contents of learning materials consistent with the demands of constructivist classroom arrangements that enhances active learning engagement that eventually promote deeper learning and understanding of science knowledge, values, and skills.

Results of this study will also be very useful among researchers in the science education field as it offers the promise of widening their appreciation of the implication of constructivist models from a purely cognitive orientation to a combination of both cognitive and affective factors especially as it relates to building arrangement for learning among communities of learners.
The aim of present study was to determine the effect of constructivist approach on the 6th grade students' achievement in science. To accomplish the afore-mentioned purpose the following objectives were established.

1.17 **Objectives of the Study**

1. To construct an instructional material comprising of lesson plan based on the principles of constructivist approach.

2. To construct and standardize an achievement test on the segment of Science of 6th grade students.

3. To compare the achievement in Science of two groups of students:
   - Taught with the help of instructional material based on Constructivist approach of teaching and
   - Taught with the help of instructional material based on Conventional approach of teaching.

4. To study the effectiveness of constructivist approach and conventional approach on the achievement in Science of male and female students studying in 6th grade of Science subject.

5. To compare the achievement of two groups of students of 6th grade Science taught with the help of constructivist approach and conventional approach in terms of urban and rural background.

6. To study the effectiveness of constructivist approach and conventional approach on the achievement in Science in relation to different components of Socio-Economic Status i.e.
   - Upper class Socio-Economic Status
   - Upper middle class Socio-Economic Status
   - Middle class Socio-Economic Status
   - Upper lower class Socio-Economic Status
   - Lower class Socio-Economic Status
7. To compare the achievement in Science of Govt school and public school students taught with the help of constructivist and conventional approaches.

8. To compare the effect of constructivist approach on the students of Experimental group at all the three levels of pairing i.e. Pretest-Posttest, Pretest-Delayed Posttest and Posttest-Delayed Posttest in terms of
   i) Gender
   ii) Locality
   iii) Socio-Economic Status
   iv) Type of the school.

9. To compare the effect of constructivist approach on the achievement of Control group students at all the three levels of pairing i.e. Pretest-Posttest, Pretest-Delayed Posttest and Posttest-Delayed Posttest in terms of
   i) Gender
   ii) Locality
   iii) Socio-Economic Status
   iv) Type of the school

1.18 Hypotheses of the Study

1. There will be significant difference in the achievement of two groups of students-
   i) Taught with the help of instructional material based on constructivist approach of teaching and
   ii) Taught with the help of instructional material based on conventional approach of teaching

2. There will be significant difference on the achievement of male students studying in the 6th grade of science subject taught with the help of constructivist approach and conventional approach
3. There will be significant difference on the achievement of female students studying in the 6th grade of science subject taught with the help of constructivist approach and conventional approach.

4. There will be significant difference on the achievement of urban Science students studying in the 6th grade taught with the help of constructivist approach and conventional approach.

5. There will be significant difference on the achievement of rural Science students studying in the 6th grade taught with the help of constructivist approach and conventional approach.

6. There will be significant difference on the effectiveness of constructivist approach and conventional approach on the achievement of Upper class Socio –Economic Status students.

7. There will be significant difference on the effectiveness of constructivist approach and conventional approach on the achievement of Upper middle class Socio –Economic Status students.

8. There will be significant difference on the effectiveness of constructivist approach and conventional approach on the achievement of middle class Socio –Economic Status students.

9. There will be significant difference on the effectiveness of constructivist approach and conventional approach on the achievement of upper lower class Socio –Economic Status students.

10. There will be significant difference on the effectiveness of constructivist approach and conventional approach on the achievement of lower class Socio –Economic Status students.

11. There will be significant difference on the achievement of Govt. school 6th grade Science students taught with the help of Constructivist and conventional approaches.

12. There will be significant difference on the achievement of Public school 6th grade Science students taught with the help of Constructivist and conventional approaches.
There will be significant differences on the achievement of Experimental Groups at all the three levels of pairing in terms of:

I) Gender  
ii) Locality  
iii) Socio-Economic Status Groups  
iv) Type of Institution

There will be significant differences on the achievement of Control Groups at all the three levels of pairing in terms of:

I) Gender  
ii) Locality  
iii) Socio-Economic Status Groups  
iv) Type of Institution

1.19 Operational Definitions of the Terms Used

In the present study a number of terms and concepts have been used to convey the specific meaning. Terms and concepts used in the study have been defined operationally as follows,

1. Constructivist Approach: - In the present study Constructivist approach means a method of teaching and learning in which the learner is exposed to construct his own knowledge, experiences, ideas and concept based on his prior knowledge and experiences from his surroundings. It is a democratic way of teaching and learning which emphasizes on the various approaches and aspects of teaching and learning such as active participation, problem solving, learning by doing, Cooperative learning, individual leaning, activity based teaching and learning. Use of conversation, discussion, interaction with others and sharing ideas from an integral aspect for construction of knowledge. During this process the child learn many skills such as observing, hypothesizing, inferring etc which leads to the development of scientific mind and positive attitude towards Science, which is the ultimate aim of Science teaching.
2. **Conventional or Traditional Approach:** In the present study the Conventional or Traditional Approach of teaching and learning means the approach involves the teacher centred methods of teaching in which the students remains as the passive listeners. This approach mainly focuses on the traditional methods of teaching and learning such as dictation method, lecture method, textbook readings, recitation etc. In the Conventional approach of teaching and learning the learner has no freedom to share his ideas, experiences, information and to form new concepts.

3. **Science Achievement:** Achievement is the assessment of academic performance which is largely confined to evaluation in terms of the objectives like knowledge, understanding, application and skill. An achievement test in the selected content including all the four levels of objectives was constructed by the investigator. Thus achievement in science in the present study is the total score obtained by the students in the achievement test constructed by the investigator. This is assessed in terms of marks or grades in Himachal Board of school education and NCERT.

4. **Intelligence:** In the present study the intelligence of students were determined through the intelligence test and the score obtained in the test was taken to classify students as high intelligence or low intelligence groups.

5. **Socio Economic Status.** Socio Economic Status of an individual or family means his social and economic position in the Society in terms of his/their income, Education, Occupation etc. In the present study SES is further divided into Five Components i.e. Upper class, Upper middle class, Middle class, upper lower class and Lower class.

6. **Locality:** Locality refers to the specified place of an individual where he/she lives. In the present study it is specifies as Urban and Rural areas.

7. **Gender:** means the classification of an individual on the basis of his/her sex. In the present study it is classified as Male and Female.
8. **Type of Institution:** means the management of the institution or school. In the present study it is classified as Govt. School and Public School.

9. **Groups:** means the number of persons or things belongs to a particular class or cluster. In the present study two groups were constituted namely experimental and Control group in both the schools. The groups which were taught with the help of Constructivist approach is known as Experimental groups and those taught with the help of Conventional approach termed as Control groups.

10. **Pre-Test:** a test carried out prior to a course or program of instruction in order to determine the entry behavior of the learners.

11. **Post-Test:** a test carried out after the completion of a course or program of instruction in order to determine the extent to which the learner has achieved the specific objectives.

12. **Delayed Post-test:** also called as the retention test. A test carried out after the 15-20 days of the Post test, used to check the retention power of the students for a particular program of instruction.

13. **Control Group:** In an experiment control group may be defined a group of subjects who do not receive any experimental treatment; the group is included for comparison purposes.

14. **Experimental Group:** In an experimental group may be defined a group of subjects who receives the experimental treatment; the group is included for comparison purposes.

1.20 **DELIMITATION OF THE STUDY:**

The present study will be delimited to the following aspects.

1. The study was delimited to 6th grade 140 students only.

2. The study was delimited to the syllabus prescribed by the Himachal Pradesh Board of School Education.

3. The study was further restricted to the Science Subject only.

4. The study was delimited to the ten chapters of 6th grade science subject.
5. The study was restricted to only one block i.e. Nalagarh, Distt Solan of Himachal Pradesh.

6. The study was further delimited to only two schools of Nalagarh Block, Distt Solan. Himachal Pradesh.

7. The study was delimited in terms of variables viz. Gender, Locality, Socio Economic Status and Type of Institute.