

Chapter - 1

Conceptual Framework and Review of Related Literature

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CONCEPTUAL FRAMEWORK AND REVIEW OF RELATED LITERATURE

1.0 Introduction

Education is a lifelong venture. “The principle goal of education is to create men who are capable of doing new things, not simply of repeating what other generations have done - men who are creative, inventive and discoverers” Jean Piaget.

Education is regarded as the richest and highest treasure of man. Now education has been treated as a basic need. Education is the most powerful instrument for growth and prosperity of a nation. It enables everyone to work towards symbiotic coexistence in diversity. Education is also considered as a tool for all-round development of a man, it broadens the horizons, deepens the insight; stimulate the thought process and helps for the self-realization. Quality education is a prime factor for the upliftment of any society. For maintaining the quality education, we need quality teachers who are committed to teaching and equipped with necessary knowledge, skills and competencies for effective teaching and ability of acceptance and integration of innovative teaching-learning strategies in the process of teaching. In India the teacher has traditionally occupied a special status; a role model for scholarly qualities, high moral character and self-esteem. The integrity of a teacher has been considered impeccable and they command respect from the society as builders of the nation. Kothari Commission Report (1964) stated that the destiny of India is now being shaped in her classrooms. This, we believe, is no mere rhetoric. In a world based on Science and Technology, it is education that determines the level of prosperity, welfare and security of the people. On the quality and number of persons coming out of our schools and colleges will depend our success in the great enterprise of national reconstruction.

Science and Technology has revolutionized our present society. In the last two decades Technology has dramatically reacted into every aspect of social and cultural lives and also on educational system to a greater extent. But at the same time Teaching and other Educational Endeavors have not taken full advantage of these changes. We have

allowed our schools to remain in the past, while our children are much ahead. In the Classroom we present our knowledge to our children in a linear, didactic manner that differs dramatically from the children's previous experience outside the school. The result is the mismatch between the learner and the educator. But it is not the children who are mismatch to the schools; rather the schools are mismatch to the children. This divergence between our children and our educational practices needs a drastic educational reform that will bring the classroom into line with society, only by renewing educational practices; we can close this gap and reunite our schools with our children and rest of the society. Teacher must know the most current research practice which can be used effectively to match particular teaching procedures. Such goals are not easy to achieve. It requires re-organization of the pre-service and in-service teacher education programs as well as the school system keeping in view the new pedagogy and challenges of globalization.

Information and Communication Technology (ICT) has the potential to transform the nature of education-the role of teacher, student, learning processes and the curriculum. Education systems around the world are under pressure to use the digital technology to teach students the knowledge and skills they need in the 21st century. The UNESCO, 1998 World Education Report, 'Teacher and Teaching in the Changing World' describes the radical implications of the ICT for conventional teaching and learning. It predicts the transformation of teaching learning process and the way teachers and learners gain access to information. With the emerging digital technologies the teaching profession is evolving from teacher-centered to learner-centered learning environment. In order to take the full advantage of ICT in teaching learning, it is essential that pre-service and in-service teachers should effectively use these new tools of learning. Teacher education institutions and programs must provide the leadership to the pre-service and in-service teachers in this direction.

To accomplish this goal requires both a change in the traditional views of learning process and an understanding of how the technology can create new learning environment in which students are engaged learners, able to take greater responsibility for their own learning and construct their own knowledge through the Constructivist Learning Approach.

Modern world has become increasingly aware of the need of constructivist learners working in cooperative groups. Unfortunately, constructivist learning environment has been included in the learning process and are not been emphasized. In today's competitive climate, where the values and success of the educational process is directly linked to publishable test scores. Cooperative work experiences are either de-emphasized or ignored; this creates a learning environment that is diametrically opposite to that which is required for the present learners. So it is very critical for teachers, teacher-educators and policy makers to ensure that the students are prepared for the challenges of the 21st century workplace. (Carnevale, 1991, 1996, 2002; Carnevale, Gainer and Meltzr, 1990, Carnevale and Porro, 1994).

Education is not an affair of 'telling' and being told, but active and constructive process (John Dewey). Constructivism is fundamentally an active and interactive view of learning. Constructivism suggests that the learner's understandings of the way the worlds' work is the result of one's own active construction rather than someone else's presentation. Constructivist believes that knowledge is the result of individual constructions of reality (Brooks, 1990). Dewey suggested that people learn through authentic experience and reflection. Piaget asserted that people develop through experiencing within their environment. Vygotsky clarified the meaning social and linguistic aspects of the environment. People actively adapt, build scheme which are the patterns of thinking and behaving that aid in making sense of one's environment and experience. Constructivism is meaning making activity and produce active learners and creative thinkers. But now there is a widespread concern that the educational experiences provided in many schools are not preparing students well for the future. It is believed that creating a paradigm shift in view of learning process, coupled with the application of digital technology may play an important role in bringing educational systems into alignment with the emerging knowledge based information rich and technologically advanced society.

Our aim of educators must go beyond specialized training of craftsmen and factory workers. The only true education is one where all Arts, Crafts, Sciences and Technologies are linked and facilitate mutual cognitive development, productive creativity and personal growth. So at the time we need teachers who are masters not

only in technology but also in content, pedagogy and above all they should be humane. Only technology and content cannot replace a teacher, the teachers must be well versed in child psychology, should have a capability to understand the children's mental, physical, psychological situation and then apply technologies with the content and pedagogy.

According to NCTE framework (1998), Teacher Education is a professional programme aiming at the development of teacher as a person and agent of social change. The professional preparation of students who want to enter the profession of teaching, teacher education prepares them, for attaining the national goals of education for all, to preserve the continuity of traditions, to fulfill the actual needs of contemporary society to meet the challenges of the uncertain future, through education. Pre-Service Teacher Education develops better understanding of children, builds the confidence, makes them familiar about methodology of teaching with new techniques, builds positive attitude towards the teaching profession, familiarizes with latest knowledge of the profession, and develops attitudes towards research and experimentation. The quality of teachers and their continuing professional education and training remain central to the achievement of quality education.

“People in this country have been slow to recognize that education is a profession for which intensive preparation is necessary as it is in any other profession”. (University Education Commission, 1948), this report is alive in its relevance today (Siddiqui, 2009). Any change in educational system demands a corresponding adjustment in the curriculum renewal; therefore it needs to be planned as a continuous process (NCERT, 1996). So the integration of ICT and other instructional strategies like Constructivist Learning Approach may help both the Pre-Service Teachers and also students to keep updated with the changing world. Intensive preparation is needed for the pre-service teachers along with the University prescribed syllabus, some professional development programmes, professional orientations are required. There is a need of introducing technology aided constructivist learning environment for the professional development of teachers. Hence in the present study the discussions on ICT, Constructivism, ICT Aided Constructivism for Science, ICT Aided Constructivism for Professional Development of Pre-Service Teachers have been evolved and explored.

1.1 Information and Communication Technology (ICT)

Societies of today have been recognized as information societies due to the impact of ICT in all aspects of human life. Technology has revolutionized the way we work and is now set to transform education. It has the potential to promote equity and access to education and bridge the gap of digital divide.

Ignorance of the law is said to be have no excuse. In 21st century ignorance of Science and Technology should also have no excuse. Because Science and Technology has become part and parcel of every one's life. It is promising for fuller and a more meaningful life. Globalization and Technological change processes that have accelerated over the past ten years have created a global economy powered by technology, fueled by information and driven by knowledge. The emergence of this new global economy has serious implications for the nature and purpose of educational institutions. The scientific and technological revolution affects the very texture of thinking of the common man. The teachers and students have to be trained in order to enable them to take full advantages of the potential technology. The development and deployment of ICT will have a profound impact on access and teaching-learning processes which concerns most of us in the education and training. The advances in ICT have enabled new forms of access to information.

ICT is the type of technology employed in the shape of tools, equipment and application support. This helps in the collection, storage, retrieval, use, transmission, manipulation and dissemination of information as accurately and efficiently as possible for the purpose of enriching the knowledge, developing communication, decision-making and problem solving ability of the user. In educational sectors, the use of ICT is recent one, earlier ICT in education means only to use Television and Radio programmes on education, slide projectors, tape recorder, over head projector, print media and graphical materials. But in the modern days, the modern ICTs are combination of both hardware and software. Like, Computers (desktops, laptops, palmtops, tablets), Application software such as word processing, spreadsheets, power point presentations, excel and multimedia software, Social networking software, internet, intranet, digital video camera, Computer database, data storage systems like ROM, RAM, CD, DVD, digital libraries, Virtual laboratories, E-mail, Blogs, World Wide Web (WWW), Hypermedia and hyper text resources, virtual classrooms, social networking and what not virtually, telephones and mobiles. Their use in education is tremendous. It has revolutionized the educational system; it is helpful to all the persons connected to it, students, teachers, parents, administrators, researchers, and the whole school system.

Information and Communication Technologies are defined as all devices, tools, content, resources, forums, and services, digital and those that can be converted into or delivered through digital forms. Which can be deployed for realizing the goals of teaching learning, enhancing access to and reach of resources, building of capacities, as well as management of the educational system. These will not only include hardware devices connected to computers, and software applications, but also interactive digital content, internet and other satellite communication devices, radio and television services, web based content repositories, interactive forums, learning management systems, and management information systems. These will also include processes for digitization, deployment and management of content, development and deployment of platforms and processes for capacity development, and creation of forums for interaction and exchange (National Policy on ICT in School Education, 2012). ICT is a “Diverse set of technological tools and resources used to communicate, create, disseminate, store and manage information”. These technologies include computers, the internet, broadcasting technology and telephony etc. (Tinio, 2007). ICT stands for the seamless incorporation of technology to support and enhance student engagement in meaningful learning and for attainment of curriculum objectives. ICT will increase the role of the teacher in the classroom. ICT on its own can never evoke learning so the role of the teacher is must.

ICT has potential to bring the existing educational system into alignment with the knowledge based information-rich society by providing the services of sophisticated tools, techniques. It helps to bring the paradigm shift in viewing the traditional methods in education, teacher centered teaching to learner centered learning, traditional teaching with chalk and talk to instructing with different communication tools, monotonous class to interactive classes, it helps the teacher to change the role from mere knowledge transmitter to environment facilitator where there would be opportunity to think, innovation and incubation of innovative ideas. As now teachers need to do multi task, and have various responsibilities to perform at the same time, ICT helps the teacher to perform all of these successfully. ICT helps the learners to seek out their relevant information and knowledge through their own efforts, understand and assimilate the information and share it through proper channel to relevant persons or peer group. And work according to their own pace of learning, set own goals for the growth and development.

Kulik and Kulik (1991), viewed computers as valuable tools for teaching and learning, educational technology was capable of producing positive effects on student achievement, Educational technology could produce substantial savings in instruction time, Educational technology fostered positive attitudes toward technology, and in general, educational technology could be used to help learners become better readers, calculators, writers, and problem solvers. Technology had an actual impact on student learning and played an important role in student learning (Kozma, 1994). The nature of ICT is that it is an artifact available to achieve the objectives. ICT is socially constructed. ICT is an ongoing perspective of meaning and action and supporting in expanding educational opportunities, increasing efficiency, enhancing quality of learning, enriching quality of teaching, facilitating skill formation, establishing and sustaining lifelong learning, improving policy planning and management and improving the community linkages.

The use of ICT in all sectors of education, particularly in school education and teacher education programs is gaining momentum and interest throughout the world. In recent years, with the rapid development of emerging technologies, the integration of ICT has increasingly attracted the attention of teachers. A simple combination of hardware and software will not make integration naturally follow (Earle, 2002). Teachers need to plan thoughtfully before they start ICT integration into a curriculum. For instance, they have to choose the correct ICT tools for particular learning objectives or contexts, modify existing resources or develop new learning environments to engage specific groups of learners, or decide scaffolding strategies for student-centered learning.

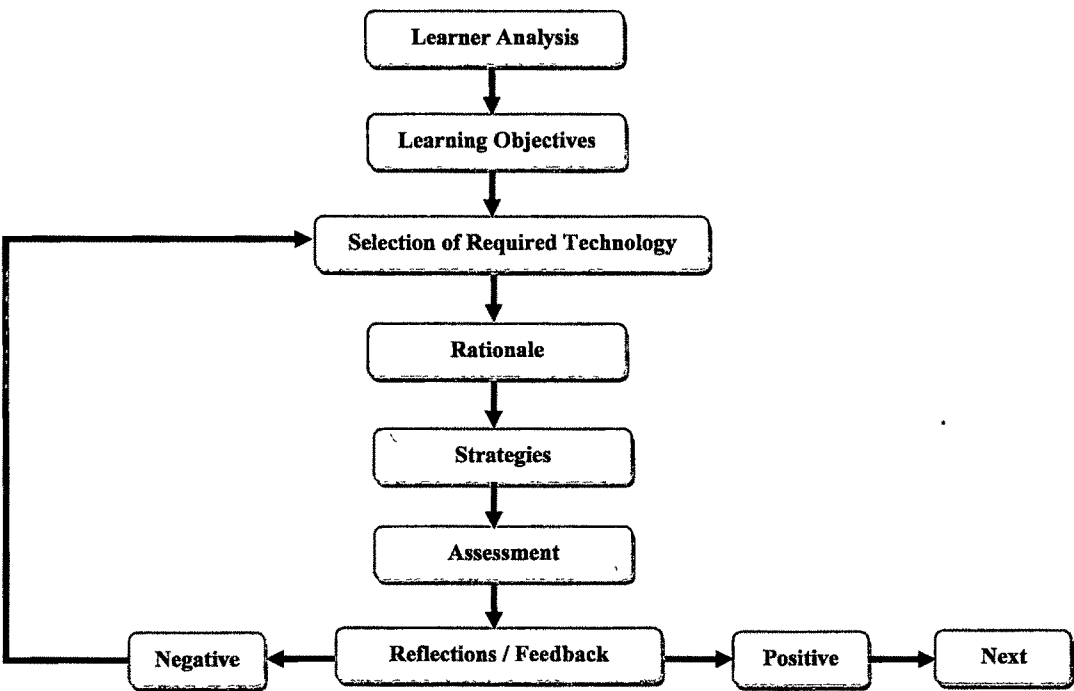
In education only by handing out to students a collection of CDs on different subjects is certainly not ICT integration. In a properly crafted ICT integrated lesson, ICT and other crucial educational components such as content and pedagogy are molded into one entity. ICT integration can be broadly defined as the process of using any ICT (including information resources on the web, multimedia programs in CD-ROMs, learning objects or other tools) to enhance student learning. It is more of a process than a product. A simple placement of hardware and software will not make integration naturally follow. Numerous traditional classroom-based instructions with technology-enhanced instruction have found significant differences in student satisfaction, attitudes and learning outcomes. The technology should be fitted into the curriculum, not the curriculum in to the technology. Effective ICT integration into the learning process has the potential to engage learners. ICT can support various types of

interactions: learner-content, learner-learner, learner-teacher, and learner-interface. These types of interaction make the learning process more interactive and learners more active and engaged. For integration of ICT in any of the subject area a model needs to be designed and developed.

1.1.1 Model for ICT Integration

There are many instructional models available to integrate ICT in Education. The model of ICT integration requires teacher-designers to justify why the technology is used and how to effectively incorporate the technology.

Figure 1: Model for ICT Integration



1.1.1.1 Learner analysis

Learner analysis is the main point in any of the teaching model. Here the teacher has to analyze the learner in terms of requirements of the learner, requirement of the ICT, learner's level of learning. Learners' capacity of utilizing the given ICT and many more. Then the problem has to be found and should state authentically. It should describe the major issues in the topic. After knowing the needs of the learner the teacher has to discuss about the Learning objectives to be achieved. For this teacher must have basic operational skills, Information Technology skills, use of Software's, effective use of the internet etc.

1.1.1.2 Learning Objectives

Learning objectives specify the intended outcomes at the end of the topic. It is worth mentioning that the behavior in a learning-objective statement should be observable and measurable.

1.1.1.3 Selection of the required Technology

In order to address the problem and achieve the learning objectives, teacher's needs to carefully compare all possible technologies that can be used for learning the particular topic. Any possible ICT tools like, multimedia courseware, web based resources, communication resources (chat, video conferencing, online forums, e-mail, mobile etc.), Computer applications like word, power point presentation, excel and many more possible ICT applications can be used.

1.1.1.4 Need for using the Technology

Technology should be used not because it is available, but it should be used to enable the process and enhance the learning. The teachers who are integrating technology in their subject should know why it is needed there, what added advantages of integration, how the technology can support the instructional process. Improper use of technology may also lead to negative effects. So one needs to know the proper use of the technology.

1.1.1.5 Strategies for the Implementation

After deciding purpose and the type of technology needed the teachers must have to decide that how to incorporate it effectively and meaningfully into the topic. Further, when designing an integration plan. The teachers also need to consider that, whether the activities can promote students' critical thinking or other higher order thinking, or the students understand what they are supposed to learn?

1.1.1.6 Student Assessment

Usually at the end of the topic, students will be assessed on how well that they have mastered the topic. The assessment should reflect both process and product. The assessment on the process examines how the student completes the learning activity, how they work together, how they construct knowledge collaboratively by using ICT. The assessment on the product aims at investigating the quality of the final outcomes, such as solutions to the problems, programs developed power point presentation. Communicating and posting through weblog.

1.1.1.7 Reflections / Feedback

After conducting the ICT integrated lessons, the teachers need to reflect upon their learning experiences. The reflections can focus on the appropriateness of the technology used. Strengths and weaknesses of the technology and possible improvement. Additionally, the teachers can also provide further suggestions on how other teachers can use the lessons for different targets in the different contexts. These suggestions may include alternative technology, instructional methods and activities, assessment approaches and ways to improve the integration of ICT. Once the feedback is positive, can go for the attainment of further objectives. If the reflections are negative, that finding some errors or any problem in understanding through the strategy then can go to the selection of proper required technology and can be continued.

According to NCF (2000), with their increasingly ubiquitous presence within and outside the school, ICT have begun to challenge what schools try to teach and the whole basis of assessing the knowledge and skills that students acquire. The process of education can no longer ignore the social and psychological impacts of the technology that structures the information and the possibilities that the global information sharing opens up, furthermore these technologies affect the way people think and learn has been widely recognized. Integration of ICT in schools therefore has a strong pedagogical rationale and is natural sequence in the evolution of the schooling process. This integration has several implications, which clearly make some demands as below,

1. The educational planner looks beyond the current classroom, devises updated plans for education in an electronic environment and expands his designs so that the computer becomes more than a subject of study and is not merely integrated into an existing curriculum, it becomes instead an integral part of the schooling process.
2. The educator accepts the broad general principles that he is challenged with;
 - Creation of framework for enhancing learning opportunities that computer-based learning material and accessible resources offer.
 - Access to information, shared educational goals and pedagogy.
 - Access to professional development opportunities for teachers which would enable them to act as facilitators of learning.
 - Flexible curriculum models which would embrace interdisciplinary and cross disciplinary thinking.
 - Development of attitudes that are value driven, not technology driven.

3. The curriculum developer re-defines his role. All innovative experiments in the areas of media production, interactive videos and multimedia computer software are curriculum development processes. They come to naught without active participation of curriculum development.
4. The teacher adopts an instructional design that helps learners, master heuristic and algorithmic strategies for tackling new problems using computer and communication technologies.
5. A method of evaluation and assessment of what students learn in ICT rich environment supported by the computer and communication technologies must evolve for this environment is going to cause perceptible shift from,
 - Traditional learning atmosphere to a climate of values that encourages exploration, problem solving and decision making.
 - Didactic classroom teaching to participatory interactive group learning.
 - Linear, sequential reasoning to search for patterns and connections.
 - Mastery of fixed body of knowledge to understanding a web of relations between the parts of a whole.
 - Collection of information to processing of information leading to knowledge management skill.
 - It is only with new skills and perceptions that the teacher can assume her new role as a facilitator of learning and implement and maintain innovations in classroom.
 - This is called for a new definitions pre-service courses and effective training and orientation programmes for those who are already in job. This new courses should help them to acquire skill of using ICT as well as making the best use of computer technology in curriculum transaction.

1.1.2 Development of ICT in India

Ever since, educational technology has come to be regarded as an important means for universalization of education in India. The widespread use of personal computers since nearly two decades ago. Advances in telecommunications and internet a decade ago along with convergence of various technologies has, in the form of ICT, opened up new opportunities and challenges in the field of education.

In India, the use of ICT in education goes back to the colonial era of the British government. India aired its first radio broadcast in June 1923 by Radio Club of Mumbai. In the 1930s, British Broadcasting Corporation (BBC) aired educational and cultural programs in India through broadcast radio. In 1937, All India Radio (AIR) broadcasted educational programs for school children (Agrawal, 2005). Since 2002, India's first educational radio station called Gyan Vani (Voice of Knowledge) has been on the air. Agrawal, (2005) this full-fledged educational radio station provides programs for different types of learners including adult learners. In 1959 India acquired its first television set for an experimental television service in Delhi. Television gradually expanded to the urban rich. In 1961 Educational Television (ETV) was introduced in the secondary schools in Delhi. This was a pilot project by UNESCO and the Ford Foundations. As part of the project, lessons for physics, chemistry and English were televised to secondary school students (Mohanty, 1984). To develop the rural community through education, in 1975 an experimental project was implemented called Satellite Instructional Television Experiment (SITE) probably the biggest social experiment anywhere in the world that established the importance of satellite communication in the field of education. In 2000, a 24-hour educational channel was launched known as DD-Gyan Darshan. In 2003, in collaboration with Indira Gandhi National Open University (IGNOU) and Indian Institute of Technology (IIT), a technology education channel was launched (Agrawal, 2005). According to Goel, 2000 'to facilitate the computer based education, the first degree in computer education was offered in 1989 in Indore, India' (Thankachan, B. 2012).

The application of computer for school education has made entry in 1984 through Computer Literacy And Studies in School (CLASS). The concern for computer education at school level was raised at National Workshop on Computer Literacy Curriculum held at NCERT in March 1984. The Class project was essentially for higher secondary school, and by 1989 about two thousand of them had computers (Agrawal, 1996). Since then, computer as a subject has been introduced in many of the secondary schools. But the use of computer as a learning tool is away from satisfactory. NCERT (2000) highlighted the concern for integration of ICT in the Indian schools that the revolution in new technology users is a fundamental challenge, converting the information society into a knowledge society. In 2004, EDUSAT launched and provided an interaction satellite based distance education system for the

country utilizing audiovisual medium employing Direct-to-Home (DTH) quality broadcast. The new technology has tremendous potential to revolutionize education and transform the existing educational provisions, changing the existing curricula, bringing in a new generation of learning material and encouraging the networking of schools.

In 2012, 23 March, the National Policy on ICT in School Education has been revised and its goals are, ICT Policy in School Education will Endeavour to:

Create

- An environment to develop a community knowledgeable about ICT.
- An ICT literate community which can deploy, utilize, benefit from ICT and contribute to nation building.
- An environment of collaboration, cooperation and sharing, conducive to the creation of a demand for optimal utilization of and optimum returns on the potentials of ICT in education.

Promote

- Universal, equitable, open and free access to a state of the art ICT and ICT enabled tools and resources to all students and teachers.
- Development of local and localized quality content and to enable students and teachers to partner in the development and critical use of shared digital resources.
- Development of professional networks of teachers, resource persons and schools to catalyze and support resource sharing, up gradation, and continuing education of teachers; guidance, counseling and academic support to students; and resource sharing, management and networking of school managers and administrators, resulting in improved efficiencies in the schooling process.
- Research, evaluation and experimentation in ICT tools and ICT enabled practices in order to inform, guide and utilize the potentials of ICT in school education.
- A critical understanding of ICT, its benefits, dangers and limitations.

Motivate and enable

- Wider participation of all sections of society in strengthening the school education process through appropriate utilization of ICT.

As the world is in a technological age today one needs to know not only how to operate this technology, but how to integrate its vast resources directly into working environment. Information and curricular material that once took hours, days or weeks to acquire is now accessible electronically within seconds or minutes. In the information age it is incumbent upon both teachers and students to know how to locate and access those materials, and analyze the source and resource efficiently as there is media crowd and how to integrate it with the subject in general and Science in particular. Constructivist learning environment provides the opportunities for teachers and students for prepare themselves for the 21st century workplace; it emphasizes the students' best individual learning style and integrates novice technologies into it.

1.2 Constructivism

The 20th century pedagogy was based on learning theories dominated by objectivism. Well structured educational system, instructional objectives, teacher-centered education, task analysis, drill and practice, reinforcement, remedial teaching with feedback, rote learning and memorization of facts objective assessment, were the salient features. The goal of the education was acquisition of knowledge and skills. Teacher was more active and dominant, whereas, the students were passive recipients of information. In the late 1970s and 1980s, many educationists began to criticize the teaching learning practice based on behaviorist school of individualized learning failed to develop ability to work collaboratively, construct knowledge independently, and develop divergent thinking for discovering new knowledge, and inventing. Further, the teaching learning strategy was mechanical, stereotypic and static which ignored critical and reflective thinking of students. As a result, constructivist pedagogy emerged in the world of educational scenario as a protest which believes that leaning is knowledge construction by learners either independently or cooperatively when they are actively engaged in social experiences and activities. Realizing the importance of constructivism in education, the National Curriculum framework (NCERT, 2005) has emphasized the constructivist perspective, learning as a process of construction of knowledge. Learners actively construct their own knowledge by connecting new ideas to existing ideas on the basis of experiences provided to them.

1.2.1 Constructivist Learning Approach - Epistemological Foundations

“As long as there were people asking each other questions, we have had constructivist classrooms. Constructivism, the study of learning is about how we all make sense of our world, and really has not changed.” Brooks (1999), so constructivism is not very new phenomenon, it was with us when people started thinking and continued. It has the past, present and future applications.

In order for any discipline to survive, it must accommodate changes in theory and practice and do so in a way that adds value to the discipline” (Kuhn, 1972). 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 provided scientific evidence for his views. Today, constructivist theories are influential throughout much of the informal learning sector.

In the last three decades, the constructivist approach has been the dominant ideology in the field of educational research. Constructivism has roots in Philosophy, Education and Psychology. Constructivism criticizes objectivism which embraces the belief that a human can come to know external reality, but constructivism holds the opposite view. That the only reality we can know is that which is represented by human thought. According to constructivism, learners are active participants in knowledge acquisition and engage in restructuring, manipulating and experimenting, to make meaning. The constructivist learning approach has been rooted from the theories of cognitive development.

The Major Exponents of Constructivism are Immanuel Kant (1724-1804), John Dewey (1859-1952), Maria Montessori (1870-1952), Jean Piaget (1896–1980), Lev Vygotsky (1896–1934), Jerome Bruner (1915-), Ernst von Glasersfeld (1917–2010) and Jean Piaget and Lev Vygotsky have worked rigorously on the field of constructivism.

1.2.1.1 Jean Piaget and Constructivism

Born in 1886 in Switzerland, Piaget is seen as the originator of the field of cognitive development. In the 1920's and 1930's, when Piaget's ideas were first becoming known, the prevailing view of children was that they were 'empty vessels' expected to passively receive knowledge from adults. Teaching was largely didactic and focused

on rote learning, his alternative view of children as active explorers, engaged in discovering things for themselves and constructing their own understanding was seen new and challenging but also as a more likely way of accounting for the diversity and creativity of human learning (Whitebread 2000a). By the 1950's his ideas have become known around the world particularly in the field of early childhood where they are seen as legitimizing the idea of learning through play, very much part of the nursery school tradition (Penn 2005).

Piaget's approach to the development of children's cognition has come to be known as constructivism. Essentially, all of Piaget's work is about the development and understanding and he described himself as an epistemologist that is someone who is interested in how humans acquire knowledge. For Piaget thought is internalized action (Piaget, 1950). Actions form the processes of reasoning and its actions and interplay between the experience of action and thought that form the basis of the way in which a child constructs a view of the world. Language then serves as a system for representing the world. He saw children as actively constructing their own understanding largely through the process of self-discovery. His image of the world was that of a young scientist, an individual thinker. The role of the adult is to act as a guide and facilitator to the child's development, providing an appropriate environment in which children can hypothesize and themselves questions. These raises some important questions for practice, including the extent to which children should be left to themselves and what would be the role of adult support and interaction.

According to Piaget cognition is an example of the adaptation between organism and environment seen through the living world. It is driven by the need to anticipate events in order to survive (Thornton, 2002). For Piaget development precedes learning and we develop in order to learn. It happens and begins with the idea of ***Scheme*** or ***Schema***. Schemes are the mental representations into which we organize knowledge in the world. That knowledge is based on experience and can lead us to conclusions that may change later in the light of further experience. A classic example of this idea that many children hold that heavy things sink whereas light things float. Many experiences will be needed to modify such a Schema. He describes the process of modification through ***Assimilation, Accommodation and Equilibration***. 'These three processes work together from birth to proper development forward' (Siegler et al., 2003).

Assimilation refers to the way in which we transform incoming information so that it fits in with our existing way of thinking about the schema, whereas accommodation is what happens when we make adjustments to a schema and adapt our thinking in the light of new information. In eating and digesting an apple, for example, we use certain biological structures and processes- mouth, teeth, stomach, gastric juices- by means of which we take in and convert the apple into forms the body can use. In a sense that body has assimilated an external object and changed it into human biological material. Piaget believed that similar phenomenon apply to mental activity, namely, that we possess mental structures that assimilate external events and convert them into mental events or thoughts. When we do attempt to eat a much bigger apple, we would have to change the way we arranged our mouth and teeth to bite into it, as well as changing other aspects leading to its digestion. In other words, we would have to accommodate our biological structures to meet the problems posed by the new object. In similar fashion we accommodate our mental structures to new and unusual aspects of the mental environment. These two processes, assimilation and accommodation, represents two complementary aspects of the general process of adaptation.

Anning and Edwards (1999) suggests that problem solving activities are valuable for encouraging accommodation of new information. The processes of assimilation and accommodation are held together by process of Equilibration. This process of equilibration is the keystone of developmental change, with long term implications whereby the child's model of the world comes increasingly to resemble reality. Essentially, when children encounter new experiences their existing schemes have to adjust. This creates a state of disequilibrium or cognitive conflict, which acts as a motivation to learning until a state of equilibrium is restored.

Implications of the Piaget's Theory

- The aim of education is to encourage the child to ask questions, try out experiments and speculate rather than accepting information unthinkingly. (Smith et al. 2003).
- Attention to children's different ways of thinking at different ages will need to be considered in making decisions about how they are best educated (Siegler et al. 2003). Children need to be 'ready in order to learn'.
- Learning is a process of active involvement of children. They learn by doing the things.

- Learning is an individual process of construction of knowledge by the child with the process being emphasized over product.
- Child initiated activities; exploring the world and testing out the ideas without external pressure are emphasized.
- The most important source of motivation is the child, who is intrinsically motivated to engage in activities.
- The environment is organized to support the open ended self-discovery learning.
- The role of adult is to observe and facilitate children's learning rather than direct instruction. The educators should create the right environment for learning but then allow the child to solve the problem and through their own active discovery. The adult attends to the unfolding of these structures and provides social and physical environments that encourage a child's normal development. (MacNaughton, 2003).
- 'Asking children to explain both why correct answers are correct and why incorrect answers are incorrect produces greater learning than only asking them to explain correct are correct' (Siegler, 2000) and can lead to the adaptation of new strategies.

1.2.1.2 Lev Vygotsky and Constructivism

Lev Vygotsky born in Russia, in 1896. Vygotsky's work was little known either inside or outside the country until the 1960's. The first translation of 'Thought and Language' with an introduction by Jerome Bruner appeared in the West in 1961 and it was not until 1978 that 'Mind in Society' a collection of essays was published. In the last years of his life worked intensively producing fragments of writings, essays and half completed experiments (Robson, 2006).

Vygotsky differs fundamentally from Piaget and majority of approaches in the information processing models. His views like Piaget the children are actively constructing their understanding as a result of experiences and in the sense of his idea can be described as constructivist. For Vygotsky this construction of knowledge occurs in the context of children's interaction with those around them. So he is considered as Social Constructivist. And he believes language plays an important role in constructing

any kind of knowledge; he says that the Language and thought influence each other. In highlighting the importance of language Wells (1987) says in 'learning through talk-as learning to talk'- children are active constructors of their own knowledge, what they need is evidences, guidance and support. Parents and teachers who treat their children as equal partners in conversation, following their lead and negotiating meanings and purposes are not only helping their children to talk, they also enabling them to discover how to learn through talk.

Implications of Vygotsky's Theory

- Learning is seen as a social process, and collaborative learning with others is prioritized.
- Children's learning is maximized when they are regularly working at the upper levels of their competence (MacNaughton and Williams, 2004). That is their Zone of Proximal Development (ZPD).
- Language is important both as a way in which children develop their thinking and understanding and as a means for sharing thoughts and understanding with others.
- The role of adult is interventionist, to extend and challenge the learner to go beyond where they would otherwise have been (Sutherland 1992).
- Adult support is contingent upon children's behavior: more help is given when children experience difficulty, with this being gradually withdrawn as children as children succeed in an activity (Wood and Wood, 1996). In the early stages the help provided is more elaborate and explicit; later it is less explicit and less frequent, focusing on hints rather than instructions (Meadows, 1993).
- Children can learn from each other as well as from adults, provided that one is more knowledgeable about the activity than the other. The gap between their understandings need not be great, however, as then the 'expert' is more likely to understand the problems the 'novice' faces (Smith et al. 2003).
- 'The environment needs to be richly stimulating with the problems to solve and a wide range of individual, small group and whole group opportunities' (Raban et al., 2003).
- The resources or physical tools which children use in their play are important supports for their intellectual development (Broadhead 2004).

1.2.1.3 Jerome Bruner

Jerome Bruner was influential in promoting Vygotsky ideas. He lies between Piaget and Vygotsky in his ideas. Like Piaget, he emphasizes action and problem solving on children's learning, like Vygotsky he highlights the importance of social interaction, language and instruction in the development of thinking. His early work involving the study of adult reasoning had an important impact on his ideas about the development of thinking in young children, emphasizing culture and growth as central factors. According to him play is an important aspect of young children's development, 'play provides an excellent opportunity to try combinations of behavior that would under functional pressure, never be tried' (MacNaughton, 2003). He is concerned to look the ways in which young children represent their experiences and their growing understanding of the world. He suggests three categories of the representations, namely, Enactive, Iconic and Symbolic representations.

The central idea of the Bruner's which has received most attention is *Scaffolding*, scaffolding is making connection between the previous ideas of particular concept to the present ideas to understand the idea better and may draw the future conclusions about the idea. It is connecting previous knowledge of the learner to know something advanced related to that knowledge in present. 'Highlight critical features and information, buffer the learner's attention against distractions, and channel the learner's activities so that there is freedom to succeed and too much freedom to go wrong. Errors are turned into opportunities to learn, procedures are commented on and explained, efforts are praised and responsibility for doing the task is gradually transferred to the learner, contingent on his or her having demonstrated an ability to succeed (Meadows, 1993).

High quality scaffolding involves joint problem solving; inter subjectivity (Shared understanding of each others' thoughts and feelings between adult and child or between child and child), warmth and responsiveness, keeping the child in the ZPD and promotion of Self-regulation (MacNaughton and Williams, 2004). In scaffolding children's understanding adults need to decide on the focus of what support is to be offered, how specific that help should be and timing of any intervention (Wood and Wood, 1996).

1.2.2 Concept of Constructivism

Constructivism has roots in Philosophy, Education and Psychology. Constructivism criticizes objectivism which embraces the belief that a human can come to know external reality, but constructivism holds the opposite view. That the only reality we can know is that which is represented by human thought. The term Constructivism refers to the idea that individuals through their own interaction with the environment construct their own knowledge and meaning. (Gale and Steff, 1995; Fosnot, 1996). This metaphor of construction comes from the idea that humans are Builders, Shapers and Designers. Constructivists believe that knowledge is the result of individual construction reality (Brooks, 1990).

The concept of constructivism has heritage in classical antiquity, going back to Socrates's dialogues with his followers, in which he asked questions that lead to his students to realize for themselves the weaknesses in their thinking. The Socratic dialogue is still an important tool in the way constructivist educators assess their students' learning and plan new learning experiences. John Dewey (1916) and Jean Piaget (1926) developed theories of childhood development and education that lead to the evolution of Constructivism. Piaget believed that through the construction of one logical structure after another, he also concluded the logic of children and their modes of thinking are initially entirely different from those of adults. The implications of this theory and how he applied them have shaped the foundation for constructivist education. Dewey called for education to be grounded in real experience. He wrote "if you have doubts about how learning happens; engage in sustained enquiry: study, ponder, consider alternative possibilities and arrive at your belief grounded in evidence." Inquiry is a key part of constructivist learning. Dewey further said that learners are active participants in knowledge acquisition and engage in restructuring, manipulating, reinventing and experimenting with knowledge to make it meaningful, organized and permanent. Learning is an internal process influenced by the learners' personality, prior knowledge and learning goals (Davidson, 1995).

Kuhn's ideas on the noncumulative, discontinuous growth of scientific knowledge are in link with Piaget's views of the staged development of individual cognition. In the words of Cawthorn & Rowell (1978), in the Kuhn's view, man is an active agent, constructing his own reality, is also at the core of Piaget's developmental psychology. As man constructs his reality he must also experience it. Thus both the world view and

the developmental level of an individual are determined by a dialectic process whereby a dynamic equilibrium is maintained between responses to environmental stimuli (accommodation) and changes in the intruding stimuli due to the existing cognitive internal structure of the human agent. As in the Kuhnian scheme, the equilibrium is not static and new cognitive structures of expectations, as they may be interpreted and evolved through the *dialectic process* (known as equilibration in Piagetian terminology).

Thus constructivism emphasizes understanding active learners already possess and the application of understanding to authentic situations. (Brophy and Good, 1994). The student-centered learning has emerged based on cognitive learning resources and influence of several theories that have developed our understanding of nature and context of learning. In student-centered environment the learner interacts with the other students, the teacher, information resources and Technology. The environment provides the learner with coaching and scaffolding in developing knowledge and skills. It provides a rich collaborative environment enabling the learner to consider the diverse and multiple perspectives to address issues and solve problems. It also provides opportunities for the student to reflect on his or her learning. This learning process is based on research that has emerged from theoretical frameworks related to human learning. Here learners are active agents who engage in own knowledge construction by integrating new information into their Schema or mental structures. The learning process is seen as a process of meaning making in socially, culturally, historically and politically situated contexts. In a constructivist learning environment students construct their own knowledge by testing ideas approaches based on their prior knowledge and experience, applying these to new tasks, contexts and situations and integrating the new knowledge gained with the pre-existing intellectual constructs.

Lonergan (1967), in his model of knowing suggests that 'human knowing is not some single operation but on contrary, a whole whose parts are cognitional activities, any instance of knowing is not a single operation, but a dynamic interacting combination of three cognitional processes; experience, understanding and judgment'. Constructivism considers learning as a meaningful learning. Ausubel is known for his use of advanced organizers to help students accomplish meaningful learning and these advanced organizers are always designed in the light of what a student already know or doesn't know about a concept. "The most important single factor influencing learning is that what the learner already knows. Ascertain this and teach him accordingly" (Ausubel, 1968). Hence the meaningful learning is established in constructivism.

1.2.3 Types of Constructivism

There are three deferent views on constructivism: Cognitive Constructivism, Social Constructivism and Radical Constructivism.

1.2.3.1 Cognitive Constructivism

Cognitive constructivism is based on Piaget's work. It focuses on internal, individual constructions of knowledge. It emphasizes learning activities that are child determined and discovery oriented. Intellect is product of evolutionary adaptation; Piaget has drawn two major principles operated in the intellectual growth adaptation and organization. Adaptation is two pronged process of assimilation and accommodation. And other most important aspect is state of equilibration. Organization refers to the nature mental structures that are adapting. For Piaget the mind is structured, or organized, in increasingly complex and integrated ways, the simplest level being the Scheme, which is a mental representation of some action that can be performed on an object. For a newborn, sucking, grasping, and looking are schemes; they are the ways the newborn comes to know the world by acting on the world. Across development, these schemes become progressively integrated and coordinated in an orderly fashion so that eventually they produce the adult mind. This process of equilibration is the keystone of developmental change, when children encounter new experiences their existing schemes have to adjust. This creates a state of disequilibrium or cognitive conflict, which acts as a motivation to learning until a state of equilibrium is restored.

1.2.3.2 Social Constructivism

Through others we become ourselves - Lev Vygotsky

Social constructivism assumes that knowledge is socially constructed reality that emerges from social interaction and language. It is a shared meaning rather than an individual experience. Vygotsky emphasizes the importance of social interaction in the construction of the knowledge, he says the relationship between instruction and internal learning is highly complex and this is not a simple transmission model of teaching whereby an adult instructs and a child listens. Instead it is a term which covers a wide range of strategies including demonstrations and discussions. For Vygotsky the social context in which learning takes place is as important as any specific activity the child undertakes; 'a child becomes himself through others' (Sutherland, 1992). This highlights the importance of language and communication

for social constructivism. Language is both the medium through which culture can be transmitted and it is also a tool of thought. Vygotsky believed that the whole process of learning is referred to as internalization. And internalization is a series of transformation between external social processes and internal psychological ones. It is an operation that initially represents an external activity is reconstructed and begins to occur internally, this involves assistance from more capable others, either adults or peer. Here an interpersonal process is transformed into an intrapersonal one; the child now provides his own assistance through talking aloud, or through inner speech. The transformation of an interpersonal process into an intrapersonal one is the result of a long series of developmental events. Internalization of knowledge, ideas and concepts is a prolonged developmental process. (Vygotsky, 1978) and it supports the development of higher mental processes and leads to more complex understanding through increased control of external cultural processes. Vygotsky suggests that for young children play; particularly role-play is a leading factor in development and a means of developing abstract thought. By providing children with opportunities to try out culturally defined roles can be act as a kind of mental support system which allows children to represent their everyday social reality (Penn, 2005).

Vygotsky introduced the concept of *Zone of Proximal Development (ZPD)*, which has had the most circulation particularly in relation to educational practice. It is the gap that exists for any individual between what he can achieve alone and what he can do with the help of other more knowledgeable persons. It is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. ZPD defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state.....what a child can do with assistance today she will be able to do herself tomorrow (Vygotsky, 1978).

1.2.3.3 Radical Constructivism

Von Glasersfeld has particularly focused on individual self-regulation and the building of conceptual structures through reflection and abstraction. "Radical constructivism is radical, because it breaks with convention and develops a theory of knowledge in which knowledge does not reflect an objective ontological reality, but exclusively an ordering and organization of a world constituted by our experience. The radical

constructivist has relinquished metaphysical realism once and for all” (Glaserfeld, 1987). According to Glaserfeld, ‘authentic’ learning depends on seeing a problem as ‘one’s own problem’, as an obstacle that obstructs one’s progress toward a goal. The farthest removed from this individualistic focus seems to be the socio-cultural approach that originated with Lev Vygotsky. Radical constructivism postulates that knowledge is explored from individual experience without information given. It calls for students to generate new solutions to the problem by going beyond the information through formulating and verifying hypotheses. Radical constructivism grew out of philosophical considerations about the nature of knowledge. Glaserfeld argues not only that knowledge is actively constructed by the learner, but that knowledge learners build up should be thought of as having an adaptive purpose, to help us to operate in the world, rather than as the discovery of an underlying reality. Radical constructivism denies the possibility of the world being directly being ‘known’, or of knowledge being directly transferred between the teacher and learner.

1.2.4 Principles of Constructivism

Brooks and Brooks (1993) suggests the following five principles as basis for constructivist classroom,

1. Posing problems of emerging relevance to students
2. Structuring learning around primary concepts and big ideas
3. Seeking and valuing students’ point of view
4. Applying curriculum to address students’ suppositions
5. Assessing student in the context of learning

1.2.5 Characteristics of the Constructivist Learning Approach

Jonassen (1994) identified the characteristics of constructive learning environment namely,

- Providing the multiple representations of reality
- Represent the complexity of the real world
- Emphasize knowledge construction
- Stress authentic tasks in meaningful context
- Providing real life settings
- Encouraging the reflection on experience
- Encourage collaboration and social negotiation among learners.

Based on the principles of constructivism and above said broad characteristics of constructivist Learning Approach, some more features can be drawn, namely,

- Acceptation of students' prior knowledge.
- Curriculum is presented from whole to part with emphasis on broader concept.
- Pursuits of student questions are highly valued.
- Curricular activities rely heavily on primary sources of data and manipulative materials.
- Students are viewed as thinkers with emerging theories about the world.
- Teachers generally behave in an interactive manner, mediating the environment for students.
- Teachers seek the students' prior view in order to understand students' present conceptions for use in subsequent lessons.
- Principle of un-structured or ill-structured knowledge domain which bears significance for designing curriculum for constructivist classroom.
- Principle of problem oriented activities.
- Principle of assimilation when it is held that learners construct knowledge by relating new information to the existing knowledge which they already possess.
- Learning is meaningful to children when it scaffolds on experiences they have already with them.
- Principle of Active learning, i.e. learning by doing.
- Principle of collaborative, cooperative learning.
- Principle of social interactions.
- Assessment of student learning is interwoven with teaching and occurs through teacher observations of students at work.

1.2.6 Constructivist Classroom

The constructivist classrooms are regular classes with the constructive environment. Where in students are no more students, they are learners, teachers are no more teachers they are facilitators, guides and mentors. The meaning of this sentence is the role of both teachers and students differs to a large extent from the regular classes. Constructivist classrooms are structured so that learners are immersed in experiences within which they may engage in meaning-making inquiry, action, imagination,

invention, interaction, hypothesizing and personal reflection. Teachers need to recognize how pupils use their own experiences, prior knowledge and perceptions, as well as their physical and interpersonal environments to construct knowledge and meaning. The goal is to produce a democratic classroom environment that provides meaningful learning experiences for learners. Constructivism unlike the conventional method of teaching-learning explores the learner's prior ideas and scaffold with the present learning concept and makes the learning meaningful. In constructivism we can say there will be construction of meaning to particular idea. It is more of meaning making process to the created new knowledge. The learner will learn only in an atmosphere where they feel they are valued (NCF, 2005). So creation of such environment where all learners' ideas, interests are considered is very important. Constructivist classes differ from the traditional classes with various regards. Brooks and Brooks (1993) offered an interesting comparison of the visible differences between 'traditional' classrooms and the 'constructivist' classrooms, they are,

- Students primarily work in groups unlike individually as in traditional classroom.
- Curriculum is presented whole to part with emphasis on big concepts whereas in traditional classroom it is provided part to whole.
- Pursuit of the student questions is considered whereas in traditional classroom strict adherence to a fixed curriculum is valued.
- Curricular activities rely heavily on primary sources unlike relying on textbooks.
- Students are viewed as thinkers with emerging theories about the world unlike its counterpart.
- Constructivist teachers generally behave in interactive manner mediating the environment for students and seeks students' point of view. Whereas traditional classroom teachers are information dispensers.

Honebein (1996), describes the goals for the creation of constructive classroom environment, they are,

- Provide experience with the knowledge construction process
- Embed learning in realistic and relevant contexts and social experience
- Encourage the use of multiple modes of representation
- Encourage the self-awareness in the knowledge construction process.

1.2.6.1 Strategies

Strategies for the constructivist classrooms would be designed depending on the concepts to be learned and the learners. But the some of the strategies the teacher may follow for the students' learning would be,

- Eliciting the prior ideas of the learners through probing.
- Building and sustaining the motivation by engaging into various activities
- Negotiating the choices by discussion, topic choice and assessment choice
- Developing Information handling skills, independent learning skills
- Developing Understanding by emphasizing on practical part.
- Attempting to connect theory and practice.
- Assessing learners as they learn.
- Communicating the results or findings through group discussions.

Brooks et. al., (1993) suggested certain classroom strategies to how to go about the constructivist classes.

- Encourage and accept student autonomy and initiative. This is one of the ways that we motivate students to take charge of their own learning. But guide them through the process of creating meaningful activities, assessments, and so on.
- Use raw data and primary sources, along with manipulative, interactive, and physical materials.
- When framing tasks, use cognitive terminology such as "classify," "analyze," "predict," and "create." This language opens up the opportunities for students to explore learning. Take it slowly and step-by-step.
- Allow student responses to drive lessons, shift instructional strategies, and alter content, according to the student's interest, curiosity and pace of learning.
- Inquire about students' understanding of concepts before sharing your own understandings of those concepts. Wait before you say, "Inertia is the tendency of an object to remain at rest or to remain in motion unless acted upon by an outside force." It may be more meaningful after students prepare for the concept by playing and then discussing a game of soccer -- what happened to the ball, what happened when players ran into each other, and so forth.

- Encourage students to engage in dialogue, both with you and with one another.
- In a traditional classroom, dialogue is often discouraged. Teachers often monopolize the talking, and the monologue takes the form of lecturing. Switching from a traditional approach to a constructivist one means breaking this habit.
- Learners formulate concepts through dialogues in the classroom. Students should be encouraged to engage in dialogue during class discussions. Group work should be organized to facilitate dialogue. Dialogue can be extended by electronic means such as e-mail or online conferencing.
- Prompt student inquiry by asking thoughtful, open-ended questions and encouraging students to ask questions of each other.
- Seek elaboration of students' initial responses. This provides the learner to think the base for their initial responses and helps to construct hypotheses.
- Engage students in experiences that might engender contradictions to their initial hypotheses, and then encourage discussion.
- Allow "wait time" after posing questions. Provide ample time for thinking during class discussion. This goes hand-in-hand with learning to frame questions so that there is no single right answer.
- Provide time for students to construct relationships and create metaphors
- Nurture students' natural curiosity through frequent use of the three-step Learning Cycle model: Discovery, Concept Introduction, and Concept Application. The Learning Cycle is a design that can be used as a general framework for many kinds of constructivist activities.

1.2.7 Nature of the Learner

1.2.7.1 Learner is a Unique Individual

Constructivism views each learner as a unique individual with unique needs and backgrounds. The learner is also seen as complex and multidimensional. Constructivism not only acknowledges the uniqueness and complexity of the learner, but actually encourages, utilizes and rewards it as an integral part of the learning process (Wertsch 1997). Learners come to classes with a range of existing ideas or conceptions of the physical world. They are not empty vessels waiting to be filled. These conceptions form useful prior knowledge that a teacher can build on. Learner

come to class with varied background, the social constructivist ideas encourages the learners to stand on their point based on their background. The present learning should be embedded based on their background and culture. Children develop their abilities of learning by the interaction with the surroundings. Learners' knowledge, background and culture will be given due importance in the classroom. For example, using a text or a set of visuals on a transport system. Coupled with discussions will allow learners to facilitate to construct the idea of transport system. Mental representation may be based on the idea of the road transport system, and a learner from rural setting may form the idea of bullock cart. Learners construct mental images of external reality (transport system) through a given set of activities (experiences). The structuring and restructuring of ideas are essential features as the learner progress in learning. (NCF, 2005). According to Glasersfeld (1989) the learners construct their own understandings and ideas depending upon their prior world of knowledge, they do not simply mirror and reflect what they read.

1.2.8 Motivation for Learning

There is a natural curiosity drive in human beings, which prompts exploration and discovery. The nature and the extent of motivation in the process of learning plays very important role in the constructivist classes. Intrinsic motivation always plays higher role, but will not neglect the influence of extrinsic motivation. According to Piaget during the process of assimilation and accommodation of new knowledge in new experience creates a state of disequilibrium or the cognitive conflict, which also acts as a source of motivation to learning until a state of equilibrium is restored. In the concept of ZPD of Vygotsky's, when the learners are given tasks just little above to their capability of performance creates a motivation among the learners to reach that task. When simple tasks get successfully experienced, learners gain the confidence and this creates a sense of motivation to go for higher and complex tasks. The sustaining the motivation to learn is depends upon the learners confidence on his potential for learning Glasersfeld (1989). The experiences of tackling the problems and success in the earlier also motivates the learner to solve some more related complex challenges in the present. The technique of Scaffolding really works for the learner to make connections and building the relationships between previous little known ideas to present unknown concepts, which also brings the sense of satisfaction and joy and increases the motivation to do more such connections to learn more concepts.

1.2.9 Role of the Teacher

'I never teach my pupils, I only attempt to provide and facilitate the conditions in which they can learn'...Albert Einstein. The role of constructivist teacher changes significantly from teachers to facilitators, facilitators should possess multiple skills to provide and manage the constructivist environment to the learners. His/her role would be like 'guide on the side' rather than 'sage on the stage'. The teacher should know that 'one size doesn't fit all' accordingly different teaching-learning strategies like problem solving, co-operative and collaborative learning, inquiry based, reciprocal teaching, cognitive apprenticeship, web quests, activity based teaching-learning strategies must be designed according to the learners various needs, should use differentiated instruction as the learners are will be from different level of previous knowledge, cultural background, language and so on. Should embed the learning with rich, authentic problem-solving environment. Here teaching is not passing the onus of learning on learners. The same responsibility lies on teachers too. A teacher tells, a facilitator asks; a teacher lectures from the front, a facilitator supports from the back; a teacher gives answers according to a set curriculum, a facilitator provides guidelines and creates the environment for the learner to arrive at his or her own conclusions; a teacher teach in a monologue, a facilitator is in continuous dialogue with the learners. The constructivist teacher should assess the learners throughout the class; it should be continuous and comprehensive evaluation. While it is advocated to give the learner ownership of the problem and solution process, it is not the case that any activity or any solution is adequate. The critical goal is to support the learner in becoming an effective thinker. A teacher needs to view his learners as active participants in their own learning, need to encourage their capacity to create and construct and make meaning of the knowledge. 'Teachers need to look at as crucial mediating agents through whom curriculum is transacted and knowledge is co-constructed along with learners' (NCFTE, 2009). This can be achieved by assuming multiple roles, such as consultant, coach and facilitator.

The process of teaching is transformed to facilitation, the characteristics of facilitation includes the environment which provides warmth, trusting, empathetic and authentic in words and actions. Warmth refers to foundation of care and acceptance of learners, trust is an attitude of high expectations, which leads to sharing power, control and voices with learners (McCombs & Miller, 2007). Empathy is means of honoring students' voices through perspective taking of their feelings, motivations and learning

processes. Authenticity refers to teachers' self-awareness and ownership of communications that express opinions, evaluations and requirements. When the teacher in the constructivist perspective considers that his students are the scientists or discoverers, he himself must be a researcher. Should involve action researches in the classroom. In this context Ingold (1962) says that the teachers should be the researchers because teaching of science and research are intrinsically inseparable and cannot weighed one against the other, these researcher-teachers are the individuals on whom the production of next generation of scientist depends.

1.2.10 Nature of the Learning Process

Learning is an active, social and constructive process that occurs best when what is being learned is relevant and meaningful to the learner and when the learner is actively engaged in creating his or her own knowledge and understanding by connecting what is being learned with prior knowledge and experience (Lambert and McCombs, 1998). Vygotsky suggests that knowledge is constructed in a social context and is then appropriated by individuals. Here in the constructivism the process of learning is emphasized rather than product. According to Tyler (1994), learning takes place through the active behavior of the student; it is what he or she does, that is learned, not what the teacher does. The construction of knowledge is lifelong, effortful process requires significant mental engagement by the learners. So active learning finds place. Vygotsky (1978) enhanced the understanding of learning as a social process. He argued that the capacity to learn from others is fundamental to human intelligence. With the help from someone more knowledgeable or skilled, the learner is able to achieve more than he or she could achieve alone. Co-operation and collaboration among the learners becomes the base for the learning in social context. Learning and development are complementary to each other. Individuals make meanings through the interactions with each other and with the environment they live in. There will be always the dynamic interaction between task, instructor and learner, so this makes teachers and learners to develop an awareness of each other's viewpoints and awareness of about their own self that what they know, we call this as *Metacognition*. It is a term often given to the processes used in higher order thinking and self-regulation; it means reflecting on own thinking and the role of self as the agent of that thinking. And then look on their own beliefs, standards and values. In this context Galileo Galilei says 'You cannot teach a man, you can only help him to find it within himself'.

According to NCF (2005), as children's metacognitive capabilities develop, they become more aware of their own beliefs and capable of regulating their own learning.

- All children are naturally motivated to learn and are capable of learning.
- Making meaning and developing the capacity for abstract thinking, reflection and work are the most important aspects of learning.
- Children learn in variety of ways-through experience, making and doing things, experimentation, reading, discussion, asking, thinking and reflecting and expressing oneself in speech or writing both individually and with others. They require opportunities of all these kinds in the course of their learning and development.
- Learning takes place both within school and outside school. For this, there is need to connect the knowledge to life outside the school and enrich the curriculum by making it less textbook-centered.

Knowledge is thus a product of humans and is socially and culturally constructed.

1.2.11 Constructivist View of Assessment

Like teaching and learning, Assessment is also not a singular entity. It is complex and dynamic and it deserves to be differentiated and understood in all of its intricacy. Assessment should be like assessment of learning, for learning and as learning. Holt and Willard-Holt (2000) emphasize the concept of dynamic assessment, which is a way of assessing the true potential of learners that differs significantly from conventional tests. Here the essentially interactive nature of learning is extended to the process of assessment. Rather than viewing assessment as a process carried out by one person, such as an instructor, it is seen as a two-way process involving interaction between both instructor and learner. Assessment should be a part of teaching and not separate from it. Constructivist teachers strive to understand children's thinking by identifying the relationships they are constructing. Assessment of scientific facts, concepts, and theories must be focused not only on measuring knowledge of subject matter, but on how relevant that knowledge is in building the capacity to apply scientific principles on a daily basis. The teacher's role in the changing landscape of assessment requires a change from merely a collector of data, to a facilitator of student understanding of scientific principles, teacher becomes one of entering into dialogue with the persons being assessed to find out their current level of performance on any task and sharing them with possible ways in which that performance might be improved on a subsequent occasion.

The assessment is learner-centered, symbiotic (mutually beneficial), formative, context-specific, ongoing, and rooted in the teaching practice. In the context of constructivist approach, assessments need to judge the progress of students in achieving the three major learning outcomes of constructivist approach: conceptual understanding in Science, abilities to perform scientific inquiry, and understandings about inquiry. Teachers have a very challenging role to play in assessment process. Assessment can foster development of the kind of knowledge frameworks that are needed for effective Science teaching. So prospective Science teachers must seek on their own initiative to build this kind of understanding of assessment in their field. Thus, assessment and learning are seen as inextricably linked and not separate processes. According to this viewpoint instructors should see assessment as a continuous and interactive process that measures the achievement of the learner, the quality of the learning experience and courseware. The feedback created by the assessment process serves as a direct foundation for further development. Assessment must be both formative and summative. And self-assessment is also plays important role for both the teachers and learners. Self assessment is at the heart of the matter. Teachers must be constantly reminded that the ultimate purpose of evaluation is to enable students to evaluate themselves. Its purpose is to improve the quality of student learning, not to provide evidence for evaluating or grading students.

Constructivist Approach is umbrella term which includes a variety of approaches in education that involve joint intellectual efforts by the learners and teachers. Specific Approaches to education that are based on constructivism include,

1. Reciprocal Learning
2. Critical Exploration
3. Cognitively Guided Instruction
4. Inquiry-based learning
5. Problem-based learning
6. Experiential learning
7. Cognitive apprenticeships
8. Cooperative learning
9. Cognitive Apprenticeship

1.2.12 Constructivist Teaching - Learning Models

There are different constructivist teaching-learning models have been evolved based on the theory. Constructivist Instructional models should be mainly based on three elements (Brooks & Brooks, 1999)

1. Students Prior Knowledge which affects future learning because what a learner already knows interacts with the new conception to which the learner has been exposed.
2. Students construct meaning through interaction with others, with materials and by observation and exploration of interesting and challenging activities.
3. Students should construct understanding around core concepts and big ideas. And apply to the new situations.

So, constructivist teachers ascertain the understanding of their students, plan mediating events that assist students in moving from a current understanding to a more scientifically accepted understanding and provide time for discussion on any needed additional experiences for students to construct deep conceptual understanding.

Many learning designs based on constructivist assumptions are available in the literature of constructivism. Constructivist pedagogy is not attached to a single model or strategy, but it will provide a view of various strategies that suggests specific instructional principles that can be a great use to create constructive learning environment in the classroom. These are descriptive but not prescriptive. The important worth mentioning models which have drawn attention of educators in the past several years are,

1.2.12.1 The Learning Cycle Model

- Exploration
- Invention and Development of Concept
- Concept Application

The learning cycle model is three step design developed by Atkin-Karplus (1962) Learning Cycle model with Science Curriculum Improvement Study (SCIS), where in Pupil learn through their own actions and reactions with minimum guidance. Students have an initial experience with phenomena. Students are introduced to new terms associated with concepts that are the object of study. The learners are expected to raise questions they can't answer with their present ideas. The concept would be the introduced and explained with the help from the teacher. The concepts applied to new situations and its range of applicability is extended.

1.2.12.2 5E Model

Developed by The Biological Science Curriculum Study (BSCS). Roger Bybee in 1997 developed an instructional model for constructivism, called 5E. These 5E represent five stages of a sequence for teaching learning. Namely,

1. Engage

Engagement is perhaps the most fundamental and enduring developmental process in learning. Learners come to class with some prior knowledge. Activities which will focus student's attention, stimulate their thinking, generate interest, access the learner's prior knowledge and frame the setting for learning. The engagement stage stimulates the curiosity and activates prior knowledge of learners. Engagement draws the learners' need, desire and commitment to attend to, participate in, cooperate with and self-regulate their learning. The activity should be a problem or an event, or a demonstration that raises questions and motivates students to discover more about the concept. This stage helps in make connections between past and present learning experiences. Teachers should make the democratic environment where the learners become mentally engaged in the concept, process or skill to be learned. It gives opportunities for teachers to understand misconception of students.

Suggested Activities

- Demonstration/Probing questions
- Experimentation
- Brainstorming
- Using Manipulative
- Graphic organizers
- Manipulative activity
- Interactive Reading

2. Explore

It Provides learners with a common set and base of experiences. They identify and develop concepts, processes, and skills. During this phase, students actively explore their environment or manipulate materials. Activity which give students time to experience, think and investigate, probe, inquire, collect information, question, test, make decisions establishing relationships and understandings and problem solve.

Suggested Activities

- Perform an Investigation
- Construct a Model
- Learn and practice a skill
- Read collaboratively
- Small-Group Discussions
- Hypotheses

3. Explain

Activity which allows students to analyze their exploration and communicate new understandings. The learner's understandings of the concepts gets clarified and modified through a reflective activity. Helps them to explain the concepts they have been exploring. They have the opportunity for expressing their views to demonstrate new skills or behaviors. This phase also provides opportunities for teachers to introduce formal terms, definitions, and explanations for concepts, processes, skills, or behaviors.

Suggested Activities

- Student Analysis & Explanation
- Supporting Ideas with Evidence
- Thinking Skill Activities: compare, classify, error analysis, and interpret

4. Elaborate

The learners apply previously learned concepts and experiences to novice situations. Activity which expands and solidifies student thinking and applies it to a real-world situation. Student communicates new understanding with formal academic language. Extends students' conceptual understanding and allows them to practice skills and behaviors. Through new experiences, the learners develop deeper and broader understanding of major concepts; obtain more information about areas of interest and refine their skills. Students are encouraged to apply, extend and enhance the new concept and related terms during interaction with the teacher and other students.

Suggested Activities

- Problem Solving within a new context
- Decision Making
- Experimental Inquiry

- Thinking Skill Activities: compare, classify, apply, judge, conclude, synthesize and extend
- Extended Reading, Drawing conclusions, communication.

5. Evaluate

Activity which allows the teacher to assess student performance and/or understandings of concepts, skills, processes, and applications. Student is demonstrating evidence of understanding. Evaluation is the snapshot of what the learners have understood. It is evaluation of all the above stages. This encourages learners to access their understanding and abilities and lets teacher evaluate students' understanding of the topic. The students must also be able to reflect on their own understanding and process.

Suggested Activities

- Develop a Scoring Tool or Rubric
- Performance Assessment
- Produce a Product
- Journal Entry
- Portfolio
- Pose new questions
- Demonstration
- Self-analysis

1.2.12.3 The 7E Model

A proposed 7E model emphasizes “transfer of learning” and the importance of eliciting prior understanding. This is the extension of the 5E model, and was proposed by Arthur Eisenkraft in 2003. Here Elicit and Extend have been added initially and at last respectively. And other 5E remains the same. Their stages of the 7E model are as follows,

1. **Elicit:** Here teacher has to uncover the prior understanding and knowledge and experiences of the learner.
2. Engage
3. Explore
4. Explain
5. Elaborate
6. Evaluate
7. **Extend:** Here the students will extend the idea to other related areas. And relate the ideas to other concepts.

1.2.12.4 Inquiry-Oriented Constructivist model and Interpretation Construction (ICON) model

This model is Black and McClintock (1995), derived a model from several computer supported learning environments. It contains,

- **Observation:** Learners make observations of authentic artifacts anchored in authentic situations.
- **Interpretation Construction:** students construct interpretations of observations and construct arguments for the validity of their interpretations.
- **Contextualization:** students access background and contextual materials of various sorts to aid interpretation and argumentation.
- **Cognitive Apprenticeship:** Students serve as apprentices to teachers to master observation, interpretation and contextualization.
- **Multiple interpretations:** students gain cognitive flexibility by being exposed to multiple interpretations.
- **Multiple Manifestations:** Students gain transferability by seeing multiple manifestations of the same interpretations.

1.2.12.5 Driver & Oldham (1989) has given Five Phases of Constructivist teaching viz,

- Orientation
- Elicitation of ideas
- Restructuring of Ideas
- Application of Ideas
- Review change in ideas

1.2.12.6 Generative Learning Model (GLM) by Osbourne & Wittrock (1983).

- Assessing antecedent knowledge
- Motivation to explore
- Compare and contrast
- Apply to new situations

After analyzing the types and models of constructivist learning approach, the researcher has developed certain characteristics regarding constructivist environment by considering cognitive, social and also radical constructivist features. And about the models the researchers felt that it goes according to the concept, the suitable approach would be used for different concepts, then only the philosophy of constructivism may realized.

Educational curricula and teaching methods are changing according to the changing world. Now the instruction is from the transmission curriculum to a transactional curriculum. In a traditional curriculum, a teacher transmits information to students who passively listen and acquire facts. In a transactional curriculum, students are actively involved in their learning to reach new understandings. Constructivist teaching fosters critical thinking and creates active and motivated learners. Learning in all subject areas involves inventing and constructing new ideas. And constructivist theory could be incorporated into the curriculum; teachers create environments in which children can construct their own understandings. Fosnot (1989) recommends that a constructivist approach be used to create learners who are autonomous, inquisitive thinkers who question, investigate and reason. A constructivist approach frees teachers to make decisions that will enhance and enrich students' development in these areas. As constructivism go hand in hand with numerous teaching-learning strategies, it takes care of all type of learner to work at their own pace, and make the learners very active. It may work to the best in different subjects especially in Science. Science because it is a subject of experimenting, hypothesizing, observing, inferring and it needs active learners to attain them. Science also needs teachers who are active and interactive. Constructivist teaching-learning approach when applied in Science classrooms may work together in the same philosophy.

1.3 Nature of Science

Man has been always very curious and trying to understand the changes going around in his environment by first hand information through his senses such as hearing, sight, taste, touch and smell. By making an effective use of these senses trying to gain the insight about the nature. This kind of systematized studying of the nature can be called as Science.

‘The word Science has its origin from a Latin word ‘Scientia’ meaning ‘to know’. There is no one definition of Science which is universally accepted. Science is a cumulative and endless series of empirical observations which result in the formation of concepts and theories, with both concepts and theories being subject to modification in the light of further empirical observations. Science is both a body of knowledge and the process of acquiring it (Fitzpatrick, 1960).

Henri Poincare explains the idea that “Science is build of facts as a house is built of stones; but an accumulation of facts is no more a Science than a heap of stones.” The true nature of Science is revealed more in the way it is sought rather than in what it is found, although the two efforts cannot be truly separated. In another way, it could be said that Science is more a verb than it is a noun. “Science is the activity where truthfulness is not obviously an essential condition for success. Its success in fact is measured by its truthfulness (Sullivan, 1963).

Science is an accumulated and systematized learning in general usage restricted to natural phenomenon. The progress of Science is marked not only by an accumulation of fact, but by the emergence of Scientific Method and of the Scientific Attitude. Over the course of human history, people have developed many interconnected and validated ideas about the physical, biological, psychological, and social worlds. Those ideas have enabled successive generations to achieve an increasingly comprehensive and reliable understanding of the human species and its environment. The means used to develop these ideas are particular ways of observing, thinking, experimenting, and validating. These ways represent a fundamental aspect of the nature of Science and reflect how Science tends to differ from other modes of knowing.

According to Dewey (1993) the heart of Science lies not in the conclusions reached, but in the method of observation, experimentation and mathematical reasoning by which conclusions are established. The goal of Science education is that students should achieve scientific literacy, and the scientific literacy is ‘The knowledge and understanding of scientific concepts needed in daily living. Scientific literacy enables people to not only use scientific principles and processes in making personal decisions but also to participate in discussions of scientific issues that affect society. Understanding scientific knowledge and processes contributes in an essential way to these skills. The economic productivity of society is related to the scientific and technological skills of the people’ (Yager 2010).

The Nature of Science world can be viewed as dynamic, the things in the universe occur in consistent patterns which can be comprehended through careful study.

- The world is understandable
- Scientific ideas are subject to change
- Scientific knowledge is durable
- Science cannot provide complete answers to all questions

- Science involves Scientific Inquiry
- Science Demands Evidence
- Science is a blend of Logic and Imagination
- Science Explains and Predicts
- Science is not Authoritarian

The basic three principles of the nature of Science can be identified,

1. An accumulated and systematized body of knowledge,
2. The scientific method of inquiry and
3. The scientific attitudes.

The first point indicates the Product of Science, while second and the third points indicate the Process of Science. In other words, Science is both a product and a body of knowledge that has been accumulated by scientists and the process in which they acquire this knowledge. The body of scientific knowledge can be classified into facts, concepts, generalizations, theories and laws. These form the structure. The second dimension of Science is the process by which knowledge is acquired. The American Association for the Advancement of Science (AAAS) provided thirteen processes for the scientific inquiry. Namely, Observation, Classification, Number relations, Measurement, Space/Time relations, Communication, Prediction, Inference, Making operational definitions, Formulating Hypotheses, Interpreting Data, Identifying and controlling variable and Experimenting.

1.3.1 Science Education

Science is a dynamic, expanding body of knowledge with open-ended exploration. The present world is in the era of Science and Technology. Science Education plays a crucial role in the process of transformation of scientific research and development. 'Science has developed at an ever increasing pace since the beginning of the twentieth century. So that the gap between the advanced and backward countries has widened more and more. It is only by adopting the most rigorous measures by putting forward our utmost effort into the development of Science that we can bridge the gap. It is inherent obligation of a great country like India, with its traditions of scholarship and original thinking and its great cultural heritage, to participate fully in the march of Science which is probably mankind's greatest enterprise today' (Nehru, 1958).

Through the Science education, pupils should be given a basis for understanding and coping with their lives, and for understanding the applications and effects of Science in the contemporary society, Science should contribute to pupils' personal and intellectual development. It can also contribute to the development of their practical capability and decision making as well as helping them to learn to work with others. The Science education needs to formulate in such a way that it should try to enable the students to live fruitfully in this scientific and technological age. And also Education Commission (1964-66), highlights the quality of Science education that, if Science is poorly taught and badly learnt, it is little more than burdening the mind with dead information, and it could degenerate even into a new superstition. As the world is becoming more scientific, the interest in the discipline of Science, Science education, Research in Science educations is increasing tremendously. Novak, 1964 also highlights in this context that the dramatic increase in new knowledge in Science and the increasing importance of Science in contemporary society have resulted in a heightened interest in the teaching of Science at all the grade levels.

In the present context teaching-learning of Science from the past traditional methods is becoming obsolete; the past educational system will not meet today's and tomorrow needs. There is need of innovations in the Science Education. Over the last few decades, Science education has undergone many changes. A lot has been done to make Science more accessible to a wider range of pupils, to broaden the focus of the curriculum, accordingly the continuous research and development is taking place to know the strategies of teaching and learning of Science in a better way, development of the Science Curriculum, Evaluation, and Extension. Despite of all these efforts, there is concern that the changes are not enough to catch hold the speed of the Scientific and technological developments.

NCF (2000) viewed the child as a scientist wherein he takes up the role of scientist and develops skills and attitudes and construct his own knowledge. Students bring the legacy of their cultural backgrounds to their studies. They have all experienced Science learning outside the classroom and can form and express their own views. This means that they have their own attitudes towards Science education and attention must be paid to them. NCF (2005) also proposes that the present society requires a teacher to be a facilitator of children's learning in a manner that the child is helped to

construct her knowledge. It also opens out possibilities for the teacher to participate in the construction of syllabus, textbooks and teaching learning materials. Such roles demand that teachers be equipped with a better understanding of curriculum, subject content and pedagogy on the one hand and community and school structures and management on the other. The teacher is the single most important source of variation in the quality of learning. The supply, development, and retention of good Science teachers is therefore of paramount importance. Students of school age spend about two-thirds of their waking lives outside formal schooling. Yet Science educators tend to ignore the crucial influences that experiences outside school have on students' beliefs, attitudes and motivation to learn. They often see these influences only as a source of misconceptions. Out-of-classroom contexts can add to and improve the learning of Science in several ways. They can promote the understanding and integration of Science concepts.

School Science is mostly embedded in the laboratory. School system should have well equipped Science laboratory because Science needs experimentation and allows for experiencing. "In good labs, students discover concepts; they don't just verify them". (Renner, 1986). These also help the students to create and construct the new knowledge and meaning. With this out-of-classroom contexts for school students are also an opportunity to engage in Science activities that would not be possible in the school laboratory either because of safety considerations or because they are too complex or might not be well equipped. Examples include launching rockets, performing ecological surveys, observing the night sky, and large scale experiments with combustion. They can provide access to rare material and to 'big' Science. Science museums, botanic gardens, zoos and Science industries provide opportunities for students to see yesterday's and today's Science in use. Artifacts and collections, and the stories associated with them; help teach about the ways in which scientific and technological knowledge has been generated and about the social enterprise in which those who engage in this work operate. Such activities also provide opportunities for Science activities which are less constrained by school bells and lesson times. Work can be more extensive and there are more opportunities for students to take responsibility for themselves and others, to work in teams and to consider their effects on the environment.

By looking at the importance of Science Education at all the levels National Knowledge Commission (NKC), (2008) also recommended that to reform the science curriculum content in line with the changing world and there is an urgent need to reduce information load of curriculum. Courses should be made engaging and the hands-on work at all the levels should be increased. Pedagogy should be modified to impart creativity and global vision training. Avenues for research should be increased at all levels. Radical changes are required in the evaluation system to encourage scientific thinking and promote better understanding of basic science concept and accordingly teachers need to be trained in new methods of evaluation. Promote quality science educational materials, launching massive Science outreach programmes aimed at students and parents. Mobile Science Labs and Science should be developed, Encouraging Industry participation in promotion of Science at all the levels.

1.3.2 Aims of Science Education

According to Position paper, National Focus Group on Teaching of Science (2006), the general aims of Science education should enable the learner to,

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

To be able to achieve the aims of Science education, it is possible through the joint efforts of School education system, Teacher Education system and higher education. Research in all the areas of educational system, adoption and practice of innovative teaching-learning strategies, implementation of advanced Information and Communication Technologies may provide the insight about the positive changes to bring into the Science education.

1.3.3 The Scenario of Science Teaching Learning

The future of India lies in scientific knowledge. But our ability to generate new knowledge and use it innovatively depends upon having a scientifically literate population. Although people learn throughout their lives, good Science education in schools is a vital preparation for scientific literacy in later life. Despite its importance, Science education in schools is threatened from a number of directions, not least by a shortage of well-qualified Science teachers but also ill-structured laboratories. UNESCO (1996) highlighted that the teaching-learning system is focusing mainly on learning to know rather than learning to do. The teachers have been prepared for traditional classrooms, but the world is moving in rocket speed in terms of information, knowledge, innovations and rapid changes in Science and Technology. Science as a subject being taught at the secondary school level more through product approach than process approach. In a large number of classes the Science has been taught as a body of established facts only. The Science classes mostly driven by chalk and talk method. Less emphasis could be seen on constructivist, activity based and technology mediated interaction classroom environment. Thus there is less scope for knowledge creation, construction and independent thinking. The Science education should prepare the students to equip themselves with the changing world; conversely there is less linkage between classroom practices and outside environment. In the same context Yager (1991) revealed that even the students who score well are unable to successfully integrate memorized facts and formulate real-life applications outside the classroom. The theory and practice are not properly linked. NCERT (1968) also highlighted about science teaching that the present curricula in Science and Mathematics is overstuffed and undernourished. Students are getting prepared in-terms of ready for examination. Here question arises that whether education is to learn or to measure? In a large number of schools the Science laboratories are not fully functional, the experiments are stereotyped. According to the position paper of National Focus Group on Teaching Science (2006) revealed that there is a gradual

decline of practical work and experimental work at secondary level. Integrating experimental work and theory has not been realized because of perceived lack of facilities and trained teachers. There is degeneration of rigour in practical examination; even well-endowed schools have tended to give only cosmetic importance to laboratory work. The Science Laboratories should be well equipped and should have well trained assistants (NKC, 2007). But it is looking as the distant dream in the present situation. The newly germinated ideas do not find incubation; such ideas are very often suppressed. Science as a discipline demands open sharing and congenial climate. The present Science classes are conducting mostly through lecture method, teacher talk is predominating and the problem-solving activities are less and the students are passive listeners (Umasree, 1991). At secondary stage, the Science teaching-learning should be strengthened; stress should be given on comprehension not on mere formal definition. Science learning should be used as an instrument of social change to reduce the socio-economic divide. Science education ought to empower students to question the social beliefs, notions and practices that perpetuate social inequality. The Science Pre-Service Teacher Education must also be strengthened. The Science teacher preparation curriculum should be in consonance with changing priorities and challenging of time. Inadequacies in the Pre-Service Education of Science teachers cannot be compensated through In-Service programs. Pre-service Science education should be based on all the skills and competencies expected of Science teachers.

Students' inquiries out of everyday experience are hardly encouraged and found to be ignored the crucial influences that experiences outside school. At present in Science Education, the shift should be from less emphasis on knowing facts to more emphasis on understanding concepts and developing abilities of inquiry, from studying subject disciplines of Science for their own sake to learning subject matter disciplines in the context of inquiry, technology, personal and social perspectives. Presently ICT in the field of Science education is still remains largely untapped and efforts have been piecemeal and sporadic, appropriate multimedia in Indian language still find a rare commodity (position paper of National Focus Group on Teaching of Science 2006). ICT could be used as leaning tool in the Science at the school level, which helps them to face challenges of a society that is fast transforming into information driven society. For any qualitative change from the present situation, Science Education in India must undergo paradigm shift. Rote learning should be discouraged; Inquiry skills should be

supported and strengthened by language, design and quantitative skills. Science teaching should give much emphasis on co-curricular and extra-curricular elements aimed at stimulating inventiveness and creativity, even if these elements are not part of the external examination system. So, there should be adequate scope for Germination of ideas, Incubation, Innovation, Creation and Construction. By including the various teaching-learning strategies which could take care the needs of varied learner, may lead to the profound development of learners. In this context use of Constructivist ideas in Science may work wonders.

1.4 Constructivist view of Science Education

Constructivism continues to be the dominant research program in Science education, and it continues to generate new research and insights. The research literature in Science education has been highly influenced in the last few decades by constructivism. According to Lorscheid and Tobin (1992), Constructivist epistemology asserts that the only tools available to a knower are the senses. It is only through seeing, hearing, touching, smelling, and tasting that an individual interacts with the environment. With these messages from the senses the individual builds a clear picture of the world. The constructivist philosophy profess that the scientific knowledge is constructed rather than discovered which resides in the individual and gets validated socially. Learning of science concepts involves the introduction of new ways of knowing through the social process of teaching, along with making sense of the natural world through personal observation and thought by connecting to earlier ideas.

The world is becoming increasingly technical; Science teachers are responsible for preparing students for this technology. They should emphasize the quality of their students' learning rather than just the quantity. Conceptual Understanding is more important than rote memorization. Science teachers should emphasize the process of Science rather than just the content, because students who understand the process are better prepared to acquire Science content on their own. The knowledge of Science changes quickly and the updating of one's knowledge is a lifelong activity. Conceptually based, process-oriented instruction calls for a lot of hard work on the part of both teachers and students. There is now enormous body of research on student learning in science which focuses on the ideas students bring with them to the class, and these affect how and what they learn. Teachers and students must actively organize, elaborate and interpret knowledge and prior and present experiences not just repeating and memorizing the concepts.

One of the aspects of constructivism according to Kelly (1995) is that 'Every man is Scientist; every person construct the world by differently testing out their constructions against experience'. Science is the building of a picture of the world. It is an intellectual enterprise aimed at understanding the world. So, the constructivism in Science is germination, incubation, creation, construction & innovation.

Learning, the process of acquiring new knowledge, is active and complex. This process is the result of an active interaction of key cognitive processes, such as perception, imagery, organization and elaboration. These processes facilitate the construction of conceptual relations. The psychology of learning Science holds the response to the challenge of increasing students' understanding of Science. Mugging up more Science facts and principles at the students is not the ultimate solution to achieve meaningful learning, providing the laboratory facilities is not the answer either; a trendy emphasis on "hands on" will not, by itself, increase students' understanding of Science. What is most important is a "minds on" emphasis in the learning of Science. for example, high students should be required to understand what is meant by important concepts in biology (e.g. Photosynthesis and cell division), chemistry (e.g., chemical equilibrium and periodic table), Physics (e.g., gravitational potential and electromagnet induction) to test students' understanding, they should be asked to explain these ideas. When the students' explanations are not clear, they should be required to clarify them.

Teachers should require students to reason scientifically. One way can do this is by modeling scientific reasoning for their students. In effect, teachers and students become collaborators in the process of scientific reasoning. Together, teachers and students should construct interesting questions about Science phenomenon; teachers and students should guess and hypothesize about the underlying causes of Science phenomena, teachers and students should collect data and design scientific tests of their hypotheses, and finally should construct models and theories and explain the phenomena. Throughout this collaboration teachers and students should be engaged in the activities that increases the thinking process. Teachers can help students to reflect on their own scientific reasoning processes that are metacognize their thinking. Teachers can consider the children play as a significant source of Science learning, which leads to the development of skills in observation and experimentation, testing of ideas and it provides an opportunity to independently discover the order of nature. (Semper, 1990).

Science teachers sometimes view students as human video cameras; passively automatically recording all the information in a text book (Murthy, 2005) instead teachers should view students as active participants, who are selective and subjective in their perception. The learners prior knowledge, interest determines what they learn, one size does not fit all, accordingly no two students learn the same thing in exactly same way, observe a demonstration, listen to a lesson, read a book, do a activity, ideally students will challenge the information they are presented, struggle with it and try to make sense of it by integrating it with what they already know.

In order to learn a concept meaningfully, students must carry out cognitive processes that construct relations among the elements of information in the concept. Should then construct relations between the concept and other concepts. Without the construction of relations, students have no foundation and framework on which to build meaningful conceptual networks. The meaningfulness of these networks depends on both the elements of information that comprise the networks and the relations that weld the elements together. Building conceptual map will surely help the learners and teachers to understand the Science better. The learning of Science is a process of construction and reconstruction of personal theories and models. Science teachers should view instruction as a process of helping students acquire progressively more sophisticated theories and models of Science phenomenon. Teachers should take students' beliefs into account when developing curriculum plans.

It is natural for students' progress through a sequence of theories and models because the stage of intellectual development that the students happen to be imposes limitations on the sophistication of the theories and models that can be understood. For example, elementary-school children usually are taught to think of electricity and magnetism as two different forces. It may be until high school that the children are taught that these two forces are actually manifestations of one electromagnetic force: electric currents produce magnetic fields, changing magnetic field also produce electric currents. To teach such things is considered challenging for the Science teachers. To counteract misconceptions in Science and facilitate conceptual change, teachers should encourage students to question come in their mind, demonstration can be carried out to refute misconceptions; however, these demonstrations will be discounted by the students as unrealistic unless the teacher can connect the demonstrations to the students' personal theories, models and real world experiences.

At the national level, National Curriculum Framework for school education (2000), brought out by the National Council of Educational Research and Training (NCERT) emphasized viewing the child as constructor of knowledge. Learning of Science up to secondary stage needs to be replaced by learning of Science and technology in view of strong organic linkages between the two. It also recommended the following:

- Scientific attitudes and skills should be developed.
- Students are needed to be exposed to the nature and structure of Science and the support it provides to the technological developments.
- Learning of Science would be built around natural and social environment.
- Focus would be on understanding of concepts and applications in the areas of matter and its properties, energy, relationship of various physical processes and the technological applications of principles of Science.
- Practical activities to be chosen should have relevance for further life through acquisition of skills and values.
- Emphasis on 'learner centered approach'.
- Critical, creative and generative thinking has to be developed.
- Flexibility in experimentation needs to be widely promoted.
- Improvisation should be encouraged but designing would also be provided as a component of exploration.
- Teachers could help the learners devise appropriate experimentation and activities within and outside the school.

1.5 ICT Aided Constructivist Science Education

Educational technologies are being refined to meet the specific needs of Science teachers. ICT provide a more "open" learning opportunity, it will cater for more student-centered learning as oppose to "closed" learning opportunity that is more instructor-dependent (Ng, 2002). Thus Constructivism requires a teacher to act as a facilitator helping students become active participants in their learning and make meaningful connection between prior knowledge, new knowledge and the processes involved in learning.

Constructivism and Technology are working hand-in-hand in the present day. Constructivism and Technology allow generating both two-dimensional and three-dimensional objects on the screen. This enables students to view the screen and move the shapes either to another side, turned around completely, or stretched, turned, or

flipped. This gives the students a better perspective of the item which they cannot hold in their hand. They can then develop better understanding of spatial sense. The internet is a breakthrough in technology and has built an endless amount of possibilities for constructivism and technology. Science is greatly aided by the ability to view sketches online, make alterations, hypothesis about specific impacts to structure and then test those impacts with a few clicks of the mouse. Science forums are available from academic institutions to aid in the development of younger students. These forums create a space for constructivism learning at its best, allowing demonstrations of mathematical and scientific theorems and experiments, followed by online discussions open for students and teachers.

The use of computer technology to support learning has been difficult to document and quantify (Clark, 1994; Russell, 1999), leaving the role of computers in the classroom precarious. In the past decade, a sudden resurgence of interest was markedly observed in the classroom use of technological innovations, along with the increased use of the Internet and other digital technologies (Reiser, 2002). The field of Instructional Design and Technology, too, saw the evolution and emergence of alternative approaches, such as cognitive and constructivist theories, that deviated sharply from traditional practices, such as behavioral models. New emphases, like electronic performance support systems, web-based instruction, and knowledge management systems, not only shook the knowledge base of the field, but also widened its horizon across business and industry, the military, health care and education, worldwide. Initiatives, such as situated learning theory and constructivism presented fresh approaches to bring about reforms in the domains of public education and higher education (Jonassen, 1999). A complementary relationship appears to exist between computer technologies and constructivism, the implementation of each one benefiting the other. Jonassen, Peck, and Wilson (1999) call technology as the designs and environments that engage learners. The focus of both constructivism and technology are then on the creation of learning environments. Likewise, Hannfin and Hill (2002) depict these learning environments as contexts in which knowledge-building tools (affordances) and the means to create and manipulate artifacts of understanding are provide for problem-solving activities in Science.

Within this shift in focus from the objectivist to the constructivist context domain, technology can play an integral part in the scientific learning environment. "The richness of the technology permits us to provide a richer and more exciting (entertaining) learning environment, our concern is the new understandings and new capabilities that are possible through the use of technology" (Duffy & Cunningham, 1996). By integrating technology with constructivist methods, such as problem-based learning and project-based learning, learners are more responsible for and active in the learning process (Grant, 2002). Additionally, everyday applications, such as word processors and spreadsheets, become powerful instruments for authentic learning, which is the prime feature of learning of Science. Constructivism offers flexibility to teachers to individualize learning for each student while using technology tools to augment cognitive and metacognitive processes. Perhaps the most useful pieces of available technology for students are hypertext and hypermedia which allow students to browse information in a nonlinear fashion. These data bases contain hyperlinks which give the decision making power as to what to explore next. This type of interactive learning also allows the student to create his or her own nonlinear data bases. "Interactive learning in this context means learning in which inquiry, feedback and ongoing collaboration play important roles" (Barr, 1990). ICT could be used by looking at its positive face and making it as a media and by creating constructivist learning environment for teaching-learning of Science would certainly bring the changes which the present world required.

Science learning is all about the building experiences which allow for observation, experimentation, recording, analysis and understanding of the various phenomena around us. NCF (2006) position paper on Teaching of Science highlights that there are various factors to be considered for effective teaching-learning practices for science. These include the social context of the students, the prior knowledge and the conceptions they have about phenomena around them, availability of lab and learning resources. A good pedagogy must allow for a judicious mix of several teaching learning methods, Integration of ICT, and different innovative strategies like experiential learning, cooperative learning and activity based learning may prove effective methods of science learning and teaching. Activities must be designed so as to allow for constructivist learning possibilities embedded with ICT. Sometimes

physical experiments may be difficult to perform, then educational tools, including multimedia, simulations, virtual laboratories, field trips virtual interactions of learners and teachers can be used to supplement the learning experiences in these situations. Karnataka DSERT position paper on ICT mediation in Teaching-Learning (2012) also suggested the Pre-Service Teachers to use various educational softwares in science teaching learning, like Kalzium. This shows the periodic table and the properties of elements. It acts as an encyclopedia, explaining states of matter, evolution of elements. Basic equations can be balanced using this tool. KStars is desktop planetarium-Astronomy with over 130000 stars and all planets. Stellarium is a desktop planetarium software that shows exactly what you see when you look up at the stars. PhET which is a fun, an interactive simulations of physical phenomena and KTechLab is a tool can be used to build our own circuits and explain their various components.

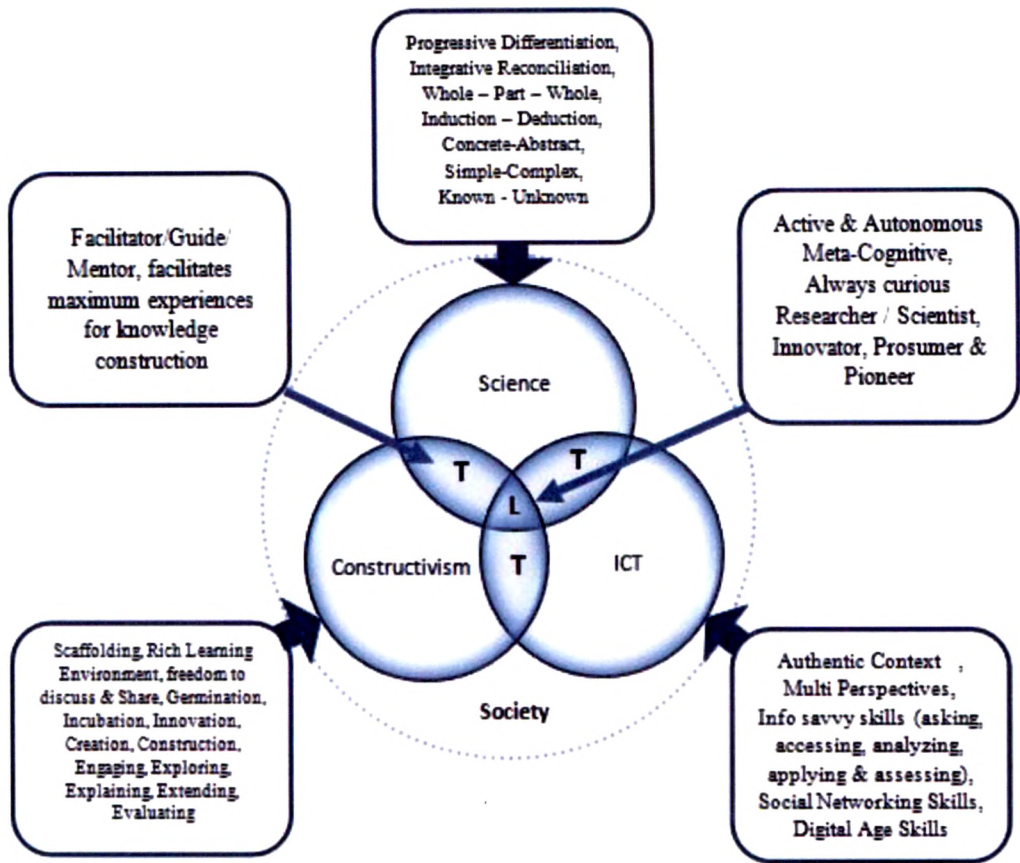
Strommen and Lincoln (1992) make the point that it is not what equipment is used, but how it is used that makes the difference. "The key to success lies in finding the appropriate points for integrating technology into a new pedagogical practice, so that it supports the deeper, more reflective self-directed activity children must use if they are to be competent adults in the future" (Strommen and Lincoln, 1992). In other words, computers and other technology should not be viewed as "add ons," but as tools which are an integral part of a child's learning experience. Teacher cannot be considered as a purveyor of information, the Science teacher must approach his professional responsibility from his own basis of reflection; his responsibility through action, he must be able create learning situations in which the student finds motivation and values in action. Teacher should always question himself that "does the student engage in intellectual activity that ranges from reflection to action?" accordingly he should plan the activities. Secondary school Science program generally presents a more formal development of the content of Science with limited attention to Science and society. Efforts to develop ideas in Science out of relationship with other ideas in the student's experience results simply in ideas in vacuo. The common classroom of question answer, right or wrong would promote only shallow concepts. Science teachers should mediate between individual learner and societal expectation. The educational setting in the school must be characterized by abundant opportunities to learn. The teaching-learning situations should be such that it creates in the student a

disposition to learn and a disposition in the teacher to teach. Such dispositions are favored and promoted by small-group teaching-learning should be facilitated. Today's instructional setting should reflect changed and changing teaching-learning conditions; it is now possible and desirable to teach Science through many innovative approaches, new media, the teacher must develop new approach like constructivist approach with the use of technology for facilitation. Science teaching in the schools should exemplify Science as a process of learning, not as the memorization of factual information in Science as the products of learning.

It has been suggested by LeBaron and Bragg (1994) that the role of technology in education is so important, that it will force the issue of didactic versus constructivist teaching. Teachers will no longer have a choice but will be compelled to use a constructivist approach in a technology-rich environment. According to NCF (2005) providing children more direct access to multimedia equipment and Information and Communication Technology and allowing them to mix and make their own productions and to present their own experiences, could provide them with new opportunities to explore their own creative imagination. In a technology-rich environment one must remember that the educational focus is on learning and instructional goals instead of the technology itself, because technology is merely tools or vehicles for delivering instruction (Campoy, 1992). It is not what equipment is used, but how the equipment is used which makes it relevant to a constructivist classroom. New insights don't happen by osmosis. They come from facing ideas that challenge the familiar ways of viewing issues-Earl & Katz (2002). Integrating these two needs the educational revolution, starting from the research and developments.

1.5.1 Model of ICT Aided Constructivist Learning Approach

Figure 2. Model of ICTACLA



This model has been evolved through ICT Aided Constructivist Learning Approach for facilitating Science Learning.

In this model of ICTACLA the Learner is at the centre of the learning process. The learner is curious, independent, active and interactive. The learner is considered as a Researcher, Innovator and Prosumer. Learners create and construct their own knowledge by connecting previously known ideas to the present unknown ideas to be learned. Thus they are the owners of their knowledge constructed.

The teacher is a facilitator of learning experiences for the process of knowledge construction. He is a guide, friend and philosopher for the learners and supports and motivates the learners. The teacher in the ICTACLA is also a learner; the responsibility of teacher increases in the learner centered approach. The Teacher

always facilitates the continuous interaction between the learner, Science concepts and ICT embedded in the philosophy of Constructivism. The process of evaluation is continuous and interwoven between the learner, teacher and teaching-learning process. The Teacher evaluates the learners, learning strategies, materials and also the self. The teacher appreciates self-evaluation and facilitates meta-cognition of their abilities.

The Science Concepts in the ICTACLA are discussed and cognized through the process of Progressive Differentiation and Integrative Reconciliation that is through whole to part to whole and through induction to deduction, concrete to abstract and simple to complex. The activities are given importance. The hands-on experiments, the demonstrations, the field trips and nature games provide the real learning experiences.

Information and Communication Technology is used as a catalyst for the teaching-learning process. It provides authentic context and multiple perspectives which allow both the teacher and the learner to work interactively for the meaningful learning. ICT helps both the learners and teachers for the individual surfing through Info-Savvy skills, like, Asking, Accessing Analyzing, Applying and Assessing, for the Social networking with different learners, teacher, experts and forums through social networking skills and to interact face to face with the researchers, experts and online groups through Digital Age skills. In nut shell ICT helps and facilitates in the learning process.

The Philosophy of Constructivism lays foundation for active and meaningful learning. The Process of construction of new knowledge by connecting to the prior knowledge through technique of Scaffolding is highly valuable. The freedom of the learners leads to the generation and expression of new ideas. The rich learning environments including Science experiments activities, group demonstrations, virtual interactions, online discussions, classroom peer-peer, peer-teacher interactions, immerse the learners into Germination, Incubation, Creation, Construction and Innovation of ideas.

1.6 ICT Aided Constructivist Learning Approach (ICTACLA) for the Professional Development of Pre-service Teachers

1.6.1 Teacher Education

Enlightened, emancipated and empowered teachers lead communities and nations in their march towards better and higher quality of life. They reveal and elaborate the secrets of attaining higher values in life and nurture empathy for the fellow beings. Teachers are the torch bearers in creating social cohesion, national integration and a learning society. They not only disseminate knowledge but also create and generate new knowledge. They are responsible for acculturating role of education. No nation can even marginally slacken its efforts in giving necessary professional inputs to its teachers and along with that due status to their stature and profession. (NCTE, 2009).

Teacher education is an integral component of the educational system. It is intimately connected with society and is conditioned by the ethos, culture and character of a nation. Teaching is a profession and teacher education is a process of professional preparation and development of teachers. “The quality of nation depends upon the quality of its citizens. The quality of its citizens depends upon the quality of their education. The quality of the education depends upon the quality of their teachers”- (American Commission on Teacher Education), the same can extendable to; the quality of teachers depends upon the quality of the teacher education programme. Teacher Education is a professional preparation for those who want to enter the teaching profession.

Teacher education has to do a variety of functions; to enable teachers to develop the potential of their pupils; to serve as a role model; to help transform education and through its society; to encourage self-confidence and creativity. Pre-Service Teachers need to develop professional attitude, professional competence and professional ethics. Teacher education ought to enhance educational profile of the Pre-Service Teachers. Increasing their knowledge base of the subjects they are to teach, pedagogy and development of skills and competencies. The ultimate aim of teacher education is to prepare effective teachers who are capable of bringing out desired behavioral change in students. Today the teacher education institutions are facing the challenge of preparing a new generation of teachers to effectively use the new learning tools in their teaching practices. For many teacher education programmes this daunting task requires the acquisition of new resources and expertise. No one method of instructions can

prepare teachers to work effectively for the knowledge society, instead approaches must be comprehensive, integrated and varied promising and innovative teaching learning methods should be incorporated in teacher education to prepare quality teachers.

Teacher education is an integrated part of social system. The character and quality of teacher education should be in tune with changing educational and social realities of a society. As establishment has over grown, the enrolment of teacher education programmes are also in large number in India. Same is the status of secondary teacher education. The quality, relevance and compatibility of a large number of teachers who are the products of these teacher education institutions are largely questionable. There is public and private dichotomy in teacher education, the private sector has mainly commercial motive, whereas, the public sector is decaying because of gross negligence. In true sense the product of large number of teacher education institutions is not teacher label able. But, with all ifs and buts the Indian teachers even irrespective of the adverse conditions in which they live, have a zeal for renewal and dedication for teaching.

Teacher education considers the Pre-Service and In-Service Teacher Education as inseparable from each other. The curriculum of Pre-Service and In-Service Teacher Education has to be redesigned to maintain continuity between the two.

1.6.2 Pre-Service Teacher Education

Pre-service teacher education is the education and training provided to student teachers before they have undertaken any teaching. According to NCTE framework (1988), teacher education is a professional programme aiming at the development of teacher as a person and as an agent of social change. It is teaching professional training programme like any other profession. Teacher education by its very nature is interdisciplinary. The major areas of inter-disciplinarily implicit in teacher education programmes include Philosophy, Psychology, Sociology, Anthropology, Economics, History and Culture. Recent researches in medical and life Sciences are opening new avenues of knowledge which are relevant to education. Besides, teacher education has an essential and inalienable component of practical work including student teaching, internship, field work, working with the community, work education, etc. The country needs teachers with different orientation and specializations to manage educational programmes.

The Nature and form of initial teacher education and training are considered as the heart of the teaching profession. They are inextricably interlinked to raise standards in schools and to improve the quality of education. According to NCFTE (2009) Pre-Service Teacher Education must engage with theory along with field experiences to trainees to view knowledge not as external to the learner but as something that is actively constructed during learning. Teacher education should integrate academic knowledge and professional learning into a meaningful whole. Initial teacher education especially, has a major part to play in the making of a teacher. It marks the initiation of the novice entrant to the calling and as such has tremendous potential to imbue the would-be teacher with the aspirations, knowledge-base, repertoire of pedagogic capacities and humane attitudes.

1.6.3 General Objectives

The general objectives of teacher education are (Curriculum Framework for Quality Teacher Education, 2009) to,

- Promote capabilities for inculcating national values and goals as enshrined in the Constitution of India.
- Enable teachers to act as agents of modernization and social change.
- Sensitize teachers towards the promotion of social cohesion, international understanding and protection of human rights and rights of the child.
- Transform student-teachers into competent and committed professionals willing to perform the identified tasks.
- Develop competencies and skills needed for becoming an effective teacher.
- Sensitize teachers and teacher educators about emerging issues, such as environment, ecology, population, gender equality, legal literacy, etc..
- Empower teachers to cultivate rational thinking and scientific temper among students.
- Develop critical awareness about the social realities.
- Develop managerial and organizational skills.

1.6.4 Pre-Service Teacher Education for Secondary Stage

For teaching at secondary stage, the qualification most sought after is one year B.Ed. which is in fact B.Ed. for secondary stage. However, at present, there are several variations for first degree level qualification which are also available. These include B.Ed. (Elementary); B.Ed. (Special Education); which too are programmes of one year

duration; B.Ed. through correspondence or distance education mode which is now of two years duration. There are certain other variations in the form of vacation courses or part-time courses which were available before NCTE norms came into force. In addition, there are four-year integrated courses for elementary stage and also for secondary stage. Teacher education programme at this stage, like at all other stages, will include the theory, practice teaching in schools, and practical work in the light of contexts, concerns, profile of teachers and general and specific objectives.

1.6.4.1 Specific Objectives

The specific objectives at this stage may include the following to,

- Enable the prospective teachers to understand the nature, purpose and philosophy of secondary education.
- Develop among teachers an understanding of the psychology of their pupils.
- Enable them to understand the process of socialization.
- Equip them acquire competencies relevant to stage specific pedagogy, curriculum development, its transaction and evaluation.
- Enable them to make pedagogical analysis of the subjects they are to teach at the secondary stage.
- Develop skills for guidance and counseling.
- Enable them to foster creative thinking among pupils for reconstruction of knowledge.
- Acquaint them with factors and forces affecting educational system and class room situation.
- Acquaint them with educational needs of special groups of pupils.
- Enable them to utilize community resources as educational inputs.
- Develop communication skills and use the modern information technology.
- Develop aesthetic sensibilities.
- Acquaint them with research in education including action research

In Teacher Education teachers who are being educated today will have to devote major part of their life to education during the twenty first century. If the present rate of explosion of knowledge continues, in a few years the teachers will find themselves in a world where their present knowledge and teaching skills to an extent would become obsolete. They will have to face the challenge of electronic media and information

technology. Any change in Educational system demands a corresponding adjustment in the curriculum of the teacher education curriculum renewal therefore needs to be planned as a continuous process and the curriculum of the Teacher Education needs careful definition. The competencies and skills in education of teachers are unrelated to work a situation that is there is mismatch between training and Nature of work in teaching. So the Pre-Service Teacher Education needs to be continuously get abreasted with the present changes and to look that there should not be gap between the theory at college of Education and practice at the school level. In this context only the NCFTE, 2009 highlights importance of bridging the needs of school education and teacher education. That is, Teacher Education Curriculum framework needs to be consonance with the curriculum framework for school education. A teacher needs to be prepared in relation to the needs and demands arising in the school context, to engage with questions of school knowledge, the learner and the learning process. The expectations of the school system from a teacher change from time to time, responding to the broader social, economic and political changes taking place in the society.

1.6.5 Present Scenario of Pre-Service Teacher Education

Studies suggested that in a single year, an average student with a good teacher can progress more than a full grade faster than an average student with a poor teacher (Secondary Education in Karnataka State (SEKS) 2011). Teachers, their competence and skills in the class would be the most important component in supporting quality education. Any effort of introducing new pedagogies or changing the curricula is critically dependent on teachers themselves. Due to emphasis on Universalization of Secondary Education the focus has shifted to the secondary teacher education sector. In addition to improve the quality of existing teachers through in-service programs, quality of future teachers required to be ensured through improvement in quality training provided in pre-service secondary teacher education colleges.

Pre-Service Teacher Education is a multidisciplinary area in which it draws basic theories from other disciplines such as Psychology, Sociology, Philosophy and similar such disciplines. This has helped Teacher Education in giving it a more inclusive and comprehensive character. Presently Teacher Education has not kept pace with enormous changes taking place in these disciplines and still adheres to the older theories which have been already replaced by novice theories, Poor quality of teacher

education due to backdated curricula, poor professional preparation of teachers and teacher educators, and isolation of the teacher education institutions from the school system and institutions of higher learning and universities. Transaction of training in teacher education institutions are based largely on traditional lecture methods which are inappropriate for new generation of students with access and skills to handle ICT. (SEKS, 2011). The present Pre-Service Teacher Education system is under pressure to provide teachers who would be capable of dealing with the learners who are the part and parcel of the globalised and highly technical world. Contributing the competent teachers to the society to create and manage the quality education is highly challenging. In the realm of higher education teacher education is finding its niche and also it is undergoing rigorous research and development. Presently there has been observed the mushroom growth of teacher education colleges. The present teaching communities need to face the challenges developed by the Science and technological knowledge and also the means to achieve the knowledge. To keep pace with these changes the colleges of teacher education needs to be highly resourceful in various respects. But the present condition is that the teacher education colleges do not possess the even minimum facilities required. Also in the Pre-Service teacher education programme there is mismatch between the training and nature of work in teaching in school (NCERT, 1996). By and large the pre-service teacher programmes are conventional in nature; there is less importance for Innovations and most of all the classes are conducting in stereotypic methods. In Teacher Education the pre-service teachers are the learners hence there is no Pre-Service Teachers-centered education. In Teacher-Education the content skills, communication skills, developmental skills, adaptability skills, inter-personal skills and evaluation skills are missing but they are much needed. Position paper on Elementary Teacher Education in Karnataka State D.Ed. Curriculum emphasizes that Constructivist approach has not given due importance and Pre-Service Teachers are not trained to use ICT in the teaching-learning process, accordingly the efforts have been made to incorporate in the curriculum and the traditional theories of acquisition of knowledge and skills have been replaced by Constructivist theories, which are yet to be introduced in the Secondary Teacher Education programme. There is need to provide orientations on recent innovations in the teaching field to Teacher Educators also. There is no constructivist environment in the Pre-Service teacher education colleges for the creation, construction and incubation of novice ideas. The teachers are getting

prepared by the past curriculum in the present and for the future children. Here the process of preparing the teachers itself doesn't involve the logic of keeping pace with the changes. The practical part of teacher education is less emphasized. There is least scope for interaction among pupils and the nature. There is less experimentation and research on new teaching-learning strategies. There is less knowledge construction. Covering the syllabus prescribed has become the only duty of teacher educators. The Science laboratories are not functional in nature and they are hardly showing their dummy presence. The computer laboratories have become the show case pieces in most of the Pre-Service Teacher Education programmes. Integration of Technology has least presence and there are no facilities for the integration of ICT including physical and human resources. There are problems of quality perception, quality scaling and quality differentiation and significant variance between expected and actual quality in Teacher Education (Goel & Goel, 2012). Strong connection needs to be constructed between teacher education and school education in order to minimize the gap between theory and practice. Teacher education programmes provides little scope for Pre-Service Teachers to reflect on their experiences (NCFTE, 2009). This means that importance to Pre-Service Teachers' own experiences, meta-cognition, and Pre-Service teacher's oriented activities are less emphasized. NKC (2008) also revealed that both pre-service and in service training of school teachers is extremely inadequate and also poorly managed in most states. Further recommended that pre-service training needs to be improved. Wherever feasible, ICT should be made more accessible to teachers, students and administration for learning, training, research, administration, management, monitoring, etc. This requires the provision of more facilities such as computers as well as connectivity and broadband facilities. Computer-aided learning also requires training of teachers and other staff in order to make the best use of the technology.

Teacher Educators should be self-motivated, as well as motivate all the Pre-Service Teachers and develop positive attitude towards the profession of teaching. There is dire need that the traditional teaching-learning processes should get transformed towards innovative, effective and efficient approaches. The laboratories should be made highly functional. Apart from this a lot of opportunity should be given to Constructivist Environment for Science Pre-Service Teachers for experimentation of scientific concepts, creation and construction of new ideas.

1.6.6 ICTACLA for Professional Development of Pre-Service Teachers

According to the Educational Resources Information Centre (ERIC) database, professional development refers to the “Activities to enhance the professional career growth, such activities may include Pre-service education, In-Service education, Continuing education, Peer Collaboration, Study Groups, and Peer Coaching or Mentoring”.

Fullan (1992) expands the definition to include “The sum total of formal and informal learning experiences throughout one’s career from pre-service teacher education to retirement”. Professional preparation and development goes beyond the term ‘training’ with its implications of learning skills. It encompasses a definition that includes formal and informal means of helping teachers not only learn new skills but also develop new insights into pedagogy and their own practice and explore advanced understandings of content and resources. Current technologies offer resources to meet their challenges and provide teachers with a cluster of support that help them continue to grow in their professional skills, understandings and interests. Professional and academic orientations would provide the future teachers for the development of professional insights and extending horizons in Science.

According to NCTE (1998), the professional preparation of students who want to enter the profession of teaching, teacher education prepares them, for attaining the national goals of education for all, to preserve the continuity of traditions, to fulfill the actual needs of contemporary society to meet the challenges of the uncertain future, through education. Pre service teacher education develops better understanding of children, builds the confidence, makes them familiar about methodology of teaching with new techniques, builds positive attitude towards the teaching profession, familiarizes with latest knowledge of the profession, and develops attitudes towards research and experimentation. According to NCF (2005), reorienting the curriculum must be among our highest priorities, informing the information of teachers, the annual plans of schools, the design of textbooks, learning materials and evaluation patterns. The Yashpal Committee Report (1993), *Learning Without Burden*, noted: “The emphasis in these programmes should be on the enabling trainees to acquire the ability for self-learning and independent thinking” and This committee drawn attention to the need for the involvement of teachers in curriculum and textbook preparation and training teachers in fostering learning through activity, discovery, observation and understanding. Teacher education must become more sensitive to the emerging

demands from the school system, for this it must prepare the teacher for the roles of being an: encouraging, supportive and humane facilitator in teaching-learning situations to enable learners to discover their talents, realize their physical and intellectual potentialities to the fullest and to develop character and desirable social and human values to function as responsible citizens and active member of a group of persons who makes a conscious effect for curricular renewal so that it is relevant to changing societal needs and the personal needs of learners.

To be able to realize this vision, teacher education must comprise the following feature:

- Understand the way learning occurs and to create plausible situations conducive to learning.
- View knowledge as personal experience constructed in the shared context of teaching-learning, rather than embedded in the external reality of text books.

Teachers need to be prepared to view learning as a search for meaning out of personal experience and knowledge generation as a continuously evolving process of reflective learning, view knowledge not as an external reality embedded in textbooks, but as constructed in shared context of teaching-learning and personal experience, appreciate the potential of productive work and hands-on experience as pedagogic medium both inside and outside the classroom.

Multimedia technology allows teachers to bring the real world to the learner through the combined use of two or more media such as sound, images, text, animation, and video. Multimedia can be used in any suitable mode to be both a presentation device as well as an enabler to learning and is therefore dependent on the strategy or methodology of use of media. This is well supported by the various approaches like constructivist approach using information and communications technology. And that as the ICT provide a more open learning opportunity, it will cater for more student-centered learning (Ng, 2002).

Technology can be used as effective tool to create new opportunities for learning and to promote student achievement. Educational technology aided any kind of pedagogy is not, and never will be transformative on its own. However it requires the assistance of educators who integrate technology into the curriculum, and align it with student learning goals. Teacher quality is the factor that matters most for student learning (Darling and Hammond, 1998). Therefore professional development of teachers becomes the key issue in using technology to improve the quality of learning in the

classroom. Recently there is much development in the use of technology in teaching-learning Science. There seems to much promise in the classroom laboratory audio-visual field, computerized instruction, virtual teaching and learning. The proper instruction of implementation of technology needs to be developed on the part of teachers.

According to DSERT position paper on ICT mediation in teaching-learning (2012) diversified use of technologies is more appropriate than using only computers. Hence ICT's in pre service teacher education need to envision the inclusive and significant use of Radio, TV, computers, video conferencing, teleconferencing, mobile telephony, Internet etc. These interventions are used not only for continuous on the job professional development but also as tools to enrich class room teaching and learning processes. Student-teachers need to be given opportunity to prepare lessons using ICT tools during their practice teaching as well. They are required to participate in projects that encourage them to collaborate amongst themselves using a variety of digital methods. Blended models also allow for greater possibilities for addressing the diverse and heterogeneous learners needs, since the teaching-learning is not restricted to the classroom and virtual learning spaces allow for greater one-one interactions, at space and time convenient to the teacher-educators and student teachers. Thus blended models can allow for catering to diverse learning needs, contexts and aspirations.

Lack of technology use for the professional development is one of the most serious obstacles to fully integrate technology aided pedagogy into curriculum. But traditional sit and get training sessions or one time only workshops have not been effective in making teachers comfortable with using technology or to adopt and integrate it into their lesson plans, instead, a well developed program that is tied to the school's curriculum goals, designed with built-in evaluation and sustained by adequate financial and staff support is essential if teachers use ICT Aided Constructivism appropriately to promote learning for all students.

According to National Curriculum Framework (2005), Teachers need to be prepared to understand children within social, cultural and political contexts, view learning as a search for meaning out of personal experience and knowledge generation as a continuously evolving process of reflective learning. View knowledge not as an external reality embedded in the text book but as constructed in the shared context of teaching-learning and personal experience.

There have been major shifts in teacher education programme. Understanding the learner needs to be given priority. The learner is seen as an active participant rather than a passive recipient in the process of learning, and his/her capabilities and potential are seen not as fixed but dynamic and capable of development through direct self-experience. The curriculum will be designed so as to provide opportunities to directly observe learners at play and work; assignments to help teachers understand learners’ questions and observations about natural and social phenomenon; insights into children’s thinking and learning; and opportunities to listen to children with attention, humor and empathy.

Another major shift in understanding the impact of the social context in educative process. Learning is greatly influenced by the social environment/context from which the learners and teachers emerge. The social climate of the school and classroom exert a deep influence on the process of learning and education as a whole. Given this, there is a need to undertake a major shift away from an overwhelming emphasis on the psychological characteristics of the individual learner to his/her social environment. Learning in school should influence and enhanced by wider social context outside the school.

Table: 1 Major Shifts Needed in Teacher Education

Major Shifts Needed in Teacher Education	
From	To
Teacher-centric, stable designs	Learner centric, flexible process
Teacher direction and decisions	Learner autonomy
Teacher guidance and monitoring	Facilitates, supports and encourages learning
Passive reception in learning	Active participant in learning
Learning within the four walls of the classroom	Learning in the wider social context
Knowledge as “given” and fixed	Knowledge as it evolves and is created
Disciplinary focus	Multidisciplinary focus
Linear exposure	Multiple and divergent exposure

(NCF, 2005)

The shift is also from personal development to professional development, acquiring knowledge to using the knowledge, individual growth to group of school wide accountability. In the present world of Science and technology, only university prescribed syllabus is not sufficient for pre-service teachers, so preparing them to accommodate to the existing conditions the integration is required.

The role of classroom teacher is the crucial factor in the full development and implementation of technology and other pedagogy to be used. The transformation of classroom technology from hardware, software and connections into tools for teaching and learning depends on knowledgeable and enthusiastic teachers who are motivated and prepared to put technology to work on behalf of their students. A well developed professional development program is essential to reach the goal of preparing teachers for effective teaching.

Professional development of teachers is imperative to capitalize on the potential of new technology as a learning tool. Professional development should enable the teachers to construct professional knowledge about pedagogy, content and technology, as well as, strategies for managing the classroom involvements brought about by the creation of constructivist learning environment supported by technology. To achieve this, teachers should be given appropriate learning experiences. These experiences should be situated in an authentic context for teachers in their school and classroom. It should build on their prior knowledge and provide opportunities for social interaction with colleagues. It should begin with investigation of problems supported by technology that are relevant to teachers. Such learning experiences enable the teachers to create learning environment appropriate for children of the information age. ICT involved education helps the pre-service and in-service teachers to become capable to the present competitive classrooms. According to NCF (2005), the judicious use of technology can increase the reach of educational programmes, help the specific learning needs and management system. The mass media can be used to support teacher training, facilitate classroom learning and be used for advocacy. The increasing use of internet has enabled sharing of information and providing space for debate and dialogue on diverse issues. Technological innovations are also necessary for requirements for the children with special needs. The technology could be integrated with the larger goals and processes of educational programmes rather than viewed in isolation or as an add-on.

According to Maor (1999), we can create a learning environment by integrating constructivist theory and ICT into our educational institutions. This will be made possible by,

- Developing greater motivation among the teachers
- Making workforce more flexible and creative
- Reducing isolation among teachers
- Making teacher a facilitator of knowledge construction
- Improving social interaction and Sharing knowledge
- Sharing responsibility for the total development of students and collective responsibility for students' success.
- Developing interdependency and interdisciplinary approach
- Breaking down the traditional communication barriers
- Changing the role of the student , teacher and community
- Providing access to the information resources and focusing on learning with technology
- Encouraging innovation and creativity in our educational institutions.

The Kothari Commission (1964-66) mentioned that the professional development of teachers in order to prepare them effectively, teacher education must be bring in to the main stream of academic life of universities. And introducing integrated courses of general professional education in universities, using methods of study which have greater scope for study and discussion for the professional improvement.

The School environments in which teachers work, and the demands placed upon them by society are increasingly complex. Teachers strive to equip learners with a wide range of skills that they are in urgent requirement to take their place in a world that is in continuous evolution; this accelerates the need for the development of teachers with more competence-centred approaches to teaching. In the constructivist classes the pupils are increasingly expected to become more autonomous learners and to take responsibility for their own learning. All the students are from different cultures, backgrounds and different learning abilities. In such context even initial teacher education of the highest quality cannot provide teachers with the knowledge and skills necessary for a lifetime of teaching. Teachers are called upon not only to acquire new knowledge and skills but also to the need for indicators on teachers' professional

development to develop them continuously. The Professional Development of every teacher needs to be considered as a lifelong task, and be structured, restructured and resourced accordingly. To get equipped with new roles of teaching in the century, it is necessary to have both Pre-Service and In-service Professional development orientations as with any other modern profession, teachers have a responsibility to extend the boundaries of professional knowledge through a commitment to reflective and constructivist practice, through research, and through systematic engagement in continuous professional development from the beginning to the end of their careers. School systems and Teacher Education Institutes need to provide them with the necessary opportunities. This in turn presents teacher education institutions, teacher educators and schools with fresh challenges when developing or implementing programmes for both Pre-Service teachers and practising teachers, and helps for their professional development. NCFTE, 2009 recommended that current models of teacher education at all levels of school education be gradually replaced by models of teacher education that integrate general education with professional development along with intensive internships with schools.

If the school teachers are expected to bring about a revolution in their approach to teaching, then the same revolution must precede in the Colleges of Education. So in the present study the importance of teacher's preparation and support for the successful implementation of constructivist approach using ICT as tools for the teaching is emphasized. There is a need to equip teachers with competencies to use ICT for their own professional development (NCF, 2009). ICT stands for the seamless incorporation of technology to support and enhance student engagement in meaningful learning and for attainment of curriculum objectives. ICT will increase the role of the teacher in the classroom. ICT on its own can never evoke learning. So the role of the teacher is a must.

Constructivist classes reveal a shift in thinking in all respect of classroom teaching and learning processes. One needs to shift from traditional view of teaching to constructive view of learning. Kelly's (1991) idea of personal construct holds good here, that is the idea that our beliefs about teaching and learning affect our classroom practice, as well as our ability to change our practice. So in professional orientation programme in this study, the researcher tried to build the strong belief about the ICTACLA among

Pre-Service Teachers. The responsibility for the professional development of teachers falls largely on the teachers themselves, they should be get updated themselves with the help of modern technologies. University instructors that is teacher educators in colleges of education need to model constructivist practices and provide supportive assistance to pre-service and in-service teachers as they grapple with these practices in their practicums and internships. Resource information about constructivist philosophy and practices oriented in terms of that respects teachers' current personal and practical knowledge would perhaps make personal and professional development toward a constructivist practice appealing. Information presented in a friendly and creative style may encourage teachers to embark on their own professional development journeys and may encourage teachers to be less reserved about risking innovative practices, thus beginning a developmental process of change.

It is not easy to adopt ICT Aided Constructivist Learning approach directly, for this teacher has to be prepared enough. In the constructivist classroom the responsibility of the teachers will be more. Teachers should be well versed in the knowledge and principles of constructivist approach. Here the knowledge is actively built, so teachers should provide the suitable learning environment like engaging students in learning, encourage group interactions. Teachers should nurture students' natural curiosity through frequent use of ICT. And provide the knowledge of ICT in various forms. So to achieve all these teachers must know the constructivist approach and ICT in order to teach to their students. When their support of ICT in the process of teaching, teachers also feel enthusiastic to teach and it will help to make the abstract ideas into concrete one. In order to achieve this teachers have to be trained well before, they need professional development programs regarding ICT and Constructivist approach. According to National Focus group (2000), in pre-service teacher education there is need to introduce use of media and technology-enabled methods of learning, making it inherent and embedded in the teaching-learning process of teachers, and to enable trainees teachers to access sources of knowledge and to create knowledge. It needs a paradigm shift and willing abandonment of familiar perspectives and practices and the absorption of new ones (Brookes, 1993). Teachers who are not familiar with the constructivist approach using ICT as tools may first require a change in the educational philosophy (Healy, 1998). So here in the present study ICT Aided Constructivist Learning Approach for Pre-service teachers has been emphasized.

1.7 Review of Related Literature

As Knowledge is cumulative, the construction of the knowledge is also expanding, each and every knowledge constructed through research and discovery will always contribute and lead to further research in the same and related areas. The meaningful review of earlier researches on the related fields plays a significant role and provides an insight to a distinct area to be focused. In the present study the review of related literature has been done mainly on the Theoretical literature and studies based on Constructivism, ICT Aided Constructivism, ICT Aided Constructivist Learning Approach for Professional Development of Teachers.

1.7.1 Review of the Theoretical Literature

The purpose is to thoroughly examine the corpus of theory that has accumulated with regards to an issue, problem or phenomenon. The theoretical literature review helps to find what theories already exist, the relationships between them, to what degree the existing theories have been investigated, and to develop new hypotheses to be tested. Often this form is used to establish that current theories are inadequate for explaining the research problems. The unit of analysis can focus on a theoretical concept or a whole theory or a framework.

“As long as there were people asking each other questions, we have had constructivist classrooms. Constructivism, the study of learning, is about how we all make sense of our world, and that really hasn’t changed.”- **Brooks (1999)**.

Constructivism is not a new concept. It has roots in philosophy and has been applied to sociology and anthropology, as well as, cognitive psychology and education. The concept of constructivism has roots in classical antiquity, going back to Socrates’s dialogues with his followers, in which he asked questions that lead to his students to realize for themselves the weaknesses in their thinking. The Socratic dialogue is still an important tool in the way constructivist educators assess their students’ learning and plan new learning experiences. **John Dewey (1916)** and **Jean Piaget (1926)** developed theories of childhood development and education that lead to the evolution of Constructivism. Piaget believed that children conceptualize the ideas through the construction of one logical structure after another, he also concluded the logic of children and their modes of thinking are initially entirely different from those of adults. The implications of this theory and how he applied them have shaped the

foundation for constructivist education. Dewey called for education to be grounded in real experience. He wrote “if you have doubts about how learning happens; engage in sustained enquiry: study, ponder, consider alternative possibilities and arrive at your belief grounded in evidence.” Inquiry is a key part of constructivist learning. Dewey said that learners are active participants in knowledge acquisition and engage in restructuring, manipulating, reinventing and experimenting with knowledge to make it meaningful, organized and permanent. Learning is an internal process influenced by the learners’ personality, prior knowledge and learning goals (Davidson, 1995).

The learning of Science is no less than scientific research itself, is in its own way an investigative and is constructive process. Recent trends in Science teaching have seen phrases such as “students construct their own knowledge” or “student constructs their own knowledge based on the existing schemata and beliefs” aspects of constructivist theory can be found among the works of Socrates, Plato and Aristotle.

Kelly (1955) postulated the theory of personal constructs which says that, like scientists, we continually hypothesize about experience; formulating expectations based on a template of reality we have created through experience and reflection. We come to believe something through accumulated experience about it and then interpret experience according to those beliefs. These hypotheses, or personal constructs, may be modified with new experiences, but some are continually reinforced and confirmed, until, over time, they may actually shape experiences whereas when they were developing, experience molded them. This goes with the lines of Piaget’s concepts of assimilation and accommodation.

Bruner (1966), initiated curriculum change based on the notion that learning is an active, social process in which students construct new ideas or concepts based on their current knowledge.

Ausubel (1963), examined the relationship between the process of meaningful learning and learner’s existing cognitive development, he maintains that learning takes place through an interaction between new materials and relevant prior knowledge that exists within the learners’ cognitive structure. Meaningful learning is learning with understanding.

Vygotsky (1978) introduced the social aspect of learning into constructivism. He defined the “zone of proximal learning”; according to which students solve problems beyond their actual developmental level in collaboration with more capable peers.

Lerman (1989) and Kilpatrick (1987) suggested that the knowledge is actively constructed by the cognizing subject, not passively received from the environment, coming to know is an adaptive process that organizes one’s experiential world; it does not discover an independent, pre-existing world outside the mind of the knower.

Glaserfeld (1987) described constructivism as a "theory of knowledge with roots in philosophy, psychology and cybernetics" proposed Radical constructivism and said that the Knowledge is not a transferable commodity and communication not a conveyance. According to him constructivism does not claim to have made earth-shaking inventions in the area of education; it merely claims to provide a solid conceptual basis for some of the things that, until now, inspired teachers had to do without theoretical foundation. In 1984, he developed a model of radical constructivism, which claims that since all experiences are subjective, knowledge and interpretation of that knowledge is also subjective, and thus constructed by the individual.

Poplin (1988b) summarized the principles of constructivist learning theory in to three categories, structuralist values, constructivist beliefs and holistic thought. According to him the learning takes place by actively engaging the learner in authentic problem solving situations. While incorporating the above principles of constructivist teaching in developing an instructional technique called Proleptic Instruction.

Wheatly (1991) hold the idea that the theory of constructivism rests on the two main principles. Principle one states that knowledge is not passively received, but is actively built up by the cognizing subject. Principle two states that the function of cognition is adaptive and serves the organization of the experiential world not the discovery of ontological reality. Thus we do not find truth but construct viable explanations of our experiences.

Papert (1991) did groundbreaking works in using computers to teach children, have lead to the widespread use of computer and information technology in constructivist environments. Through trial and error, peer cooperation and hands on activities students are able to envision and discover new possibilities of and within themselves.

The constructive perspective of learning states that "knowledge is built by the learner, not supplied by the teacher" (Papert, 1990). Here, Papert distinguishes between 'instructionism' and constructivism where instruction connotes more control and directiveness while constructivism connotes a flexible setting that fosters and supports learning. Creating such learning environments seems intrinsically problematic. Therefore, it is important that careful planning and design to the extent possible is employed, and that the environment also includes proper support and guidance and rich resources and tools.

Brooks (1993) explained the constructivist is far more panoramic and therefore elusive. They claimed that teachers should not look for what students can repeat but for what they can generate, demonstrate and exhibit, they have five guiding principles of constructivism: i. using the problems of relevance to the students in instruction; ii. Learning is structured around primary concepts. iii. Valuing students' point of view; iv. Adapting curriculum to address students' suppositions; and v. Assessing students learning in the context of teaching.

Biggs (1999) contrasted between two teaching strategies, one on what teacher does and the other, on what the student does and came to the conclusion that the latter to be more effective. Hence, new learning and teaching strategies may have to be introduced to prepare students to become independent learners.

Soloman (1999) is of the opinion that there are many ways technology can be used, but the best way and the most instructionally sound are those that provide students with real and authentic experience. Authentic episode in the classrooms can help would-be teachers to examine the events and reflect on the solutions, it could lead to peer discussion of real life encounters in the classroom.

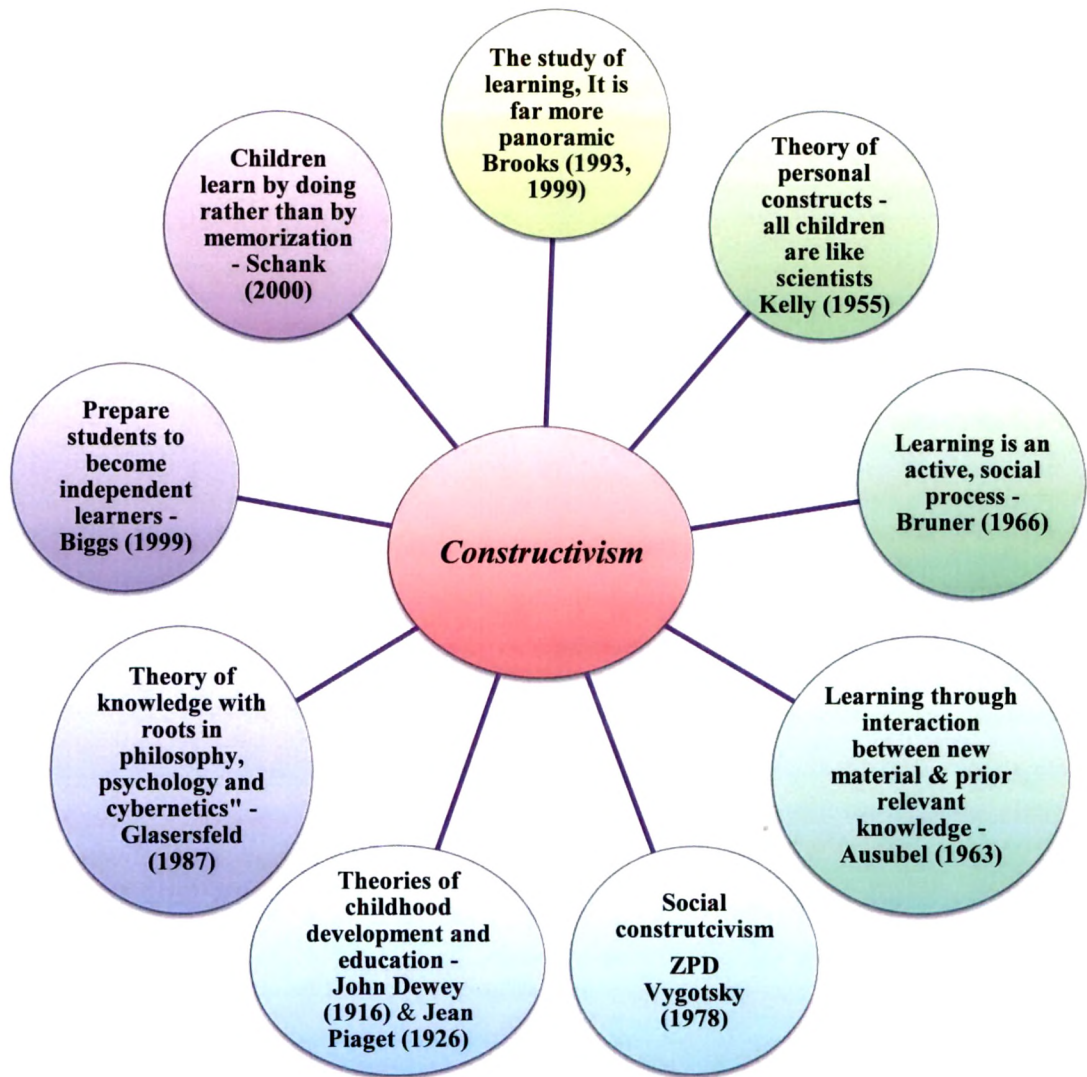
Schank (2000) believed that children learn by doing rather than by memorization and testing. Furthermore, children learn best within the context of goal based scenarios, which provide an authentic context, experience and purpose, thereby motivating children to learn. Emphasized the practice of skills that are relevant to the real world experience of the student.

Matthewes (1994) believes that constructivism attempts to steer a path between teacher-dominated instruction and student-led discovery learning. The contrast with the extreme didacticism is reasonably clear cut but the contrast with discovery learning

is less so. He argues that a discovery approach class would pass for a constructivist one and any difference between the two is mainly philosophical rather practical. According to **Phillips (1997)** that the difficulties that in dealing with constructivism begin with the very first attempt to present even an approximate definition of it, "The situation has become so confusing that to be told that a particular individual is a 'constructivist' is to acquire no useful information whatsoever". **Ernest (1995)** also points out that "there are many varieties of constructivism as there are researchers". His idea may be which type to follow or which not to follow, but one can go according to the situations of the classroom and the concept to be dealt. Some teachers may integrate all possible types to deal with varied children. **Tobias (1991)** it is preposterous to expect every student to be another Darwin, Newton and Einstein. But it is highly important and timely in having faith that all learners will be the discoverers of their own leaning and creator of the meaning to the learning. **Airasian and Walsh (1997)** "Constructivism seems to pass the onus of creating or acquiring knowledge to the student". But in constructivist classes it is not entirely responsibility of learners to learn on their own, the guidance and facilitating the environment will be always there on the part of teachers.

Derek (2008), since Constructivism is receiving a growing amount of attention and is having an impact on pre-service training, it can no longer be regarded as an exercise in lateral thinking designed to stimulate innovation. Its fundamental premises need to be examined and the implications of constructivism need to be explored.

Figure 3. Concept Map of Theoretical Literature



1.7.2 Reviews of Related Studies on Constructivism

McDavitt and David (1995) investigated the effectiveness of experiential learning in promoting student understanding and achievement, as compared to traditional expository instruction. The sample has divided into two heterogeneous groups and taught a single lesson on air using identical content objectives. The control group was taught through expository instruction while the experimental group taught using constructivist, experiential techniques. The expository lesson consisted of lecture, note-taking, reading, viewing diagrams, answering and asking questions, filling out worksheets, and memorizing facts and vocabulary. The experimental lesson comprised 10 hands-on experiments that the students carried out alone, in small groups, and as a class, with each student recording hypotheses and results and with discussion of the experiments taking place. Each group was given the same assessment tool, which tested both lower order and higher order learning outcomes. Results indicated that experiential learning produced higher achievement at all levels of thought for learners of all ability levels. They recommend that the entire educational system recognize and make use of children's natural cognitive processes through system-wide experiential education.

Lord (1997) compared student learning in two sections of an introductory college biology course for non majors. Groups were taught in the traditional teacher-centered, lecture/laboratory format (86 students) and in a student-centered constructivist format (98 students). The latter group performed significantly better on the same tests, maintained a better attitude throughout, and enjoyed the course more.

Paulson (1999) evaluated the findings of a 15-year study that addressed the efficacy of the inclusion of active learning and cooperative learning instructional methods in lecture formatted organic chemistry courses. Of particular note is that the study encompasses his students only, and the same types of student assessments were used through the duration of the study (essay tests). It is found that percentages of students passing the course increased with the inclusion of student-centered teaching.

Gibson (2000) examined the impact of constructivist instructional methods on pre-service teachers' attitudes towards teaching and learning Science. It was reported that constructivist teaching methods improved pre-service teachers' perceptions.

Dethlefs (2002) investigated the relationship between constructivist learning environment to student attitudes and achievement in high school mathematics and in terms of self efficacy, intrinsic value and learning strategies in Algebra and Biology, further these relationships were examined as a function of student gender and prior achievement. A purposive sample of 804 high school students enrolled in Biology and Algebra were selected for the study. Although the dimensions of constructivist learning environment that contributed to predicting students achievements and attitudes varied by content area and criterion, the results of the present study generally provide strong support for the positive relationship between constructivist learning environment and student attitudes and little support for a direct relationship to student achievement. Teacher's reports of overall constructivist learning environment were not co-related with achievement or attitudes. Observer reports of constructivist learning environment were co-related with students' intrinsic value and learning strategies. Students' reports of constructivist learning environment were correlated with all three attitude measures. Multiple regression findings showed that neither overall constructivist learning environment nor standard based teaching practices achievement in any content areas. Overall constructivist learning environment and standard based teaching practices were significant positive predictors of students' intrinsic values and learning strategies in all the three content areas after controlling for student and classroom demographic variables. Both were also significant positive predictors of self-efficacy in Algebra. An addition, standard-based teaching practice was a significant positive predictor of students' self efficacy in Biology. No specific dimensions of constructivist learning environment were consistently related to student achievement. However several dimensions of constructivist learning environments emerged as significant predictors of students' attitudes, including personal relevance, shared control and student negotiation.

Akar (2003) examined the impact of constructivist learning process on pre-service teacher education students' performance, retention, and attitudes in Classroom Management Course. An experimental design and a case study design were used together. In the sample, the experimental group was subjected to social constructivist learning process, while the control group was subjected to traditional instruction for eleven weeks. Data were collected through qualitative and quantitative methods. Findings show that posttest scores were not statistically different between the experimental and the control groups. However, a significant difference was found in

the retention scores in favor of the experimental group. The conceptual change the learners went through was evident in their metaphorical images which tend to change from a more controlling image to images that depict leadership, sensitivity to individual differences, and student learning. Descriptive findings indicate that retention was fostered through constructivist activities that mainly included reflective writing, critical thinking, and problem solving. Factors such as active learning, meaningful and enjoyable learning environment, and the attitudes of instructors had a positive impact on student learning. Nevertheless, the load of reflective diary writing and portfolio preparation tasks, and collaborative work could be overwhelming and discouraging and these impacted negatively on learners' attitudes towards the course.

Carolyn (2004) examined students' views of classroom management strategies in assertive discipline and constructivist classroom settings. This case was designed to investigate the students' views of teachers' behavior management strategies in two contrasting classroom types. An assertive discipline classroom that represents the behaviorist paradigm and a constructivist classroom that emphasizes the social cognitive paradigm. Data was collected using videotaping to support the classroom instruction, record classroom management methods and approaches and observe teacher and students behaviors when rules were disobeyed and in-depth interviews with each classroom teacher and each student. The classroom teachers included in the study were interviewed to examine their theoretical beliefs about behavior management. The students and teachers favored constructivist classroom.

Howard and Sester (2004) examined the extent to which there is relationship between constructivist leadership roles and composite score achievement in North Carolina high schools. Here four roles of constructivist leadership are derived from a convergence of cognitive theory, organizational learning theory and recent conceptions of supervision. These roles are as follows, 1. Principal as designer of learning structures, 2. Principal as leader of learners, 3. Principal as a change, 4. Principal as the liaison to the outside world. Research methods include interviews, surveys and member checking of all instrumentation among seven principals in a North Carolina school district during a pilot study that focused on four constructivist principal roles present in the respective high schools. Also quantitative surveys were emailed to all 319 high schools; in addition, interviews are conducted among leadership teams at three levels of North Carolina schools in an effort to triangulate data in the

dissertation. The leadership teams are comprised of teachers at two schools of excellence. Two schools of distinction and two schools that are low performing ones, results of this study demonstrate that many constructivist leadership roles viewed as critical to impacting student achievement by high school principals. However definition constructivist practice and implementation of constructivist roles needs further research at high schools across the country.

Kroll (2004) investigated the development of understanding of constructivist theory among students in the Masters level elementary teacher education program within a particular course. The questions explored include: how do students' ideas of teaching, learning and knowledge develop within the context of their experience in this course? How do they come to understand constructivism? What are their definitions of constructivism? What is the course of the development of this understanding? The nature of the students' learning processes is examined through three sources of data: dialog journals, videotaped sessions and the instructor's reflective teaching journal. The study looks both at student development and instructional practice to further understanding of how student teachers can learn to apply constructivist theory to their teaching and to understand the learning process, both within themselves and their students. The study explored that how the way the student teachers are taught theory can help them to investigate their own ideas of learning and teaching with constructivist theory in order to think critically about their own practice in an ongoing developmental manner.

Dogru and Kalender (2007) compared Science classrooms using traditional teacher-centered approach to those using student-centered constructivist methods. In their initial test of student performance immediately following the lessons, they found no significant difference between traditional and constructivist methods, however in the follow up assessment 15 days later, student who learned through constructivist methods showed better retention of knowledge than those who learned through traditional methods.

Lawson and Jennifer (2008) examined the co-operative inquiry as a professional learning strategy for inner city principals. They attempted to identify the central issues of concerns and means of redress for school leaders in high poverty communities, many of which focused on educational leadership, school management, the context of their school within impoverished communities, and the challenges of personal

wellbeing. The findings of this study suggests that co-operative inquiry was an effective strategy in that the approach was participatory, democratic, empowering, life-enhancing and fostered community building among participants. The findings also suggest that the approach was effective in that it was grounded in action research cycle of planning action observation and reflection. The study further examined the use of dialogue as a means of constructing knowledge regarding these issues and identified the ways in which such knowledge impacts upon the professional practice of these principals. Findings suggest that participants gained knowledge from each other, offered knowledge from each others, constructed knowledge together as perspectives. Findings also suggest that meaning is best when dialogic interactions are transcribed into print. Thus, dialogue is a form of communication in and of itself. Further this study posits that dialogue has unique power to be both a process for meaning making. As well as an ontological means of clarifying one's own sense of reality.

Sridevi (2008) studied the effectiveness constructivist approach on students' achievement in Science, of Science at secondary level, and also examined the relationship among these. The quasi experimental design was used. 36 students were participated in the experimental group and 32 students in control group. Achievement test in Science, Science process skill test, scientific attitude scale, reactions scale and semi structured interviews were constructed and used. Lessons were developed through 5E constructivist model. The data was analyzed through student 't' test, Pearson's Product Moment Correlation and ANOVA. In the findings, the constructivist approach found effective in Science, perception of nature of Science, Science process skills and scientific attitude and also equally effective on boys and girls. There was a positive relationship among achievement in Science, perception of nature of Science, Science process skills, and scientific attitude with each other. Study implied that constructivist approach is more effective than the conventional method of teaching in Science.

Ann-Kim and Sungmi (2009) by using tasks and stimulate estimation and professional reasoning the investigators tried to elucidate the thought process of middle school students and to explore whether and if so how, these thought processes change as the students are engaged in this proportional tasks. These proportional tasks involved estimating the number of pattern blocks in a container. Pattern blocks are commonly the number of classroom geometry manipulative that have proportional size, relationships. The researcher designed three tasks. How high equal height and of

equal number, in how high tasks were done. In how high task, the students were able to tell the no. of blocks and shown the measurement of their height in the container and asked to estimate the high of the different number of the same forms of block. In the other two tasks the students were asked to estimate no. of pattern blocks in each container. Using Peageterian interview researcher explored students' thought processes which engaged in the proportional tasks and students were interviewed individually and group wise. Findings shown that a student's development of proportional reasoning during the group session demonstrated the potential of group discussion to promote developmental changes. Even though the researcher did not explain during the session. On the other hand some students did not change their reasoning in the group discussion. How high task was the easiest and equal number tasks were more difficult.

Eischen and Debra (2009) studied on the stories: the power of narrative knowing in the evaluation of students internship experience, examined how students in terms of meaning of their internship experience through their narrative and valuable constructs about work they developed through their internship experiences. It was possible to gain useful insights into ways in which they transitioned from academia to work place. This study revealed the constructivist process that facilitated the development of knowledge of the workplace.

Freed and Maxine (2009) formulated a multiperspectival conceptual model of transformative meaning making to facilitate better understanding of the process. Meaning making is the central to transformative learning. Transdisciplinary, complexity, Hermeneutics and social constructivism approaches were combined to capture the multifaceted dimensions of transformative learning and meaning theories were analyzed, interpreted and synthesized and provided scaffolding for the model. Meaning making is not only by cognitive, epistemic and rational nor is the language the sole medium of meaning construction. Semantic, affective, intuitive and imaginative aspects are significant as the historical, socio-culturally embedded individual engages in the pattern recognition and formation activities of meaning making. The primary operations of the process are interpretation, translation and transformation with attendant periods of ambiguous paradoxically liminality, reflection, reflexivity and recursion are central characteristics of both central characteristics of both transformative meaning making and research process of the study.

Forbes (2009) conducted a study that the Pre-Service teachers need to begin developing their pedagogical design capacities for inquiry by learning how to translate their conceptions of inquiry into classroom, study involved analysis of curricular artifacts and survey data from prospective elementary teachers as well as interviews, observational field notes, reflective journals were also used. Results shown that pre service teachers were able to translate their espoused inquiry framework into planned and enacted Science lessons and have implications for practice and theory and provided novel insights into the teacher-curriculum relationship, teacher learning, the nature of goals of inquiry oriented Science teaching-learning.

Gopal and Tamilselvi (2009) conducted a study to provide an understanding of how the 5E instructional method combined with educational technology tools can be used in teaching undergraduate college level anatomy and physiology laboratory classes. The topics like 'Heart' and 'Vascular system', to accomplish this researcher created a class website and including pronunciation, spelling, an interactive tool and web links, in such a way that any teacher can customize and use these tool for their classes. The results indicated that the students took advantage of the technology provided.

Goodling and Teres (2009) conducted a study to determine that are there any differences in the perception of scientific inquiry between experts and practiceners and if a difference was shown to exist, to analyze those perceptions in order to better understanding the extent of that difference or gap. A disconnect was found between how experts and practiceners differed from both experts and literature in three key areas, first although teachers indicated that students would be manipulating materials, second practiceners implied active, physical engagement with materials , third teachers emitted their role in laying the foundation for inquiry and also found that practiceners and experts alike noted the lack of methodologies in the Sciences, educational method courses and areas of the curriculum. It also shown that teachers are resistant to change.

Joblonski (2009) studied the pedagogical beliefs, training and access to technology by students in classroom. Linear regression was used to test three different models to predict the frequency and type of technology used by the students; findings indicate that the best model to predict frequency of students' technology use was one that included access to computers in classroom and the laboratory. Pedagogic beliefs were a non significant variable, but teachers reported changes in their teaching due to students use of technology, which included instructional practices that are associated

with both didactic and constructivist pedagogies. The study implied that technology resources used to be more accessible and teacher teaching in technology should be more timely and appropriate to available resources and curricular objectives. In addition if mandated computerized testing limits, students access to computer labs, resources planning should consider alternatives.

Hung and Man (2009) examined the effects of inquiry-based Science instructional and traditional Science instruction on student achievement across Science, mathematics and reading and also compared the effect of these both on student achievement. Results indicated that inquiry-based Science instruction was significant with Science mathematics and reading achievement. Findings supports the theoretical position that inquiry based Science instruction have robust benefits across the curriculum. This study suggests that the student's achievement can be promoted by supporting and encouraging teachers to implement inquiry based Science instruction.

Jett and Pamela (2009) worked on teacher's valuation and implementation of formative assessment strategies in elementary Science classrooms, in this study the investigator surveyed elementary teachers in one school district through questionnaire to ascertain their perspectives on value and implementation of formative assessment. 4 teachers were selected for intensive observation of lessons utilizing what each perceived to be formative assessment strategies. Investigator used mixed methods approach. To analyze the data from three sources, a questionnaire, classroom observations and teacher interviews. Factor analysis and confirmatory structural equation modeling were used to determine the validity of the questionnaire about teacher's beliefs and use of formative assessment strategies. Regression analysis determined no significant correlation between years of experience and use of formative assessment. Interview analysis of case studies indicated that those who had a more student-focused or constructivist approach to Science teaching were more likely to effectively use to university teacher educators, education administrators, professional development trainers and professional learning communities. Researchers have highlighted importance of constructivist approach which encompasses various formative evaluation techniques.

KyongNa (2009) investigated the effect of incorporating active learning strategies such as small group learning without authentic tasks, scaffolding and individual reports, which were employed to enhance students learning and critical thinking in a large undergraduate general Science education class. Results indicate that active

learning strategies had a positive significance on undergraduate students' learning of Science concepts and implied that active learning strategies in a large class were useful to enhance students' learning and to enhance critical thinking and engaging in critical thinking process.

Loyens et al., (2009) studied the conceptions of constructivist learning environment, and how they differ from conventional classes. Investigated this on three groups in both conventional and constructivist curricula using cross-sectional design. The conceptions were in the form of activities mainly, construction of knowledge, cooperative learning, self regulation, motivation to learn. The data were analyzed by two-way MANOVA. And found significant difference between the groups. And Study implied that the learning environment makes the difference with respect to students' conceptions of constructivist learning activities.

Sounders and Soundra (2009) studied the Science teachers perceptions of implementing constructivist principles into instruction and examined the difference in beliefs and perceptions about the implementation of constructivist principles in support of National Science Education Standards, for Science teachers who adopt constructivist principles and those who do not, also examined correlations between a teachers of years of experience and his/her implementation of constructivist principles in instruction. The sample included teachers from all over the United States who were members of the National Science Teachers Association. All demographic data was descriptively summarized. The two groups were compared on their overall constructivist principles survey score using dependent sample t test, results were significant. The data revealed that no significant difference between teachers who implement constructivist practices and those who do not with regard to their beliefs and perceptions. There was no significant difference found between teachers who implement constructivist practices and those who do not with regard to their scientific knowledge mean rating or their constructivist practices rating.

Akcay et al., (2010) investigated on scientific literacy in different sets of classroom; one is in student-centered and other in traditional class. The results of this study indicate that students in the student-centered STS sections achieved significantly better than students in the teacher-directed STS sections in terms of understanding and use of process skills, use of creativity skills, development of more positive attitudes; and the ability to apply Science concepts in new contexts.

Treadwell and Wilson (2010) studied the impact of discovery learning in writing instruction on fifth grade student's achievement. The purpose of the study was to determine whether discovery learning a method based on constructivist learning theory, the research questions examined the impact of factors related to the implementation of discovery learning on students writing achievement. 46 students participated in this 8- week. Concurrent triangulation mixed methods used. Pretest and post tests were given both experimental and control group students, the data were analyzed using independent 't' test. Results indicated that insignificant mean difference between two groups. Focus group interviews were conducted with student participants to verifying the impacts of discovery learning. Which were analyzed through open, axial and selective coding. Data from quantitative methods concluded that discovery learning positively impacted student achievement. Study implied and recommended that teachers should incorporate discovery learning into writers' workshop to increase student engagement in the writing process and an extended study applying discovery learning methods is conducted. This study promotes positive social change addresses the local problem by providing writing instruction that enhances students written communication; thus students may be more inspired writers who are use writing to impact positive changes in their community.

Galting and Pfitzner (2010) compared the impact of field versus university based Science methods on pre-service teachers' beliefs and abilities to design inquiry based Science instruction for diverse learners. Highlights the importance of field based Science methods for inquiry based Science instruction in pre-service teacher training institutes. This mix method study compares teacher training institutes. This mix method study compares the experiences of 32 pre-service teachers with a specific focus on four pre-service teachers involved in either a field based Science method course or a university based Science method course. It examines the impact of two courses on pre service teachers' confidence in the teaching Science content and beliefs regarding the role of inquiry of inquiry based Science instruction with culturally and linguistically diverse students. Findings indicate that both field and university based instruction have strengths and weaknesses. Study suggest that field based methods have a stronger impact on improving pre-service teachers beliefs and skills in regard to designing inquiry based instruction for diverse learners, while university based course promotes greater confidence in pre-service teachers ability to teach different Science content areas.

Nath and Sajitha (2010) examined the basic psychological theories of the learner centred curriculum of school education in the state of Kerala. Initially the curriculum was based on the principles of behaviourism. The curriculum then revised in the light of social constructivism, and further incorporated the principles of Critical pedagogy. The Curriculum at this stage is designated as Issue based curriculum, where social issues are the backbone. Eight social issues were identified and curriculum was developed in a critical approach to social issues relevant in global setup. The major curricular innovations that have taken place in Kerala secondary education system in recent years is so revolutionary.

Williamson and William (2010) assessed the constructivist elements in the online learning environment. The purpose of the study was to develop and pilot test a methodology to determine the relative importance and presence of constructivist elements in online learning classes. A case study method was used to assess the effectiveness of four key constructive elements they are, Knowledge construction, collaborative learning, Authentic learning, and Self-regulation in an online master level public health course. The key elements of knowledge construction, co-operative learning and use of the authentic learning were found to be positively contribute to students learning in an online environment, while the findings of the fourth key element i.e., self-related learning did not support the sub construct. Collaborative activities such as working in team was clearly the most important element cited by the students as contributing to their learning; indicating that collaborative learning is a critical instructional element, working with an actual local public health agency on a community assessment project was also suggests that authentic learning is also effective as important to their learning. Study also suggests that authentic learning is also effective. Evidence supporting the positive role constructivist elements can play in student learning was supported in both co-relational analysis of the questionnaires and in the focus group discussion.

Beatrice and Hall (2010) worked on students' appropriation of thinking strategies in a constructivist classroom. This mixed method examined oral contributions and personal journal writing for eight focal students in 11th grade integrated History/English classroom to ascertain whether and to what extent students had appropriated three types of cognitive strategies desired and modeled by their teachers. Quantitative and qualitative analysis of two week work showed an overall increased use of strategies

involving evaluating, connection making and questioning sources. Overall in oral mode, instances of cognitive strategies made up approximately 1/3rd of student talk. In the written mode, there were four times as many instances of cognitive tool preparation rose over 50% of the written material. Some students active in one mode produced discourse and used cognitive tools differently in other mode. The results suggests that informal, expressive journal writing affords students more opportunities to practice desired constructivist learning skills than does discussion and offers teachers an opportunity to track such higher order thinking more easily than discussion.

Brooks and John (2010) worked to find out the effectiveness of constructivist Science instructional methods on middle school student achievement and motivation. The guiding research questions involved understanding that which method of Science instruction would be most effective at improving students' achievement in Science and the factors that contribute to motivate students to learn Science. Quantitative data were collected using a pre test and post test single group design, t test and ANOVA were used to test quantitative hypotheses. Qualitative data were collected using student's reflection journals and classroom discussions, student's perspectives were transcribed, coded and used to arrive at findings. The findings of this study supported the recommendation made by Science reformists that the best method of Science instruction was a constructivist method. Participant's comments favored constructivist classes. Implications included that for social change at local level included potential increases in student achievement in Science and possibly increased understanding that can facilitate similar changes at other school. From global perspectives constructivist oriented methods might result in students becoming more interested in majoring in the Science at the college level and in becoming part of scientifically literate work force.

Brown and Gennean (2010) studied the constructivist learning characteristics in learning communities, the purpose of this study was to identify which constructivist learning environmental characteristics were perceived by minority students enrolled in learning communities. A co-relational study was conducted and 102 minority students who were enrolled in two different learning communities were administered a survey. The survey was used to identify which traits of the constructivist learning environment were perceived by students in their learning community. Results of this study indicated that the students perceptions were that all seven areas of constructivist learning

environment were present in their learning communities but to verifying degrees. The student's perceptions were all positive and indicated that they are more aware of collaborative inquiry, the opportunity to construct knowledge and to reflect on prior experiences in their learning community classes.

Bimbola et al., (2010) examined the effectiveness of constructivist-based teaching strategy on academic performance in integrated Science by Junior Secondary School students in South-West Nigeria. Quasi-experimental research design was used to achieve the purpose of this study. Participants were 120 Junior Secondary School Students, Findings revealed that the constructivist instructed students had higher scores on the post test and the delayed post test, compared to those exposed to conventional (lecture) method of teaching. Concluded that if integrated Science teachers could incorporate constructivist-based teaching strategy into their teaching methods, there would be an improvement in academic performance of Junior Secondary School Students in integrated Science. The researchers recommended that integrated Science teachers should incorporate constructivist-based teaching strategy in their methods of teaching.

Chris et al., (2011) explored the changing influences and relevance of passive and experiential methods of learning within what can be described as a new era of entrepreneurial education. The paper is theoretical in its intent and adopts a social constructionist view of knowledge and learning. The research approach is informed by practitioner-based practice and research, education and participation as a process of social learning. Findings indicate that the development of experiential knowledge in entrepreneurs is an incremental process that evolves throughout the course of their working lives. This means that attempts to stimulate "real life" experience through formal modes of passive education and training are unlikely to have a strong influence or impact on the development of the entrepreneur as a practitioner. And implied that how knowledge is constructed through a situated practice of knowing, and demonstrates how a practice-based perspective might be useful for the study of entrepreneurial education.

Yilmaz et al., (2011) studied the views on epistemological beliefs, gender, and subject areas. The data collection tool was adapted from "The Traditional Teaching (TT) and Constructivist Teaching (CT) Scale," developed by Chan and Elliot (2004). Participants consisted of 490 pre-service teachers from different teacher education

programs in Turkey. Findings showed that pre-service teachers preferred constructivist teaching views more than traditional teaching views, and this correlated with their epistemological beliefs. Male participants preferred constructivist teaching views significantly more than female participants did.

1.7.3 Reviews of Related Studies on ICT Aided Constructivism

Duffy and Barowy (1995) described the effects of the implementation of constructivist techniques with interactive computer simulations on conceptual understanding of plant nutrition and critical thinking skills in heterogeneously grouped secondary biology classrooms. The study focused on three strategies for teaching plant nutrition: traditional, constructivist and computer-facilitated. This paper outlines the results on student learning as well as emergent issues concerning implementing technological and pedagogical innovations in high school Science classrooms. Results indicated that post-test gains were the greatest for the traditional class followed by the constructivist class, indicating that the traditional class learned the more traditional content. Video data indicated that the students spent significant amounts of time trying to understand the nature of the computer model and how to operate the software. Observations also indicated that there was no closing discussion to help students connect what they learned on the computer to what they had learned from other activities in the class. It was concluded that since there was no significant difference among the post-test gain, open-ended scores, and The Critical Thinking in Biology (TCTB) test, it might be implied that each strategy is as effective as the other in promoting conceptual change and critical thinking skills.

Harrington and Oliver (2000) identified critical characteristics of a situated learning environment from the extensive literature base on the subject; second, to operational the critical characteristics of a situated learning environment by designing a multimedia program that incorporated the identified characteristics; and third, investigated students' perceptions of their experiences using a multimedia package based on a situated learning framework. The learning environment, for pre-service teachers, comprised a multimedia program an assessment in mathematics together with recommended implementation conditions for the classroom. Eight students were observed and interviewed to explore their perceptions of situated learning framework provided effective instructional design guidelines for the design of an environment for the acquisition of advanced knowledge.

Brush and Saye (2001) reported on how student-centered learning environment was used to help grade 11 students use different cognitive and metacognitive scaffolds with hypermedia supported learning to explore specific topics from a set of multimedia content resources and tools, research results shown that the hypermedia embedded scaffolds were used prolifically by the student groups. Many of the groups used hyperlinks to explore database and demonstrating they were active participants in construction of their own knowledge during multimedia group activity.

Smeets and Mooji (2001) investigated how ICT was employed in the student-centered classroom, students worked in small groups for the ICT work and teacher used variety of contexts and tasks, such as simulation, problem-solving activity, word processing, games and exercises. Results shown that active learning and higher order learning were fostered. And concluded that ICT employed student-centered classes worked out effectively.

Ekaterina and Koubek (2002) worked on constructivism and online professional development, A study of the beliefs and practices of foreign language teachers. This multiple case study investigated and in-service teachers' instructional practices, beliefs and reflections in an online Instructional Planning GOLDEN (German Online Distance Education Network) course. Data were collected through extensive multiple sources of information including Interviews, online observations, teachers' narratives, course documents artifacts and e-mail communication between the participants and the instructors. The case covered the time period of seven months. The multiple data sources were triangulated to reveal the categories such as the role of the text book, role of the frameworks, vocabulary teaching, grammar teaching. Task structuring and sequencing, lesson planning, lesson implementation, grouping and assessment in which the in-service teachers showed improvement over the courses of the semester. However the degree of improvements was not same and varied among the participants. The study also showed the discrepancies between teachers' instructional practices and their beliefs in some cases and variation of reflectivity among the participants. This research provided in depth understanding of four cases in unique situations. It should not represent or generalize the entire population of in-service teachers but rather examine individual situations more closely. However the findings can offer important information for further online professional development or any other distance education courses.

Gaensler and Edwina (2004) conducted a qualitative study where the researcher actively participated in the class culture. The social constructivist theory of learning, supporting the belief that meaningful learning occurs when individuals are engaged in social discourse, guided the study. The participants were the 30 undergraduate students. The data has been collected by observations, in-class survey, in-class and online quizzes, journaling, semi structured interviews with students, document analysis. This study showed that the integration of WebCT-based course and learning principles rooted in social constructivism resulted in learning which was both active collaborative and where reflection and integration of new ideas with pre-existing knowledge also played major roles. It has demonstrated the positive impact on student's perception and comfort in using technology when the instructor encouraged use of electronic instructional tools.

Tsai and Lee (2005) explored high school students' and teachers' preferences towards constructivist Internet based learning based learning environments. Findings shown that students when compared to their teachers expressed more preferences towards the Constructivist Internet Learning Environment.

Cubukcu and Zuhail (2008) worked to determine teacher candidates' preferences regarding internet-based learning environments in student-centered education by involving the teacher candidates enrolled at Osmangazi University, Faculty of Education, Primary School Teaching, Mathematics Teaching and Computer and Educational Technologies Education programmes. This study is a descriptive study. The data collection scale consists of the "Constructivist Internet-based Education of Science Scale (CILES-S). The sample group of teacher candidates in the study showed differences with respect to their preferences regarding internet-based learning in student-centered education. The candidates scored higher in the internet-based learning environments of Cognitive Development and Critical Judgment. The lowest average scores of the sample group were observed in the internet-based learning environment of Epistemological awareness. As the consequences of the traditional teaching approach, we can indicate that the taught material is not long-lasting but easily forgotten, that students do not sufficiently acquire the knowledge and skills that are aimed at developing, and that students lack transferring their knowledge to real life. In our current situation, individuals prefer to use educational resources where and when they want, based on their individual skills and abilities. Throughout the world, because the internet infrastructure has developed quite rapidly, it has been offered as an alternative way for a rich learning and teaching environment.

Cakir and Mustafa (2008) drawn attention of all to the literature in the areas of learning, specifically, constructivism, conceptual change and cognitive development. Emphasized the contribution of such research to our understanding of the learning process. This literature provides guidelines for teachers, at all levels, in their attempt to have their students achieve learning with understanding. Research about the constructive nature of students' learning processes, about students' mental models, and students' misconceptions have important implications for teachers who wish to model scientific reasoning in an effective fashion for their students. Researcher communicated this research to teachers, textbook authors, and college professors who are involved in the preparation of Science teachers. This conceptual study was divided into two major parts. The first part concentrates on a critical review of the three most influential learning theories and constructivist view of learning and discusses the foundation upon which the constructivist theory of learning has been rooted. It seeks an answer to the question "What are some guiding principles of constructivist thinking that we must keep in mind when we consider our role as Science teachers?" The second part of this paper moves toward describing the nature of students' alternative conceptions, the ways of changing cognitive structure, and cognitive aspects of learning and teaching Science.

Lynn and Markham (2008) studied the effectiveness of online, self faced, faculty training on Learner-Centered Accessibility (LCA), to determine if the LCA course was effective in developing participants understandings, knowledge and skills. The LCA course was specifically designed to target faculty responsibility for the development of web-based courses to provide them with information concerning the issues of accessibility and learner-centered approaches when designing their own web based courses. This study employed evaluation methodology, using both quantitative and qualitative data. Five faculty members and two teaching assistants completed three online modules that provided participants with examples, tools, materials and instructions on how to design learner-centered accessible online courses. Participants completed various data-collection instruments including initial baseline demographic instrument. A pre and post course devised Attitude Toward Disabled Persons Scale (ATDP) a post-course questionnaire. Follow up interviews were conducted were inspected using the checklists of checkpoints for web content accessibility guideline 1.0 prior to taking learner-centered accessibility course and after completing a redesign of their course. The data indicated that the designing for LCA course was effective in developing participants understanding and knowledge of accessible designs.

Cakir and Perit (2009) worked on how online small groups co-construct mathematical artifacts to do collaborative problem solving. They investigated instructional practices enacted by virtual terms of secondary students as they co-construct mathematical artifacts in an online environment with multiple interaction spaces including text chat, whiteboard and wiki components. The findings of the dissertation arrived at through ethno methodologically-informed cases of online sessions are organized along three dimensions. Mathematical affordances like white board and chat spaces allow terms to co-construct multiple realizations of relevant mathematical artifacts. The sequence of actions that lead to construction and modification of shared inscriptions makes the visual reasoning process visible. Co-ordination methods like team members achieve a sense of sequential organization across dual media through temporal coordination of their chat postings and drawings. Drawings and text messages are used together as semiotic resource in mutually elaborating ways. And group understanding in terms develop shared mathematical understanding through joint recognitions of connections among narrative, graphical and symbolic realizations of the mathematical artifacts that they constructed to address their shared task. The interactional organization of the co-construction work establishes as indexical ground as support for the creation and maintenance of a shared problem space for the group. Each new contribution is made sense in relation to this persistently available and shared indexical ground, which evolves sequentially as new contributions modify the sense of previous contributions.

Jonghwi and Park (2009) designed a well-formed activity system for an ICT supported constructivist learning environment CHART perspective. Much of the educational research has suggested that ICT promotes constructivist classrooms. This study examined a grade seven teacher's constructivist instructional practices in a technology rich mathematic classroom through a lens of Cultural, Historical, Activity Theory (CHART) and is consisted of two phases, contradiction analysis and oversight intervention. Findings from the contradiction analysis indicated that it was not ICT's per-se that made contradictions in ICT supported constructivist activity: rather it was the changed nature of the class activity system due to the introduction of ICT's that called for systemic adjustment of classroom practices as a whole. Based on the identified contradictions, on-sight intervention was designed and implemented. It focused on transforming an ill-formed activity system of the current instructional practices of the participant teacher into a well formed one.

Goldstein and Marion (2009) worked on developing dialogic argumentation skills via scaffold instant messaging. This study was conducted as part of an argumentation curriculum implemented in an urban public middle school. The first year of this curriculum was successful in promoting the development of argumentation skills. It remained to be determined whether these skills could be promoted more effectively with the use of additional scaffolds during online argumentation. This study explored the efficacy of one particular argumentation scaffold. Which require the learners to assign functional labels to their message during online argumentation. 63 seven grade students engaged in 10 argument sessions. Working in same side pairs, they argued with the series of opposing via instant messaging about two consecutive issues. One group of students (n=32) used the scaffold for some of these sessions; a comparison group (n=31) never used the scaffold. At posttest, the students who used the scaffold performed better on measures of argument recognition, relative to the comparison group. They more successfully distinguished between strong and weak argument showed a preference for strong argumentative moves. Results were in conclusive as to whether the scaffold also promoted, enhanced argument production skills or more effective collaborative processes among learners. Benefits of this research include implications for instructional design of online learning environment for adolescents. Furthermore, it is of interest to schools genuinely committed to promoting better thinking in their students.

Andersson and Annika (2010) investigated a case study on e-learning in Sri Lanka with focus on students underlying beliefs about how one learns. E-learning programs are most often set up with the assumption that students should think, act and learn independently and with underlying values of constructivism and learner-centred learning. For students used to classroom-based, didactic education the transition to the e-learning paradigm is, however, neither predetermined nor immediate. And aimed to find out if, and how, the e-learning practice manages to transform students into more independent and self sustaining learners. Findings show that students increasingly adopt the e-learning view on learning as they progress through the program. Students take increasingly more ownership of their learning and the teacher is no longer seen as the container of all knowledge. The importance of discussions also increases over time indicating that knowledge is no longer seen as being transmitted but rather created.

Cakici et al., (2010) explored the effect of constructivist Science teaching on the students' understanding about matter, and to compare the effectiveness of a constructivist approach over traditional teaching methods. The study was conducted with 33 fourth grade students. Students were randomly divided into two groups as control group (CG, n=17) and experimental group (EG, n=16). An achievement test consisting of 13 open-ended questions was developed through piloting. Initially, pre-tests were applied to both the CG and EG. Following the first four weeks, the EG was taught using the constructivist teaching practices, while the CG was taught using the traditional teaching practices based on direct speech and question-answer. Then, the post-tests were carried out in order to determine the effect of a constructivist teaching approach on student learning. Students' responses to the questions have been categorized mainly as scientific, partially scientific and non-scientific. Responses in the non-scientific category were further classified as either a misconception or nonsensical. A comparison of the responses between the CG and EG was made using a chi-square test. The results revealed that there was a significant increase in achievement within the EG students compared to the CG. In particular, the teaching based on the constructivist approach appears to be effective in eliminating the misconceptions the EG students had prior to the instruction.

Tremblay (2010) investigated the use of a cell phone-based audience response system (ARS) in post-secondary Science teaching. Survey results show that students who either used or watched others using such a system enjoyed the activity, reported less boredom in class, found the activity made the class more interactive and were more emotionally engaged in the classroom. In addition, the activity was not considered to be a waste of either the students' time or learning time. From an instructor perspective, the resulting change of pace and the renewed student attention during a lecture was a positive outcome of the cell phone ARS. Significant participation frequency effects that were documented suggest that the degree of participation in the ARS activity may affect the students' perceived desire for use of this technology in more than one class per semester.

1.7.4 Reviews of Related Studies on the ICT Aided Constructivist Learning Approach (ICTACLA) for the Professional Development of Teachers

Senapathy (2004) attempted to integrate digital technology into constructivist learning environment for effective learning and expressed that constructivist revolution offers a new vision of the learner as an active sense maker and suggested new methods of instruction.

Aksal et al., (2008) investigated to find out the outcome of constructivist approach within teaching-learning process in developing learning and transferable skills of learners, by emphasizing on collaborative learning, experiential learning, developing portfolio and assessments as learning tool in Information Technology in Education course in two different classes of teacher education programme. Followed by qualitative research methodology. Self-reports of learners, questionnaires, researchers' observations by research diaries are the relevant data collection methods. Research findings revealed that although learners had first experience on constructivist approach based course by various activities such as portfolio, group works, etc. Learners had enriched learning and course helps to develop especially team work, communication and logical, critical thinking skills. Portfolio became essential activity to foster learning and skills development of learners.

Anita and Jayachandran (2009) studied Technology Integration practices of foreign language pre-service teacher. This case study examined how two foreign language teaching pre-service teachers integrate technology during student teaching and their general issues and concerns regarding technology integration in the real world context of the field placement sites. The data gathered from Reflective Journals, Classroom Observations, Interviews were analyzed qualitatively. The study found that the technological capabilities of individual teachers and their field placements, mentors interact and jointly affects initiation and adoptions of technology in the classroom but negatively impacts integration as it drives future teachers to chase the latest technologies without learning how to use existing ones effectively. The findings also stimulates attention to what is probably the most determining aspects of technology integration in student learning the professional and social partnership involving the university based teacher education programs and local schools.

Marjorie and Terpstra (2009) studied the developing technological pedagogical content knowledge: pre-service teacher's perspectives of how they learn to use educational technology in their teaching. This study used activity theory and current conceptions of knowledge for teaching content with technology to analyze the working knowledge and experience of a group of seven pre-service teachers in order to yield insights into how pre-service teachers learn to teach with technology. In seven pre-service teachers, two secondary, five elementary who had participated in technology integration. Mini grant program shared their internship technology implementation and their perspectives on how to learn to teach with technology. The pre-service teachers' data on teaching with technology implementation were analyzed for evidence of technological pedagogical content knowledge (TPCK) and its components using activity theory. The pre-service teachers' perspectives on learning to teach with technology were examined for setting and mediating tools that enabled in terms to learn to teach with technology. Findings of this study revealed that pre-service teachers exhibited more technology knowledge than technological pedagogical knowledge and TPCK. In addition pre-service teachers exhibited more TPK than TPCK and suggested that teacher educators need to call explicit attention to educational technology modeling and aid their pre-service teachers in making connection to possible and in conceptualizing technology can be used as a tool and employ lesson designing from the technology entry points.

Heravi and Naser (2009) studied the K-12 teachers' integration of computer technology for instructional purpose. The purpose of this qualitative multi case study was to explore the reasons why K-12 public school teachers are not using computers for instructional purposes. The sample was 20 teachers. The perception of teachers within the current study lead to the conclusion that the lack of access to computer technology equipment, the need for specialized training in use of computer technology and teachers dispositions to use technology contributes to the low use of computer for instructional purpose. School administrators may improve the teachers' use of computer technology by providing more school preparation time and more specialized training opportunities.

Lutonsky and Rose (2009) investigated how pre-service college credit computer training, in-service training, gender and experience influence teachers computer skills as measured by the Basic Technology Competencies for Educators Inventory (BTCEI) and interviews. The study investigated what basic computer skills participants had, what skills participants thought teachers should have and how in-service and pre-service training and years of experience help the teachers to learn computer skills. Participants were 402 teachers; three participants were randomly selected from each category of low, medium or high scores on BTCEI to participate in Interview. Quantitative data were analyzed using three way ANOVA and qualitative data techniques were used to code participants' interview responses into themes. Results indicated that teachers who had pre-service training had skills than teachers who did not have. And teachers wanted to learn more technology through in-service training and technology access was also most important and helpful in adding participants in learning basic skills. In conclusion professional development in the form of in-service training needs to be offered to teachers so that they have at least 20 hours of training or more and seven to nine pre-service college credits are needed for teachers to indicate high computer competency skills.

Ann and Koch (2009) studied Teacher Education & Technology Integration: how do pre-service teacher perceive their readiness to infuse their technology in the learning environment and evaluated the perceptions of pre-service students in their ability to integrate University course work and field experiences. Results suggested that there was no significant difference among grade levels in their perceived ability to integrate technology. Results revealed that multiple areas of significant differences before and after their field experiences, ability to use online content responses journals, integrating technology into learning environment & total score of the survey. Additionally it revealed that the perceptions of early childhood student's ability to integrate technology into learning environment was significantly lower than that of the elementary & secondary students within the same program. And who had well integrated modeling technology in high school revealed significantly higher perceptions of their ability to integrate technology into learning environment. Conclusions from results provided an insight into technology savvy characteristics of pre-service teachers within a teacher education program which has technology as one of its core themes technology modeling and program design within a teacher education program can have impact on pre-service teachers to have stronger perceptions about their ability to integrate technology.

Lourdusamy et al., (2001) developed a program on creating a constructivist-learning environment using ICT to teach concepts skills in classroom management at National Institute of Education, Singapore. Data was collected from 564 Post graduate Diploma in Education students. Designed the questionnaire and feedback was obtained, Descriptive statistics is used to describe the pattern of usage and the perception of student on the use of ICT in delivering the content of this module. The result of this study indicate male students to be more self-directed than the female student, this may be due to the fact that the male students are more at ease with computers than their female counterparts. Most students complain that the heavy workload of the program does not allow them to read widely. Time management seems to be a factor that needs attention to help students cope with the one year program. This exploratory attempt to blend electronic media learning with face to face learning suggests that this mode of course delivery can be successfully used in teacher education by creating an interesting mix of learning activities and providing the incentives to the student teachers.

Pedersen and Liu (2003) conducted a study among 15 middle year Science teachers to identify key issues in the implementation of a computer based programme designed to support student-centered learning and to examine teachers' beliefs about these issues. The computer based program presented students with a complex Science problem that required them to undertake investigations of various planets and moons of solar system, programs offered several challenges to students, data collected from teacher-interviews, observations. Findings showed that while the teachers recognized the importance of student-centered learning, their understanding of the term varied from considering the need and interest of learners and then providing instructions based on those needs all teachers expressed their beliefs that, it is motivating and helping learners, effective in developing problem solving skills and they felt that it is highly attractive and intrinsically motivated to students. It is more student-centered and less teachers directed.

Barry and Dorit (2005) validated and studied the effectiveness of an Online Questionnaire for Evaluating Students' and Teachers' Perceptions of Constructivist Multimedia Learning Environments through a survey (CMLES). This questionnaire assesses teachers' and students' perceptions of the learning environment when students use online multimedia programs while teachers use constructivism as a referent for their teaching. The design of the questionnaire was based on a constructivist approach to learning and focused on the process of learning with the multimedia program and on

the nature of that program. To validate and see the reliability a study involving 221 students in 12 high school classrooms into statistical validation and interpretive validation of the questionnaire was undertaken. For this sample of Grade 10 and 11 students who completed the actual and preferred forms of the questionnaire, the CMLES scales demonstrated a high degree of internal consistency reliability (with alpha reliability coefficients ranging from 0.73 to 0.82), as well as satisfactory factorial validity and discriminant validity. Therefore, the study supports the reliability and validity of the CMLES for assessing students' and teachers' perceptions of one important aspect in evaluating learning environments which promote the use of multimedia programs and constructivist learning approaches.

Martha and Casa (2006) implemented Constructivist Web based Learning and determining its effectiveness on a Teacher Preparation Course. Researcher described the design of an online course to reflect a constructivist approach to teaching and learning, and how students are able to identify the constructivist elements of the course. Key to this study is to determine how effectively the student participants believe the course prepares them to become K-8 teachers, and which elements of the course are most beneficial and which are not. 94% of the students who took the course over two semesters were able to identify at least four of the constructivist elements of the course. Furthermore, 100% of the student participants found the course to be effective. The data stem from pre-and post-questionnaires and course evaluations.

Boone and Kent (2009) examined the impact of professional development program for teachers in the five essential elements of reading instruction. This inquiry was to determine if increasing teacher knowledge of content and pedagogy had a direct correlation to student outcomes. They studied the effects of professional development on teachers' practice in the class and the effects of their practice on student achievement. Used mixed methodology, quantitative data considered of the scores from the Scholastic Reading inventory administered before and after professional development. The qualitative data which was gathered through interviews, lesson plans, and artifacts, supported alternate hypotheses which predicted that teachers who participate in professional development will change their classroom practices and positively affect student lexile scores. The results found that teachers implemented the strategies they learned in the professional development programs and that these programs increased student achievement. This investigation is important to social change in education because it makes a contribution to closing the gap between theory and practice in the classroom.

Chai et.al., (2009) investigated the change in Singaporean pre-service teachers' epistemological beliefs and beliefs about learning and teaching over the course of a teacher preparation program. An online survey was administered during the first week of a nine-month program and the same survey was administered after the 413 participants had completed all their course work and teaching practice. Participants exhibited significant changes in epistemological beliefs and beliefs about learning and teaching-participants indicated more relativistic epistemological outlooks and less constructivism in beliefs about teaching. At the end of the teacher preparation program, they seemed to less value effort in learning and believed more in innate ability.

Ng'ambi and Johnsyon (2009) conducted a study on ICT mediated constructivist study for the academic support for teachers, they examined the effect of using an ICT and ICT aided constructive approach to increase academic support to students and to teach critical thinking skills in which students acquired project management skills was to increase support and teach critical thinking skills. The conclusion is that a constructive approach aided by an anonymous web based consultative environment facilitates learning.

O'Connell and Francis (2009) conceptualized that for most of the last fifty years teachers and administrators have perceived professional development and the instructional role primarily in terms of what one individual does with classes of others. Teachers, like their students, were considered to be rather passive acceptors of the instruction rather than active modifiers. Thus there was very little effort to gather empirical evidence that professional development worked especially when it came to its impact on student achievement. This project proposes a research design to gather empirical data on the Iowa Professional Development Model supported by technology. In this study educators were provided with an opportunity to integrate or vertically transfer much of what they learn through their professional development activities. The primary means of achieving this was through the building of a mature professional learning community connected by technology providing the key components of coaching and feedback reducing teacher isolation. These communications led to increased teacher understanding of the constructivist strategies, simulated change and resulted in increased student achievement.

Petras and Carol-Lynn (2010) conducted a descriptive study on Science and mathematics teachers' pedagogy, ICT use and perceptions of how ICT impacts their learning. From the findings it can be implied that Science teachers are more likely than maths teachers to use tools that would contribute to the development of 21st century skills. However the results shown that both were using traditional hands-on materials rather than digital tools and resources. Perceived impact of ICT use on Maths and Science teachers was positive. For Science teacher's technical and pedagogical competency, professional collaboration and pedagogical professional development found to be significant indicators of ICT use. This study contributed to increasing the understanding of how teachers' pedagogical orientation can affect their use of ICT for teaching and learning, this conclude that a shift needs to be made towards the pedagogical orientation of lifelong learning; these pedagogies would provide a means to achieve increased ICT use by teachers.

Yager et al., (2010) examined the effectiveness of the Iowa Chautauqua Professional Development Program in terms of changes in concept mastery, use of process skills, application of Science concept and skills, student attitudes toward Science, student creativity, and student perceptions regarding their Science classrooms. 12 teachers who agreed to participate in an experimental study where an inquiry approach was utilized with one section and traditional strategies in another section. The data collected were analyzed using quantitative methods. The results indicate that student use and understanding of Science skills and concepts in the inquiry sections increased significantly more than they did for students enrolled in typical sections in terms of process skills, creativity skills, ability to apply Science concepts, and the development of more positive attitudes.

Kimetal (2011) examined how pre-service teachers gain situated knowledge about teaching with technology by engaging the experiences of practicing teachers through Web-enhanced, Case-Based Activity (CBA). Situated knowledge of exemplary teachers often espouses a constructivist epistemology and a student-centered pedagogy when they use computers for teaching. Also, their knowledge for teaching with technology requires linking computer skills with associated curriculum and pedagogical strategies. Based on this initial framework, in this study, pre-service teachers' changes in perceptions and understanding about teaching with technology were documented over the course of a semester. A qualitative case study was used, and

constant comparative methods were used to continually compare emerging themes and refine categories. Web-enhanced CBA helped most pre-service teachers to both understand appropriate uses of technology and refined their perspectives by using experienced teachers' captured knowledge and practices. Research is needed to refine our understanding of situated case-based approaches' potential to promote both meaningful technology integration knowledge and skill and to address a range of everyday classroom teaching and learning issues, decisions, and practices.

Bandyopadhyay (2013) explored the notion of technology integration and examined the individual and collective role of factors that influence teacher ability to integrate technology in developing country. And studied the relationship between technology and pedagogy, examining to what extent these tools alter the teaching styles of teachers. Followed a mixed method design. Found that technology integration is a complex process and the ability to use it effectively for teachers in the sample. Further there was no statistical significant difference in the pedagogical styles of teachers with access to technology and those without. Both groups of teachers display very similar teaching styles and are engaging in as much or as little constructive pedagogy as one another.

1.7.5 Implications of the Review for the Present Study

The constructivist theory is not new one; it is as old as human birth and evolution. According to Brooks (1999), As long as there were people asking each other questions, the constructivist classrooms were existing. Constructivism, the study of learning, is about how we all make sense of our world, and that really hasn't changed. In the present context the constructivism is gaining a lot of importance in terms of discussion, research and development.

The reviews have been done on both the theoretical and methodological aspects on Constructivism, ICT Aided Constructivism in Science and ICT Aided Constructivism for Pre-Service Teachers.

The reviews have been done based on the conceptual framework of the constructivism and its characteristics and development and its guiding principles (Piaget, 1926; Dewey, 1993; Davidson, 1995; Bruner, 1966; Wheatly, 1991; Brooks, 1993; Schank, (2000). Kelly (1955) compared all learners to scientists in his theory of personal construct. Constructivism is meaningful learning, experiencing and understanding

(Ausubel 1963); Vygotsky (1978) introduced social aspect in constructivism which plays very important role in knowledge acquisition from the social interactions. Glasersfeld (1984) developed a model of radical constructivism, which claims that since all experiences are subjective, knowledge and interpretation of that knowledge is also subjective, and thus constructed by the individual.

The studies reviewed focused on the effectiveness of Constructivist Approach in Science, ICT supported Constructivist learning among Science students, Development of Technology based Constructivist Environment for Students, Developing a program on Constructivist Learning Environment using ICT to teach concepts and skills in classroom management. Studies also focussed on Pre-service Teachers, to know their attitudes towards teaching and learning Science, understanding of Constructivist Approach, Effectiveness of ICT supported Constructivist Learning Approach, Examining the Pre-Service Teachers' participation in Web-enhanced, Case-Based Activity in Constructivist approach, Integration of Technology practices in Pre-Service Teacher Education, ICT supported Constructivist Learning Approach on College Biology Students, Designing a well-formed activity system for an ICT supported constructivist learning environment, online professional development program in constructivist environment and on ICT mediated constructivist study for the academic support for teachers.

The result of reviewing the related literature made clear that many studies followed the experimental design, wherein the researchers studied the effectiveness of designed, developed and implemented strategies on students and pre-service teachers. Most of them have used constructivist, experiential techniques, hands on experiments in small groups, field visits, scaffolding techniques, providing multimedia environments, discussion through 5E method, argumentation techniques, classroom interactions and discussions, and followed self-assessment strategies. In the studies reviewed the investigators have used both qualitative and quantitative data collection tools, namely, Achievement test in Science, Science Process Skill Test, Scientific Attitude Scale, Reactions Scale and Interview, Semi Structured Interviews, Narrations and Classroom Observations constructed by the researchers and dialogue journals, videotaped sessions and the instructor's reflective teaching journal used as data sources and used some validated tools, namely, Constructivist Internet-based Education of Science Scale-CILES-S (Cubukcu & Zuhail, 2008), The Critical Thinking in Biology (TCTB) test,

(Duffy et al.,1995), Constructivist Multimedia Learning Environments through a survey-CMLES (Barry & Dorit, 2005), the researchers have designed their programs based on classroom constructivist principles and some have used the constructivist principles through the lens of Cultural, Historical, Activity Theory-CHART (Jonghwi & Park, 2009) and Basic Technology Competencies for Educators Inventory-BTCEI (Lutonsky & Rose, 2009). This has matched with the researcher interest and motivated the researcher to develop the program on ICT Aided Constructivist Learning Approach, and to go for experimental design and to develop various tools for the data collection, namely, achievement test, questionnaires, reaction scale, Interview, Semi structured interview and Focused Group Discussions.

Important findings and implications of the reviews include that, Experiential learning in Science produced higher achievement at all levels of thought for learners of all ability levels (McDavitt & David S, 1995), the Constructivist teaching methods improved pre-service teachers' perceptions about teaching Science (Gibson, 2000), provide strong support for the positive relationship between constructivist learning environment and student attitudes and little support for a direct relationship to student achievement. Teacher's reports of overall constructivist learning environment were not co-related with achievement or attitudes (Dethlefs, 2002), the constructivist leadership roles viewed as critical to impacting student achievement by high school principals (Howard & Sester, 2004), It has helped pre-service teachers to investigate their own ideas of learning and teaching with constructivist theory in order to think critically about their own practice in an ongoing developmental manner (Kroll, 2004), the constructivist approach found effective in Science, perception of nature of Science, Science process skills and scientific attitude and also equally effective on boys and girls. There is a positive relationship among achievement in Science, perception of nature of Science, Science process skills, and scientific attitude with each other. Study implied that constructivist approach is more effective than the conventional method of teaching in Science (Sridevi, 2008), active learning strategies in a large class were useful to enhance students' learning and to enhance critical thinking and engaging in critical thinking process. Collaborative activities such as working in team is the most important element contributing to students' learning; indicating that collaborative learning is a critical instructional element (Williamson & William 2010), through this approach the pre-service teachers were able to translate their espoused inquiry framework into planned and enacted Science lessons and have implications for

practice and theory and provided novel insights into the teacher-curriculum relationship, teacher learning, the nature of goals of inquiry oriented Science teaching-learning (Forbes, 2009), the teacher educators need to call explicit attention to educational technology modeling and aid their pre-service teachers in making connection to possible and in conceptualizing technology can be used as a tool and employ lesson designing from the technology entry points. (Marjorie & Terpstra, 2009), Lourdasamy et al., (2001) suggest that time management seems to be a factor that needs attention to help students cope with the one year program. This exploratory attempt to blend electronic media learning with face to face learning suggests that this mode of course delivery can be successfully used in teacher education by creating an interesting mix of learning activities and providing the incentives to the student teachers. The retention could be fostered through constructivist activities that mainly included reflective writing, critical thinking, and problem solving (Akar, 2003). Learning environment makes the difference with respect to students' conceptions of constructivist learning activities (Loyens et al., 2009). Bimbola et al., (2010) strongly recommend that the Science teachers should incorporate constructivist-based teaching strategy in their methods of teaching. Yager et al., (2010) the student use understanding of Science skills and concepts in the inquiry sections (Constructivist) increased significantly more than they did for students enrolled in typical (traditional) sections in terms of process skills, creativity skills, ability to apply Science concepts, and the development of more positive attitudes.

As the consequences of the traditional teaching approach, we can indicate that the taught material is not long-lasting but easily forgotten, that students do not sufficiently acquire the knowledge and skills that are aimed at developing, and that students lack transferring their knowledge to real life. In our current situation, individuals prefer to use educational resources where and when they want, based on their individual skills and abilities throughout the world, because the internet infrastructure has developed quite rapidly, it has been offered as an alternative way for a rich learning and teaching environment (Cubukcu & Zuhail, 2008).

ICT may provide the solution, through the use of technology teachers can provide opportunities for the students to think critically and discuss among their peers supported by ICT (Olsen, 2000), appropriate use of technologies can make learning for students interesting and enriching. Therefore it is important that educators make

serious considerations of matching the appropriate use of the technology with the content to maximize the students' potential in learning. Frand (2000) envisages that the educators' role of teaching the students may change with the introduction of technology. The phrase "sage on the stage" may change to "guide on the side" as educators take a step back from the normal role of being information giver to one that facilitates for the learning process of the student. A shift needs to be made towards the pedagogical orientation of lifelong learning; these pedagogies would provide a means to achieve increased ICT use by teachers, Petras & Carol-Lynn (2010).

ICT can play a significant role in development of learner-centered learning environments where computer serves as tools or helping students to access multiple sources of information to build knowledge and understanding. ICT encourages students' co-operation and reflection on the information obtained while simultaneously providing teachers with opportunities to adapt the learning content and tasks to meet the diverse needs of learners. Moreover innovative and creative teachers well intervene these technologies in a variety of ways into their teaching program to ensure the best outcomes for their students. (Smeets & Mooij, 2001). The constructivist model is descriptive but not prescriptive. It describes in the broadest of strokes the human activity of knowing and nowhere specifies the detailed craft of teaching. It is important to understand that the constructivism is not an instructional approach; it is a theory about how learners come to know, although instructional approaches are typically derived from such epistemologies, they are distinct from them.

In the Teacher Education Colleges, when Pre-Service Teachers enter their initial practicum experience they are confronted with differing teaching philosophies of their own, their professors and their school mentors (Sullivan et al., 2000). Within this situation, pre-service teachers struggle to find their own niche of teaching Science and learn to reflect as both learner and teacher (Kelly, 2000). Our goal of Science education is to help pre-service teachers have an easy transfer from personal university experiences to teaching Science in the "real" classroom environment while maintaining the integrity of newly learned teaching strategies (Segall, 2001).

Pedersen & Liu (2003) suggested that there is a need for professional development opportunities for teachers prior to their use of computer-based programs designed to support student centered learning. Progress of this approach requires that pre-service teachers be weaned off traditional approaches and that they should adopt constructivist

views of knowledge. In this regard the study by Boone & Kent (2009) found it is important to social change in education because it makes a contribution to closing the gap between theory and practice in the classroom. Building of a mature professional learning community connected by technology providing the key components of coaching and feedback reducing teacher isolation is very important component of professional development. These communications lead to increased teacher understanding of the constructivist strategies, simulated change and resulted in increased student achievement (O'Connell & Francis, 2009).

Through only one or two strategies of the constructivist approach there was reported no change across traditional method; it requires a blend of mixed activities and approaches. There has been found gap between teacher education instruction and practical school instruction. Theory and Practice were found to be disconnected. According to Bandyopadhyay (2013) the technology integration is a complex process and the ability to use it effectively for teachers, so professional orientations may help in this regard. Kimetal (2011) stated that there is need of research to refine our understanding of situated case-based approaches' potential to promote both meaningful technology integration knowledge and skill and to address a range of everyday classroom teaching and learning issues, decisions, and practices.

A disconnect has been found that the studies are either completely on School Education, or on Teacher Education, the gap found is that there is no linkage between teacher education and school education. None of the studies focused on establishing the link between the teacher education and school education. So, there is a dire need that researches should be conducted in teacher education and whose implications could be seen at school level, which may bridge the gaps found. The process of integration of ICT aided Constructivism should evolve from the teacher education programmes itself. If the revolution is expected in schools, it should starts from the Colleges of Education. More research could be in teacher education professional preparation and professional development areas through training and orientation programs. Research also could be conducted in trying to connect theory in teacher education and practice in school education. All these ideas have contributed to genesis of the present study. So the present study focuses on designing, developing the programme on ICT Aided Constructivist Learning Approach in Science for Pre-Service Teachers and whose effectiveness has been seen through the school students' interaction and achievement.

1.7.6 Rationale for the Present Study

The infusion of Information and Communication Technology in education has created a significant impact on the instructional content development and the methods of communicating information to the learners. This leads to the evolution of new concepts and innovative teaching techniques in the instruction-learning process. It seeks to create a generation of learners whose learning is defined as the ability to retain, synthesize and apply conceptually complex information in meaningful ways (Lamberts & McCombs, 1998). It also encourages better student learning through the learning objectives of project based learning or learning by doing (Berman, Macpherson & Schank, 1999) and to enable problem solving, analysis, creativity and communication to take place in the classroom. (Bates, 2000). ICT has been found to affect the student's motivation (Guthrie et.al.,2004) and it has also been found that using ICT in the Education helps to increase the Interest in the subjects and understanding various levels of subject domains, increases critical and creative thinking (Maor,1999). With the help of ICT we can get access to information within a few seconds by internet and communicate the same to any person at any corner of the world. So in today's competitive world it is highly desirable that our students should not lag behind in terms of knowledge. ICT can transform the learning environment into one that is learner centered. It encourages active and collaborative learning. Only ICT implementation into education cannot do miracles. ICT should be integrated with certain learning theories.

Constructive Learning approach is basically student centered learning. It will give new status to the learner as the active constructor of the information within the learning activity instead of being passive respondent to the externally determined world of education. Constructivism challenges the learners to move beyond fact learning to more transferable cognitive understanding. From this approach Students can learn better and explore themselves, can get the self-awareness and meta-cognition. But in the present classrooms the teaching is going on in the traditional method where the students learn mechanically. Particularly, the subjects like Science where experiments are conducted, if the teaching is done in mechanical way, and then the students cannot

go into the depth of the subject. They will lack both the scientific inquiry and scientific attitude. NKC (2008) also recommended that to reform the science curriculum content in line with the changing world and the courses should be made engaging, include the hands-on activities. Mobile Science Labs and Science Clubs should be developed. Studies have shown that when the classroom has the constructive philosophy, the students gain the meaning out of the learning. With its help abstract concepts are becoming easy; the learning process is joyful. Similarly the findings of Ramkumar (2003) also stated that the students' autonomy to learn has been increased and they showed a willingness to change the ideas in light of evidence in the classes conducted through instructional strategy based on constructivism. So, there is a need to adopt the constructivist learning approach. When various forms of information and communication technologies are used as tools in the constructivist approach it will strengthen the learning and meaning making process.

NCF (2005) visualizes a major shift in the conceptualization of learning and teaching. It defines teaching as a process that enables learners construct knowledge. Teacher is considered as facilitator, who encourages learners to reflect, analyze and interpret in the process of knowledge construction. Teacher education should emphasize integration between theory and practice as well as integration between content and pedagogy. Karnataka State revised the Elementary teacher education curriculum based on the constructivism, highlighting its importance for future teachers and learners. No attempts have been made to revise in Secondary teacher Education Programmes based on constructivist ideas. The present study may provide the insight for the authority to integrate ICTACLA. The goals, strategies and instruments envisaged in NCF 2005 need to be found reflected in B.Ed. Curriculum, there would be enormous disconnect between the outlook of future teachers entering our classroom and school curriculum. Strong linkages need to build between Pre-Service Teacher Education and School Education. The Practice needs to be strengthened; orientations need to be provided on this aspect both for Pre-Service Teacher and also to Teacher Educators. There is a need for orientation courses on ICT aided Constructivist Learning Approach in Science thoroughly; it should be part of curriculum. School students are also in great confusion in following different methodologies of their teachers and pre-service teachers in the

practice teaching , However entire educational system recognizes and makes use of children's natural cognitive processes through system-wide experiential education. Definition of constructivist practice and implementation of constructivist roles needs further research at high schools across the country. "In order for any discipline to survive, it must accommodate changes in theory and practice and do so in a way that adds value to the discipline" (Kuhn, 1972).

Today's instructional setting should reflect the changed scenario of teaching- learning and its advancements. It is now possible and desirable to teach Science through various media, and other situations other than conventional classroom. Certainly technology alone never invoke learning, it needs to be embedded with certain teaching-learning pedagogies such as constructivist learning. But it is not easy to adopt this approach directly, for this teacher has to be prepared enough. In the constructivist classroom the responsibility of the teachers will be more. Teachers should be well versed in the knowledge and principles of constructivist approach. Here the knowledge is actively built, so teachers should provide the suitable learning environment like engaging students in learning, and encourage group interactions. Teachers should nurture students' natural curiosity through frequent use of ICT and provide the knowledge of ICT in various forms. The technology integration is a complex process and the ability to use it effectively for teachers, so professional orientations may help in this regard. (Bandyopadhyay, 2013), Kimetal (2011), There is need of research to refine our understanding of the technology integration, knowledge and skill and to address a range of everyday classroom teaching and learning issues, decisions and practices.

So, to attain all these teachers must aware of the constructivist approach and ICT in order to teach to their students. When their support of ICT in the process of teaching, teachers also feel enthusiastic to teach and it will help to make the abstract ideas into concrete one. In order to achieve this teachers have to be trained well before, they need professional development programs regarding ICT and Constructivist approach. It needs a paradigm shift and willing abandonment of familiar perspectives and practices and the absorption of new ones (Brookes, 1993). Teachers who are not familiar with

the constructivist approach using ICT as tools may first require a change in the educational philosophy (Healy,1998). Progress of this approach requires that Pre-Service Teachers be weaned off traditional approaches and that they should adopt constructivist views of knowledge. In this context Boone and Kent (2009) also suggest that it is important to bring change in teacher education because it makes a contribution to closing the gap between theory and practice in the classroom.

In the Indian context very few studies have been found which concentrated on designing constructivist learning approach for school students, and developing technology supported constructivist learning approach. Not many studies have been conducted on constructivism in India, and among all the studies reviewed, no such studies have been found which focus on professional development of teachers with technology integrated constructivist approach and whose effectiveness has been studied at the school level. But still an optimistic view could be drawn; there is positive inclination that NCF (2005) highlighted on Learning and knowledge in terms of constructivist pedagogy. Reorienting the curriculum to this end must be the highest priority. NCERT (2005) also highlighted the importance of constructivist perspective. This also created a base for conducting such studies.

The Teacher Education and School Education have a symbiotic relationship and development in both of these sectors mutually reinforces both. If the school teachers are expected to bring about a revolution in their approaches to teaching, that, the same revolution must find a place in the Colleges of Education. University Education Commission (1948-49) report stated that “People in this country have been slow to recognize that Education is a profession for which intensive preparation is necessary as in any other profession”. This report is alive in its relevance today (Siddiqui, 2009). There is a need to equip teachers with competencies to use ICT for their own professional development (NCF, 2009).

To achieve this there is an urgent need of introducing ICT Aided Constructivist Learning Approach for the professional development of teachers. Hence the present study has emerged. The present study focuses on professional development of the pre-service teachers through ICT aided Constructivist Approach.

1.8 Present Study

Development and Implementation of ICT Aided Constructivist Learning Approach for the Professional Development of Pre-Service Teachers

1.9 Objectives of the Study

1. To develop ICT Aided Constructivist Learning Approach in Science for the Pre-Service Teachers.
2. To study the effectiveness of ICT Aided Constructivist learning Approach in Science in terms of
 - i. Reactions of Pre-Service Teachers.
 - ii. Reactions of School Students.
 - iii. Reactions of Teacher Educators.
 - iv. Academic achievement of School Students.
 - v. Observations by the Investigator, the Pre-Service Teachers and Teacher Educators.
 - vi. Reflections of Pre-Service Teachers.
 - vii. The emerging status of the ICTACLA.
3. To study the level of professional development of Pre-Service Teachers through ICT Aided Constructivist Learning Approach.

1.10 Hypotheses

1. There will be no significant difference between observed frequencies and expected frequencies against equal probability on various statements of Reaction Scale for Pre-Service Teachers.
2. There will be no significant difference between observed frequencies and expected frequencies against equal probability on various statements of Reaction Scale for School Students.
3. There will be no significant difference between pre-test mean and post –test mean scores from single of the School Students.
4. There will be no significant difference between the observed frequencies and frequencies expected against equal probability on various elements of Observation Schedule.
5. There will be no significant difference in the observations of practice teaching lessons by the Researchers, Pre-Service Teachers and Teacher Educators.

6. There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Experimental group of Pre-Service Teachers As Learners.
7. There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Experimental group of Pre-Service Teachers As Teachers.
8. There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Experimental group of Pre-Service Teachers both As Learners and As Teachers.
9. There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Control group of Pre-Service Teachers As Learners.
10. There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Control group of Pre-Service Teachers As Teachers.
11. There will be no significant difference in the Pre-Intervention observed frequency distribution and Post-Intervention observed frequency distribution against the Five class Intervals for Control group of Pre-Service Teachers both As Learners and As Teachers.
12. There will be no significant difference in the Pre-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers As Learners.
13. There will be no significant difference in the Pre-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers As Teachers.
14. There will be no significant difference in the Pre-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers both As Learners and Teachers.
15. There will be no significant difference in the Post-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers As Learners.

16. There will be no significant difference in the Post-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers As Teachers.
17. There will be no significant difference in the Post-Intervention observed frequency distribution against the Five class Intervals for Experimental and Control group of Pre-Service Teachers both As Learners and Teachers.

1.11 Operational Definition of the Terms

1.11.1 Information and Communication Technology

Information and Communication Technologies in the present study includes MS Office, Internet Surfing, Creation and Sharing of Blogs, Wiki-Space, Wiki-Education, Wikipedia, Social Network Services, Hyper Linking, Navigating, Use of Educational Softwares. And use of all these for the process of Development and Implementation of the Intervention Programme.

1.11.2 ICT Aided Constructivist Learning Approach

ICT Aided Constructivist Learning Approach in the present study refers to the Programme developed by the Researcher by using Constructivist Learning Principles with the help of ICT. The Programme is inclusive of concepts of ICT, Constructivism, and Integration of ICT Aided Constructivist learning approach for the professional development of Pre-Service Teachers and model Science Lesson designs employing ICTACLA.

1.11.3 Professional Development of Pre-Service Teachers

The Professional Development of Pre-Service Teachers in the present study includes the development of knowledge, understanding, skills and applications on ICT Aided Constructivist Learning Environment at College of Education level and School level. It has been studied through orientation programme; designing and practicing the lessons employed ICTACLA at the college level and implementing them at the school level by the Pre-Service Teachers, Questionnaires, Reaction of School Students, Pre-Service Teachers and Teacher Educators, Achievement of School Students, Observations, Focused Group Discussions and Semi-Structured Interviews.

1.12 Delimitations of the Study

The study was delimited to Science Pre-Service Teachers of Secondary level.