CHAPTER-I

CONCEPTUAL FRAMEWORK

1.0.0 Introduction

Increased globalization since recent decade is the result of advancement in technology and science. As a result of which there is an apparent change in the process of education also. The roles of students and teachers as teaching-learning process have changed due to technology and communication progresses. Thus the society is transformed into an information-based society. Thus the reflection of technological advancement has also impacted the global outlook.

Due to globalization the spirit of competitiveness has got its pace at all levels of work. And it can be achieved by improving the standards in quality of work. Thus it can be achieved by raising the standards of quality of education. They can be maintained up to the needs and expectancies of the society.

As per University Education Commission (1948), most urgent reform required for transformation of education is relating to the needs and requirements of people and endeavoring daily life and thus making it a powerful tool for social transformation which is must for fulfillment of goals of nation. There should be transformation in the education for the achievement of national goals of increasing productivity, and thereby acquiring social and national integration thus accelerating modernization and cultivating social as well as moral and spiritual values.

Many apparent changes in the education sector have been observed in the recent past decade maintaining the basic national goals. Education is nowadays defined in terms of the learning of students rather than teaching of a teacher. It has made a shift in the form of instructions given by instructor and made teaching more learner centric. In learning of a student it has became more important that what prior knowledge the student already has which can be related to new teaching-learning concepts. Learning principles serve as the guide in the felicitation of teaching process. Thereby improving teaching quality for the core satisfaction of teacher as well as student may be derived. Teacher's role has transformed from a teacher-centric to student-centric wherein the teacher serves the role of a guide of the student in the

process of teaching-learning. Wherein learning is the equal shared responsibility of both the student and the teacher. This may have led to the revolution in GG the field of science as described by Kuhn (1966).

1.0.1 Scientific Paradigm

Scientific Paradigm is defined as a universally recognized scientific achievement which provides model to community practitioners for problems and their solutions over a period of time. According to Kuhn, T. (1966) it can be the answers of the questions to what is to be observed or what is to be scrutinized. Also for structuring the questions for the interpretations of the scientific investigations. The procedure to be followed by the scientific experiment and the materials required for pertaining the experiment. Is supported by the variety of questions to be answered by the students during observation of an experiment. It also requires the apparatus of the experiment to be investigated and the performance of the experiment.

Finally, the results of the experiments are analyzed and interpreted to find solutions to the problems (questions) raised.

The question's entailed in Kuhn's scientific paradigm (1966) can be addressed in various ways through paradigms of learning and instruction. There are various paradigms of learning and instruction like behaviorist, cognitivist, humanist and constructivist.

1.0.2 Paradigms of learning and Instruction

Teaching learning process can be taken up using any of the following paradigms of learning, behaviorist, cognitivist, humanist and constructivist.

Behaviourist paradigm: Believes stimulus is important for learning. It deals with stimulus response and feedback as a process of learning. In this paradigm feedback plays a major role. Behaviourist paradigm is also known as the "black box theory", as it does not consider how brain processes the information.

Cognitivist paradigm: Cognitivist paradigm believes, 'whole is greater than its parts'. The human mind does not accept any information in the same form, rather the individual compares the information with the existing one, works on it, interprets and

then responds. That means there is an element of choice. It is referred to as ‘white box theory’. Teaching here is from simple to complex that is from assimilation to accommodation: the schema needs to expand to accommodate new information. Time is needed for equilibration. Motivation towards learning in cognitivist paradigm is intrinsic.

Humanist paradigm: Humanist paradigm of learning views that humans have a natural tendency of growing, learning and developing fully. Thus integrating the learning with personal growth and the full development of individual’s emotional, psychological, creative, social, physical and spiritual potential. Humanist teacher is expected to respect children, show empathy and genuineness.

Constructivist: Constructivist learning enhances student’s logical and conceptual growth. Students make meaning based upon their experiences. Learning is student centered as students are expected to construct their own knowledge. Types of constructivism are discussed in the next subsection.

1.0.3 Types of Constructivism

Tomorrow will not be like today therefore there is need for constructivism. Future is and will be unpredictable. Different people will be affected differently. Three types of constructivism are presented below.

Personal Constructivism: It is the knowledge at personal level. Wherein the knowledge is constructed by the active involvement of the learner, and not passively gained from the surrounding environment. Learner connects the new knowledge with the prior knowledge and past experiences and constructs the personal learning.

Radical Constructivism: It views knowledge as the dynamic process of adaptation for experiences to be interpreted. Here all kinds of experiences are subjective in nature. In the present society wherein there is the diversity of large opinions by public in all the aspects is the outcome of radical constructivism.

Social Constructivism: Proponents of social constructivism is Lev Vygotsky (1978) and is championed by Bruner (1990). Socially mediated learning can be the summation of individual learning. Here each individual participates in the collective

learning. It is used as a teaching strategy, wherein students construct knowledge collectively and they share the meanings with other peers, also class discussion, small group collaboration and meaningful activities are assigned to the students. They have to collaborate and share their voice that helps in constructing knowledge and making of meaning.

In the current study social constructivism was used for teaching physics at diploma engineering level.

1.0.4 Constructivism as a Learning Theory

Constructivism is a philosophy traced from the 18th century in the work of Vico Giambattista. It views learning as the personalized knowledge of an individual based on its past experiences and understandings. One can explain if at all one has understood something. (Yager, R. 1991).Human beings are active recipients of information, the knowledge is actively learnt by them and they make connections to their past experiences by assimilating knowledge by constructing their own interpretation (Cheek, D. 1992). Jean Piaget (1972), Vyogotsky (1978) and John Dewey (1967) are the contributors in the philosophy of constructivism. It emphasizes that a theory of learning which is based on the reflections on our own experiences from which our own understanding of the world is constructed. And we produce individual rules and make mental models and sense of our own experiences.

Constructivism in educational description is imensely meant by one's own experiences. Each student arrives into a classroom with their own experience and they are the basis of cognitive structure. There is a possibility of validity, invalidity or incompleteness preconceived structures. If the new knowledge is matched with the information or experiences already in memory, then the learner can reformulate or complete the existing structure. For integration of the new idea and its utility of the inferences of the memory there is the need of elaborations and relationships between old perceptions and new ideas to be personally drawn by the students. If learner's prior experiences are not connected with the new knowledge there is the possibility to forget the concepts very soon. Thus, to make learning meaningful, there is the dire need of active involvement of the learner for the construction of new acquired information onto his/her existing mental framework.

1.0.5 Learning Process in Constructivist Approach

Constructivist perceive learning as a process of knowledge construction. Knowledge construction is actively done by the learners through connecting new acquired knowledge to their prior understanding by activities presented to them. As recommended by NCF 2005 the meaning of knowledge construction is the individual and social learning occurred in a class by the active involvement of each student. To construct means to learn. And thus strategies for promoting learning by all is provided by it. Teacher's role is organizing information by conceptual clusters of problems, questioning the discrepant situation for engaging the interest. To develop new insights and making connections to the prior learning of students.

An Idea is taken holistically as a broad concept and then it is broken down into parts. Student-centered teaching-learning is planned to encourage students to ask questions, carry out their own experiments, making own analogies and drawing conclusions. Special guidelines are provided for a teacher teaching with constructivist approach. Such as: Becoming ay resources in student learning and not by becoming the primary source of information; Engaging students by providing experiences challenging their prior conceptions of the existing knowledge; Allowing their responses for driving lessons and seeking elaborations of their initial responses; Allowing thinking time after posing a question; encouraging the spirit to ask thoughtful and open-ended questions; Encouraging the spirit of discussion between participant student groups; Making use of the terms as classify or analyze or and create from the cognitive terminology during formulating activities; Encouraging by accepting autonomy of students and their initiative by letting go control of classroom; Making use of raw data and primary sources along with manipulated and interactive materials; by connecting the process of finding out and insisting on free expressions from students.

Thus learner centered and experiential process of learning is done by constructivist approach. It is an educational theory and a key perspective to inform pedagogy. Many books for teachers and other constructivist research scholars are available for guidance of teaching science with a constructivist view.

In the science education, constructivism is a dominant paradigm in learning, teaching and research. It is used broadly in Constructivism is widely used in many fields and not always with the same meaning. The following subsection offers an account of how constructivism is most commonly understood in science education.

1.1.0 Constructivism and Science Education

Science Education is now an established field which has its own journals, conferences, university departments and so forth worldwide. Constructivist perspective on learning and supporting approaches to constructivist teaching had a effective role on its development. Constructivism was a psychological flavor in major drawn from the work of Piaget, J (1972), Ausubel, D (1961), Gagné, R (1985) and Bruner, J (1990). Science education and research are combined by the work of Jean, P. (1972) Bruner, J. (1990). Personal construct theory by Kelly, G. (1955) and social constructivism by Lev Vygotsky's (1978) have been also main contributors in the same field.

The scholars from psychology initiated the first generation of science education researcher. University of Waikato (Aotearoa /New Zealand), University of Leeds (United Kingdom) and University of Surrey (UK) developed active research centers focusing on students' ideas in science. They influenced highly on future learning. This proved to be 'alternative conceptions movement' supported by a series of influential publications on children's ideas on science and their implications for learning.There was still a need of seminar contributions and 'hard core' of a constructivist research program into the learning and teaching of science. For a long period of time, constructivism is taken as an epistemological base for researches in science education also took place. Science learning was considered as an individual process of concept development. Learning was viewed as an individual process executed in the mind of each student with the concept development. To describe and explain learning, constructivism cab be taken as basis for science education.

1.1.1 Constructivist Approach and Experiential Learning

Sound educational principles must be recognized and incorporated by the teaching process. It is found by prior educational researches and practices that experience provides an enormous impact on learning and all individuals have

different learning styles, and that these styles come into play in significant ways. And also that adult learner differs from children. This knowledge can be used in an experiential design of constructivist approach, as a teaching approach.

Kolb, D. (1970) defined this type of learning as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combinations of grasping and transforming experience."

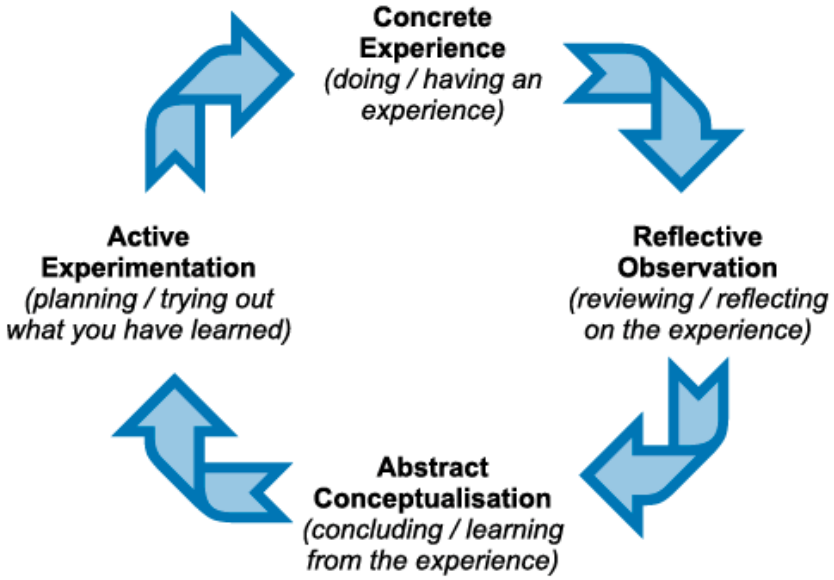

Figure 1.1: Experiential Learning Cycle by Kolb, D. (1970)

Figure 1.1 indicates the experiential learning cycle by Kolb, D. (1970) operates on two levels: a four stage cycle of learning and four separate learning styles. Active experimentation provides concrete experiences and observation which can be used as basis of reflection and conceptualization when knowledge construction takes place. "Learning is the process whereby knowledge is created through the transformation of experience" (Kolb, D).

1.1.2 Constructivism, Science and Cognitive Psychology

Conclusions on investigations of teacher behaviours stated that there was very little improvement in classroom teaching as described byWelch, L. (1985). He also remarked that in the learning process if students are considered as primary actors then the study of desirable behaviors can be done at different levels. His researches found lack of study on student behaviors and suggested that it can be done while learning science. His major psychological research finding was that learning was influenced by the students' prior knowledge and on how the students learn. It is difficult to separate teacher and student behaviors as both occur simultaneously. Thus in practice, teaching and learning mutually impact on each other. However there is the need of studies on isolation of both processes and studying them independently.

Constructivist thinking, teaching and learning have been gaining ground in the recent past. Fensham, M. (1992) stated that the constructivist view of learning had the most conspicuous psychological influence on curriculum thinking in science, since 1980. Tobin, K. (1993) remarked that constructivism has gained popularity over recent decade, representing a shift in paradigm for science education. Yeany, H. (1991) gave emphasis under constructivism stating that there is a probability of unification of thinking. He also argued for research in curriculum development and teacher education. The same was also found by Scott, Asoko, Driver and Emberton (1994), they viewed that learning science from constructivist perspective has involves epistemological and conceptual development in science education by the perception of constructivist approach.

Learning as per constructivist approach is viewed as a dynamic and social process wherein students actively construct meaning from their prior experiences and understandingswithin social setting (Driver R., Asoko, Leach, Mortimer and Scott, 1994). It also emphasizes that students come to the science classroom with lots of strongly formed ideas about how the natural world works. In the view of constructivists, students should be considered as active learners and should not be taken as be passive recipients of knowledge supplied by teachers. Thus learning may be viewed as a active and complex process of acquiring new knowledge. Teaching-learning is an active interaction between teachers and learners wherein learners try to

make sense of what is taught by attempting to fit these with their own experience and prior knowledge.

1.1.3 Various Approaches in Science Teaching for Conceptual Reconstruction

Constructivist approach to science teaching emphasizes on generative learning and inquiry strategies. Also inquiry based instruction promotes conceptual knowledge of learners by framing on prior understanding and active engagement of the study content and its real life applications. Neale and Smith, 1990 suggested that science teaching-learning can be based on discovery learning, experimentation, and open-ended problems. They focused on attributes of a good science teachers who can be help the students to achieve deeper understanding, using their ideas to guide lessons, providing experiences for students' ideas to arrive at concrete knowledge. The classrooms are transformed into learner-centered places wherein group discussion, exploration and problem solving are occurring commonly.

Learning in students takes place by their own actions and reactions in a new situation. There is new exploration with the least guidance by teacher. The experience received which is new raises questions or complexities that cannot be resolved with their present conceptions or accustomed patterns of reasoning. It is the opportunity for students to voice potentially conflicting or partially inadequate misconceptions that spark debate and reflection on their ideas. This may result to the identification of regularity in a phenomenon.

Constructivism reflects many theoretical positions emphasizing on learning as a conceptual change, curriculum development and science teaching. It also focuses for adopted teaching methods which help learners in reconstruction of conceptual understanding by identifying student's views and ideas and by giving chance to explore student's ideas for testing their own understanding, or to account any event or make predictions. It also helps to provide stimuli for students for developing, modifying or changing their knowledge.

Students' learning can be improved by constructivist teaching methods . They help students to understand, recall and apply essential information, concepts and skills. They originate from cognitive psychology. They make lessons relevant, students' prior knowledge is activated, help in elaborating and organizing the

information, and encourage questioning. Useful techniques can be: Advanced organizers wherein general statements are given prior to instruction to relate new information by activating prior knowledge, increasing accommodation; Analogies of similarities help students to learn new knowledge by connecting their past experiences and Elaboration activates are planned for using new material that helps students to connect the ideas with existing knowledge.

1.2.0 Social Construction of Knowledge

Driver and Easley found constructivist view as insufficient to science learning. As science is a body of knowledge, so the learners cannot discover the rules and definitions of the scientific community. Students cannot independently discover the Driver explained science as a public knowledge which is "carefully checked construction" rather than a discovery. Science learning emphasizes learners to visualize scientific community. Teacher as a part of scientific community helps students in a way of developing a particular viewpoint as shared with the members of community of science. Science learning involves a mix social processes involved with personal learning. Individuals must be involved in knowledge construction process and its meaning making and develop a perspective to view scientific community. Science learners have to gain knowledge about the rules to manipulate the symbols of science with the contact of teachers and proffesors of science community. Science knowledge acquired in classrooms must relate and match with the existing concepts of science community.

Learning scientific knowledge in a community involves individual knowledge construction and enculturation as argued by Cobb, T. (1996). According to Cobb, socio-cultural and constructivist perspectives constitute the background for each other." Fosnot (1996) also focussed that socio-cultural and individual constructivist processes are interwove, as individuals are social beings so they do not act alone but mutually share their knowledge with others socially.

1.3.0 Nature and Characteristics of Science

Science education has defined tenets of the nature of science that are understandable by students and important for all citizens to know. Nature of Science as analyzed recently by William Mc Comas and Joanne, O. (2001)is: Science is an

attempt to explain natural phenomena. It is contributed by people from all cultures. It also has a tentative character but is durable too. It relies on observation, experimental evidence, rational arguments and skepticism. As there are many ways of scientific approach there is no universal step-by-step scientific method. Any new scientific knowledge should be clearly and openly reported. Scientists creatively and accurately record, peer review and reproduce the data. All the observations are theory laden. Since centuries science is evolved revolutionary. It is a part of social and cultural traditions and its ideas are affected by the social settings. Science and technology impact each other. Scientific laws and scientific theories have independent roles and so theories do not become laws even with additional evidence.

It can also be refined to the following tenets.

Scientific knowledge is tentative (subject to change). Science is empirically derived from observation of the natural world. Nature of science is inferential, imaginative and creative. Moreover it is subjective and theory laden, embedded socially and culturally.

These tenets provide a more accurate view of the scientific enterprise at primary to secondary school level.

The important additional aspects are:

- The distinction between observation and inferences.
- The relationships between scientific theories and data.

Teaching science at secondary level is done as an integrated subject. At higher secondary level and at college the teaching of physics, chemistry and biology becomes more discipline oriented and focused. Core subjects are taught by expert teachers with appropriate objectives.

1.3.1 Physics and Skill Development

Teaching-Learning physics provides lifetime benefits of knowledge and skills required by employers. Some of these benefits are qualitative as the pleasure to read and understand the latest discoveries in science. Also there are other are more specific benefits. Acquired skills useful in many contexts are called *transferable skills*. They

include a practical approach to problem solving, and the reasoning and logical ability to communicate well. Thomas (2013) and Ramesh (2014) focused that concepts and skills can be effectively constructed when the students are engaged in science experiments and observations.

The transferable skills developed in learning physics include:

Analytical: As teaching-learning of physics enhances the ability to think clearly constructing logical and reasoned arguments and also paying attention to details.

Problem Solving: The Mathematics and physics teaches problem solving, both academic and practical. They apply to day to day life application. More practice leads to better and clear learning. Learning to formulate the problems precisely, to identify the key questions and to use simple problems and limiting cases to guide to more complicated problems.

Self-study: Physics develops the ability to teach yourself. During physics teaching-learning much experience is gained by searching for inventions and discoveries and digesting information from a variety of sources. Also they include lectures, the library and experts guidance.

1.3.2 Constructivism and Physics Teaching:

Constructivist learning as an approach to teach physics with the help of a figure.

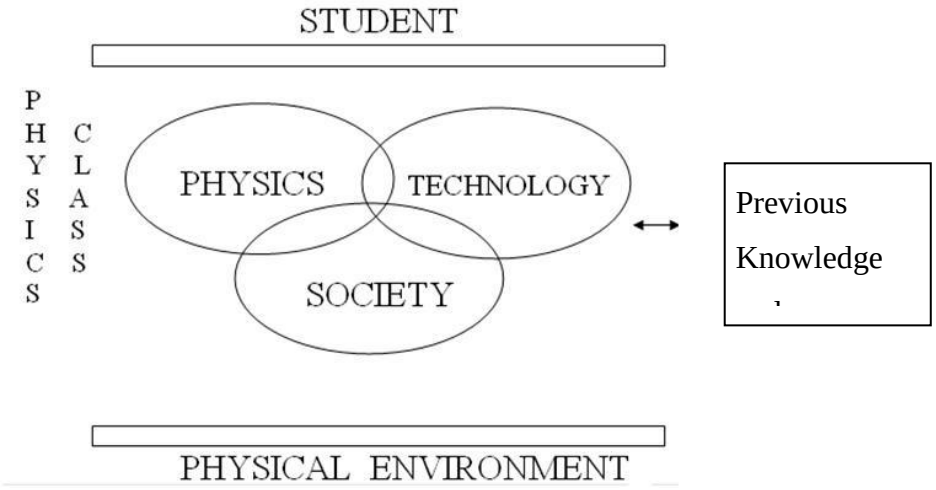

Figure 1.2: Social construction of knowledge in classroom

Figure 1.2 shows that in the classroom setting the three elements namely Physics, Technology and Society work in an integrated manner. It is in the intersection of the three in the presence of previous knowledge and experience that the knowledge is constructed and conceptual reconstruction takes place.

Considerations for using Constructivism: The5E's **Instructional Design** is one of the ways of constructivist approach to teach physics. It is a strategy of learning that is based on students' existing knowledge and beliefs. New knowledge is acquired by the activities which can connected to past experiences and understanding.

The teacher teaching with constructivist approach adopts teaching by giving a chance to explore to students, guides and facilitates the teaching by encouraging the spirit of inquiry and making students learn to think differently and creatively. Teaching is done by the activities planned for students involving individual as well as social learning. with the use of raw data and primary information.. Teacher allows students individual working and helps in learning from their own explorations. Finally students develop exploring their learning as accumulated, evolving knowledge. This approach is suitable to learners of all age groups.

The 5 E's is an instructional model based on the constructivist approach to learning, developed by Bybee. R. (2009), Biological Science Curriculum Study Centre (BSCS), emphasizes that learners constructs new ideas over their prior knowledge. The 5 E's model is helpful for students of all age groups.

Each E in the E's model focuses a learning phase beginning with alphabet E. i.e. Engage, Explore, Explain, Elaborate, and Evaluate. It employs the process of teaching-learning to explore to the common activities, developed on prior knowledge and experiences, making and constructing meaning, and continually assessing the understanding of a concept.

Step 1: Engage: This phase of the 5 E's starts the process. An "Engage" activity focuses on:

Making connections between past and present learning experiences and anticipating activities and focus students' thinking of current activities based on the learning

outcomes. Students are engaged mentally in the teaching-learning process to the content to be taught.

Step 2: Explore: This phase provides a common base of experiences to students. They identify and develop concepts, processes and skills. Students are actively explored to their environment and allowed to manipulate materials and formulate a basis for new knowledge.

Step 3: Explain: This phase promotes s teacher to explain the concepts which they have been exploring. They can be given the opportunities to verbalize their conceptual understanding or demonstrating new skills or behaviors. Teacher conceptual explanation or introduction to formal terms is done in this phase.

Step 4: Elaborate: This phase elaborates and extends conceptual understanding of students by allowing skills to be enhanced. Learners develop deeper and broader understanding of major concepts through the experiences given to them, obtaining more information about areas of interest, and refining their skills.

Step 5: Evaluate: This phase encourages learners assessing their understanding and abilities and allows teachers to evaluate or test students' understanding of key concepts and skill development based on learning objective.

- To be concerned that our students not only “have” the material but that they make sense of it” and can use it effectively.
- To make deep changes in the way our students think, teachers will have to help students confront their incorrect beliefs.
- To help students find new concepts to understand concepts that they do not naturally build.
- To find ways of actively engaging students who learn differently than others do. (Redish 1996, 2004)
- It is equally important to give students opportunity to communicate what they have learned. It means over-viewing the entire structure of the subject, developing

linkage within the subject and with outside the subject, monitoring and reflecting on process of learning individually.

- To provide for peer learning, for learning from each other.

1.3.3 Constructivist Approach to Teach Physics

Following are the features of constructivist approach to teach physics:

- Multiple perspectives and representations of concepts and content are presented in teaching-learning and students are encouraged to explore.
- Teacher plays the role of guide or facilitator.
- Meta cognition is encouraged by providing activities, opportunities, tools and environments and also self analysis –regulation, -reflection and awareness at all phases is done.
- Learning is mediated and controlled by student centrally.
- Natural complexities of the 'real world' are reflected in the learning situations, environments, skills, content and tasks which prove to be relevant, realistic, and authentic.
- Construction of knowledge is reinforced and not mere reproduction of knowledge is emphasized. Learners are involved individually and also socially by doing social negotiation, collaboration and sharing experiences with teacher as a guide in the knowledge construction process.
- The learner's prior knowledge, ideas, beliefs and attitudes play central role in the knowledge construction process.
- Problem-solving, higher order thinking skills, insights in to modeling, experimentation, and laboratory skills are acquired.
- Errors done by students in exploration phase provide the chance for insight into student's previous knowledge construction.

- Students are encouraged during exploration phase to seek knowledge independently and managing the pursuit of their goals.
- Increasing complexity of tasks, skills and knowledge acquisition is provided to learners for apprenticeship training.
- Conceptual interrelatedness and interdisciplinary learning provides the opportunities of Knowledge complexity.
- For promoting the learner to alternative viewpoints Collaborative and cooperative learning are encouraged.
- For students to perform beyond the limits of their ability, scaffolding is facilitated.
- Teaching is interwoven in learning and assessment is authentic at all phases of teaching-learning.

1.3.4 Learner's Changing Profile and Need for Constructivist Approach

Learner's profile has changed a lot over a period of last two to three decades. The learner prior to 2-3 decades were much docile, passive and dependent on knowledge and teaching learning process that occurred in the classroom. Emphasis was given more to rote memorization and repetition. The learner was 'tamed' to not ask any questions abide by rules and regulations of the school.

The learner in the 21st century, acquainted with information and communication technology is led to any information he requires on the finger-tip which has made him more independent and dynamic, therefore, expects more matter than the one given in textbook, gets bored by lectures, expects more activity and real life connects, questions the relevance of knowledge being provided, seeks information from multiple sources nationally as well as internationally. At the same time the 21st century learner is also lazy, despises long answers and expects more of MCQ's (Multiple Choice Questions) and short answers. The overall profile of learner is more about experimenting and trying out new things, even testing their own limit, is more intolerant and indifferent engrossed in the selfie, groupfie, whatsapp and facebook world, conscious about looks and trends. Also due to the availability of vast

information on the internet, students often are drawn to confusion for the authenticity of the content.

Constructivism would give a vent to students to make and think regarding the topic under discussion. During the discussion with multiple perspectives their curiosity of understanding from different sources will get satisfied. In such discussions students are likely to be able to modify their attitude, knowledge, beliefs and values regarding topic under discussion and will attain conceptual reconstruction. It is expected that students will also be able to relate the complexity of knowledge and also interlinking of content. Constructivist approach also provides an environment where collaboration and scaffolding help in conceptual reconstruction. As the students engage and explore knowledge assessment becomes easier and simpler.

Thus, constructivist approach may suit to the changed profile of learner providing the chance to reflect on their personalized knowledge and by sharing of experiences in a group to construct the new knowledge.

In this subsection, nature of science, in science also physics and skill development through physics, constructivism and physics teaching followed by changing profile of learner. In the next subsection technical education is presented.

1.4.0 Technical Education in India

A very low Gross Enrollment Ratio (GER) of 18.8% with respect to higher technical education in India is found which indicates that only about a fifth of the population in the age group of 18-23 years has access to technical education in India. India's GER is found far below those of most developed countries and even below those of the other BRIC nations (Brazil, Russia, India and China) as illustrated in figure 1.3 below. Access to technical education differs widely across states. Data indicates southern states are more progressive and have better GERs as well as higher availability of educational colleges and universities.

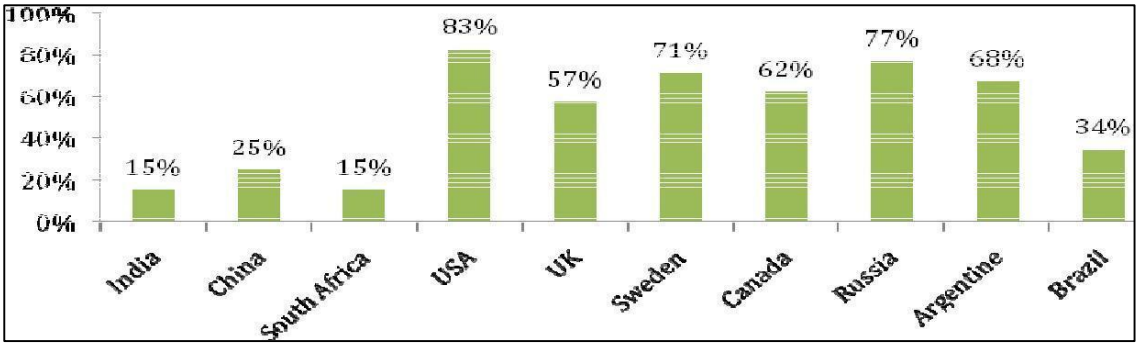

Figure 1.3:GER of selected countries*GER for India (15%) corresponds to 2014

According to BRICS Commission Report (2015), if an economy is growing rapidly, there emerges the shortages of skills. It is found that the Indian and Chinese economies are facing skill shortages and there is widespread need of responsive and agile system for development of skills.

1.4.1 Technical Education in 11th and 12th Five Year Plans

According to the Planning Commission Report for the 11th Five year plan there are about 5,114 Industrial Training Institutes (ITIs) imparting training in 57 engineering and 50 non-engineering trades. State Government-run are 1,896 and private are 3,218. The total seating capacity in these ITIs is 7.42 lakh (4 lakh seats in government ITIs and the remaining 3.42 lakh in private Industrial Training Centre (ITCs). Private training provides also run a number of vocational training institutes. In education at grade 8 and above the formal training system of India begins.

International Labour Organization, (ILO) flagship reported the sustained growth of quality jobs in emerging and developing countries. According to Raymond Torres, Director of the ILO Research Department 2014)To tackle underemployment of both youth and adults, quality of jobs is required to be improved. This is also a major economic problem in many emerging economies and developing countries. It is essential to make decent work a central goal in the post-2015 development agenda as per this evidence. Developing countries will have essentially to create around 40 million new jobs every year in order to keep up with the growing working age population, over the next decade.

According to 12thFive Year Plan of India, skill building is an effective instrument to improve the quality and contribution of labor to the overall production.

It is also an important part to push the production frontier outward and to increase the economic growth rate trajectory. It is also an effective instrument to empower the individual by improving his/her social acceptance or value.

Ministry of Labour and Employment in 2009 formulated the previous National Policy on Skill Development which provided a review after five years to align with the policy. The policy aimed to expand on outreach, equity and access of education and training by establishing several industrial training institutes (ITIs), technical schools, polytechnics, vocational schools and professional colleges to facilitate apprenticeships, sector-specific skill development, adult learning, e-learning, training for self employment.

Government of India launched a number of initiatives aimed at developing skills and promoting entrepreneurship among youth. The Union Budget 2015 paved way for the launch of National Skills Mission. The Union Cabinet chaired by the Prime Minister has cleared an institutional framework for the National Skills Mission, and also approved the first integrated national policy for developing skills and promoting entrepreneurship on July 2015. The mission formulated a three-tiered, high powered decision making structure, with its governing council being chaired by the Prime Minister.

The new National Policy for Skill Development is the country's first integrated national scheme for developing skills and promoting entrepreneurship at a large scale and was approved by the Union Cabinet. The government set a target of skilling 40.2 crore people by 2022, and the initiatives are aimed at the fulfillment of this objective.

1.4.2 Recommendations on Higher Technical Education

Government initiates holistic sustenance through financial support, infrastructure support and policy support for technical education. Collaboration with countries like Germany, Australia, Canada was done for teaching reforms and their modern vocational education teaching pattern was learnt. Employment issues were addressed by ensuring industry- institute partnership achievement of the market demand was done. Accountability was fixed by making laws, growth rate of private institutes was regulated and quality of education in private institutions was improved.

Table 1.1: Summary of Major Committees and Recommendations

Committee	Title	Year	Recommendations
Sarkar Committee	Higher Technical Institutions for the Post-War industrial development	1945	Setting up of Indian Institutes of Technology
Thacker Committee	Postgraduate Engineering Education and Research	1959-1961	Funding for 100 PhDs annually
Nayudamma Committee	Postgraduate Education in Engineering & Technology	1979-1980	PG minimum qualifications for industry, R&D, etc…
Nayudamma Committee	IIT Review	1986	Greater flexibility in Academic programme, Focus on engineering research, Faculty mobility
P. Rama Rao committee	Reshapping Postgraduate Education in Engineering & Technology	1995	21 months M. Tech, increased scholarship amount, Assured employement for M. Techs, National Doctoral Programme
R. A. Mashelkar Committee	Strategic Road Map for Acedmic Excellence of Future RECs	1998	Conversation of RECs into NITs with the status of a Deemed to be University and structural changes in governance
U. R. Rao Committee	Revitalising the Technical Education	2003	Regional inequity to be removed. Faculty shortage tobe addressed. Need for planning and coordination in the working of AICTE
P. Rama Rao Committee	IIT Review	2004	Increase UG output of IITs, Fund infrastructure increase, Add new IITs but maintain quality

Various committees gave major recommendations focusing on improvement of quality of education and expanding the facilities of IITs. Faculty shortage and need for Ph.Ds was also highlighted. Improvement in infrastructure was found.

1.4.3 Technical Education and Skill Shortage in India

Another important goal of the 12th Plan of India was inclusive development. To determine the accessibility and cost of higher and technical education for a student, economic resources, mobility, and socio-cultural background are important criteria. Various disparities are visible across geographical regions, genders, socio-economic and socio-religious groups (Figure 1.4). The GER found amongst SCs and STs is much lower than the national average, Muslims also have a very low GER. Lower access mostly due to socio-economic factors is found in Scheduled castes and minorities while lesser number of institutions serving tribal areas was found. Migration of students from these groups is required. But non-availability of residential facilities and supporting infrastructure in the institutions becomes a point of concern. These inferences are drawn from the estimates of National Sample Survey Organization (NSSO's 61st and 64th round).

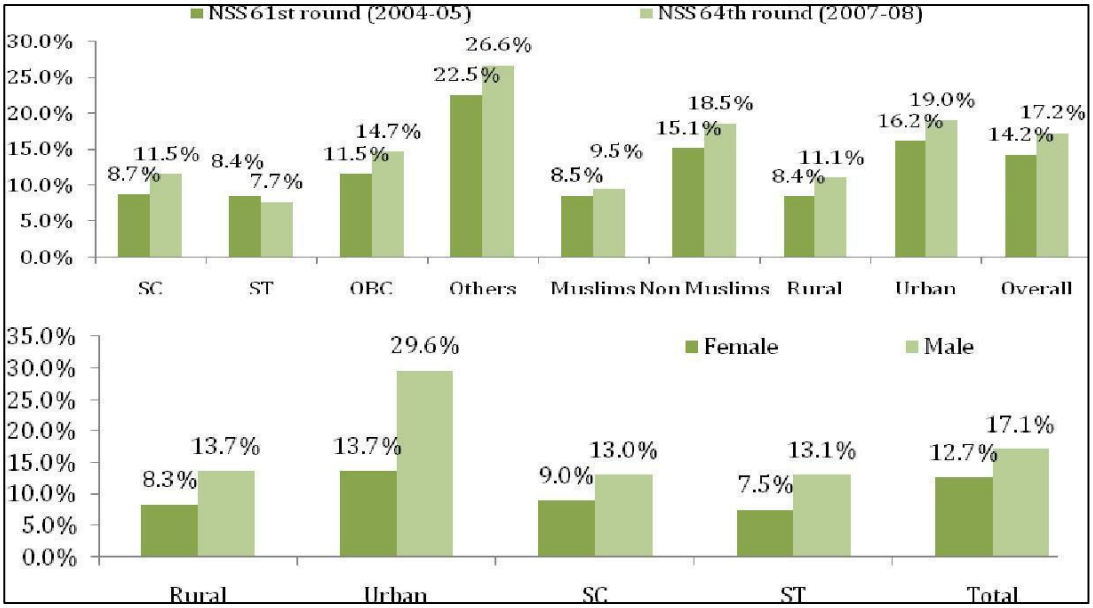

Figure 1.4: Gross Enrollment Ratio across categories (Based on MHRD Statistics of Higher Technical Education)

Important issue of gender disparities is seen. In the age group 18-23 years, males are ahead of females. Estimated GER for women and girlsis found to be 15.8 percent and for men it is 22.8. It focuses on major sustained efforts in improving gender disparities.

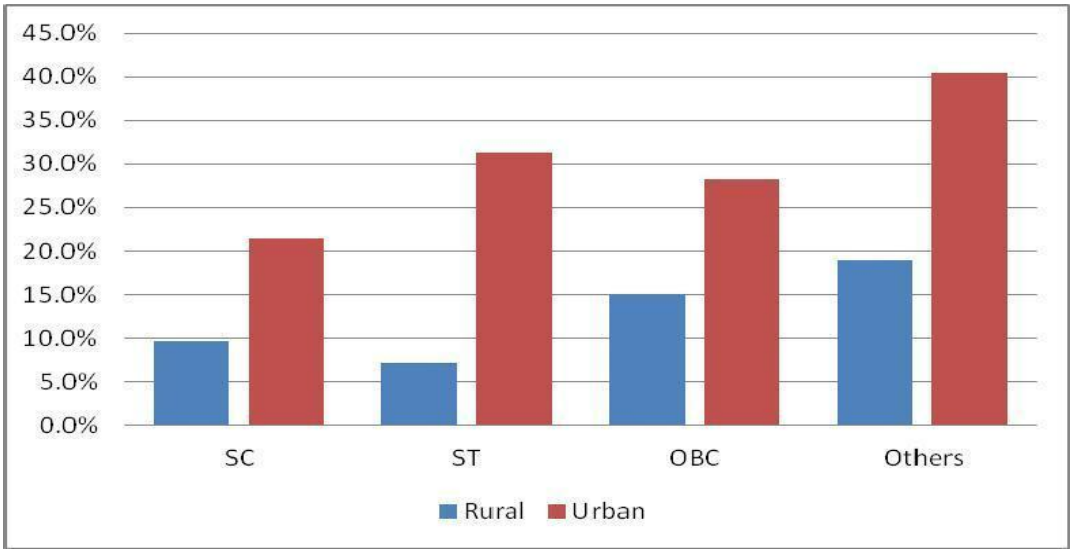

Figure 1.5: GER among Socio- Economic Groups

Stark inequities is found in the analysis of the GER amongst caste groups along rural and urban areas. GER for SC (9.6%), ST (7.1%), OBC (15%) in rural areas is found quite low compared to their respective GER in urban areas (Figure1.5). This major difference assigns to improve education facilities and opportunities for these social groups for higher and technical education.

Changing demographic profiles in India vis-à-vis China, Western Europe, and North America has led to the contemporary focus on technical education and skill development in India. This also suggests that India has a unique"demographic dividend" for 20 to 25 yearsas a window of opportunity. Two factors (a) declining birth rates and (b) improvement in life expectancy are found due to the demographic dividend. Age distribution is changed because of declining birth rates and makes difference for a smaller proportion of population in the dependent ages and for relatively larger share in the productive labor force. Therefore low dependency ratio is found that provides comparative cost advantage and competitiveness to the economy.

Skilled workforce can be cultivated in the near future because of the advantage that India has of "demographic dividend" (younger population compared to the ageing population of developed countries).

The global economy may witness a skilled man power shortage to the extent of around 56 million by 2020. Thus, the "demographic dividend" in India needs to be

exploited to meet the skilled manpower requirements of India and abroad and also to expand the production possibility frontier.

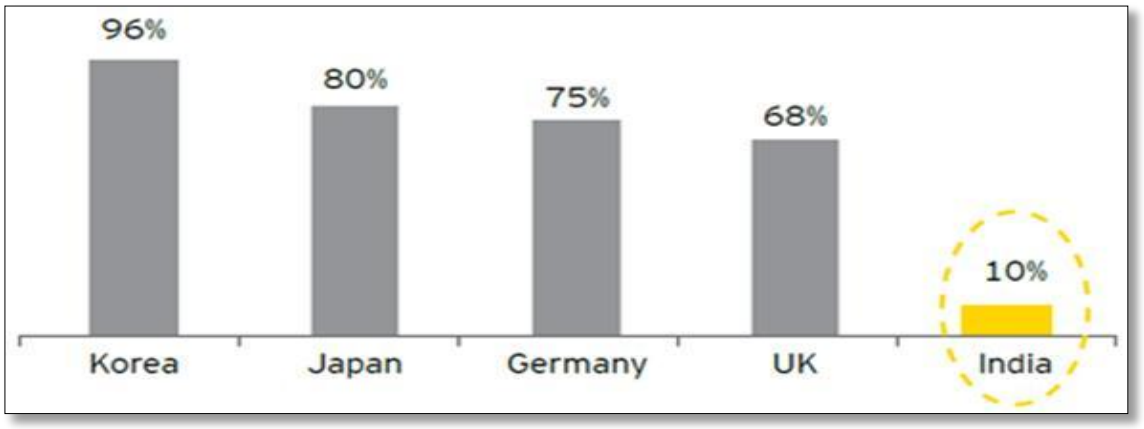

Figure 1.6: Percentage of workforce receiving skill training (2014)

A graphical report by planning commission of India (2014) is shown in figure 1.6, which describes India's work force receiving skill training is extremely low as compared to other countries of the world. Government of India was majorly concerned for this.

Engineering profession is acquired by designed education system for training of engineers. Hence economy has to meet the challenges and needs for engineering education. Education system needs to be responsive and adaptive to the demands of technological and industrial changes. Engineering educators need to be conversant with existing practices in industries and should also act as agents to bring in innovation and improvements in technical education. Engineering education system in India initially focused on production of engineering graduates for implementing, operating and managing the growing industrial sector which relied mainly on imported technology.

Analyzed data for the entire country and comparison with other countries is shown. It mainly focuseson the numbers. The inputs and outputs for engineering education are shown in Figure 1.7. The number and quality of under-graduates and graduates is a direct indication of the growth in engineering education. Quality assurance would be on employability, salary and feedback from industry and society.

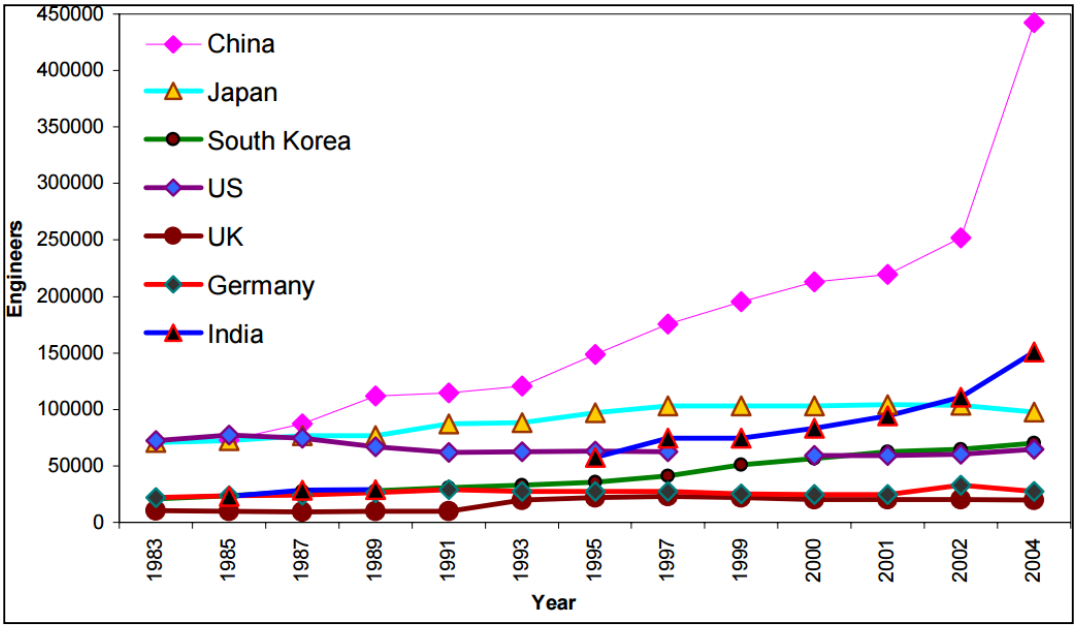

Figure 1.7: Growth in Under Graduate Engineers in Different Countries(Source AICTE reports)

For most recent years, the number of under graduate engineers per million populations and growth rate of under graduate engineers for the period 1985-2004 is shown in figure 1.7. It can be seen clearly that India has one of the highest growth rates. As per AICTE reports, about 30% of the fresh engineering under graduates are estimated to be unemployed even one year after graduation. Complaints for the shortage of quality engineering under graduates is found from several industrial leaders. From this statistics quality is impacted through present growth.

1.4.4 Strata of Technical Education in India

Engineering qualifications in India are categorized as following:

Course of Diploma in engineering for the duration of 3 years for which eligibility criteria is matriculation.

Course of Graduation in engineering education for the duration of 4 years for which eligibility criteria is Standard 12 passed or after passing Diploma course in engineering. Both B.E. i.e. Bachelor of Engineering and B.Tech. i.e. Bachelor of Technology are equivalent. AICTE conducts an entrance examination for the admission of this course.

Master's degrees with the duration of 2 years by completing bachelors degree in the fields of engineering and technology, Science,etc. Master of Engineering, Technology, Science, Master in Computer Application. Entrance Examination is conducted for the admission in this course.

Doctoral degree is for the duration of 3 to 5 years depending on the topic chosen: Eligibility for pursuing doctorate degree in any field is after successful completion of Masters Degree in the particular field.

The current study focused on diploma level engineering.

1.4.5 Diploma in Engineering

The Diploma Course in Engineering is a technical qualification below undergraduate aiming to provide students with basic knowledge of engineering, computing, mathematical techniques in the job field and ability to apply the basic problem solving techniques. Its duration is 3–4 years. It is recognized as equivalent to Inter-Science by many countries in the world. Passing Diploma in Engineering course leads to further engineering studies in undergraduate level or the students are eligible for employment as supervisors, foremen, sales engineers, draughtsman, service station managers, auto engineers, junior instructors, etc. Diploma in engineering can be pursued as a career across world after passing matriculation examination or its equivalent.

Polytechnic institutes recognized by State Boards of Technical Education and State Directorates of Technical Educations and recognized by All India Council for Technical Education (AICTE) offers Diploma in Engineering Course. Diploma Holders are eligible for the examination of Associate Member of the Institution of Engineers (A.M.I.E), Member of Indian Institution of Industrial Engineering (MIIIE), Navi-Mumbai which is equivalent to the BE. They are also eligible for lateral entry to the third semester engineering courses in various Technical Universities. and for part-time entry in various Technical Universities offering Degree/Bachelor of Engineering Courses.

1.4.6 Gujarat Technological University

Gujarat Technological University (*GTU),* is a statewide institution affiliating many engineering, pharmacy, and management colleges across Gujarat. The prime objective of establishing GTU is to ensure technical education in Engineering, Pharmacy, MBA and MCA at higher level all over the State. It ensures education with its recent syllabi and leadership in learning for advancement of quality in the various fields of science, management, engineering, and computer applications.

High Quality Education is sensitized by the colleges affiliated to Gujarat Technological University. The list of affiliated colleges is attached in appendix no. 2.The university was established on the 16th of May, 2007 administered by the State Government. Earlier, before the existence of this university, Gujarat University was heading all colleges affiliating technical colleges in Gujarat state. For more efficient and effective technical education the state government formulated GTU. The results are declared from February to April for final semester (winter exams) and from June to August of final semester summer exams.GTU Innovation Council' (GIC) is established by GTU at ACPC Building, LD Campus in the year 2013which is headed by Mr. Hiranmay Mahanta. GTU Innovation Council aims to facilitate student startups by providing necessary facilities, organizing workshops, helping students to find relevant mentors and other industrial workshop activities weekly. It also imparts the training to faculties, conducts workshops on Training the professors, Flash Ventures, Social Entrepreneurship Boot camp. Students can patent their innovative ideas and projects under a separate wing of IP Clinic for Final year student projects.

Crowd funding Initiator program was launched by GTU in association with Start51 which is an indigenous crowd-funding platform all over India. Crowd funding Initiator (CFI) is aimed to help student startups with necessary guidance and funding. Reports seek about 70 student startups from around Gujarat are enrolled, among which a few projects were selected for the one-month-long boot camp. This boot camp was divided into four parts: Ideation, Incentive Model, Pitch Presentation and Funding. Crowd funding Initiator took 8 projects live on a dedicated crowd funding portal for funding.

Faculty Development Programs: The University has the largest Faculty Development Program in the country for training in different aspect of pedagogy and technology.

Practice-Orientation: It provides high innovative facilities to the students, Professors and Principles/ Directors to make the technical education more practice-oriented. The colleges affiliated to GTU utilize these facilities, created by GTU.

Disciplines in Diploma Engineering

Diploma in Engineering can be pursued in Aeronautical, Automobile, Civil, Mechanical, Electrical, Architectural, Electronic, Enviornmental, CAD, Mining Engineering, Instrumentation branches in India.

List of polytechnic colleges in Gujarat is attached in Appendix no.2

1.4.7 Polytechnic Colleges in Vadodara

There are different colleges in Vadodara, Gujarat offering technical education at Diploma level and Degree level. They are:

1) The Maharaja Sayajirao University of Baroda
2) Butler Polytechnic College
3) Parul Group of Institutes
4) Sigma Institute for Engineering
5) K.J Institute of Engineering and Technology
6) Madurai Kamraj University Study Centre.

Of these, Butler Polytechnic College for technical Education was established in 2005 affiliated to Gujarat Technological University, Accredited by AICTE it offers Diploma Level Courses in the branches of Civil Engineering, Mechanical Engineering, Electrical Engineering and Architectural Engineering.

1.4.8 Subjects Taught at Diploma Level

The Following subjects are taught in First Year Civil and Electrical Diploma Engineering:

- Engineering Mathematics
- Engineering Physics
- English
- Basic Engineering Drawing
- Environment Control and Hazards Management
- Computer Application and Graphics
- Contributor Personality Development
- D.C. Circuits
- Engineering Chemistry
- Electrical Engineering Workshop Practice

1.4.9 Looking beyond Content: Skill development for engineers

Focused attention on reforming engineering education is given to help the students develop skills. Instructions to be given to expertise the skills are based on the neural, cognitive and behavioral sciences.

To become a successful engineer, an individual requires many qualities and skills to pursue a successful career. As Engineering is a dynamic field, so it requires people who are able to work across disciplines, and adapt to new challenges continuously.

Good technical skills with variety of other skills are necessary. They are:

Technical Competence: As there are many technological advances in the globalized era, having technical skills to carry out a job successfully is utmost required. And engineering education is the basis of teaching technical competence.

Communications Skills: Communication skills of reading, writing and software are utmost important to become an effective engineer.An engineering having good communication skills is noticed earlier as compared to one not having it.

Leadership Skills: Leadership is about action. Leadership skills are required most during project management wherein the following task of planning, setting priorities, delegations, making decisions and guiding and leading the team members are attributed. **Teamwork:** The ability to work in a team is most essential to become an effective and efficient engineer. Experience of team work can also be gained by volunteering the activities.

Problem solving: As an engineering student has to solve the problems by looking into the issues that require thinking ability by analyzing the options and creating great solutions to the problems that are arrived for the first time.

Mastery in each of these qualities and skills is required to become an effective engineer. Attributes of a successful engineer is he should be well-rounded, with knowledge of the key skills having an ability to apply them when required.

Constructivism supports collaborative approach and experiential meaning making process. Learner connects the new knowledge with already existing knowledge is entailed by the philosophy of constructivism.

Teaching-learning process of science subject in technical institution may involve scientific, cognitive and constructivist approaches that aid conceptual reconstruction of students' knowledge. Nature of Science is tentative and empirically based on observation of the natural world. Science is socially and culturally embedded. Science is classified as a subject bifurcated into natural science and physical science. Life sciences are categorized in Natural science and physical science includes chemistry and physics.

1.5.0 Physics Taught at Diploma Level in Technical Education

Physics is considered as mother of all engineering disciplines. It plays a key role in the future progress of mankind. It includes the study of matter, energy and their interaction. Curriculum varies at different levels of engineering education. At diploma level it comprises of the following units:

Units and Measurements, Force and Motion, General properties of matter, Elasticity, Heat Transfer, Nanotechnology, Radioactivity, Light and Sound, Static and

Current Electricity, AC Current, Semiconductors at civil, mechanical and electrical branches.

1.5.1 Teaching-Learning approaches used in Technical Education

Learning process is influenced by the context of teaching-learning for determining the learning outcome. Teaching approaches vary across different engineering and science courses and on the prior experiences students.

Learning is done in many ways— by seeing and hearing; on reflecting and acting; logically and intuitively reasoning; visualizing and memorizing and by drawing analogies and building mathematical models. There are different teaching methods. Some faculties teach by giving lecture or by demonstration or discussion; others may focus on principles and applications. Student's learning in a class is governed by the student's native ability and prior understand with that to teaching style of teacher. There is a chance of mismatches between teaching-learning styles of engineering students and engineering educators.

There may be incompatibility found between learning styles of most engineering students and teaching styles of most engineering professors, according to R., Felder & L., Silverman (1998). Most engineering students are found visual, sensing, inductive and active, many creative students can be global learners trying to understand things in a holistic manner by inter relating and integrating knowledge in a larger context. Global learnersare aware of concepts and their details. Group studies and multitasking are favorable to such learners.

To meet the needs of most of the engineering students having diverse styles of learning a small number of techniques used by instructor can be sufficient . Active learners requires the teaching learning process to be active while reflective learners learn much in situations that provide them opportunity to think about the information taught.

Global learners should be set free to learn on their ownmethods of solving problems and should not be forced to adopt one strategy. They should be periodically exposed to advanced concepts before the scheduled teaching learning to be introduced for whole class. This can be helpful for promoting higher order thinking skills.

- **Practical Example:** This method demonstrates the model first and then explains the making of the model. It is targeted to illustrate making the Theoretical base is made to illustrate and toexplain new material. And then application of knowledge of the content matter is used to solve real life engineering issues.

- **Interactive Method of Teaching (IMT):** Interaction among students and teacher is done for teaching learning of new concept. It can be through questions and answers, or by discussions, or by exchanging thoughts. Cooperative spirit is developed as both students and teachers get opportunities to know each other, work together for solving the problems.

- **Show and Tell method:** It is an example of practical method. Perspective of the problem is changed by interchanging the roles of student and teacher. Students is given a chance to explain a given theory to the rest of the class by demonstrating a physical example.

- **Case Studies:** It is based on the background and complexities actually encountered by a practicing engineer, their activity, event, or problem. Students can relate the theory to the 'real world' more effectively by this method.

- **Project Learning:** This involves a didactic approach to learning. Learners are benefited from the diversity of a group by bringing in individual abilities. They learn individual skills of critical thinking and problem solving, creativity and innovation, collaboration/teamwork and leadership, cross-cultural understanding, communications and information fluency, career and project management

- **Seminar Method:** This method is a form of class organization of higher education wherein a group of advanced higher studies students are engaged under the direction of educator to discuss the problems of engineering.

- **Individualized Method of Learning (IML):** A student gets the opportunity to work at his own pace. Active involvement of student is done in performing specific learning tasks, and successful learning experiences are attained by the student.

Thus, there are various teacher centric and also student centric teaching methods used in technical education. Any method can be adopted based on the relevance of the content wherein students undergo experiential learning, can work in group and are able to reflect on their own understandings. Constructivist approach can be helpful to make student learn the subjects at technical level.

The present study focuses on developing and implementing instructional design based on constructivist approach to teach selected common units of physics at Diploma engineering level.

1.6.0 Research Questions

The following are the questions formulated by the researcher to begin the exploration:

- Can teaching- learning in technical education be made easy and effective?
- Can Instructional Design be patterned based on constructivist approach to teach physics to Diploma engineering students to make learning effective?
- Can Constructivist approach be employed in enabling students understand the contents of physics syllabus of engineering at diploma Level?
- To what extent is the constructivist approach effective in fostering learning?

1.7.0 Rationale of the Study

National attention on education of scientists and engineers is focused due to increasing importance of technology in modern economic system and increased globalization of scientific and technological ideas, development, and production. Due to this research into thinking and learning has produced dramatic new understandings and produced new technologies to build effective teaching-learning environments for technical education. Improvement of instructional endeavors is achieved by thesynergy of bringing together basic research on cognition with education research focused directly on the disciplines of science and engineering. As the sources of knowledge have increased with the technology and internet, the individual construction of knowledge has become important in learning. Due to many available sources of information, knowledge has become digitalized. Knowledge of students is

created within. Student learns the subject internally. So constructivist approach wherein knowledge is created internally and linked with prior knowledge becomes important. It enhances the learning by logical and conceptual growth. And thus constructivist approach can be suitable with the technological advances, wherein the students' prior knowledge is linked with new gained knowledge and the students share their knowledge by discussions, negotiation and meaning making process of their learnt concepts.

Technological advances are accelerated at an unprecedented pace. It should lead to the development of skills by training in response to technological change. Labor markets are affected by globalization. Information and communications technologies have led a dramatic effect on productivity and on the demand of skilled workers and with those having broader workplace competencies can assure higher wages.

Teaching-learning processes in technical education should be given utmost importance. Students should be given experiential learning so that they can understand and reflect on their knowledge. Researchers in the past decade suggest that learning is enhanced when the frequency with which student actively responds during teaching-learning process is increased. Educators must invite students to experience the world's richness, encourage them to ask questions, and challenge them to explore the world's complexities, not solely focus on academic achievement scores.

To effectively improve the way our educational system works, we must retrain the classroom teacher as a constructivist, since the teachers, who have trained in the traditional teaching approach, wherein the teacher dominates the classroom with the over use of the textbook (Kim, 2002).

To overcome difficulties faced in teaching-learning process, constructivist approach to teaching-learning of physics may prove effective, as Constructivist approach allows the teacher to teach facts and theories more effectively in conjunction with hands on experiences in which students apply those concepts. Review of studies shows teaching-learning through constructivist approach increased students ability to retain greater amounts of academic information over time. This maintenance effect suggests that teaching-learning through constructivist approach might help students to

be more successful in their careers. The review of studies conducted in different subjects such as algebra, mathematics, social studies, computers and non-art majors at different levels as primary school level, college level, in pre service teacher education level using statistical techniques for data analysis show effectiveness of using constructivist approach. They proved to be effective in terms of students achievement scores and memory retention. Thus, it can be concluded from the above studies that constructivist approach is adopted at different levels and in different subjects and is found to be effective as a teaching- learning approach. Diane, J. (2005), Avila, L. (2006),Esmaiel, Y. (2006), Siemears, C. (2007), Cook (2007) and Bijas, J. (2012) and have found that constructivist teaching is effective in teaching English, Science, General Studies, learning, thinking personal understanding. The studies of Akanwa, Alphonsus and Ovute (2014) have shown effectiveness of constructivist approach. Research findings have also revealed that constructivist approach, Cooperative learning, activity based method and experiential learning developed science process skills. Thomas, M. (2013) Many other studies have been done on constructivist paradigm of learning and in Physics. The constructivist approach gives theoretical underpinnings for best-practice instructional methods designed for helping students to develop the skills and it also provides guidance for further research in the area.

First Year Diploma students were selected as a sample for present study as all the students enter in Diploma Polytechnic studies after qualifying Standard 10th Board examination from different Boards namely CBSE or GSEB. The students were from different schools having different backgrounds, Vernecular medium of instructions, different perception for subjects and also different socio economic status. So it provided a need for adopting an approach wherein different multimedia methods such as power point presentation, hand outs, activity sheets provide opportunities to students for sharing their ideas with their peers, in the process of teaching learning of utmost importance. Students' working in groups helps them to explore their knowledge and connect prior knowledge to new learning to concertize the core concepts of engineering.

Thus, constructivist approach is better suited for varied learners gathered in one class. In further studies of engineering to senior classes the students were acquainted with each other while in first year they were new to each other, so all have

different understanding of the subject, wherein there is a need to understand the content commonly same as from this level they will be developing their understanding which will be firm for further engineering studies.

The study follows 5 E as constructivist approach as it is a basic design which takes care of students prior knowledge of the content linked with socially constructed knowledge in a group. The structure of process of learning incorporates personal involvement of students and also working in groups and providing time to reflect on their knowledge and learn new knowledge of the content socially.

Different studies have been done on constructivist paradigm of teaching learning of science. However, as far as the researcher has reviewed the studies, no research has been reported at the teaching learning of physics at Diploma Engineering Level. Hence the researcher chose to pitch the study at Diploma engineering level and assess the usefulness of the constructivist approach in teaching physics at the level. Thus constructivist approach was implemented in the process of teaching-learning of physics at a technical college.

1.8.0 Statement of the Problem

Development and Implementation of an Instructional Design based on Constructivist Approach to teach Physics at Diploma Engineering Level

1.8.1 Objectives of the Study

Objectives of the study:

- To develop an Instructional Design based on constructivist approach to teach physics at Diploma Engineering Level
- To implement the developed Instructional Design based on constructivist approach to teach physics at Diploma Engineering Level
- To determine the effectiveness of the instruction
    - By comparing mean achievement scores of Experimental and Control Group.

- By comparing post-test mean achievement scores of experimental and control group on delayed comprehensive post-test.
- By comparing student involvement and interest in learning.
- By studying opinion of students regarding the instructional design

1.8.2 Operational Definitions of the Terms

1.8.2.1 Instructional Design as per this study is the systematic development of units from physics at diploma engineering level using constructivist approach to ensure quality of learning.

1.8.2.2 In this study **constructivist approach** refers to the learner centered approach of teaching-learning process wherein suitable activities are planned in which students learn by reflecting on their own experiences, constructing an insight to their understanding of learning. The instructional design was based on the activities organized on 5 Es i.e. Engage, Explore, Explain, Extend and Evaluate.

1.8.2.3 Effectiveness in this study refers to increase in scores of Achievement Tests of both Post-tests and delayed comprehensive post-test, prepared by the researcher.

1.8.2.4 Traditional Approach is where teaching is teacher-centric and Power and responsibility of class control are held by the teacher and they play the role of instructor by giving lectures and decision maker with respect to curriculum content and specific learning outcomes. In this study Teacher centered approach was used to conduct teaching.

1.8.3 Hypotheses

Five hypotheses were formulated for assessing the effectiveness of the instructional design modeled after constructivist paradigm of learning. As instructional design had three units: Unit 1: SI Units, Unit 2: Sound and Waves and Unit 3: Light. All the three units had their unique aspects. The researcher was interested in understanding in how students construct knowledge and assimilate knowledge related to three different units? To see the effectiveness of instructional

design individually, for each unit and collectively for all units was the purpose of formulating five hypotheses.

- There will be no significant difference between the mean achievement scores of the Control group and Experimental group on test conducted on the contents of unit I

- There will be no significant difference between the mean achievement scores of the Control group and Experimental group on test conducted on the contents of unit II

- There will be no significant difference between the mean achievement scores of the Control group and Experimental group on test conducted on the contents of unit III

- There will be no significant difference between the mean achievement scores of the Control group and Experimental group on comprehensive test conducted on the contents of all the three units.

- There will be no significant difference between the mean achievement scores of the Control group and Experimental group in Delayed comprehensive post-test.

1.9 Conclusion

The conceptual framework deals with constructivism as a philosophy, as approach to learning. Science, nature of science, experiential learning, collaborative learning and social constructivism are discussed. It discusses about higher education in general and technical education in particular. It is followed by demographic dividend and skill shortage. The teaching of physics using constructivist approach at Diploma engineering level is discussed. Finally, rationale of the study and objectives are presented. The next chapter deals with reviews of related literature.

Chapterization of thesis:

First chapter deals with the philosophy of constructivism and teaching learning paradigms, types of constructivism, science nature of science, teaching learning approach using constructivism. It also focuses on higher education scenario

in India, demographic dividend and skill shortage. The later half of the chapter deals with physics teaching using constructivist approach and collaborative approach in general and technical education in particular. Towards the end research questions, statement, objectives, operational definition and hypotheses are presented.

Second chapter deals with review of related literature: the studies in the review are classified into various types.

a) Studies on development and implementation of instructional packages.

b) Studies on teaching-learning of different subjects.

c) Studies on constructivist approach in different subjects.

Third chapter deals with the methodology of research, it explains the variables, population, sample and sampling technique. Research method and design are discussed subsequently. Procedure of data collection, process of tool and instructional design development and validation process are discussed after that. Towards the end the process of data analysis to be adopted to analyze the collected data is mentioned.

Fourth chapter deals with the Process of preparation of instructional design and its implementation at the classroom level at the diploma engineering level. It deals with the step by step presentation of the units and their respective analysis with the help of Researcher's observation of students during instructional process.

Fifth chapter describes the data analysis and interpretation.

Sixth chapter describes the summary and findings of the study.

Sixth chapter is followed by **bibliography and appendices**.