1.0.0 INTRODUCTION

Learning is acquiring new or modifying existing, knowledge, behaviors, skills, values, or preferences and may involve synthesizing different types of information. The ability to learn is possessed by human, animals and some machines. Human learning may occur as part of education, personal development, schooling, or training. Both teaching and learning are important in the educational environment. In the traditional method of teaching the focus is on the transmission of knowledge from expert teacher to novice learner. The traditional view of knowledge is based on the common-sense belief that a real world exists regardless of whether we take interest in it or even notice it” (Bodner, 1986).

The traditional knowledge implies that the knowledge is reality that will be replied in learners’ mind. Furthermore, traditional education view focused on “instructional goals such as recalling facts, generalization, defining concepts and performing procedures” (Almala, 2005 as cited in Kelly’s study). Therefore, this view ignores the difference of preexisting knowledge of individual and active learning. There are some approaches of teaching like Dalton approach, Hebartian approach, Indian approach etc. which based on the pre-existing experience of students. But these have certain limitations also viz; teaching begins with part to whole, learning is not so much interactive, product is important and knowledge is fixed. On the other hand, constructivist view learning as the product of interaction between existing understanding and new knowledge (Parkins, 2004). Furthermore, constructivist’s view learning as an active process in which the learners actively construct knowledge as they try to comprehend their reality world. The constructivist teaching begins with the whole – expanding to parts, Pursuit of student questions / interests, Primary Sources / manipulative materials, Learning is interaction – building on what students already know, Instructor interacts / negotiates with students, Assessment via student works, observations, points of view, tests. Process is as important as product, Knowledge is dynamic / change with experiences, Students work in groups.

Problem solving, reasoning, critical thinking and active use of knowledge are goals of constructivism. Constructivist approach gives priority not to teach the same concepts to all students but to carefully analyze students’ understanding to increase learning. Constructivist teachers consider what students think about concepts and formulate lessons
and plan instruction on the basis of students’ needs and interests. They structure lessons to develop students’ higher order abilities such as critical thinking, minded consideration and reflection, problem solving and active use of knowledge and skills (Brooks and Brooks, 1999).

Constructivism is a part of epistemology as branch of philosophy has a long history (Hawkins, 1994) and major theorists such as Dewey, Montessori, Piaget and Vygotsky are constructivists at root. These theories, however, failed to support significant reforms in education because these could not translate constructivist perspectives into educational practice. Constructivism is a learning theory which states that people learn best when they actively construct their knowledge. Knowledge construction can be made possible by solving authentic problems, which usually requires collaboration with others (Duffy, Lowyck, Jonassen, 1993). In addition to the real world or authentic problems and collaboration, another essential element of constructivist approach is the learner’s prior knowledge. Learners will not be able to solve any given problem unless they have the relevant prior knowledge and skills. The constructivist view of learning is based on the premise that learners construct their own personal meaning out of a given education experience. Constructivist practice is characterized by complex learning environments, authentic tasks, multiple representations of context, shared responsibility of learning, constructed knowledge and student focused instruction. Constructivists further contend that learning is social and embedded in a particular cultural setting (Cobb and Bowers, 1999).

The aim of constructivists learning is not to predetermine what the learners will do, but provide opportunities that shape the learner’s own learning through rich teaching materials which make the knowledge meaningful and useful (Erdem and Demirel, 2002). While stating their opinions, the learners use various sources such as where they might gather the data about the problem (interviews, field trips, etc.) and where they might show the gathered data like cartoons, graphics, photographs, exhibition, drama, play, scenario, etc. (Cunningham, 1992). Every source where the information is gained provides new opinions about the problems. This theory encourages the learners to use their active techniques such as experiments and problem-solving to build more knowledge. Thus, learning in a constructivist environment should be reflective, collaborative, inquiry-based and evolving. Through these processes the learners will integrate their new knowledge with
the previous one, which in turn will assist them in building their current conceptions. Constructivism is centered on the belief that cognition is the result of “mental construction”. Hence, it provides academic freedom to students. Students use their own learning strategies by adapting different approaches of constructivism.

1.1.0 TRADITIONS OF CONSTRUCTIVISM

There are different constructivist traditions as below:

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

1.1.2. Radical constructivism: Ernst von Glasersfeld was a prominent proponent of radical constructivism, which claims that knowledge is not a commodity which is transported from one mind into another; rather, it is up to the individual to "link up" specific interpretations of experiences and ideas with their own reference of what is possible and viable. That is, the process of constructing knowledge is dependent on the individual's subjective interpretation of the experience not what "actually" occurred. For example, a teacher has the responsibility of ensuring the student can makes sense of the material being taught through the consideration of how the student will interpret the work rather than repeating phrases, words and definitions in the way the teacher sees fit. Further since knowledge is a subjective construct rather than a compilation of empirical data, it is impossible to know the extent to which knowledge reflects an ontological reality.

1.1.3 Critical constructivism: A series of articles published in the journal Critical Inquiry (1991) served as a manifesto for the movement of critical constructivism in various disciplines, including the natural sciences. Not only truth and reality, but also "evidence", "document", "experience", "fact", "proof", and other central categories of empirical research (in physics, biology, statistics, history, law, etc.) reveal their contingent character as a social and ideological construction. Thus, a "realist" or "rationalist" interpretation is
subjected to criticism. Kincheloe's political and pedagogical notion (above) has emerged as a central articulation of the concept. While recognizing the contractedness of reality, many representatives of this critical paradigm deny philosophy the task of the creative construction of reality. They eagerly criticize realistic judgments, but they do not move beyond analytic procedures based on subtle tautologies. They thus remain in the critical paradigm and consider it to be a standard of scientific philosophy per se. Joe L. Kincheloe has published numerous social and educational books on critical constructivism (2001, 2005, 2008), a version of constructivist epistemology that places emphasis on the exaggerated influence of political and cultural power in the construction of knowledge, consciousness, and views of reality. In the contemporary mediated electronic era, Kincheloe argues, dominant modes of power have never exerted such influence on human affairs. Coming from a critical pedagogical perspective, Kincheloe argues that understanding a critical constructivist epistemology is central to becoming an educated person and to the institution of just social change.

1.2.0 CONSTRUCTIVIST LEARNING ENVIRONMENT

Jonassen (1999) proposed a model for designing constructivist learning environments. Since the epistemological belief of the constructivism that knowledge cannot be transmitted, the design puts the emphasis on providing learning experiences that facilitate knowledge construction and in meaning making and described that the essential components in the constructivist learning environments include;

1. Problem, question or project as the focus of the environment: the focus on problem, question or project constitutes a learning goal driving the learning process. The desired quality of this driving power is to be interesting, relevant and authentic. Three major components need to be included in the design of the problem:

(a) The problem context: a description of the physical, organization, and socio-cultural context in which the problem occurs should be represented to the learners.

(b) The problem representation or simulation: the principle of representing the problem is to make the representation interesting, appealing and engaging. The representation of the problem needs to be authentic to "present the same types of cognitive challenges as those in
the real world," as well as to be interesting and relevant to the learners so that they can engage in solving the problems.

(c) The problem manipulation space: meaningful learning needs to be a minded activity, in which the learners are provided opportunities to manipulate objects and interact with the environment. The problem manipulation spaces exactly provide such opportunities. They can be the causal models for students to test the effects of the manipulation by receiving feedback in the changes of the physical objects or the simulation, or they can be the students' argumentation to support their solutions to problems.

2. Related Cases: Representing a set of related experience, the related cases support learning by scaffolding student memory; providing different perspectives, themes and interpretations, the related cases conveys the complexity of the problem and enhance student cognitive flexibility.

3. Information Resources: CLEs have to provide just-in-time information to help learners comprehend and solve the problem.

4. Cognitive Tools: Cognitive tools are computer tools that help "visualize (represent), organize, automate, or supplant thinking skills." There are different types of tools differing in their functions:

   i. Problem/Task Representation Tools: they help learners to visualize and construct the mental model about how the objects behave and interact.

   ii. Static and dynamic Knowledge Modeling Tools: the tools help the learners' to make their understanding of the problem explicit. The questions of "what do I know" and "what does it mean" are the center of the inquiry.

   iii. Performance Support Tools: the tools share the cognitive loads to perform routine tasks such as calculation and memorization.

   iv. Information Gathering Tools: Information searching tools can be provided to eliminate the distraction and help the students to focus on problem solving.
v. **Conversation and Collaborative Tools:** social negotiation and interaction are part of the learning process. Learning can facilitated through support of discourse community, knowledge-building community and communities of learners.

vi. **Social/Contextual Support:** the implementation of the design of any learning environment has to accommodate contextual factors to get support for its success.

### 1.3.0 CONSTRUCTIVISM IN SCIENCE TEACHING

Science education plays an important role in our life. We need ‘science education for citizenship’. It would be designed to develop the curiosity of young people about the natural world around them, and help them acquire a broad appreciation of the important ideas and explanatory frameworks of science and how scientific enquiry works. The processes and ideas of science are of great importance to everybody in three ways. *The first* is in their personal lives, for example so that they can validly identify the components of a healthy life-style. *The second* is in their civic lives, so that they take an informed part in social decisions, for example on future options for electricity supply. *The third* is in their economic lives, where they need to be able to respond positively to change in the science-related aspects of their employment (The ‘Beyond 2000’ report60). It is common that most science education focuses on the scientific learning of the learners rather than the growth of learners’ knowledge as holistic individual (Taber, 2006). So there should be proper teaching method of science so that students can grasp the scientific knowledge more and more easily.

Why do we teach science in the laboratory, practitioners, usually list three significant reasons; (a) The first is that science is a practical-sourced discipline; most innovations and understandings of our current knowledge of science is derived from experiments of our predecessors and experiments we, as practicing researchers, complete in the lab every day. In teaching a student to be a scientist, we must teach them how to conduct practical work in the lab. (b) A second commonly reported reason is that it confirms the theory delivered in lectures – students have a chance to test out some principles, reactions or other material covered in lectures for themselves. The great experimenter, Faraday, reportedly said that he “was never able to make a fact his own without seeing it”. (c) A third reason is that it gives students an opportunity to develop their skills in writing a scientific report. The
weekly/regular reports students write allow them to develop their report writing skills in writing what they have done, summarizing their results and presenting their findings in the context of the greater scientific body of knowledge in the form of a discussion.

These reasons are valid, and based on the notion of educating students to be professional scientists but in the 21st century laboratory, are they enough? There is no shortage of evidence of significant shortcomings of the traditional methods of teaching in the literature, nor of innovations on how to redress the balance.

Constructivism is one of theory of learning which well developed in the recent year and becomes most significant and dominant perspective in science education (Taber, 2006). One of the main aims of science education is to make a meaningful understanding of science concepts. Constructivist approach seems to be effective in providing meaningful learning. According to this approach, this kind of learning can take place only when the learner relates the new information to his already existing knowledge. Knowledge cannot be transmitted to the learner’s mind from a textbook or by the teacher. Instead, students construct their knowledge by making links between their ideas and new concepts through experience they acquire in school or daily life. These types of experiences can result in assimilation in which new knowledge is incorporated into existing cognitive structure or they can lead to disequilibrium in which experiences cannot be reconciled within the existing structure and accommodation, where cognitive structure is reorganized, occurs.

Accommodation allows a return to cognitive equilibrium (Bodner, 1986). Thus, from this point of view, learning is a process of conceptual change. For this reason, effective teaching requires the teacher to consider the learners’ personal knowledge. In practice, prior knowledge may be missing or may include wrong conceptions or the learner may fail to make the link between new knowledge and his existing structure (Taber, 2001). Therefore, for effective teaching, the cognitive level of the learners and their conceptual development which means the extent of prior knowledge about the topic necessary for learning new knowledge should be considered. Furthermore, the subject that will be taught should not be too complex. However, this simplification should be done carefully since it may cause students to develop wrong conceptions. Briefly, there should be a correlation between the scientific topics and to what extent the students comprehend this knowledge (Taber, 2000).

Generally, students’ wrong ideas about a particular topic are called as misconceptions which prevent learning and very resistant to change. In chemistry, students hold several
misconceptions in many areas such as mole concept (Staver and Lumpe, 1995), chemical equilibrium (Gussarsky and Gorodetsky, 1988; Camacho and Good, 1989; Pardo and Solaz-Patolez, 1995), solutions (Ebenezer and Ericson, 1996; Abraham et al., 1994) and electrochemistry (Garnett, 1992).

Conceptual change can be accomplished if students are given opportunity to be aware of their ideas, to encounter ideas other than their own and to realize the deficiency in their reasoning. This can be promoted by group discussions which allow students to construct their own knowledge out of exchanges with their friends and the teacher. In this way, students can control their learning process. Research studies showed that oral discussions develop students’ critical thinking ability and understanding of the content (Gall and Gall, 1990; Hogan, K., Nastasi, B. K. and Pressley, M., 2000). In essence, the constructivist approach oriented instruction used in this study was to activate the students’ existing schemata (misconception) related to chemistry.

2.0.0 EMERGENCE OF THE PROBLEM

With the advent of child-centered learning, number of approaches emerged for making teaching-learning process more effective and interesting. Constructivist approach is a revolutionary and radical teaching approach. It is completely different from the traditional approach as there is a shift of power from the “expert teacher” to the “student learner”. In the traditional teacher-centered approach, the teacher is knowledgeable in the subject matter and the focus of teaching is on the transmission of knowledge from the expert teacher to the novice student. In contrast, Constructivism is an important modern concept in science education and should put teachers on the watch for evidence of students’ prior conceptions. Most experienced teachers are aware of many of these prior conceptions and try to present a logical argument to students to overcome these “misconceptions”. However, experienced teachers encounter more and more of these alternative conceptions every year that they teach. It is common perceptions that the teachers face the difficulties to explain the concepts in chemistry. Students could reject, accept, or assimilate the concepts or ideas which are given by the teacher, because they already have their own concepts which recognize as “prior knowledge”. This prior knowledge could be strongly held by students and it is difficult to be changed (Treagust, Duit, Fraser, 1996).
A number of studies conducted with reference to constructivist approach, in varied disciplines in different parts of the world, maintain that constructivist teaching-learning positively related to the student’s achievement and in their particular subjects. Some of the recently carried out research in this field include: Festus, and A. Ekpete (2012) recently conducted a research on *Improving students’ performance and attitude towards chemistry through problem-based-solving techniques (PBST)* and found that acceptable methods of instruction are capable of changing students’ performance and attitude towards chemistry.

Oludipe and Oludipe (2010), who carried out the research entitled *Effect of constructivist-based teaching strategy on Academic performance of students in integrated Science at the junior secondary school level*. The study revealed that when 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. Kelly (2008) carried out research on *The role of constructivism in teaching and learning chemistry* reached at findings that The teaching strategies which informed by constructivism are powerful to create the meaningful learning process in chemistry. The meaningful learning process will help students to understand the chemistry concepts through the active learning process.

Likewise, Charif, M (2010) carried out research on *The effects of problem based learning in Chemistry education on middle school Students’ academic achievement and Attitude* and found the significant difference in students’ achievements and attitude after the use of PBL. The method of the studies show that efforts to develop constructivist teaching material as well as to use constructivist approach as a teaching tool result in improved achievement and Laboratory competence of students. These results indicate that constructivist approach as a cognitive tool for learners and instructional tool for teaching. The constructivist teaching learning approach has few researches to its credit, viz.

**Table: 1 Showing the researches related to Constructivist Approach**

<table>
<thead>
<tr>
<th>S.NO</th>
<th>YEAR</th>
<th>NAME OF RESEARCHER</th>
<th>TOPIC</th>
<th>FINDINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2012</td>
<td>Festus, C. And O. A. Ekpete</td>
<td>Improving Students’ Performance and Attitude towards Chemistry through Problem-Based-Solving Techniques (PBST)</td>
<td>The Findings of this study had further established the Fact That acceptable methods of instruction are capable of changing Students’ Performance and Attitude towards Chemistry.</td>
</tr>
<tr>
<td></td>
<td>Year</td>
<td>Authors</td>
<td>Title</td>
<td>Summary</td>
</tr>
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<td>----------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2</td>
<td>2012</td>
<td>Kulshresth, A.K and Mehta, S</td>
<td>Development of Co-operative Learning based Instructional Material in Science For Secondary level</td>
<td>Study revealed that Social and co-operative skills may be enhanced through the use of Co-operating Learning Material.</td>
</tr>
<tr>
<td>3</td>
<td>2011</td>
<td>Tatli, Z and Ayas, A</td>
<td>Virtual Chemistry Laboratory: Effect of Constructivist Learning Environment</td>
<td>Teachers who adopt the Constructivist learning approach organize the knowledge around problems, questions and concepts and organize activities that will help students to develop new perspectives and build up connections with their previous learning.</td>
</tr>
<tr>
<td>4</td>
<td>2011</td>
<td>Kulshrestha, A.K and Kanupriya</td>
<td>Effect of Constructivist Problem-Based Learning Approach on the Academic Achievement of Grade VII Social Science Pupils</td>
<td>Results show that academic achievement is increased after the implication of problem based learning approach.</td>
</tr>
<tr>
<td>5</td>
<td>2011</td>
<td>Kulshrestha, A.K and Gautam, Amit</td>
<td>Development of Constructivism Approach Based Instructional Material For Biology Students</td>
<td>Results of the study indicate that pupil teachers are oriented with the help of development of instructional material their attitude towards Constructivist approach can be tempered.</td>
</tr>
<tr>
<td>6</td>
<td>2010</td>
<td>Aydin, N and Yilmaz, A</td>
<td>The Effect of Constructivist Approach in Chemistry Education on Students' Higher order Cognitive Skills</td>
<td>The results indicated that 5e learning model was more influential on students' higher order cognitive skills and induced more positive attitudes toward science education as a school subject.</td>
</tr>
<tr>
<td>7</td>
<td>2010</td>
<td>Ogundola, P. et al.</td>
<td>Effect of Constructivism Instructional Approach on Teaching Practical Skills to Mechanical Related Trade Students in Western Nigeria Technical Colleges</td>
<td>Findings showed a significant difference between the students taught with Constructivist teaching approach and those in the control group. Significant difference does not exist between male and female students exposed to the Constructivism approach.</td>
</tr>
<tr>
<td>8</td>
<td>2010</td>
<td>Oludipe, B and Oludipe, D.</td>
<td>Effect of Constructivist-Based Teaching Strategy on Academic Performance of Students in Integrated Science at the Junior Secondary School Level</td>
<td>Research concluded that 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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The Effects of Problem based Learning in Chemistry Education on Middle School Students’ Academic Achievement and Attitude</td>
<td>The findings of the research indicate that there is significant difference found in Achievements as well as attitude of experimental and control group after the use of PBL.</td>
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</tr>
<tr>
<td>9</td>
<td>2010</td>
<td>Cherif, M</td>
<td>Laboratory Assessment in Chemistry: An Analysis of the adequacy of the Assessment Process</td>
<td>Obtained results show that laboratory assessment in chemistry allows for a valuation of the degree of integration of theory and practice, and of the level of development of professional competence in the laboratory.</td>
</tr>
<tr>
<td>10</td>
<td>2010</td>
<td>Prades, Anna et al.</td>
<td>The Effectiveness of Constructivist Approach-Based Experiments in Teaching Selected Physics Concepts</td>
<td>The findings show that Constructivist approach experiments are effective in enhancing students’ achievement and in developing a more positive attitude towards the subject than the traditional approach.</td>
</tr>
<tr>
<td>11</td>
<td>2010</td>
<td>Tobago, L.C.</td>
<td>The Role of Constructivism in Teaching and Learning Chemistry</td>
<td>The teaching strategies which informed by constructivism are powerful to create the meaningful learning process in chemistry. The meaningful learning process will help students to understand the chemistry concepts through the active learning process</td>
</tr>
<tr>
<td>12</td>
<td>2008</td>
<td>Kelly</td>
<td>The Effects of a Constructivist Teaching Approach on Student Academic Achievement, Self-Concept, and Learning Strategies</td>
<td>The results revealed that constructivist teaching is more effective than traditional method in terms of academic achievement but not effective in terms of self-concept and learning strategies.</td>
</tr>
<tr>
<td>13</td>
<td>2005</td>
<td>Jong, K.S</td>
<td>Effect of Constructivist Learning Principles Based Learning Materials to Students’ Attitudes, Success and Retention in Social Science</td>
<td>The findings of the research indicate that constructivist learning based material increase student’s academic success and retention in social studies but don’t increase attitude.</td>
</tr>
<tr>
<td>14</td>
<td>2005</td>
<td>Karaduam et al.</td>
<td>The Effect of Constructivism based Teaching Strategies on Gender related Differences in Solving Student’s Misconceptions in Chemistry.</td>
<td>Finding show that female (57%) responded better than males(43%) at formal operational level</td>
</tr>
<tr>
<td>15</td>
<td>2001</td>
<td>Omoniyi, A.O</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.0.0 JUSTIFICATION OF THE PROBLEM

Unfortunately despite the growing importance of science as a valuable part of educational repertoire of students, the standard of teaching science has been steadily decline. If we look at the evolution of school science in India, we see a clear trend of including more and more content overwhelmingly in the form of factual information in the syllabus. Laboratory have decline, and even demonstration, once common, are now confined to elite schools (Mukherjee, 2007). Thus the factual information that dominates the syllabi is not supported by any kind of activity, which can make it plausible or even comprehensible. Students, therefore, have no option to memorize the facts. The consequence of this is that students find science not only difficult but also boring. For science students Laboratory is a place to gain skills for accomplishing and performing experiments. Experiments are meant to learn scientific procedure. Students learn skills on by one to become competent scientist, pharmacist, and laboratory technicians and many other professionals and Laboratory work is needed to explain and present, illustrate the cause and effect of certain abstract chemical principles and theories. So, this study also dealt with Laboratory Competence of chemistry students.

In science education, many research studies indicated that the type of instruction affected students’ attitudes toward science as a school subject (Chang, 2002; Parker, 2000). Students’ attitudes, feelings and perceptions of science are important for science achievement and their selection of career related to science in the future. In this study, the effect of treatment on students’ attitudes toward chemistry was also investigated.

The above analysis raised some research questions in the mind of the researcher such as:

1. Is Constructivist approach effective on Academic Achievement of student in Chemistry?
2. Is Constructivist Approach effective on Lab competence of Chemistry students?
3. Is there any effect of Constructivist Approach on Attitude of students towards Chemistry subject?

As mentioned earlier that constructivist approach in teaching has been used in many fields but there is dearth of such studies in chemistry. Although, some studies on the development
and implementation of constructivist teaching approach in science have been conducted (referred in Table: 1). However, very little researches have been reported with reference to constructivist approach to chemistry students at senior secondary level. A number of studies conducted in the reference of Laboratory Assessment and its role in science Chemistry teaching. But there is a dearth of researches related to Laboratory Competence based teaching in Chemistry subject with incorporation of Constructivist approach.

Attitude is as important as the Academic Achievement because it is a fact that causes taking aside during the decision process which was gained by learning and giving guidance to the student’s behaviour. So, the researcher realized to study the Attitude of students towards Chemistry as a dependent variable of Constructivist approach. Therefore, the need for conducting the present study was felt to utilize the asset of constructivist teaching for improving three domains of the personality i.e. Academic Achievement (cognitive), and Laboratory competence (psychomotor) and Attitude (affective) towards Chemistry as a subject.

4.0.0 STATEMENT OF THE PROBLEM

In order to find out the answers of above mentioned research questions, the following problem can be selected as below:

EFFECT OF CONSTRUCTIVIST APPROACH ON ACADEMIC ACHIEVEMENT, LAB COMPETENCE AND ATTITUDE OF STUDENTS TOWARDS CHEMISTRY AT SENIOR SECONDARY LEVEL

5.0.0 DEFINITIONS OF THE TERMS EMPLOYED

Definitions of the terms employed in present study are laid down as follows;
5.1.0 CONSTRUCTIVISM

Constructivism is a view of learning based on the belief that knowledge isn't a thing that can be simply given by the teacher at the front of the room to students in their desks. Rather, knowledge is constructed by learners through an active, mental process of development; learners are the builders and creators of meaning and knowledge. Constructivism draws on the developmental work of Piaget (1977) and Kelly (1991). Constructivism is a theory of learning which describes how learners build on existing or prior knowledge to incorporate new knowledge, based on their learning experiences. The theory is based on the principle that knowledge is not “discovered”, but constructed in the mind of the learner. (Bodner, 1986)

In reference to the present study Constructivist Approach is an innovative and collaborative teaching-learning strategy to make the student active so that they construct new knowledge in Chemistry on the basis of previous knowledge and facts.

5.2.0 LAB COMPETENCE

Competencies are the characteristics of a person that are related to superior performance in a job and can be common across situations (Spencer & Spencer, 1993; Gonczi, 1994). Competence” as a combination of knowledge, skills and behavior used to improve performance; or as the state or quality of being adequately or well qualified, having the ability to perform a specific role.

In the present study Lab Competence is an Individual’s capacity to acquire knowledge and skill in specific area of chemistry laboratory work.

5.3.0 ACADEMIC ACHIEVEMENT

Academic achievement is the outcome of education-the extent to which a student, teacher or institution has achieved their educational goals.

In this study Academic Achievement is the learning outcomes in Chemistry subject.
5.4.0 ATTITUDE TOWARDS CHEMISTRY

Thurstone (1931) defines an attitude as the degree of sensation to an object or an individual. This definition would be comprehended that the attitude is one of the important determinants of human behaviors.

In the present study “Attitude” refers the affinity towards the positive and negative sides of behavior related to Chemistry subject.

6.1.0 OBJECTIVES OF THE STUDY

Objectives of the present study will be laid down as follows;
1. To analyze content of XI class Chemistry text-book.
2. To develop Instructional material based on constructivist approach.
3. To study the effect of Constructivist approach on Academic Achievement of the students in Chemistry subject.
4. To study the effect of Constructivist approach on Lab Competence of the students in Chemistry subject.
5. To study the effect of Constructivist approach on Attitude of the students towards Chemistry.
6. To study the Reactions of students towards Constructivist approach.

7.0.0 HYPOTHESES OF THE STUDY

Hypotheses of the study will be as follows;

H₀1. There will be no significant difference in the mean gain Academic Achievement scores of the students in experimental and controlled groups.

H₀2. There will be no significant difference in the mean gain Lab Competence scores of the students in experimental and controlled groups.

H₀3. There will be no significant difference in the mean gain Attitude scores of students towards Chemistry in experimental and controlled groups.

H₀4. There will be positive reactions of students towards Constructivist approach.
8.0.0 DELIMITATIONS OF THE STUDY

In order to make study more specific and methodical it has been delimited to following point laid down as follows;

1. The school of CBSE Board from Agra city will be selected for the study.
2. Only XI\textsuperscript{th} class chemistry students will be selected for the study.
3. Chemistry Text book of CBSE Board will be selected.
4. Academic Achievement will be delimited to Achievement in Chemistry.

9.0.0 METHODOLOGY OF STUDY

The methodology of the study has been stated in the following heads:

9.1.1 VARIABLES OF THE STUDY

The variables of study have been classified as following:

9.1.1 Independent Variable: Constructivist Approach

9.1.2 Dependent Variables: Academic Achievement

Lab Competence
Attitude towards chemistry
Reaction towards Constructivist Approach

9.1.3 CONTROL OF EXTRANEOUS VARIABLES:

The extraneous variance will be control by identification of effective variables and using effective strategy of control which has been shown in the table-2:
Table 2: Possible Extraneous Variable and Techniques of Control

<table>
<thead>
<tr>
<th>Extraneous Variable</th>
<th>Technique of Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Subject relevant variable</strong></td>
<td></td>
</tr>
<tr>
<td>1. Age</td>
<td>Constancy (16-18)</td>
</tr>
<tr>
<td>2. Intelligence</td>
<td>Constancy (Average intelligence)</td>
</tr>
<tr>
<td>3. Aptitude</td>
<td>Randomization</td>
</tr>
<tr>
<td>4. Motivation</td>
<td>Constancy</td>
</tr>
<tr>
<td><strong>B. situation relevant variables</strong></td>
<td></td>
</tr>
<tr>
<td>1. Temperature</td>
<td>Constancy</td>
</tr>
<tr>
<td>2. Humidity</td>
<td>Constancy</td>
</tr>
<tr>
<td>3. Noise</td>
<td>Elimination</td>
</tr>
<tr>
<td>4. Lighting level</td>
<td>Constancy</td>
</tr>
<tr>
<td>5. Time of the study</td>
<td>Constancy</td>
</tr>
<tr>
<td>6. Culture</td>
<td>Constancy</td>
</tr>
<tr>
<td>7. SES</td>
<td>Randomization</td>
</tr>
<tr>
<td><strong>C. Sequence relevant variables</strong></td>
<td></td>
</tr>
<tr>
<td>1. Practice</td>
<td>Elimination</td>
</tr>
<tr>
<td>2. Fatigue</td>
<td>Elimination</td>
</tr>
</tbody>
</table>

9.2.0 METHOD OF THE RESEARCH

Experimental method of research will be used in present study. According to John W. Best (2001), “Experimental research is the description and analysis of what will be or what will occur under carefully controlled conditions.”

Experimental research provides for much control and therefore, establishes a systematic and logical association between manipulated factors and observed effects. The researcher defines a problem and purposes a tentative answer or hypothesis. The researcher tests the hypothesis and accepts or rejects in the light of the controlled variable relationship that he has observed. These assumptions are based upon the Law of the single variable. John Stuart Mill (1846) defined this law in his work Methods of Experimental Inquiry.
9.3.0 DESIGN AND PROCEDURE OF THE STUDY

Design and Procedure of the study will be as follows;

9.3.1 RESEARCH DESIGN

Pre-test and Post-test Randomized Two Group research Design will be applied as follows:

Table 3: Showing the Experimental Design

<table>
<thead>
<tr>
<th>Groups</th>
<th>Pre-test</th>
<th>Treatment of Independent variable</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group</td>
<td>Pre-test</td>
<td>20 Lessons will be taught by constructivist Approach.</td>
<td>Post-test</td>
</tr>
<tr>
<td>Control Group</td>
<td></td>
<td>20 Lessons will be taught by Traditional Approach.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Academic Achievement, Lab Competence and Attitude towards Chemistry</td>
<td></td>
</tr>
</tbody>
</table>

9.3.2 PROCEDURE OF THE STUDY

Detailed procedure of the study given in three phases as follows:

PHASE 1: PREPARATORY PHASE

In the preparatory phase following activities will be done:

1. **Content Analysis**- Content analysis of class XI\(^{th}\) chemistry text book will be done to know which topic can be taught though constructivist approach.
2. **Selection of Topics**- After content analysis topics (which is mostly related to laboratory) will be selected from the Chemistry text book.
3. **Development of Instructional Material**- The researcher will develop a Instructional material based on constructivist approach and steps will be as follows:
4. Development of Achievement test- The Pre-Achievement test will be developed for the topics which the students have already learned and Post-Achievement test will be constructed to study the effect of Constructivist approach on learning outcomes of students.

5. Development of Attitude Scale towards Chemistry- In addition to the cognitive domain, assessment of affective domain is also necessary because it makes the learner responsible. Thus, to determine the Attitude of students towards Chemistry as a subject, Attitude Scale will be developed by the researcher.

6. Development of Reaction Scale- In order to find out the reaction of students towards Constructivist Approach, Reaction Scale will be developed by the researcher.
Before Experimentation there will be assignment of groups. A more adequate design is the parallel group technique in which the relative effects of two treatments are compared on the basis of two or more groups, which are equals in all the relevant aspects. This is essentially the implementation of J. S. Mill’s Principle of difference. In an educational experiment, the group being compared generally is equated on chronological age, IQ, Sex, General background and any other factor considered relevant to the problem under investigation.

**PHASE 2: CLASSROOM EXPERIMENTS**

The aim of the phase will be to introduce an intervention with the experimental group of learner. The intervention will involve using a constructivism based pedagogical approach in learning of the chemistry subject.

To see the effect of Constructivist approach on Achievement, Lab Competence and Attitude towards Chemistry implementation of developed instructional material in class XI will be done. The researcher will make the two groups via experimental and controlled group on the basis of odd and even no. of their serial number in class register. After assigning groups researcher will taught the Experimental group with the help of developed instructional material and controlled group with the traditional instructional material. The outcome will be compared to that of control group of learners, taught the same topic, using the traditional approach.

**PHASE 3: EVALUATORY PHASE**

The effect of constructivist approach will be evaluated on the basis of administration of post achievement test for the determination of cognitive learning outcomes, lab competence test to know the skills of students i.e. How they perform in the laboratory, Attitude scale towards Chemistry to determine the interest, self-efficacy, affinity and anxiety of the students in Chemistry subject. Reaction Scale will be given to experimental group for taking feedback/suggestions about Constructivist approach.
9.4.0 SAMPLE OF THE STUDY

The process of sample selection is given below:

1. **Selection of Institution:** By purposive sampling Senior secondary CBSE institute will be selected.

2. **Selection of Class:** 2 sections of class XI\textsuperscript{th} will be selected for the experiment.

3. **Selection of Students:** 40-40 students will be selected randomly from the two sections of class XI\textsuperscript{th}.

![Flowchart showing sampling procedure]

**Fig: 2 Showing the Sampling Procedure of the Study**

9.5.0 TOOLS OF THE STUDY

Following tools will be used in present study:

1. Self constructed Achievement Test on selected topics under experiment will be used.

2. Lab Competence Test developed by Meena Bhuddisagar and Renu Moyade Kotwatle (2011) will be used.

3. Attitude Scale towards Chemistry will be constructed by the researcher.

4. Self constructed Reaction Scale towards Constructivist approach will be used.
9.6.0 STATISTICAL TECHNIQUES

Following statistical techniques will be used in present investigation:

9.6.1 DESCRIPTIVE STATISTICS

Certain descriptive statistics will be use in order to describe the nature and distribution of the scores obtained on the various tests so following methods of statistical analysis will used in the present study:

1. **Mean**: The mean value will be computed as a measure of central tendency of the distribution of achievement scores.

2. **Standard Deviation**: This will be computed to study the variation in the scores and to do other various computations.

3. **Graphical Representation of data**

9.6.2 INFERENTIAL STATISTICS

1. **T-Test**: To measure the significance of difference between the mean scores of Experimental and Control group t-test will be used.

2. Some other statistics will be used if the conditions of experiment and analysis of data will demand.

10.0.0 SIGNIFICANCE OF THE STUDY

The findings of the study will be significant in the following way:

**For Students**: Through the processes of constructivism the learners will integrate their new knowledge with the previous one, which in turn will assist them in building their current conceptions. Constructivism is centered on the belief that cognition is the result of “mental construction”. Hence, it provides academic freedom to students. Students use their own learning strategies by adapting different approaches of constructivism. New knowledge is actively built, and then time is needed to build it.

**For Teachers**: It is a fact that teacher’s performance is most crucial input in the field of education. The teacher can plan, develop and implement various students centered activities, so as to promote attitude towards chemistry. The better art of teaching can be
achieved by adopting such innovative approaches of teaching. If learning is based on prior knowledge, then teachers must note that knowledge and provide learning environments that exploit inconsistencies between learners' current understandings and the new experiences before them. This challenges teachers; for they cannot assume that all children understand something in the same way. Further, children may need different experiences to advance to different levels of understanding. If students must apply their current understandings in new situations in order to build new knowledge, then teachers must engage students in learning, bringing students' current understandings to the forefront.

**For Teacher Training Program-** From this study teacher candidates’ conceptual understanding of content, constructivism, and constructivist pedagogy can be changed. And also teacher candidates can be empowered to plan an implementation of constructivist pedagogy in particular chemistry subject in classroom situations.

**For Text Book Writers-** It will help text book writers to write text books in sequential order by keeping in mind the constructivist approach. Writers can make their books effective with using Constructivist view in planning the chapters.