Chapter - 2

Review of Related Literature and Studies

2. Introduction

The literature review of this Study encompasses topics related to Constructivist strategies, approaches and Learning Model for academic achievement in Chemistry. The literature review enables to obtain clarity on the definition of the key terms used in this Study and to examine the extent of research already done in the subject areas. It is to be examined whether past studies have indicated any outcomes with respect to impact of the independent variables in the Study and the relationship among the dependent variables.

A brief account of the relevant literature reviewed is presented with a context of academic achievement below in the following sections:

2.1 Studies related to initial studies of Constructivist learning

2.2 Studies related to Constructivist learning with 5E's model

2.3 Studies related to Co-operative learning approach

2.4 Studies related to Collaborative learning approach

2.5 Studies related to problem solving approach

2.6 Studies related to use Concept map approach

2.7 Studies related to Constructivist learning and Achievement in Chemistry

2.1 Studies related to initial studies of Constructivist learning

Piaget (1964) reported that traditional methods of teaching are verbal (expository, didactic) and formal, that is teacher centered, with the teacher lecturing and the student being the passive recipient of knowledge. Research on concept acquisition has revealed that children learn by active interaction initially with concrete objects and later with abstract entities. Piaget has also suggested that cognitive development itself occurs through such an active involvement, an interaction of the child with objects and phenomena that leads to cognitive conflicts and subsequently to equilibration or self-regulation.

Ausubel's (1968) found that meaningful learning can be achieved only when pre-exist in the mind, the necessary relevant concepts and cognitive structures will subsume the new knowledge otherwise rote learning has to be invoked. Piaget theory and Ausubel's theory use

into teaching-learning and to foundation of the student alternative conceptions movement on the philosophical and epistemological theory of constructivism has led to the advocacy of constructivist methods. Cardemone (1975) made the first use of concept maps. He found that the preparation of a master concept map for the topic of ratio and proportion helped him to plan instruction on this topic. Bogden (1977) also found that concept maps prepared by him in a genetics course were found to be valuable in learning the course by a small minority of students. Cardemone (1975) and Bogden (1977) did not have words on the linking lines between concepts. In the years to follow, the fate of concept mapping existed in a dilemma till 1984. Novak and Gowin (1984) notified about the potential of concept maps as instructional tools and gave the concept maps their present shape. They carried extensive experiments with concept mapping in school teaching learning process to grow the science of concept mapping at an exponential pace. Novak worked with many more colleagues on different aspect of concept mapping.

Stuart (1985) reviewed the use of concept maps in research, instruction and assessment. He presented a variant of Novak, Gowin and Johansen's system of scoring concept maps and acknowledged the deficiencies of current scoring schemes. It was concluded that a more holistic and qualitative scoring technique needs to be developed. Trochim (1997) reported concept mapping as "soft science" and the artistic one as "hard art" to imply that the process has some qualities of both, but probably does not fall exclusively within either's domain. In the spirit of hard art, a 'gallery' of final concept maps from twenty projects is presented, partly to illustrate more examples of the process when used in a variety of subject areas and for different purposes, and partly for their aesthetic value alone.

Lamer (2001) conducted a study with an objective of finding whether significant difference existed in male and female, high and low achieving students, and students with different learning styles with respect to their perception of constructivist pedagogy. 152 secondary school students were selected for the study. A significant difference was found in the perceptions of male and female, high and low achieving students regarding constructivist pedagogy. A significant difference was found in visual and tactile learners with respect to their perception of constructivist instruction.

Heyoung (2001) conducted a study to determine whether the present Korean teacher education programme for secondary school teachers was effective in improving teacher understanding of constructivism because the current Korean National Science curriculum emphasized both ideas as reforms. After the treatment in the pre-service and in-service

teacher education programmes, the teachers were inclined to agree with ideas of constructivism. Pre-service programme was more effective than that of in-service programmes in improving teachers' perspectives of constructivism and science and technology.

Laura Azzarito and Catherine D. Ennis (2003) investigated how teachers used social constructivist strategies to encourage student construction of knowledge and meanings, and how students constructed knowledge and meanings in two middle school physical education classrooms. A qualitative naturalistic design was used to collect data over a five-month period with two experienced middle school physical education teachers. Data included 11 weeks of observational field notes and interviews with teachers and students. Data were analysed using cross-case and inductive analysis. Findings indicated that the teachers' strategies created a learning environment in which students actively constructed knowledge and meanings by making connections to their peers and by connecting physical education to their lives, their communities, and the real world. Students shared information, assumed leadership and responsibility, and became decision-makers. By connecting to their peers, students felt supported in their learning. This finding also supports social constructivist pedagogy in physical education to encourage individual growth and social awareness in communities of learners.

Karaduman and Gultekin (2007) investigated whether the learning materials that were based on constructivist learning principles had any effect on social studies' attitude, academic success and retention of 5th grade students. The findings of the study indicated that learning materials based on constructivist learning principles increased students' academic success and retention in social studies but have any effect on their social studies' attitude.

Kroesbergen and Van Luit (2005) investigated the effects of a constructivist mathematics intervention for secondary students with Mild Mental Retardation (MMR). A total of 69 students from elementary schools for special education participated in the experiment, 48 boys and 21 girls as a sample. At pre and post-test, two multiplication tests were administered. The findings reveal that students improved significantly during the training period. However, students who received directed instruction showed greater improvement than students who had received guided instruction. Their findings show that students with MMR can profit from constructivist instruction, although direct instruction seemed to be more effective.

Sridevi K.V. (2006) took up a quasi-experimental study to find whether constructivist approach to science instruction could help 8th standard students of Mysore, India to improve the Science achievement and Attitude towards Science. The sample included 37 boys and 31 girls in total. The experimental group consisted of 36 eighth standard students, of which were 21 boys and 15 girls the control or alternate group consisted of 32 eighth standard students, which included 16 boys and 16 girls. This study also attempted to understand how the students construct their own meanings. Purposive sampling was employed to select the schools for the study. An Achievement test in Science and an Attitude towards Science scale was developed by the researcher. The students were tested on the above tools before and after the treatment. Analysis of Covariance test was performed to control the initial variance. The results showed that Constructivist teaching is more effective than traditional teaching in terms of Achievement in Science and Attitude towards Science among 8th standard students. It was found that constructivist approach was equally effective for both boys and girls in improving Achievement and Attitude towards science. A constructivist environment was preferred to a traditional classroom by the students. The results confirmed research supporting the positive effect of constructivist learning practices and view that constructivist approach to teach science is a viable alternative to traditional modes of teaching.

Pachaurya, A. C. (2008) stated in the article "Constructivist Approach in Teaching and Learning Science" that an attempt has been made to explain constructivist approach to teaching and learning science, how constructivist approach can be accomplished on the basis of investigating activity. The conclusions drawn out of the study were (a) Constructivist teaching does not mean transmission of the ready-made information to the pupils, (b) Similarly constructivist learning does not mean passive acceptance of the transmitted information but instead it is rather active construction of the meanings in a wide variety of ways, (c) Teacher's role in constructivist way of learning science has in facilitation of concept development and nurturing it further and the teachers had to be co-learners as well because extended learning is needed by them for expanding their conceptual width.

Sood, J.K (2008) published an article titled "Learning Science as a Constructivist / Conceptual Change Process". The author highlighted three issues in contemporary science education mentioned in NCF-2005. First, science education is not achieving the goal of equity and inclusiveness, second, science education is developing competence, but does not encourage inventiveness and creativity third science education is dominated by traditional examination system, there is a need of an equitable science curriculum, in which both the

content and the pedagogy are inclusive of all students enabling them to participate in ways that are appropriate for them.

Merill (2009) undertook research to compare the Brain-based teaching Strategy (Constructivist Teaching Strategy) and Conventional lecture in acquiring Higher Order Cognition. Secondary objective was to elicit the student's feedback about these Approaches. The researcher employed quasi-experimental method and 2 x 2 x 2 factorial design with repeated measure on the last factor. Convenient sampling was used to select 72 medical-surgical nursing second degree students and two groups of 36 students made by the researcher. Findings of the research concluded that significant difference was observed between the skills gained by the two groups but feedback given by students about the approaches did not significantly differ. Students had overall positive responses about the Constructivist activities.

Oludipe Bimbola and Oludipe I. Daniel (2010) examined the effectiveness of constructivist-based teaching strategy on academic performance in integrated science of Junior Secondary School students in South-West Nigeria. Quasi-experimental research design was used for this study. 120 Junior Secondary School Students were randomly selected from four out of the 25 co-educational Junior Secondary Schools in Ijebu-ode local government area of Ogun state of South-west Nigeria. The findings revealed that the constructivist instructed students had higher scores on the post test and the delayed post-test, compared to those exposed to conventional method of teaching. The study concluded that if integrated science teachers could incorporate constructivist-based teaching strategy into their teaching methods, there would be an improvement in academic performance of Junior Secondary School Students in integrated science.

Gautam and Kulshrestha (2011) developed Constructivist Approach based instructional material for XI grade Biology students and determined its efficacy on Attitude of pupil teacher towards Constructivist Approach. The sample consisted 40 teacher trainees divided into two groups i.e., experimental and control group (N=30 for each group). Orientation of Constructivist Approach using developed instructional material for 10 days was given to experimental group whereas orientation of Constructivist Approach without using developed instructional material to control groups. Self-developed Attitude Scale towards Constructivist Approach was administered to measure Attitude of pupil teachers towards Constructivist

Approach. Result of the research revealed that Constructivist Approach capable to change Attitude of pupil teachers towards Constructivist Approach.

Etuk et.al, (2011) objectified to study Achievement and Attitude towards Primary Science using Constructivist Instructional Strategy. Experimental research design with two intact groups was employed in this research work. The population of pupils was 650 in 21 public primary Senatorial District of River state, Nigeria. Total 180 pupils were taken from four intact classes from four schools in the area. The investigator of the study used Primary Science Achievement Test and Primary Science Attitude Scale to gather data. Statistical analysis used in the study was analysis of co-variance and multiple classification analysis. The researcher summarized that pupils taught With Constructivist Instructional Strategy gained high scores in Achievement Test as well as Attitude test than the pupil taught with expository strategy. Study also concluded that pupils from urban school did well than rural schools' pupils regarding Achievement and Attitude.

Khalid and Azeem (2012) aimed to develop and implement Constructivist Instructional Module in teacher education arena. The researcher compared Constructivist Instructional Module to Traditional Approach of teaching. Quasi experimental equivalent two group design was used in the study. Sample of the study was 64 students (32 in each group). Research group was taught through Constructivist Module while Control group was taught with Traditional Approach. Inferences of the study was drawn by applying t-test which shows that pretest score was insignificantly different whereas posttest score was significantly different regarding performance. The researcher concluded that good performance of experimental group was because of teaching through Constructivist Module.

Sharma (2012) investigated the impact of Constructivist Approach on students' understanding the concepts of work, energy and power at senior secondary level. Sample for the study was selected in form of the two groups viz, experimental and controlled group (N= 46 in each group) of students of Government Senior Secondary School, Jobner Road, Phulera Jaipur, Rajasthan (India). Experimental group designated for group using Constructivist teaching and control group designated using chalk and talk (lecture) method. Conceptual Understanding Questionnaire comprised of multiple choice questions related to the concepts of work, energy and power was administered on the sample groups of students. Open ended questions were also included in the questionnaire. Mean scores, standard deviation (S.D.) and t-value between students of controlled and experimental groups were calculated and result

revealed that there is a significant difference in the conceptual understanding the concepts of work, energy and power of two groups of students. It is suggested by the researcher that teachers should be exposed periodically to programmes where they can refresh and update their content and pedagogic aspects and appraised about the emerging trends of the educational challenges of today's scenario.

Sridevi (2013) conducted study to see whether constructivist approach to science instruction could promote perception of nature of science among eighth grade students or not. Purposive sampling was employed to select the schools for the study. Perception of Nature of Science Test was developed by the researcher and was administered before and after the treatment. Analysis of Covariance test was performed to control the initial variance. The results showed that Constructivist teaching is more effective than Conventional teaching in terms of perception of nature of Science among 8th standard students. It was also found that Constructivist Approach was equally effective for both boys and girls in improving Achievement and Attitude towards Science. A Constructivist environment was preferred to a traditional classroom by the students. The results confirm research supporting the positive effect of constructivist learning practices and view that constructivist approach to teach science is a viable alternative to traditional modes of teaching.

Thomas et al. (2014) studied to find out whether the Constructivist Strategy enhances affective outcomes among integrated science students or not. Total 200 participants of grade 8 were involved in study. Non-equivalent control group design and affective Achievement Test with psychometric integrity was used. The results confirmed that the use of the Constructivist Strategy improves affective outcomes. The results also revealed that the students in conducive psychosocial environment had superior affective outcomes than their counterparts in non-conducive environment. Interactional effects among the variables were not significant. There was no significant difference found between high and low cognitive achievers regarding affective achievement.

Toraman and Demir (2016) aimed to conduct meta-analysis associated to the previous studies on the effect of Constructivist Approach on student attitudes to lessons and to analyze their results. The researcher employed meta-analysis method of grouping similar studies on a particular topic pertaining to specific criteria and combining the findings. The findings of the research revealed that students taught Constructivist Approach show more positive attitudes towards lesson than that of control group in which student were treated with traditional

learning methods. Only significant differences were seen in lesson subjects as moderating factors. This conclusion was reached when studies regarding the attitudes of students were considered. Overall, the attitude towards science and technology lessons were found more positive than displayed towards mathematics and other curricular subjects. The result of the study can be credited to the fact that the nature of science and technology lessons makes them more appropriate for the application of the Constructivist learning approach.

2.2 Studies related to Constructivist learning with 5E's model

Ajaja (2013) conducted a study to compare the achievement of students taught with concept mapping, cooperative learning, 5E learning cycle and lecture methods with the intention of identifying which one among them could be most suitable for teaching biology. The design of the study was pre-test/ post-test, delayed post-test quasi experimental repeated measures design. The samples of the study consisted of four mixed secondary schools, 259 students and eighth biology teachers. The findings of the study showed significant effect of the four instructional methods on achievement and retention; students in the 5E learning cycle and cooperative learning groups significantly outscored those in the concept mapping and lecture groups on achievement and retention tests; students in concept mapping outscored those in lecture group both on immediate achievement and retention tests; students in 5E learning cycle and cooperative learning groups did not significantly differ on achievement and retention tests; males and females in all the four groups did not significantly differ on the achievement tests; and a non-significant interaction effect between gender and method of instruction on achievement.

Madu and Ezeamagu (2013) investigated the efficacy of the constructivist strategies the 5Es viz., Engagement, Exploration, Explanation, Elaboration and Evaluation at the primary school level. 134 fourth standard primary pupils participated in the study. 72 pupils were taught the concepts of fraction in fourth standard primary mathematics using the 5Es, while 62 pupils were taught content comparable unit on fraction using the regular conventional method. Pupils in the treatment group made significantly greater gains on fraction achievement test than the comparison group. Results of the study showed promising occasionally robust trends on numbers and numeration outcomes thus contributing to the growing body of evidence suggesting that 5Es approach not only facilitated pupils' mathematics learning outcomes, but were also found to support pupil's number and numeracy development.

Tandel (2014) tried to test the development of metacognitive knowledge and regulation in science pupil-teacher of Gujarat through implementing 5E learning model of Constructivist Approach. Mixed method and convergent parallel mixed method was used. The researcher selected 10 B.Ed students from urban and rural college of Palanpur tehsil,Banaskantha district. Observation, interview, reflection essay and self-developed metacognitive skill inventory were used in the study. Result although suggested that laboratory experiences makes the environment to metacognitive skills comparing with classroom learning, but the researcher recommended the need for replication of the study because of the variation in the results.

Chowdhury (2016) investigated the effectiveness of Constructivist 5E learning on Mathematics Achievement. To fulfill the objectives of research, qualitative cum quantitative method was followed by the researcher. Pretest Posttest two groups quasi-experimental design was employed. 30 students of Experimental group were taught using constructivist 5 E learning approach while other 30 students of control group were taught with traditional teaching method. Mathematics Achievement Test (MAT) was used to measure Mathematics Achievement of IX grade students. Data analysis revealed that Mathematics Achievement significantly improved using Constructivist Strategy in contrast to traditional method. It is also found that Constructivist 5 E learning Approach is equally effective for both boys and girls. Students who taught in Constructivist learning environment have significantly improved their understanding and application abilities as compared to knowledge and skill abilities.

Kumar (2016) investigatedteaching biology at senior secondary level through constructivist approach. To fulfill the objectives of research, qualitative cum quantitative method was followed by the researcher. Pretest Posttest nonequivalent two groups quasi-experimental design was employed. Both groups were made equivalent and finally each group contained 22 students. Biology Achievement Test was used to measure Achievement of class XI Biology students. Data analysis revealed that Biology Achievement significantly improved using Constructivist Strategy in contrast to traditional method. It is also found that Constructivist learning Approaches JIGSAW I, II and Puzzles is effective for students. Students who taught in Constructivist approach have significantly improved their understanding and application abilities as compared to knowledge and skill abilities.

Siddiqui (2016) published an empirical research on effectiveness of 5E Learning Cycle Model of Constructivist Approach on ninth grade students' understanding of colloids. Pretest posttest control group quasi-experimental design was used in the research. The sample included 60 students of ninth grade belonged to two different sections of a secondary school in Kishanganj, Bihar, India. Self-developed Chemistry Achievement Test based on colloids concept was applied to test the understanding of colloids and has Cronbach alpha reliability coefficient 0.87. Paired samples t-test was used to measure difference between the pre- and posttest Achievement scores in Chemistry for each of these groups. Analysis of Covariance (ANCOVA) was used to determine difference between Control and Experimental groups since, differences in pretest scores were significant. Data analysis through SPSS proved that acquisition of scientific concept related to 'Colloids' significantly enhanced through the instruction based on 5E learning Cycle Model as compared to traditionally designed instruction in Chemistry.

2.3 Studies related to Co-operative learning approach

Ponnusamy and Sudarsan (2005) conducted a study on 'Student Achievement and Cooperative Learning method in Mathematics at upper primary level'. The major objectives were to study the effectiveness of Co-operative Learning in enhancing the Mathematics achievement of the students at the upper primary level and to study the effect of variables such as sex and standard on the achievement of the students who learned through Co-operative Learning method. The findings indicated that the Co-operative Learning contributed a lot to improve the academic performance of the students in 7th and 8th grades in learning Mathematics. The standard and gender had no effect on the performance of experimental group students and therefore the effectiveness of Co-operative Learning was generalized.

William L. Anderson, et.al., (2005) conducted a study on, 'Comparison of Students' Performance in Co-operative Learning and Traditional Lecture Based Bio-Chemistry Classes'. Student performance in two different introductory Biochemistry curricula was compared based on standardized testing of student content knowledge, problem solving skills and student opinions about the courses. In conclusion it was determined that problem based small group co-operative learning approach to undergraduate Biochemistry education was a more effective educational tool for engaging students in the course material while also improving students' performance.

Chinnappa Arasu (2006) investigated 'The Effectiveness of Co-operative learning approach in teaching Chemistry at +1 level'. The major finding was that there existed significant difference between the control group and the experimental group in their post – test performance, (t-Value in 2.75), which was significant at 0.05 level for two tailed test. This result showed the superiority of the co-operative learning approach over the traditional method of instruction.

SatyaPrakash and Patnaik (2006) conducted a study on 'Effect of Cooperative Learning on Achievement Motivation and Achievement in Biology'. The finding indicated that there was positive effect of Cooperative Learning on Achievement Motivation, and the Cooperative Learning had a positive effect on achievement in Biology in terms of knowledge, understanding and application objectives as well as total achievement.

Thankarajathi (2007) conducted a study on 'Co-operative Learning Approach in Learning Mathematics'. The objective was to find out the effectiveness of the Co-operative Learning Approach over the conventional method in learning Mathematics of high school high, average, and low achievers. The results indicated that there was significant difference between the post test scores of students in co-operative learning group and conventional group. There was significant difference between the post test scores of high, average and low achievers in the co-operative learning approach group. There was significant difference between the pre-test and the post-test scores of the conventional method group and the co-operative learning approach group students in terms of sex, locality, tuition undergone and type of tuition.

Mehra (2008) investigated the 'Effectiveness of Co-operative Learning on Achievement and Retention in Mathematics of Seventh Graders with Different Cognitive Styles'. The objectives were to compare the main gain on achievement scores in Mathematics of the students taught through different instructional treatments, to study the effectiveness of the two instructional treatments for the field independent and field dependent students, to study the effectiveness of two instructional treatments for field independent and field – dependent group of students at knowledge, comprehension and application levels of objectives, to compare the retention scores of students exposed to different instrumental treatments, to study the effectiveness of the two instructional treatments for field independent group of students with respect to retention, and to study the effects of two instructional treatments for field independent and field dependent groups at knowledge comprehension and application

levels of objectives on retention scores. The results indicated that students when exposed to Co-operative learning yielded better mean gain on achievement scores and retention scores as compared to those taught through conventional group learning. Field independent and field dependent students yielded comparable mean gain on achievement scores but field independent students exhibited better retention than field dependent group of students. Through co-operative learning, students yielded better mean gains on achievement scores and retention scores on items, related to knowledge than those related to comprehensive level; but yielded comparable mean gains on item related to comprehensive levels and application levels.

Kaul (2010) conducted a study on 'The Effect of Learning Together Techniques of Co-operative Learning Method on Students Achievement in Mathematics'. The major objective was to find out the effect of the co-operative learning method over the traditional method in teaching Mathematics in the seventh grade. It was observed that learning technique of co-operative learning method was more effective than the traditional method of teaching Mathematics in the seventh grade.

Mehta and Kulshrestha (2012) studied the effect of Cooperative Learning on Social and Cooperative Skills. The researcher conducted this study on 80 students CBSE English medium school, in experimental group 40 students and in control group 40 students as a sample. Observational schedule having 12 items was constructed to measure skills. t-Test was applied to analyze the data. Research findings indicated that Cooperative Learning improves cooperative skills, face to face interaction skills and feeling of accountability.

2.4 Studies related to Collaborative learning approach

Revathi (2015) surveyed on titled 'Effect of Collaborative Learning on Learning Outcomes of Students with Special Needs in Inclusive School'. In total of 256 children were involved in the study and among them 60 were Students with Special Needs. Purposive sampling technique was used to select the inclusive schools wherein children with special needs were enrolled. Quasi-experimental pre-test – post-test design was adopted in the Research study. Researcher analysed academic gain of Collaborative learning was effective in enhancing the academic performance of students with special needs, the results indicate that collaborative learning was found to be efficacious in improving their academic performance.

Sulaiman and Shahrill (2015) investigated the impact of collaboration in the learning of secondary school Statistics in three government secondary schools in Brunei Darussalam. In total, 71 students participated in this study. A series of lessons and group-based activities on Statistics were conducted that consisted of hands-on activities and application of mathematical concept to real-life problems and worksheet-based instruction. Data were collected using pre and post-tests on secondary school Statistics; a readily available 4-point student work rubrics was used as reference on collaboration that focused specifically on the level of collaboration skills acquired; and a questionnaire on students' attitudes on collaborative learning. The results from the pre- and post-tests revealed an 11.8 percent increase in the test scores, and 47.9 percent of the students worked collaboratively within their groups and shared the responsibility towards the given tasks. The responses from the questionnaire indicated that 96 percent of the students found working collaboratively as a group assisted them in enhancing their learning of Statistics. Majority of the students also believed that they gained more knowledge and learnt specific skills and processes when they work in groups. This study has shown that collaborative learning helped to improve students' performance academically as well as to develop the necessary skills of the 21st Century.

Laal, Naseri, Laal and Kermanshahic (2013) examined when groups of learners help each other, collaborative learning occurs. Collaboration is a philosophy of interaction and personal lifestyle where people are accountable for their actions, including learning and respect the abilities and contributions of their peers. The advances in technology and changes in the organizational infrastructure put an increased emphasis on teamwork. Group members have to think creatively, assess problems, and make decisions as a team. In all situations where people come together in groups, it suggests a way of dealing with people that respects and highlights individual group members' abilities and contributions. Application of learning in collaboration, can lead to many advantages. This article seeks to describe the potential advantages of learning in collaboration.

Brown (2009) surveyed students' perceptions of Collaborative Learning (CL). The research was aimed at providing depth and detail on students' perceptions of what they have gained from the process and possibly indicates what areas might need to be improved or changed. Analyses of data revealed that most students claim to have derived academic benefits such as better comprehension and improved performance, and acquired generic skills - enhanced communication and problem-solving skills. About half of the respondents believe they gained social skills: they found CL enjoyable and made new friends. Most students agree that CL

practices should be encouraged and continued. It was concluded that students' perception of CL at the University of Botswana is similar to findings in the stated literature. It was recommended that, in addition to focusing on academic benefits of CL, teachers should also be concerned with the social aspects of CL.

Gokhale (1995) reviewed the concept of collaborative learning, the grouping and pairing of students for the purpose of achieving an academic goal, has been widely researched and advocated throughout the professional literature. The term 'collaborative learning' refers to an instruction method in which students at various performance levels work together in small groups toward a common goal. The students are responsible for peer learning as well as their own. Thus, the success of one student helps other students to be successful. In collaborative learning, students work together in small groups to complete projects by questioning each other, and discussing and sharing information. This is in contrast to the competitive process usually used in the classroom.

Laal (2015) studied on Positive Interdependence in a Collaborative Learning settings. The success of one person is dependent on the success of the group; this is referred to as positive interdependence. All members should rely on one another to achieve the goal and need to believe that they are linked together to succeed. Positive interdependence is the belief of anyone in the group that there is value in working together and that the results of both individual learning and working products would be better when they are done in collaboration. This article aimed to describe the basic concept of collaborative learning and also to present diverse forms of structuring positive interdependence in a collaborative setting.

Terenzini, Cabrera, Colbeck, Parente and Bjorklund (2013) examined the extent to which undergraduate engineering courses taught using active and collaborative learning methods differ from traditional lecture and discussion courses in their ability to promote the development of students' engineering design, problem-solving, communication, and group participation skills. Evidence for the study comes from 480 students enrolled in 17 active or collaborative learning courses/sections and six traditional courses/sections at six engineering schools. Results indicate that active or collaborative methods produce both statistically significant and substantially greater gains in student learning than those associated with more traditional instructional methods. These learning advantages remained even when differences in a variety of student pre-course characteristics were controlled.

Yau, Gupta and Karim (2003) conducted a study on Smart Classroom facilitates collaborative learning among college students. Students in such an environment form small groups to solve a specific problem or develop a group project. In a Smart Classroom, each student has a situation-aware PDA. Students' PDAs dynamically form mobile ad hoc networks for group meetings. Each PDA monitors its situation (locations of PDAs, noise, light, and mobility) and uses situation to trigger communication activity among the students and the instructor for group discussion and automatic distribution of presentation materials. Middleware can effectively address the situation awareness and ad hoc group communication for pervasive computing by providing development and runtime support to the application software. This study developed a Reconfigurable Context-Sensitive Middleware (RCSM) for such purposes.

Haugwitz, Nesbit and Sandmann (2010) Data were gathered from 248 secondary students (14 years old, 56 percent Girl) who learned about the circulatory system in 77 self-selected collaborative groups. The learning outcomes of biology students who summarised by collaborative concept mapping were compared with those of students who summarised by collaborative writing. Learning groups randomly assigned to construct concept maps instead of conventional summaries generated more relations in the summary task and their members obtained higher individual scores on a post-test. The concept mapping strategy was found to be advantageous only for students whose cognitive ability was below the median for the sample and who were placed in groups with other students having low cognitive ability.

Tudge (1992) studied the performance of student pairs on a science task, concluding that collaboration was as likely to diminish performance as to improve it. In this study, 153 students aged 5 to 9 worked in pairs on a series of tasks involving a balance beam. Researchers manipulated weights applied to the balance beam, as well as the distance from the fulcrum. Students were asked to predict which side the beam would tilt toward when the supports were removed. Children's responses were coded into several categories according to the degree of sophistication of the decision rule used to support their prediction. Researchers tested four different types of student configuration: individual students, students who demonstrated equivalent decision rules a pre-test, and students demonstrating unequal decision rules at pre-test - one student adopting a higher rule, and the other adopting a lower rule. During collaboration, student took turns making predictions and justifying their predictions. The results suggest that collaboration had a strong impact on student performance, with changes in reasoning persisting for several weeks afterwards. The study found that the group of less competent students (those using inferior decision rules) was the

only group that improved significantly on post-test. However, the more competent students (those using superior decision rules) were the only group that declined significantly post-test. Thus, collaboration was as likely to decrease as increase student performance.

Hong (2010) investigated the effects of a collaborative science intervention on high achieving students' learning anxiety and attitudes toward science. Thirty-seven eighth-grade high achieving students (16 boys and 21 girls) were selected as an experimental group who joined a 20-week collaborative science intervention, which integrated and utilized an innovative teaching strategy. Fifty-eight eighth-grade high achieving students were selected as the comparison group. The Secondary School Student Questionnaire was conducted to measure all participants' learning anxiety and attitudes toward science. In addition, 12 target students from the experimental group (i.e., six active and six passive students) were recruited for weekly classroom observations and follow-up interviews during the intervention. Both quantitative and qualitative findings revealed that experimental group students experienced significant impact as seen through increased attitudes and decreased anxiety of learning science. Implications for practice and research are provided.

Kirschner, Paas, Kirschner and Janssen (2011) investigated Differential effects of problem-solving demands on individual and collaborative learning outcomes. The effectiveness and efficiency of individual versus collaborative learning was investigated as a function of instructional format among 140 high school students in the domain of biology. The instructional format either emphasized worked examples, which needed to be studied or the equivalent problems, which needed to be solved. Because problem solving imposes a higher cognitive load for novices than does studying worked examples it was hypothesized that learning by solving problems would lead to better learning outcomes (effectiveness) and be more efficient for collaborative learners, whereas learning by studying worked examples would lead to better learning outcomes and be more efficient for individual learners. The results supported this crossover interaction hypothesis. Consequences of the findings for the design of individual and collaborative learning environments are discussed.

Wendt (2013) examined the effects of online collaborative learning on middle school students' science literacy and sense of community. A quantitative, quasi-experimental pre-test – post-test control group design was used. Following IRB approval and district superintendent approval, students at a public middle school in central Virginia completed a pre-test consisting of the Misconceptions-Oriented Standards-Based Assessment Resources

for Teachers (MOSART) Physical Science assessment and the Classroom Community Scale. Students in the control group received in-class assignments that were completed collaboratively in a face-to-face manner. Students in the experimental group received in-class assignments that were completed online collaboratively through the Edmodo educational platform. Both groups were members of intact, traditional face-to face classrooms. The students were then post tested. Results pertaining to the MOSART assessment were statistically analyzed through ANCOVA analysis while results pertaining to the Classroom Community Scale were analyzed through MANOVA analysis.

Shukor, Tasir, Van der Meijden and Harun (2014) attempted to investigate the students' behaviour and their strategies to construct knowledge during online collaborative discussions Online collaborative learning allows discussion to occur at greater depth where knowledge can be constructed remotely. However, students were found to construct knowledge at low-level where they discussed by sharing and comparing opinions; those are inadequate for new knowledge creation. Using the combination of content analysis and sequential analysis technique, this research found that groups those being able to construct high-level knowledge tend to negotiate on shared information. Argumentation is also found to contribute for successful knowledge construction at higher-level. This study suggested triggering argumentation and emphasizing on problem-solving tasks for better knowledge construction sustainability.

Hmelo-Silver and Barrows (2008) described a detailed analysis of knowledge building in a problem-based learning group. Knowledge building involves increasing the collective knowledge of a group through social discourse. For knowledge building to occur in the classroom, the teacher needs to create opportunities for constructive discourse in order to support student learning and collective knowledge building. In problem-based learning, students learn through collaborative problem solving and reflecting on their experiences. The setting for this study is a group of second-year medical students working with an expert facilitator. The analysis was designed to understand how the facilitator provided opportunities for knowledge-building discourse and how the learners accomplished collective knowledge building. The results indicate that the group worked to progressively improve their ideas through engaging in knowledge-building discourse. The facilitator helped support knowledge building through asking open-ended metacognitive questions and catalysing group progress. Students took responsibility for advancing the group understands as they asked many high-level questions and built on each other's thinking to construct collaborative explanations.

Hogan, Nastasi and Pressley (1999) studied the social and cognitive processes involved in construction of shared understanding during an eighth grade science inquiry unit while constructing a conceptual artefact. In comparison to ineffective groups, Successful effective groups had many agreements and neutral reactions to other students' ideas whereas less successful groups were more likely to have disagreements. These results suggest that certain kinds of moves are associated with knowledge building discourse but they are less clear about how opportunities for these moves are provided.

Rosen and Rimor (2009) focused on academic online course in collaborative database learning environment and examine the conditions for effectiveness of collective and individual knowledge construction in this environment. The purpose of this study was to examine whether learners with a collaborative learning orientation differ from learners with an individual learning orientation, as was measured through their contribution to the process of knowledge construction in a collaborative online database environment. The results of the study showed differential achievements among learners with different learning orientations. The learners with collaborative learning orientation succeeded more in the collective criteria of knowledge construction compared to the less collaborative ones. On the other hand, the less collaborative participants within the forum gained higher scores in the personal criteria of knowledge construction compared to the collaborative ones. While the 'collaborative learners' contributed more collective knowledge, the 'individual learners' focused on constructing their own personal knowledge. These findings have important implications on planning, coordinating and evaluating collaborative learning environment.

Ellis (2001) examined a subject that is presented using both face-to-face and asynchronous online forms of communication, discussing the differences in terms of collaborative learning. The traditional form of collaborative learning has been via face-to-face groups working together. The on-line forum can provide a different collaborative learning environment, due to its student-centric, asynchronous, written form. As a result of an investigation into the differences between face-to-face and online asynchronous communication, insights into the impact on collaborative learning emerged.

Van Boxtel, Van der Linden and Kanselaar (2000) presented the results of an experimental study of the influence of task characteristics on the characteristics of elaboration of conceptual knowledge in social interaction. With pre-test and post-test individual learning outcomes measured. This study constructed a coding scheme that focuses on the

communicative functions and propositional content of utterances and on elaborative episodes. The subjects were 40 students who worked in dyads on a collaborative task about electricity in one of four conditions. And compared a concept mapping task with a poster task and investigated the effect of a phase of individual preparation. The post-test scores were significantly higher than the pre-test scores. Individual preparation created better learning results and the asking of more questions. The concept mapping conditions showed more discussion of electricity concepts, collaboratively elaborated conflicts and reasoning, but no higher individual learning outcomes. In the concept mapping conditions, elaboration was related to individual learning outcomes.

Tolmie et al (2009) measured the impact on work and play relations of a collaborative learning programme involving 575 students 9 to12 years old in single- and mixed-age classes across urban and rural schools. Data were also collected on student interactions and teacher ratings of their group-work skills. Analysis of variance revealed significant gains for both types of relation. Multilevel modelling indicated that better work relations were the product of improving group skills, which offset tensions produced by transactive dialogue, and this effect fed through in turn to play relations. Although before intervention rural children were familiar with each other neither this nor age mix affected outcomes. The results suggest the social benefits of collaborative learning are a separate outcome of group work, rather than being either a pre-condition for, or a direct consequence of successful activity, but that initial training in group skills may serve to enhance these benefits.

Dollman, Morgan, Pergler, Russell and Watts (2007) improve student social skills through the use of cooperative learning, in order to develop a positive classroom environment that is conducive to learning. The action research project will involve approximately 95 students, 95 parents, and 200 teachers. It is the intent of the teacher researchers to improve students' social skills through the following strategies: roleplaying, jig sawing, think pair- share, and graphic organizers. This study was conducted for twelve consecutive weeks (from October 2, 2006 to December 18, 2006) in the 2006 fall semester. The teacher researchers hope that improved social skills will create a positive learning environment that will benefit all students. The teacher researchers agree with research that has shown the need for disciplinary measures is the result of acquisition deficits (student does not know the skill), performance deficits (student knows how to perform the skill, but fails to do so), fluency deficits (student knows how to perform skill, but demonstrates inadequate performance), and internal/external factors (negative motivation or depression) (NASP, retrieved 2006). Each week the

instruction will involve a mini-lesson for skills, work in cooperative groups, problem solving etc., Researchers have advocated the implementation and use of cooperative learning in order to increase student achievement and social skills development (Siegel, 2005). With the implementation of cooperative learning strategies, these teacher researchers hope to improve the social skills of their students.

Nevgi, Virtanen and Niemi (2006) focus on the question of how to advance collaboration through the Web and support lifelong learning. First, the theoretical framework and architecture of a new web-based tool, the 'IQ Team', is introduced. IQ Team is an interactive online assessment and support system to learn social skills needed in cooperative work, and belongs in an interactive online assessing and tutoring system, 'IQ Form', developed for the Finnish Virtual University. IQ Team has three main elements: (1) interactive self-evaluation test banks, (2) online tutoring sets and (3) learning diaries. In the creation of IQ Team, the validation process was conducted with two samples (n = 259 and n = 275). The online students' social skills in different groups were explored, and the feedback data from different user groups were analysed. The online students scored high values for social skills, and no differences were discerned between university, Open University and technical students. The qualitative data (n=35) were collected in order to get users' feedback of the tool. The qualitative data consisted of interviews, open-ended questions and online discussions. The users of IQ Team reflected that the tool benefited them to become aware of their group work skills and developed their collaborative learning skills. IQ Team provides a powerful tool for online instruction and communication in higher education and in the Open University to promote joint-regulated learning.

2.5 Studies related to problem solving approach

Sow (2006) discussed about the effect of Constructivist Strategies and Direct Instruction using Multimedia on Higher and Lower Order Knowledge Task and Problem-Solving ability of learners with different psychological profiles on the topic 'periodic table' in chemistry. Pretest posttest 2x2 quasi-experimental factorial design with repeated measures for the moderator variables (intelligence and internal LOC) in a nonequivalent control group was used. Intervention was performed by teacher assistants who were supervised by two assessors for five weeks. t-test, correlation, Analysis of covariance (ANCOVA) and stepwise linear regression techniques were used to determine the contribution towards the dependent variables. Sample involves 156 students of age group 16 to 17 years from four rural

secondary schools. Result declared that there was no significant difference in lower order knowledge task whereas significant difference was found in higher order knowledge task of two groups. The study concluded that Constructivist Strategies were more effective than Direct Instruction for Higher Order Knowledge Task and also stronger for developing Problem Solving Ability and Internal Locus of Control of learners.

Arora and Kulshrestha (2011) did a research to investigate the effect of Problem Based Learning on Academic Achievement in Social Science for VII graders. Sample consisted of total 60 students in experimental (N=30) and control group (N=30). Pretest posttest two group design was used in intervention. 10-10 lesson plans based on (PBL) problem-based learning approach for experimental (PBL approach) and control (traditional approach) group were used respectively. Analyzed data revealed that PBL Approach was more effective than Traditional Approach regarding Achievement in Social Science.

Erdal Bay, Birsen Bagceci and Bayram Cetin (2012) investigated whether there is a significant difference in the learners' problem-solving skills and meta-cognitive levels when the authentic task-based social constructivist approach is used in an experimental group and a traditional approach is used in a control group. In this research, semi-experimental designs with pre-test – post-test control groups were used. The experimental group was taught by constructivist approach (task based collaborative learning process) on the other hand, the control group was put in learning environments based on meaningful learning approaches. 89 teacher candidates (trainees) formed the experimental group and 48 teacher candidates formed the control group. The adapted Problem-Solving Scale of Heppner and Peterson was used for acquiring data on problem solving skills. Meta cognitive awareness scale was developed by the researcher and used for obtaining the data on meta-cognitive levels. It was found that the experimental group teacher candidates significantly scored higher in problem solving skills and meta-cognitive levels than the control group. It was concluded that the task-based social constructivist approach had positive effects on teacher candidates' problem-solving skills and metacognitive levels.

2.6 Studies related to use Concept map approach

Pandey (1999) conducted a study to investigate effectiveness of concept mapping as a teaching learning strategy in science. Main objectives of the study were- (i) to investigate the effectiveness of concept mapping as a teaching learning aid in science learning for secondary school students. (ii)to investigate the effectiveness of concept mapping as a teaching aid in

science learning for secondary school students. (iii) to investigate the differential effectiveness of concept mapping as a teaching learning aid and as a teaching aid in science learning for secondary school students. (iv) to investigate the differential effectiveness of concept mapping as a teaching learning aid in science for male and female students. (v) to investigate the differential effectiveness of concept mapping as a teaching aid in science for male and female students. Pre-test – post-test equivalent group experimental design was used. It was concluded that- (i) the science achievement of students who learn science through concept mapping as a teaching learning aid is significantly better than science achievement of students who learn science through traditional method of teaching. (ii) the science achievement of students who learn science through concept mapping as a teaching aid is significantly better than science achievement of students who learn science through traditional method of teaching. (iii) the science achievement of students who learn science through concept mapping as a teaching learning aid is significantly better than science achievement of students who learn science through concept mapping as a teaching aid. (iv) the science achievement of male students and the science achievement of female students who learn science through concept mapping as a teaching learning aid is not significantly different. (v) The science achievement of male students and the science achievement of female students who learn science through concept mapping as a teaching aid are not significantly different.

Chang, Sung and Chen (2002) conducted a study to investigate the learning effects of a concept-mapping strategy. They designed 3 concept mapping approaches, map correction, scaffold fading and map generation to determine their effects on students' text comprehension and summarization abilities. The sample consisted of 126 fifth grade students. The experimental results showed that the map correction method enhanced text comprehension and summarization abilities and that the scaffold fading method facilitated summarization ability.

Snead and Young (2003) conducted a study to investigate the effectiveness of concept mapping on science achievement of 182 African American middle grade science students, distributed in to eight intact earth science classes (by ability levels). A quasi, non-randomized, control-treatment group, pre-test – post-test experimental design was used for this research study. Ability level was examined as a covariate on student achievement. Analysis of covariance indicated no significant overall effects of treatment on science achievement. A statistically significant effect was found between concept mapping and

control group students on achievement among the average students measured by combined performance on assessment items.

Rao (2003) worked on the effectiveness of concept mapping on academic achievement, cognitive skills and concept attainment of science students at VIII grade. The results of this study, conducted under the ERIC project of NCERT, revealed that concept mapping as an instructional tool had an effect on the achievement of students and their cognitive skills in science. The students also reflected on positive attitude towards concept mapping as an effective instructional tool.

Brown (2003) conducted a study to investigate group approach to concept mapping in high school biology. The sample consisted of 97 students. The control group represented biology classes that did not use concept mapping during the photosynthesis and cellular respiration unit. The two experimental groups represented classes in which students created their concept maps on their own and classes where students worked in small groups to create maps through collaboration. The results indicated that the classes involved in group concept mapping outperformed the classes where students created concept maps as individuals or did not make concept maps at all. From pre- to post-test, students on average increased their scores by more than 2 in the group mapping classes as compared to increasing scores of approximately one in both the other two groups. The control group mean was slightly greater than the mean of the individual- maps group yet was significantly lower than the group- maps group. Forty-four percent of the students correctly answered both parts of the two-tier questions on the post-test. Thirty percent of the students who correctly answered the questions were students who created concept maps as individuals and the remaining 20percent of the students who correctly answered both parts of the two-tier test question were in the control group.

Gopal (2004) conducted a study to investigate the effect of the use of concept maps on the teaching and learning of English grammar. The sample consisted of 94 students of class IX. Main finding of the study indicated that the students taught through concept map perform better on their understanding of the concepts of English grammar as compared to the ones taught through commonly prevalent options.

Rao (2004) conducted a study to investigate effect of Concept-Mapping on science achievement, cognitive skills and attitude of students. The main objectives of the study were (i) to develop and implement concept mapping as a strategy in the selected few units of science for VIII standard students and study its effect on the achievement, concept

attainment, and the process skills of students belonging to different intelligence groups, (ii) to study the attitude of students towards concept mapping in science, (iii) to study the gender differences in science achievement, process skills and attitude towards concept mapping. The study was quasi-experimental in nature wherein non-randomized pre and posttest design was used. The intact classes of eighth standard as a whole were considered as experimental (N=47) and control group (N=42) for the study. They were selected from two local schools of Mysore city. Raven Progressive Matrices was used to group the students according to their intelligence. An achievement test based on selected units of the eighth standard syllabus, a process skills test and a concept attainment test were developed to measure the students" achievement, process skills and attainment of concepts in science. An attitude scale was developed to measure students" attitude towards concept mapping. The data obtained was analyzed descriptively and inferentially by calculating percentages, mean, SD, t-ratio and F-ratio. Major findings were: (i) the experimental group students had performed better when compared to control group students on the achievement, process skills and concept attainment on the posttest occasion. The analysis of students" (experimental) attitude towards concept mapping revealed that almost 90percent of them had a very positive attitude; (ii) the F values obtained showed that there is a difference between the different intelligence groups of the experimental group in their post achievement test implying that the concept mapping strategy has had a differential effect on students belonging to different intelligence groups; and (iii) there was no difference between girls and boys in their achievement, process skills, concept attainment and in their attitude towards concept mapping.

Aimee A. Bancroft (2004) studied the 'Effects of Concept Mapping on Student Achievement in Tenth Grade Biology Students' at a Catholic high school with 300 students located in southern Louisiana. The students were tested with researcher-constructed pre and post-tests containing objective and subjective questions. The students in the treatment and control groups were exposed to the same teaching techniques covering same content. They were given the same pre-test after the initial lessons. However, after the pre-test the control group was given a traditional oral review of the material and the experimental group was exposed to the concept map centered review. After that, students completed the post test. Test scores were statistically analysed using an ANCOVA and found that concept mapping enhanced student achievement.

Derbentseva, Safayeni and Canas (2007) examined concepts and propositions from a theoretical perspective, and established the need for an extension to Cyclic Concept Maps.

Cyclic Concept Maps are considered to be an appropriate tool for representing knowledge of functional or dynamical relationships between concepts. Concept Maps, on the other hand, are viewed as an appropriate tool for representing hierarchic or static knowledge. The two maps complement each other and collectively capture a larger domain of knowledge, thus forming a more effective knowledge representation tool.

Joseph D. Novak et al (2006) in "The Theory Underlying Concept Maps and How to construct them" reported concept maps as graphical tools for organizing and representing knowledge. Concept mapping has been shown to help learners, to learn meaningfully, researchers to create new knowledge, administrators to better structure and manage organizations, writers to write, and evaluators to assess learning. At first glance concept maps appeared to be just another graphic representation on information, understanding the foundations for this tool and its proper use lead the user to see that this is truly a profound and powerful tool which first look like a simple arrangement of words into a hierarchy but when care is used in organizing the concepts represented by the words and the propositions or ideas are formed with well-chosen linking words, it becomes elegantly complex with profound meanings.

Asan (2007) conducted a study to determine the effects of incorporating concept mapping on the achievement of fifth grade students in science class. The sample consisted of 23 students at elementary school, Trabzon, Turkey. The students were tested with teacher-constructed pre- and post-tests containing 20 multiple-choice questions. A nonequivalent control group design was used. Three instruments were used in this study: (1) Multiple Choice Test, (2) Concept Map Scoring Rubric, and (3) Student Interview Questions. The pupils in the experimental and control groups were exposed to the same teaching techniques covering a unit on heat and temperature. They were given the same pretest after the initial lessons. However, after the pretest, the control group was given a traditional oral review of the material and the experimental group was exposed to the review by the use of Inspiration, which is computer-based concept mapping tool. After these reviews, the students on both groups were given the posttest. Test scores were analyzed for any statistically significant difference in the scores on the test. The results indicated that concept mapping has a noticeable impact on student achievement in science classes.

BouJaoude and Attieh (2007) conducted a study to investigate the effect of using concept maps as study tools on achievement in chemistry. Objectives of the study were (1) to examine

whether or not the construction of concept maps by students improves their achievement and ability to solve higher order questions in chemistry, (2) investigate the differential effect of the treatment by gender and achievement level, and (3) explore the relationships between performance on concept maps and chemistry achievement. Participants were 60 tenth-grade students randomly divided into two groups. The study spanned six weeks in a class that met five times a week. The students were pre- and post-tested using a teacher-constructed chemistry test. Results showed that while there were no significant differences on the achievement total score, there were significant differences favouring the experimental group for scores on the knowledge level questions. Moreover, there were gender-achievement interactions at the knowledge and comprehension level questions favoring females and achievement level – achievement interactions favoring low achievers. Finally, there were significant correlations between students" scores on high level questions and the convergence and total concept map scores.

Kharatmal (2009) covered a short review on concept maps in science education research with an illustration of a case study in Indian school context. Two different methods of representing knowledge i.e. description and concept maps were compared for eliciting students" knowledge structure of school biology. There is a significant increase in the number of concepts and valid relations when the students used the concept mapping method. It indicated that concept maps aided in recalling and networking of concepts and they have been found to be a feasible tool in organizing knowledge for meaningful learning.

Qarareh (2010) investigates the effect of using the concept mapping strategy in teaching on the achievement of fifth graders in science. To achieve this goal, eighty students were randomly selected and then divided in to two groups. The experimental group was taught by using concept mapping and the control group was taught by traditional method. To answer the questions of the study, analysis of variance was used. The study shows that using the concept map shows greater effect on academic achievement.

Karakuyu (2010) conducted a study to investigate the effect of students" concept mapping on their physics achievement and attitude toward physics lesson. Participants were 58 ninth-grade students from the two classes" enrolled in general physics course in a high school in Turkey. The sample consisted of 58 students of class X. Physics Achievement Electricity Test and Concept Maps Attitude Scale towards Physics was used as a tool for the study. Results showed that there were no significant differences in the attitude and achievement

between the experimental and control groups. However, the experimental group students were observed to have a tendency of more positive attitude than the control group students. Results also showed that drawing concept map instruction was more effective than traditional instruction in improving physics achievement of the participating students.

Khawaldeh and Laimat (2010) conducted a study to investigate the contribution of conceptual change texts, accompanied by concept mapping instruction to eleventh-grade students' understanding of cellular respiration concepts, and their retention of this understanding. The result showed that conceptual change texts accompanied by concept mapping instruction was significantly better than traditional instruction in retention of this understanding.

Awofala (2011) investigated the effect of concept mapping strategy on achievement in mathematics of 88 junior secondary Nigerian students. Research questions of the present study were- (1) will there be any significant difference between the pre-test achievement scores of students exposed to the concept mapping strategy and those exposed to the regular teaching method? (2) will there be any significant difference between the post-test achievement scores of students exposed to the concept mapping strategy and those exposed to the regular teaching method? (3) will there be any significant difference between the students" analysis, synthesis and evaluation levels of cognition after being exposed to the concept mapping strategy and the regular teaching method? The study adopted a pre-test posttest non-equivalent control group quasi-experimental design and data were analyzed using the t-test statistic. Results showed that concept mapping is an effective strategy for teaching and learning mathematics. The strategy is also capable of improving students" mastery of content at the higher-order levels of cognition.

Benay, Semsar and Kennedy (2011) conducted a study to investigate student's perception of usefulness of concept mapping across four different physiology courses that varied in their implementation. Three of the courses had similar responses, with about half the students saying concept mapping was of little or no value, while in the fourth course students found them far more useful to their learning.

Dammani (2012) conducted a study to investigate the effect of concept maps, intelligence and their interaction in terms of development of the reasoning of the students. The sample consisted of 75 students (35 females and 40 males). Nonequivalent Control Group Design has been used. She concluded that concept mapping was found to be effective for both high and low intelligent students.

Sharma (2012) conducted a study to investigate effect of concept mapping strategy on the learning outcome in relation to intelligence. Sample consisted of 200 students of class IX. Pretest-Posttest equivalent group designed was used. Main findings were: (i) concept mapping strategy has significant effect on learning outcome in social studies. (ii) Effect of concept mapping strategy on learning outcome is greater than that for traditional method. (iii) There is no significant difference in learning outcomes of social studies students with high and low intelligence exposed to concept mapping teaching strategy.

Singh (2012) conducted a study to investigate the differential effectiveness of concept mapping and constructivist strategy to teaching science. The sample consisted of 30 students from upper elementary school. Findings indicated that concept mapping is more effective than constructive strategy for teaching science. There were found no significant difference between achievement level of boys and girls taught through concept mapping strategy while achievement level of boys was more than that for girls taught through constructive teaching strategy.

Cheema and Mirza (2013) conducted a study to analyze effect of concept mapping on academic performance of VII grade students in the subject of general science. This quasi-experimental research, based on 2 x 2 factorial research design, involved 167 students from two schools. Major objectives of the study were- (i) to find out the effect of concept mapping as a learning strategy on the academic achievement of students, (ii) to study differential effect of concept mapping on academic achievement of male and female students, (iii) to find out the interaction effect of concept mapping as a learning strategy and gender on students'' academic achievement. During the treatment of five months, experimental group was trained to develop concept maps for three weeks. Subsequently students developed concept maps of general science content individually, shared those in groups and were compared by teacher with scientifically accepted concept maps for possible correction and improvement. Data on gain achievement scores were analyzed through 2-way ANOVA. Results showed that the students taught through concept mapping performed better than the students taught through traditional teaching method. However, male students taught through concept mapping performed significantly better than the female students.

Sharma, Harsana, and Sharma (2013) conducted a study to investigate effectiveness of using concept maps in Science among VI grade students. Pre-test - post-test equivalent group design was used. The sample consisted of 100 students (50 boys and 50 girls) studying in

class VI. Mean, standard Deviation, t- ratio and correlation (Karl Pearson) were used to analyze the data. The main findings of the study showed a significant difference between the means scores of the control group and experimental group. It indicated that concept maps enhance learning of basic concepts in science.

Aziz and Rahman (2014) conducted a study to find out if the metacognitive strategy of concept mapping enhanced achievement in science at secondary level. A total of 120 students of class IX from two senior secondary schools of Delhi participated in this experimental study. The study was quasi-experimental in nature where in pre and posttest design was used to determine the effect of concept mapping strategy on students" achievement in science. Mean, standard deviation and t- test were used to analyze the data. Results of the study showed that the use of concept mapping strategy was more effective than the lecture cum discussion method in enhancing students' achievement in science.

Luchembe, Chinyama and Jumbe (2014) conducted to show the effectiveness of concept mapping as a teaching strategy to undergraduate students taking introductory physics course. The sample consisted of 70 students. A mixed method approach was used. Findings revealed that the mean score for the experimental group's posttest was higher than the mean score of the control group. This showed that concept mapping was more effective than the tutorial sheet strategy.

Chawla and Singh (2015) conducted a study to investigate the effect of teaching through concept mapping on the achievement in chemistry among girls. Sample of the study consisted of 118 girls (59 in experimental group and 59 in controlled group) of IX class from two Government schools of Ludhiana city. Experimental group was exposed to Concept Mapping method and the controlled group was exposed to conventional method (lecture and discussion) for twenty-five days. Mixed group intelligence test (MGTI) by Mehrotra (2008) was used to match the groups. Achievement test in chemistry (developed and standardized by the investigator) was used as a tool for data collection. The results of the t- test analysis of the gain scores showed that achievement in chemistry of the girls taught by Concept Mapping was significantly more as compared to girls taught by conventional method.

Singh and Moono (2015) conducted a study to investigate the effect of composite use of concept maps and traditional method on student achievement in selected topics in chemistry. There were three groups involved in the study i.e. Control, experimental group1 and experimental group 2. The Pre-test – Post-test true experimental research design was used for

the study. The sample of the study consisted of 39 first year students at Mufulira College of Education. Each of the three groups was randomly assigned 13 students. The control group was treated using the traditional method, the experimental group 1 was treated using the concept map method while experimental group 2 used composite of both the traditional and concept map methods. One-way ANOVA at an alpha (α) = 0.05 was used to analyze the results of the pre- test and posttest scores. Results indicated that there was no significant difference in the performance of the students in all groups. This result implied that the entry level performance for all the groups was not significantly different. The means of the posttest results showed that there was a significant effect of the use of both traditional teaching method and concept map teaching method. The experimental group 2 performed better than both control group and experimental group 1 in the post test scores. Post hoc comparisons using the Tukey HSD test indicated that the mean scores were significantly different. The results strongly support that when students are taught using both the concept map teaching strategy and traditional teaching strategy, they achieve the best scores.

Joel and Kamji (2016) conducted a study to find out the role of concept mapping in remedying students" problem-solving difficulties in stoichiometry. The pre-test – post-test control group design was employed. The sample consisted of 60 male and female students. The control group was taught using lecture method, while the experimental group was taught using concept mapping. Analysis of post-test mean scores using t-test showed that there was a significant difference between the post-test mean scores of students taught stoichiometry using concept mapping strategy and those in the control group. No significant difference between the post-test mean scores of male and female students taught using concept mapping strategy was found, the efficacy of concept mapping strategy in enhancing students" problem solving ability in stoichiometry among male and female students was therefore established.

Gawade and Patankar (2016) conducted a study to investigate effect of concept maps on academic achievement in the subject biology among the higher secondary level school students. The sample was selected from four colleges from by random selection method. They concluded that concept map strategy used for teaching Biology was effective for higher secondary level school students.

Kristina, et al., (2016) conducted a study to explore whether the students achieve better learning results while using traditional (frontal) method or conceptual maps during their learning process. The sample consisted of 101 students attending second grade of natural

sciences and mathematics high school in Osijek. The results showed that students who use conceptual maps achieve better results in comparison with the students who have processed new teaching units by the means of frontal method.

Appoji and Shailaja (2017) conducted a study to investigate the effect of concept mapping on academic achievement of students in physics in relation to gender. The sample of the study included 80 students from VIII standard physics subject of Belagavi district. Each group consisted of 22 girl students and 18 boy students. The study is quasi experimental in nature. Main findings of the study were (1) the posttest scores of academic achievement of boy students are significantly higher as compared to pretest scores in experimental group in physics. (2) the posttest scores of academic achievement of girl students are significantly higher as compared to pretest scores in experimental group in physics.

Ghorai and Guha (2018) conducted a study to investigate the effect of concept mapping teaching strategy on physical science achievement in relation to intelligence level (High, Moderate and Low Intelligence). True experimental research design of randomized Solomon four equivalent groups was used. The study consisted of 41 sample of class IX student. Mixed type Group Test of Intelligence (MGTI) by Mehrotra (2008) and Achievement test in physical science (developed and standardized by the researchers) was used as a measuring tool. t-Test and ANOVA were applied for analyzing the result. Result of the study showed that changing in teaching strategy (concept mapping and demonstration) did not produce any significant difference among the high, moderate and low IQ students' achievement in class IX physical science subject.

Pandey (2019) conducted study on Effectiveness of Concept Attainment and Concept Mapping Teaching Strategies for teaching Biology to class IX students. This study used non-equivalent single group pre-test post-test quasi experimental design. Cluster random sampling technique was used for 310 students in different experimental groups and control groups. Researcher self-constructed Biology Achievement Test used to measure the achievement of the students in biology. Second tool was Neo- Personality Questionnaire' constructed by K.S. Misra has been used to measure different personality traits of the students. Third tool was 'Culture Fair Intelligence Test Scale 3, Form A, constructed by R. B. Cattel and A. K. S. Cattell, has been used to measure intelligence. ANOVA t- and F-ratios at 0.5 level.

2.7 Studies related to Constructivist learning and Achievement in Chemistry

Jong Sukkin (2005) conducted the study on "The Effects of a Constructivist Teaching Approach on Students Academic Achievement Self-Concept, and Learning Strategies". The purpose of the study was to determine the effectiveness of a constructivist teaching approach in mathematics of elementary school education in terms of academic achievement self-concept and learning strategies. 76 sixth grade students were selected for this study and were divided into two groups (experimental and control group). The experimental group was taught using the constructivist teaching approach and the control group was taught using the traditional teaching approach. Research design for this study was of a non-equivalent pre- test post-test control group design. Thestudy concluded that (a) Constructivist teaching is more effective in terms of academic achievement of students (b) Constructivist teaching is not effective in terms of students" self-concept, enhancement in student learning. However, it is having some effect upon motivation to learn academic tasks, causing anxiety in the academic learning process and self-monitoring in terms of learning for tests.

Sola and Ojo (2007) measured the comparison among three methods of teaching experiments in separation of mixtures in chemistry. Pretest posttest four group experimental design was applied in the study and sample consisted of 233 randomly selected senior secondary schools from four local government areas of Ogun state, Nigeria. Chemistry Achievement Test was used before commencement of teaching and after experiments performed. Three experimental groups were taught using project, inquiry and lecture-cum- demonstration method while control group was treated with Traditional method of teaching. t-test, ANOVA and Sceffe post-hoc analysis were used to analyse the collected data. Result of the research revealed that achievement scores are significantly different among four groups. From the t-test analysis it was found by the researcher that project method was significantly more powerful than lecture cum demonstration method to enhance performance in chemistry practical and lecture cum demo method facilitate better performance than inquiry method.

Vickneasvari and Krishnasamy (2007) examined the effects of a multimedia constructivist environment on Form Four students' achievement and motivation in the learning of "Chemical Formulae and Equations". Multimedia Constructivist Instruction (MCI) and Multimedia Objectivist Instruction (MOI) courseware were developed. The MCI was assigned to 80 students whereas the MOI was assigned to 89 students. Students' ability levels (high-ability, HA or low-ability, LA), cognitive styles (field-independent, FI or field-dependent, FD) and gender were the moderator variables. The study found that, the MCI

students performed significantly better and were significantly more motivated than the MOI students. Whereas the HA students performed significantly better and were significantly more motivated than the LA students. The FI students did not perform significantly better but were significantly more motivated than the FD students. The male students did not perform significantly better but were significantly more motivated than the female students. HA students performed significantly better and were significantly more motivated than the LA students in MCI. Whereas the HA students using MCI performed significantly better but were not significantly more motivated than the HA students using MOI. The LA students using MCI did not perform significantly better but were significantly more motivated than the LA students using MOI. The FI students performed significantly better and were significantly more motivated than the FD students in MCI. The FI students using MCI performed significantly better but were not significantly more motivated than the FI students using MOI, and the FD students using MCI did not perform significantly better but were significantly more motivated than the FD students using MOI, whereas the male students did not perform significantly better but were significantly more motivated than the female students in MCI. The male students using MCI performed significantly better but were not significantly more motivated than the male students using MOI, and the female students using MCI also performed significantly better but were not significantly more motivated than the female students using MOI. Thestudy found that multimedia constructivist environment fostered the learning of "Chemical Formulae and Equations".

Sreelekha and Nayar (2008) studied the effectiveness of concept attainment model in Learning Chemistry at Secondary Level. The experimental group scored a significantly higher mean post-test score (33.3) when compared to the mean post-test score of control group (27.9). The significant t-value (4.12) revealed that the CAM was effective in improving the over-all level of achievement in Chemistry of the students. Users differed in the amount of concept map training they received and the type of learner they tended to be (meaningful vs. rote learners).

Oguz (2008) did a study to find out the effects of active learning methods based on Constructivist Approach on the prospective teachers' Achievements, Attitudes towards the Subject matter and Perceptions about the learning process. Pretest posttest two group experimental design and qualitative research method were used. Experimental group was subjected to Constructivist Learning Process and control group was subjected to Traditional Learning Approach. Sample of the study consisted of 43 sophomores at Dumlupinar

University Education Faculty. On the basis of results, it was found that achievement mean score of experimental was better that that of control group and also significant difference was seen between both the groups. In the case of attitude, no significant difference was found in the attitude of both groups. From the findings, it can be interpreted that Constructivist learning activities enable the students more successful and develop positive perception.

Aydin and Yilmaz (2010) determined the effectiveness of Constructivist Approach on students' Higher Order Cognitive Skills, students' Attitude towards Science Education and on gender differences of students' understanding the acid-base concept. Sample of the study was 300 students of eighth class. Pretest posttest two group design was used. Experimental group was treated according to 5E learning and control group through Traditional method of teaching. Acid-Base Knowledge Test, Science Process Skill Test and Logical Thinking Skill Test were administered before commencement of the experiment. The Acid-Base Achievement Test and Attitude Scale towards Science Education were applied as pretest and posttest. Result of the study implied that 5E learning model of Constructivist Approach was more effective in acquiring Higher Order Cognitive Skills and enhance positive Attitude towards Science.

Charif (2010) intended to determine the impact of Problem Based Learning (PBL) on students' Performance and Attitude towards Chemistry. The seeker of the problem used pretest posttest experimental-control group design. Sample of the study included seventh grade students of private school in Lebanon. Chemistry Achievement Test and Attitude Questionnaire were given to collect data which was analysed using mean, standard deviation, t-test. PBL used to teach research group, on the other hand conventional method was applied on control group. Findings presented that implementing PBL Approach improves Achievement and Attitude.

Tang, Zain and Abdullah (2010) developed educational software for learning organic reactions using qualitative reasoning. This paper discussed the development techniques, simulation results, and student evaluation of a software tool that aimed to help chemistry students learn organic processes through the study of causal theories in a chemical system. The simulation technique used is qualitative reasoning that emphasized the importance of conceptual knowledge and causal theories in education. The results showed that the tool is effective in terms of its ability to promote student's understanding of organic reactions

through the inspection of the explanations generated by the software, where students are seen as the recipients of knowledge delivered via the "explanation" pedagogy.

Festus and Ekpete (2012) tried to investigate the influence of PBST on students' Performance and Attitude towards Chemistry. The researcher has employed two groups: pretest - posttest research design in the study. To fulfill the purpose of the study, researcher selected 98 students of age range 14-16 from two senior secondary public schools in Obio. The researcher did not choose any method to make the groups instead of it he converted two sections; one into experimental group and other one in control group. It was seen by the researcher after intervention that Problem Based Solving Technique of instructions is capable of changing student's performance and Attitude towards Chemistry.

Richard et al. (2015) determined the effect of Constructivist Teaching Approach on students' Achievement in Chemistry. The purpose of this study was to determine the effects of Constructivist Teaching Approach (CTA) on students' Achievement in Chemistry. Quasi-experimental method of research and Solomon-Four Non-Equivalent Control Group Research Design was used. The sample comprised 160 students from co-educational secondary school in Baringo North Sub-County through purposive sampling. Chemistry topic of "Structure and Bonding" was taught using Constructivist Approach in experimental group while conventional teaching method was used in the control groups. The researcher trained the Chemistry teachers in the experimental groups on the technique of CTA before the treatment. The experimental groups were treated with the Constructivist Teaching Approach (CTA) for three weeks. Data was analyzed using t-test, ANOVA and ANCOVA. The results of the study exhibited that the Constructivist Teaching Approach significantly improved students' Achievement in Chemistry. The results of this study may be of significance for Chemistry teachers, teacher trainers and curriculum developers in improving the teaching-learning process and achievement in Chemistry.

2.8 Methodological Implications of RRL

The overview of the researches reviewed related to Constructivist learning strategies and Achievement in Chemistry. Researches have shown that using Social Constructivist Strategies has a great effect on students' achievements. Related literature has supported the researcher at every stage of research work and in the current study the researcher took help from the related researches in many ways:

Statement of the proposed study first stage of a research study are to identify a research problem and presented it in front of experts and it is necessary to clear the purpose of the research statement leads to hypotheses formulation. In this reference, the review of related studies is beneficial for the researcher to clear all the things before conducting research. There are several strategies related to the constructivist approach and used to examine its effectiveness in previous researches like 5 E's learning by Karsli and Ayas (2014) and Elvan Akar (2005), Cooperative learning by Kulshrestha and Mehta (2012), and Tandel and Gordiya (2012), Problem Based learning by Festus Ekepte (2012) and Kulshrestha and Arora (2011), Inquiry-based learning by Acar and Tarhan (2011) and many other studies.

The researcher has selected 5 E's learning model of constructivist approach for the study. Researcher developed 5 E's learning lesson plans with the help of these researches studies, blogs and articles such as Tonny Harringtone (2014), Gautam and Kulshrestha (2012), Cheska Lorena (2009), Reata Breidi (2008), Ertug Evrekll (2008) and Elvan Akar (2005), etc. and approaches like (i) cooperative learning by Ponnusamy and Sudarsan (2005), William L. Anderson, et.al., (2005), SatyaPrakash, C.V. and Patnaik, S.P. (2006), Palalvi Kaul (2010), Mehta and Kulshrestha (2012) etc., (ii) concept map by Pandey (1999), Chang, Sung and Chen (2002), Snead and Young (2003), Manjula P. Rao (2003), Brown (2003), Kharatmal (2009) Awofala (2011), Dammani (2012), Sharma (2012), Sharma, Harsana, and Sharma (2013) Luchembe, Chinyama and Jumbe (2014), Singh and Moono (2015), Gawade and Patankar (2016), Appoji and Shailaja (2017), Ghorai and Guha (2018), Pandey (2019) etc., and (iii) collaborative learning by Revathi (2015), Sulaiman and Shahrill (2015), Laal, Naseri, Laal and Kermanshahic (2013), Brown (2009) Gokhale (1995), Laal (2015), Terenzini, Cabrera, Colbeck, Parente and Bjorklund (2013), Haugwitz, Nesbit and Sandmann (2010), Hong (2010), Kirschner, Paas, Kirschner and Janssen (2011), Nevgi, Virtanen and Niemi (2006), etc., and (iv) problem solving by Sow, K. (2006), Arora and Kulshrestha (2011), Erdal Bay, Birsen Bagceci and Bayram Cetin (2012) etc.

The literature review gives an idea about properly defined each variable before framing the objectives of the study. Therefore, the researcher defined the variables e.g. Constructivist approach, Academic Achievement, and reactions towards Chemistry learning after reviewing the previous researches thoroughly. Researches that could help the researcher in this way are Bodner (1986), Gonczi, (1994), and Allport (1935).

Deciding the purpose of the research, the researcher has chosen the appropriate research methodology. Previously conducted researches have adopted survey, correlational (achievement) and comparative study (for gender, grade, and schools) and experimental method (measure the effectiveness) as well as historical method (qualitative). From the review, decided to use a quasi-experimental method in the present study. The experimental method follows various designs according to the groups involved in the study. The researcher searched out the books (Koul 2010 and Kothari 2008), theses (Kulshrestha and Gautam 2012, Akar 2003), research projects (Bharucha, 2010). Thus, Quasi-experimental: pre-test – post-test two-group research design was used in this study.

In the previous studies, the sample size varied (40-80) according to the experimental research method of the study. Since the researcher opted experimental method and the studies aimed to find out the effect. Researcher developed constructivist strategy in Chemistry theory for intervention. Duration of Intervention in the previous studies varies from 10 days to 60 days (1hr to 3hrs per day) based on the purpose of research work. These studies supported in deciding period of intervention which is kept 60 days for one hour each day in the experimental group and control group taught regular traditional method.

Based on the objective of the research work, Chemistry Achievement tests were developed by the researcher. On reviewing the previous researches conducted regarding Reaction scale towards Constructivist learning chemistry such as Agnihotri (2010), Xiaoying Xu (2010), Cheung (2009), Richard, et al., (2001), Geban et al., (1994). But these were varied from the purpose of present research in many ways i.e. standard of students, the culture of test, and norms of the test. Therefore, taking help from these scales, the researcher decided to construct the reaction scale towards constructivist learning Chemistry for XI class students for Indian context in Questionnaire foam.

Overall related literature employed Descriptive (Mean, Standard deviation) as well as inferential statistical techniques (t-test, Mann Whitney U-test, ANCOVA, ANOVA, correlation, multivariate analysis). Similarly, the researcher of the present study adopted Mean SD and Mann-Whitney U-test for analysing the data.