A study on Effectiveness of Constructivist Strategy on Achievement in Chemistry among Higher Secondary School Students

A
Synopsis
Submitted to
The Maharaja Sayajirao University of Baroda
for the Requirement
of the Degree of
DOCTOR OF PHILOSOPHY

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Declaration

I, Ashok Nakum, registered as a research student, bearing registration no. FOEDU/228 for Doctoral Programme under Department of Education, Faculty of Education and Psychology, The M. S. University of Baroda do hereby declare that I have completed the pre-synopsis seminar, course work and research work.

I do hereby declare that the thesis is submitted in original and is the outcome of the independent research carried out by me and contain no plagiarism. The research is leading to new facts. This work has not been submitted to any other university or body in quest of a degree, diploma or any other kind of academic award.

I do hereby further declare that the scale, diagrams of any other material taken from other sources (including but not limited to books, journals, web) have been acknowledged, referred and cited to the best of my knowledge and understanding.

Date: 06-01-2021
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1.1 Introduction

Constructivism entered mainstream educational thought and research in the 1970s by Piaget and Vygotsky (Windschitl, 2002). Constructivism forms one of the major theories developed, arising from the work of Jean Piaget's theory of cognitive development. Piaget's stage theory also became known as constructivism, because he believed children needed to construct an understanding of the world for themselves. Piaget's theory saw children as an active learner rather than being passive recipients.

Constructivism is a theory of knowledge that argues that humans generate knowledge and meaning from an interaction between their experiences and their ideas. During infancy, it is an interaction between their experiences and their reflexes or behaviour-patterns. Piaget called these systems of knowledge schemata. Piaget asserts that learning occurs by an active construction of meaning, rather than by passive recipient. He explains that when a learner, encounters an experience or a situation that conflicts with his current way of thinking, a state of disequilibrium or imbalance is created. He must then alter his thinking to restore the equilibrium or balance. To do this, he makes sense of the new information by associating it with what he already knows, that is, by attempting to assimilate it into his existing knowledge. When he is unable to do this, he accommodates the new information to his old way of thinking by restructuring his present knowledge to a higher level of thinking.

Constructivism is a learning theory based on the notion that people are “active” knowledge seekers powered by innate curiosity (Sunal and Hass, 2002). The idea that knowledge is not transmitted from teacher to student but actively constructed by each student or group of students is central to constructivism.

Social Constructivism emphasizes how meaning and understanding grow out of social encounters. Vygotsky’s Social Constructivism suggests that knowledge is not solely constructed within the mind of the individual; rather, interactions within a social context involve learners in sharing, constructing, and reconstructing their ideas and beliefs. The social interactions provide the necessary language skills and understanding of cultural norms that facilitate learning through the use of tools available. Thus, social interactions with the teacher and other students become a significant part of the learning process. Social Constructivism can be enhanced through the social involvement of students in various

situations. Social Constructivist classes reveal a shift in thinking in which the basic assumptions about what knowledge is, about how people learn, and about what is important.

Johnson and Johnson et.al. (1991) proposed five elements that are essential for increasing the likelihood of success of the co-operative learning endeavour.

- Positive Interdependence
- Individual and Group Accountability
- Group Processing
- Face to face interaction

The following Four Vygotskian principles are to be applied in a Social Constructivist class rooms with Constructivist 5E's (i.e. engage, explore, explain, evaluate and extend) Model:

1. Learning and development is a social collaborative activity.
2. The Zone of Proximal Development can serve as a guide for curriculum and lesson planning.
3. School learning should occur in a meaningful context and not be separated from learning and knowledge children develop in the "real world".
4. Out of school experience should be related to the child's school experience.

The 5E's Model

Engage: Pique students' interest and get them personally involved in the lesson while pre-assessing prior understanding. Students are introduced to the instructional task during the engage stage. They make connections between past and present learning experiences and think about what they will learn during the upcoming activities. Activities are designed to engage students. Through activities and experiments, the lesson plans stimulate students' curiosity and encourage them to ask their own questions.

Exploration: Get students involved in the topic so that they can develop their own understanding. Exploration experiences provide students activities that help them to identify and improve upon misconceptions if any, processes and skills. Learners have hands-on fun in lab activities that help them to use prior knowledge to generate new ideas, explore questions and possibilities, and design and conduct a preliminary investigation. The teacher acts as a facilitator, providing materials and guiding the students' focus.

Explain: Provide students with an opportunity to communicate what they have learned and figure out what it means. During the Explain stage, students begin to communicate what they have learned by demonstrating their conceptual understanding, process skills or behaviors. Students share ideas with each other and with their teacher, who provides an explanation of the content that is meant to guide them toward a deeper understanding.

Elaboration: Allow students to use their new knowledge and continue to develop a deeper and broader understanding. During the Elaboration stage, students expand on the concepts they have learned, make connections to other related concepts and apply their understandings to the world around them through additional activities. Teachers extend students' conceptual understanding and skills.

Evaluation: Assess how much learning has taken place. The Evaluation phase helps students and teachers assess how much learning and understanding has taken place. It allows teachers to evaluate students' progress towards achieving the educational objectives. Evaluation can occur at any point during the instructional process.

1.2 **Social Constructivist Strategies**

The Social constructivist classroom is an environment where students build or construct their own knowledge. Many activities are hands-on and involve building on the work of others. Various strategies of social constructivism and provide social environment for children to construct their knowledge are:

Cooperative Learning: Cooperative Learning framework used for classroom activities is based on Social Constructivism. In cooperative learning, the focus moves from teacher centered to student-centered education. Instead of sitting in a lecture or reading text, students are given a task or problem and are asked to identify a possible solution on their own and with the help of others. Rather than disseminating information directly, the teacher guides students to the source of the information they may require. Cooperative Learning theory recognizes the importance of the student's existing knowledge and puts that knowledge to work.

Collaborative Learning: In a Vygotskian classroom, learning is promoted through collaboration - collaboration among students, and between students and teacher. From a social constructivist perspective as students share background knowledge and participate in the give and take of collaborative and cooperative activities, they actually negotiate meaning.

They build knowledge, not as individuals, but as a group. People who surround the individual student, and the culture within which he lives, greatly affect the way he or she makes sense of the world. Srinivas (2017) explained Four Collaborative Learning Strategies are given below:

- **Think-Pair-Share**: this strategy followed tree steps: (1) The instructor poses a question, preferable one demanding analysis, evaluation, or synthesis, and gives students about a minute to think through an appropriate response. This "think-time" can be spent writing, also. (2) Students then turn to a partner and share their responses. (3) During the third step, student responses can be shared within a four-person learning team, within a larger group, or with an entire class during a follow-up discussion. The caliber of discussion is enhanced by this technique, and all students have an opportunity to learn by reflection and by verbalization.
- **Numbered Heads Together:** Members of learning teams, usually composed of four individuals, count off: 1, 2, 3, or 4. The instructor poses a question, usually factual in nature, but requiring some higher order thinking skills. Students discuss the question, making certain that every group member knows the agreed upon answer. The instructor calls a specific number and the team members originally designated that number during the count off respond as group spokespersons. Because no one knows which number the teacher will call, all team members have a vested interest in understanding the appropriate response. Again, students benefit from the verbalization, and the peer coaching helps both the high and the low achievers. Class time is usually better spent because less time is wasted on inappropriate responses and because all students become actively involved with the material

Concept mapping: Concept maps have their origin in the learning movement of constructivism. The technique of concept mapping was developed by Joseph D. Novak and his research team at Cornell University in the 1970s as a means of representing the emerging science knowledge of students. It has subsequently been used as a tool to increase meaningful learning in all subjects as well as to represent the expert knowledge of individuals and teams in education, government and business.

Four major categories of concept maps:

a. *Spider:* information systematically organized in a central theme or a concept map. Outwardly radiating sub-themes surround the center of the map.

b. *Hierarchical:* Presents information in a descending order of importance. The most important information is placed on the top. Distinguishing factors determine the placement of the information in the map.
c. *Flowchart:* information Organized in a linear format in the map.
d. *Systems:* Organizes information in a format which is similar to a flowchart with the addition of 'INPUTS' and 'OUTPUTS'.

Problem Solving: While problem solving accompanies the very beginning of human evolution, the nature of human problem solving processes and methods has been studied by psychologists over the past hundred years. Social psychologists have recently distinguished between independent and interdependent problem solving. In psychology, problem solving refers to a state of desire for reaching a definite 'goal' from a present condition that either is not directly moving toward the goal, is far from it, or needs more complex logic for finding a missing description of conditions or steps toward the goal. In psychology, problem solving is the concluding part of a larger process that also includes problem finding and problem shaping. Considered the most complex of all intellectual functions, problem solving has been defined as a higher-order cognitive process that requires the modulation and control of more routine or fundamental skills. Problem solving has two major domains: mathematical problem solving and personal problem solving where, in the second, some difficulty or barrier is encountered. Further problem solving occurs when moving from a given state to a desired goal state is needed for either living organisms or an artificial intelligence system. Review of the related Literature.

Problem-solving involves three basic functions:

1. Seeking information
2. Generating new knowledge
3. Making decisions

1.3 **Review of the related Literature (in brief)**

The researches reviewed related around to Social Constructivist Strategies (SCS) 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.

The literature review gives idea about defined each variable in proper manner before framing 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 Vickneasvari and Krishnasamy (2007), Jong Sukkin (2005), Appoji and Shailaja (2017), Gawade and Patankar (2016), Chawla and Singh (2015), Singh (2012), Rao (2003), Wendt (2013), Sow (2006), Brown (2003), Luchembe, Chinyama and Jumbe (2014), Chawla and Singh (2015). Hypotheses and delimitations of study while keeping the previous work in this area i.e. Sridevi (2006), Pachaurya (2008), Sood (2008) Thomas et al. (2014), Panigrahi and Tandel (2014), Ponnusamy and Sudarsan (2005), Revathi (2015), Pandey (1999), Sharma (2012), Gawade and Patankar (2016).

There are several strategies related to constructivist approach and used to examine its effectiveness in previous researches. The researcher has selected 5 E's learning model of constructivist approach in accordance to the purpose of study. Researcher developed 5 E's learning lesson plans with the help of these researches studies, blogs and articles like 5 E's learning by Ajaja (2013), Madu and Ezeamagu (2013), Panigrahi and Tandel (2014), Chowdhury (2016), Siddiqui (2016), Aydin and Yilmaz (2010) and many other studies. Developed more specific lesson plan with 5E's learning model using approaches like (i) cooperative learning by Mehta and Kulshrestha (2012), Kaul (2010), Mehra (2008), etc., (ii) concept map by Pandey (2019), Ghorai and Guha (2018), Appoji and Shailaja (2017), Gawade and Patankar (2016), Chawla and Singh (2015), Sharma, Harsana, and Sharma (2013), 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), Yau, Gupta and Karim (2003) Haugwitz, Nesbit and Sandmann (2010) etc., and (iv) problem solving by Sow (2006), Arora and Kulshrestha (2011), Erdal Bay, Birsen Bagceci and Bayram Cetin (2012) etc.

From review, decided to use quasi-experimental method in the present study. Two group Quasi-Experimental research: Pretest-Posttest design was used in this study. The researcher used only 76 students (42 students for control group and 34 students for experimental group) as a sample for the study and can be managed in Chemistry theory for intervention time period of intervention which is kept 60 days for one hour daily in experimental group and control group taught regular traditional method.

1.4 **Rationale and significance of the study**

Today's age is the age of Chemistry. Right from cradle to grave most of activities are controlled and fashioned by Chemistry. Chemistry is important in everyone's life whether one knows it or not but is directly affected by it. The purpose of Chemistry education is to develop scientific literacy which helps them to be interested in, and understand the world around them, to engage in the discourses about Chemistry, to be able to identify questions and draw evidence-based conclusions, and to make informed decisions about the environment and their own health and well-being. This being the situation it becomes very important that all the school Students not only be aware about the basic concepts of Chemistry but possess thorough understanding of concepts, principles, facts and theories of Chemistry. The school days are the foundation for further study and therefore vigorous methods and approaches for cultivation and promotion of Chemistry should be adopted.

It is observed that the students performed poorly in questions testing understanding or application of knowledge to new situation and majority of students were unable to answer questions that appear to be different from what they typically encountered in their books. NCF (2005) comments that it is harsh reality that children's voices, their experiences hardly find place in the classroom. Often the voice heard is that of the teacher and even when students speak that is only to respond to the question raised by teacher or repeating teachers' words. Students are rarely given opportunities to do things nor do they have opportunities to take the initiative.

The same is supported in the study by Umashree (1999), where in it was found that of classroom observation of 240 lessons in secondary science in 185 cases (77%) the lesson was introduced by simply writing the topic on the blackboard and recounting the previous days' lesson. Eighty percentage of the classes observed revealed the fact that the students participated only as a passive listener. The student participation if any was limited to seeking clarification on the teaching point. The teachers also felt that when it comes to examination, the students are expected to reproduce some sections of scientific information contained in the textbook, and hence they did not see the essentiality of conducting discussion sessions or participatory sessions.

Ravula (2013) found that most of the secondary teachers of social science working in both private and government schools are focusing more on completing the syllabus in time by

presenting the content to the learners rather than giving importance to the students in learning the concepts. Even Malhotra (2006) holds similar views stating that “Teachers often provide lecture and students largely observe the teacher rather than actively participating in the classroom.”

In January 1998, the National Science Teachers Association (NSTA) adopted its position statement, the National Science Education Standards (NSES): a vision for the improvement of science teaching and learning. In that statement, the NSTA strongly supports NSES by asserting teachers regardless of grade level should promote inquiry based instruction and provide classroom environments and experiences that facilitate professional development activities should involve students' learning in science.... Teachers in the learning science and pedagogy through inquiry.... and inquiry should be viewed as an instructional outcome (knowing and doing) for students to achieve in addition to its use as a pedagogical approach. In other words, both elementary and secondary' school science teachers must, develop teaching competencies and strategies for providing inquiry base investigations for students. Educational curricula and teaching methods are changing continuously. The focus of instruction is from the transmission curriculum to a transactional curriculum. In a transactional curriculum, students are actively involved in their learning to reach new understandings. Constructivist teaching fosters critical thinking and creates active and motivated learners. A constructivist approach can be used to create learners who are autonomous, inquisitive thinkers and investigators.

There is a great need for research into the dimensions of the instructional and nurturing effects of various types of instructional practices in chemistry education today. Competence in teaching stems from the capacity to reach out to differing Students and to create a rich and multi-dimensional environment for them. This demands that we widen our experience with different models of instruction in various classroom settings. Chemistry education researchers also should make an attempt to know exactly what changes in knowledge occur as a result of instruction. Chemistry education research, thus, should direct its attention to improve the existing procedures of chemistry instruction and to establish new and verified procedures for teaching chemistry. Also the reviewed studies revealed that the constructivist pedagogy provides opportunities for students to construct relevance of content by relating new learning to students' personal experience and prior knowledge. So the investigator has decided to apply constructivist strategy to the teaching of chemistry subject.

1.5 **Statement of the Problem**

A study on Effectiveness of Constructivist strategy on achievement in Chemistry among higher secondary school students.

1.6 **Objectives of the Study**

1) To develop strategies based on constructivist learning for teaching of Chemistry in Standard XI.

2) To study the effectiveness of the strategies based on constructivist learning in Chemistry for Standard XI students in terms of their academic achievement.

3) To study the reaction of students to the strategy based on constructivist learning in Chemistry.

1.7 **Hypotheses of the Study**

In pursuance of the objectives of the study the following null hypotheses were formulated:

H01 There is no significant difference in Pre Achievement test mean scores of Experimental and Control Groups.

H02 There is no significant difference in chapter wise Achievements tests mean scores of Experimental and Control Groups.

H03 There is no significant difference in post-test Achievement mean scores of experimental and control groups.

H04 There is no significant relation in terms of previous standard (X) chemistry knowledge and standard XI Chemistry concepts of experimental and control groups.

1.8 **Variable of the Study**

Table 1: Names of types and variables

Sr. no.	Types of variable	Name of variable
1.	Independent variable	Constructivist Learning Strategy
2.	Independent variable	Traditional Teaching Method
3.	Independent variable	Previous standard chemistry Knowledge
4.	Dependant variable	Achievement
5.	Dependant variable	Reaction of Students

1.9 **Explanation and Operationalization of the terms**

Explanation of the terms

- ***Treatment:*** Treatment refers to the strategies of teaching which were adapted to teach Chemistry to the eleven standard students. The treatment will include teaching of Chemistry through Social Constructivist Strategies.
- ***Traditional Method of Teaching (TMT):*** Traditional method of teaching is teacher-centered in which teacher imparts knowledge and students simply receive it. In this environment, information is taught to the class in the form of chalk and talk and lecture, making use of learning aids. After teaching there may or may not be the scope for interaction. More emphasis is given to rote memory of the content matter rather than the thinking process.

Operationalization of the terms

- ***Social Constructivist Strategies (SCS):*** In this study Strategies of teaching chemistry which allow the student to construct their own knowledge while working in groups/individual and those which adopted Social constructivist principles, 5E model and constructivist approaches (Cooperative Learning, Collaborative Learning, Concept Mapping and Problem Solving) and instructional material, activity, etc. These strategies were used to facilitate investigator in terms of the learning of the students along with the lesson plan.
- ***Achievement in chemistry:*** Achievement in Chemistry in the present study were the total scores obtained by the students on item representing knowledge, understanding, application and skills in the Chemistry Achievement test constructed by the researcher.

1.10 **Delimitation of the Problem**

The study has the following delimitation:

- The present study was delimited to standard XI of Gujarati Medium Schools of Anand city affiliated to Gujarat Secondary and Higher Education Board.
- The present study was delimited to academic achievement only in Chemistry of standard XI in Gujarati Medium School.

- The present study was delimited to four Units in Chemistry textbook of Standard XI of the year 2019-2020. (i. e. *Unit: 4 Chemical Bonding and Molecular Structure, Unit: 7 equilibriums, Unit:13 hydrocarbon and Unit:14 Environmental chemistry*)

1.11 Research design

In the present study Non-Randomized the researcher decided to use two groups (purposive sample) Pre-test post-test design. The design of the study is presented as below:

$$\mathbf{O_1 \quad X \quad O_2}$$
$$\mathbf{O_3 \quad C \quad O_4}$$

Where,

O_1 and O_3 = Pre-test,

O_2 and O_4 = Post-test

X = Experimental group (Constructivist Strategies)

C = Control group (Traditional Strategy)

1.12 Population

The study was carried out in Anand district in the state of Gujarat. There are 73 Gujarati medium schools with higher secondary classes in Anand district following Gujarat State Board Syllabus (as per Anand DEO Office record, 2019). All higher secondary classes students of Anand district formed the population of the study.

1.13 Sample

In the presently study, samples were selected by 'Purposive Sampling Technique'. As the researcher decided to work at the higher secondary level of school, he has to select the sample from standard eleven to Twelve. The investigator selected the students of standard eleven from the sample science stream schools. The reasons behind the selection of sample for the research work are as follows:

1) The Experimental sample school must have permitted to use chemistry laboratory, class and ICT technology conveniently for research work.
2) Primary and secondary level school students may not to understand chemistry subject learning as a discipline through Constructivist strategy and it can be difficult to gather them at the place of learning strategy manipulation for 60+ days constantly. The

parents of this level of students may not permit them to attend the program at the place, other than their school.

3) From higher secondary level, the researcher decided to select standard eleven, because standard nine is an entrance of secondary level and mind-set of the students of standard nine may be of the primary level. Hence, the researcher stratified the sample on the base of the 'standard of education'.

As the present study was experimental one, the researcher had decided to select two schools from the population. The researcher selected purposive sampling technique in the selection of school. Gujarati medium schools with Higher Secondary classes and following Gujarat State Board Syllabus, Schools were ready to provide facilities for implementing the developed Constructivist learning strategy. Two schools of Vallabh VidyaNagar city were purposefully selected for the present study: (1) BAPS Swaminarayan Vidyamandir and (2) R.P.T.P. Higher Secondary Science stream School for the experiment group and Control group respectively. All students in the class were included. There were thirty-six students in experimental group and forty-two in control group.

1.14 Tools for Data collection

The following tools were constructed and used for the data collection: In this case study the researcher has used more than one tool.

1) **Achievement Tests:** The Investigator were constructed Achievement tests which are:

   a) ***Achievement test 1*:** The Investigator was constructed the pre-test based on the selected chapters of Chemistry in standards X. The test was total 50 marks having different test items like supplying M.C.Q. and Subjective short/long answer questions with appropriate weight age.

   b) ***Achievement test (2-5)*:** In the present study, Unit wise evaluation was an integral part of the teaching learning process. Achievement tests (2-5) are administered at the end of a chapter served main purposes, such as to find out how much the Students have not learned in the specific chapter. The test was if total 30 marks having different test items like supplying M.C.Q. and Subjective short/long answer questions with appropriate weight age.

c) ***Achievement test 6:*** The Investigator was constructing the post-test basses on the selected chapters of Chemistry in standard XI. The test was if total 50 marks having different test items like supplying M.C.Q. and Subjective short/long answer questions with appropriate weight age.

2) **Reaction Scale (RS):** A Reaction Scale was constructed in order to know the reaction of students towards Social Constructivist Strategies for teaching chemistry. The researcher selected items statements to collect the opinion of students regarding the method used for teaching, the classroom environment and evaluation techniques adopted relationship between the teacher and the students and among the students, daily assignments. The Reaction Scale was checked for the content validity by the guide, experts and Chemistry teachers. Some items were modified based on the suggestions of the experts. Reaction Scale towards Social Constructivist Strategies of Teaching is a Likert scale with response: Strongly disagree, Disagree, Neutral, Agree, and Strongly Agree.

The tools were sent to the experts to examine it in terms of: 1. The instruction part given for each question. 2. The coherence between instruction and the item. 3. The language used for the preparation of items.

1.15 Conducting the Experiment/Intervention and Data Collection

Phase-I **(Development of Instructional Strategy and Tools):** Development and validation of Social Constructivist strategies for teaching Chemistry to the experimental group, achievement tests and reaction scale.

Table 2: Instructional Strategy and activity

Sr. no.	Contain/ topics	Constructivist Strategy	Activity	Example
1	Chemical bonding and molecular structure	Cooperative	Demonstration Atomic-Model Showing, students will prepare ball and stick model for selected molecules and followed by discussion	Geometrical structure of molecules, polar and non-polar bond
2	Hydrocarbon	Concept map	Concept Map	Alkane alkene and alkyne compound
3	Equilibrium	Problem solving	Maths number line with ball and stick model demonstration and problem discussion	Acid base reaction and ionisation
4	Environmental chemistry	Cooperative and Collaborative	Peer Presentations and discussion	Global warming, acid rain, ozone layers deduction, water pollution

***Phase-II* (Implementation):**

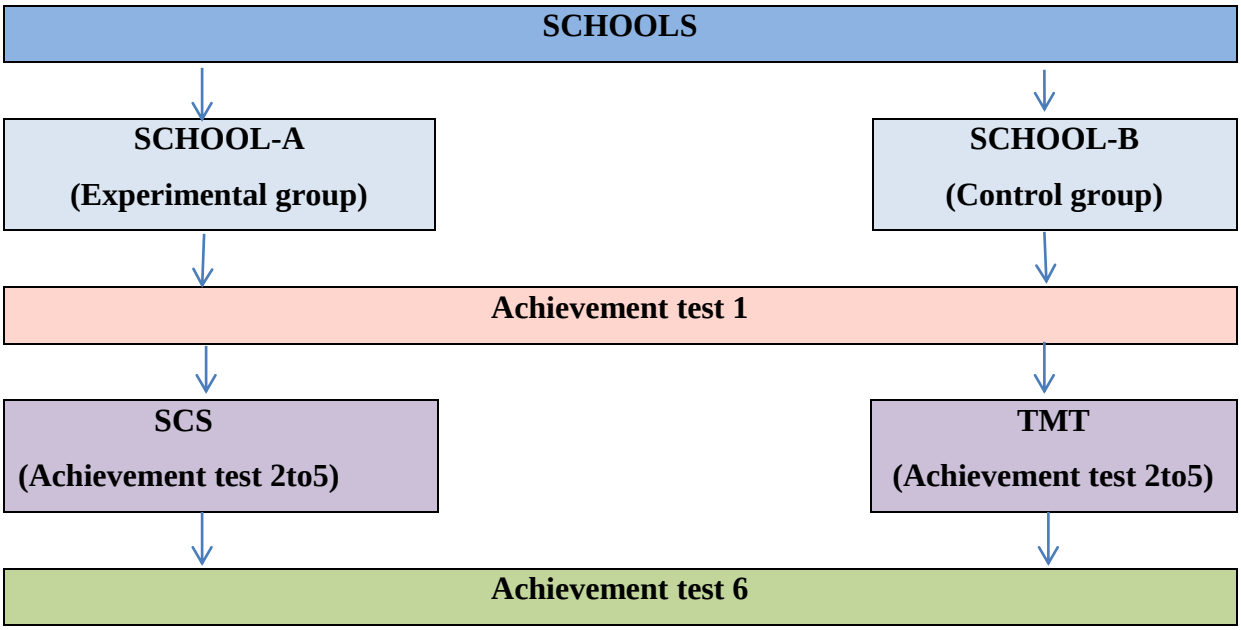

Figure 1: Implementation of SCS to the case group in school.

First, Achievement test 1 was administered for knowing students' previous knowledge about Chemistry (selected chapters). Then Achievement test 2-5 as Achievement test. Then give treatment of constructivist teaching-learning strategy. Then the respective 4 Units (Unit1 - Chemical Bonding and Molecular Structure, Unit4 – equilibrium, Unit6 – hydrocarbon and Unit7 - Environmental chemistry) in chemistry were taught to the experimental group using the strategies. Here, the lesson plans for teaching selected content of chemistry based on SCS for eleven standard syllabuses were developed. The lesson plans were given to experts in the field of Education for scrutiny and the suggestions of experts were incorporated. These lessons were tried out and changes were made to suit the classroom conditions. Achievement test were taken after each completion of a Unit. Then implement achievement test 6 as post-test in both groups. And, researcher was implemented reaction scale for collecting reactions of students towards constructivist strategy in experimental group.

The data was collected in the form of

- Pre-test scores for achievement in previous standard chemistry.
- Achievement test scores in terms of individual Units.
- Post test scores in chemistry.
- Questionnaire for students' reactions toward learning strategy.

1.16 Analysis of the Data

To achieve Objectives of the study, the data collected was statically analysed using the following technique.

- Descriptive statistics such as mean and SD were worked out on the score of Achievement in Chemistry.
- Inferential statistics: Mann Whitney U test employed for testing the significance of difference between the means of students' achievement in chemistry with respect to certain variable undertaken for study.
- Frequency and per cent was worked out for studying the reaction of students in experimental group towards Constructivist strategy.

Online statistics Calculator was used for statistical calculation and MS Excel software was used for preparation and Comparison of charts and tables.

1.17 Major Findings of the Study

- There is a significant difference in achievement between the pre-test and post-test in the experimental group.
- The constructivist learning strategies enhanced achievement in Chemistry of eleventh standard students.
- Students showed more favoured reaction towards Constructivist learning strategies.

1.18 Discussion

This section is devoted to discussion of the findings of the present study.

1. Peer group learning and Active participation in the constructivist classroom

The present study shows that the Reactions of students exposed to Constructivist learning strategies are active participation in group learning. It reveals that Constructivist learning strategy is effective for teaching Chemistry to students. Results of the studies of Gawade and Patankar (2016), Sharma, Harsana and Sharma (2013), Ching and Chi-Yao Ni (2012), Qurarch (2010), Asan (2007) and Rao (2004) lend support to the findings of the present study. Gawade and Patankar (2016) and other researchers found that concept mapping is an effective strategy for peer group in Chemistry learning. Sharma, Harsana and Sharma (2013), Ching and Chi-Yao Ni (2012), Qurarch (2010), Asan (2007) and Rao (2004) found that Peer

group learning and Active participation through Constructivist learning strategy in Sciences. In the Reaction scale tool Item numbers 9, 11, 14, 19, 32, 33 and 34 results shows student's reaction that students learning concepts of Chemistry Peer group, and also item numbers 5, 6, 7, 8, 14, 16, 17, 18, 19, 32 and 33 results shows student's reaction that student actively participated in Chemistry learning.

2. Achievement of Students through constructivist learning strategy.

Achievement tests (2-5) shows that cooperative, collaborative, problem solving and concept map are the different constructivist strategy shows better learning environment and motivation in students. Result exposed cooperative learning strategy are greater than mean score of achievement test-2 of learning by traditional method, and problem solving strategy are greater than mean score of achievement test-3 of learning by traditional method, concept mapping strategy are greater than mean score of achievement test-4 of learning by traditional method, cooperative learning and collaborative learning strategy are greater than mean score of achievement test-5 of learning by traditional method. In the Reaction scale tool Item numbers 2, 15, 16, 22, 23, 24, 25 and 34 results shows student's reaction that students easily understand concepts of Chemistry, and also item numbers 1, 3, 4, 10, 12, 13, 18, 21 and 22 shows that student taking interest in Chemistry learning. So that final post-test mean scores of students exposed to Constructivist learning strategy are greater than mean achievement tests-6 scores of control group. The literature reviews Vickneasvari and Krishnasamy (2007), Jong Sukkin (2005), Appoji and Shailaja (2017), Gawade and Patankar (2016), Chawla and Singh (2015), Singh (2012), Rao (2003), Wendt (2013), Sow (2006), Brown (2003), Luchembe, Chinyama and Jumbe (2014), Chawla and Singh (2015) supported in academic achievement and interest in Chemistry as subject.

3. Effect of four different strategies

In the present study researcher have taken four different chapters for content and also used different constructivist strategy for teaching learning of chemistry. All these strategy independent but all strategies follow constructivist 5E's model based on literature review. Chemical bonding and molecular structure, Equilibrium chemistry, Hydrocarbon and environmental chemistry are taken chapters used with 5E's model with different constructivist strategies like Cooperative learning, Problem Solving, Concept map, Collaborative and Cooperative learning strategies respectively. Achievement tests (2-5) mean

scores and Mann Whitney U-test results are shows that all learning strategies effectiveness more than traditional method.

4. Indian classroom learning and constructivist learning

In the Indian classroom setup, students are seated in one rectangular room, black board sticks on one of the walls. Teacher use lecture method for teaching. And student learns as passive receptor. But in the constructivist classroom setup, students have does activities and learn through his/her own way, conceptual development through activity or peer teaching and learning. Constructivist classroom learning process is different from regular traditional classroom setup. The Constructivist environment also play its role because under cooperation, collaboration, problem solving and concept map, the students are sharing ideas and conceptual knowledge, discussing on given information, interacting is very important for which our students are not well versed. This shows that Constructivist classrooms provide enough opportunities for active participation in learning process to students to interact and learn. It helps to acquire the skills that are more suitable to the students to work in a group. Whereas traditional classroom are more confined to their activities and hardly scope for speak-out in classroom and sharing their ideas on particular concept, Constructivist classrooms fills that gap of active participation in learning and sharing.

It creates teaching-learning environment in the classroom wherein student during moments of interaction, ask doubts to each other and solve their queries with teacher and within peer group. Student and the facilitator both learn to appreciate the differences and strength. Students with low self-confidence are also actively engaged in learning through Constructivist learning. Intra group and Inter group interaction benefits them in the learning process. It also benefits the group of learners who restrict one's social relationship to few contacts to the extreme of those who wish to have relatively unrestricted, social contacts. However, it can be possible through constructivist strategies.

1.19 Educational Implications

The present research clearly shows that changing from a traditional competitive classroom to a constructivist learning classroom one does not diminish student achievement; it significantly improves achievement. In the present study, students were individually accountable for their academic performance and the group was also responsible for every group member's performance. Thus a positive effect on students' achievement in Chemistry

was found to suggest the usefulness of constructivist strategy for improving students' achievement.

Based on the researcher's observations from this study a few other implications are as follows:

- Constructivist strategy learning suggests a new role of teacher. A teacher, accustomed to being the sole source of information for teaching the passive learners in the classroom has to change to be a facilitator in the learning process to actively encourage the student to:
  - help each other and learn from each other
  - participate in discussions
  - facilitate each other's' learning
  - engage in problem solving in a free democratic way
- When student is not able to understand teacher's explanation, group members are able to explain in simpler words that are more easily understood. In this way, it improves student's perception about learning and decreases the feeling of alienation.
- Teacher educator should be given importance to train them for developing lesson plans for constructivist strategy and environment.
- Constructivist strategy should include games, recreational activities like solving puzzles and riddles, holding group discussions on some general topic related to current affairs to create more interest among students. Ultimately, the participants of constructivist strategy learning sessions or the members of the group begin to take control of their own learning.
- The topics in different subjects to be taught by constructivist strategy learning should be so decided that they should require use of skills that students feel capable of using to maximize their involvement in tasks.
- Important skills such as critical thinking, creative problem solving and the synthesis of knowledge can easily be accomplished through constructivist group activities in the inclusive classroom.

1.20 **Conclusion**

This study shows that constructivist strategy learning can enhance students' readiness to work with their peers. It reduces communication apprehension and increases development of

empathy and broader perspective to resolve an issue amicably. All this is done in the light of understanding the 5 E's model of constructivist strategy learning.

Group work can fail if we do not take into account the social interactions among Students and the competencies developed within the classroom context. A better understanding of their classroom culture leads to developing successful and without boundary constructivist strategy structures across syllabus and standards.

Interpretation of the results during this study show that the post-test achievement means scores of the experimental group and control group, equating them on the basis of their mean scores of Chemistry subjects, differ significantly in favour of the experimental group who were taught using constructivist strategy. Students of Standard XI benefitted significantly in achievement in Chemistry subject when taught using constructivist strategy.

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