

Chapter - 5

Summary, Findings, Discussion and Conclusion

5. Introduction

This part of the research deals with the main findings and discussion regarding data analysis and interpretation, and its primary aim is to find out the effectiveness of Constructivist Pedagogical Treatment. This chapter describes the crux of the entire research work carried out for the completion of the study precisely and concisely. This research created an opportunity for the researcher to study the effect of the Constructivist Approach on the Academic Achievement of Higher Secondary school students.

5.1 Rationale

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 health and well-being. Chemical bonding and molecular structure, Equilibrium, Hydrocarbon, and Environmental Chemistry are fundamental concepts in higher secondary school. This being the situation it becomes very important that all the school Students not only be aware of the basic concepts of Chemistry but possess a thorough understanding of concepts, principles, facts, and theories of Chemistry.

Research studies revealed that students hold misconceptions in chemistry. Some of the conceptual areas in which most studies have been conducted are chemical equilibrium (Sendur et al., 2010), acid-base (Kousathana et al., 2005), chemical bonding (Coll & Taylor, 2002; Ozmen, 2004), atomic orbital and hybridization (Nakiboglu, 2003), buffer solution (Orgil & Sutherland, 2008), solutions and their components (Çalık & Ayas, 2005; Pinarbasi & Canpolat, 2003), organic chemistry (Childs & Sheehan, 2009, Ratcliffe, 2002; Johnstone, 2006) and electrochemistry (Huddle & White, 2000). Jusniar, et al. (2020) found

misconceptions impact other concepts in chemical equilibrium. For example, “Catalyst accelerates the rate of reaction and activation energy (E^*) increases, the rate of reaction accelerates by adding Catalyst.” impacts the misconception that “Catalysts increase activation energy so that forward reaction is faster than reverse reaction.” The same misconceptions happen in chemical bonding, environmental and hydrocarbon, and other areas of chemistry, because of teaching method not able to provide understanding in depth.

The school days are the foundation for further study and therefore vigorous methods and approaches for the 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 a new situation and the 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 the harsh reality those children’s voices, their experiences hardly find a 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 a teacher or repeating teachers' words. Students are rarely given opportunities to do things nor do they have opportunities to take the initiative. 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.’ Ravula (2013) also found that most of the secondary teachers of social scientists 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.

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 one widen our experience with different models of instruction in various classroom settings. Chemistry education researchers also should 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 a constructivist strategy to the teaching of chemistry subject.

5.2 Reviews

The reviewed related researches on Social Constructivist Strategies and Achievement in Chemistry have been classified under the following sections:

- Studies related to initial studies of Constructivist learning
- Studies related to Constructivist learning with 5E's model
- Studies related to the Co-operative learning approach
- Studies related to the Collaborative learning approach
- Studies related to the problem-solving approach
- Studies related to use Concept map approach
- Studies related to Constructivist learning and Achievement in Chemistry

The overview of the researches reviewed related to Constructivist Strategies and Achievement in Chemistry crystallized some of the issues and observations that helped in framing hypotheses, selection of tools for collection of data, sampling techniques, adopting experimental design, and employing statistical techniques for analysis of data for the present study. Researchers have shown that using Constructivist Strategies has a great effect on students' achievement levels.

The overview of the related literature made clear that there are many research studies conducted on Constructivist teaching-learning in different school subjects. Apart from this, studies reviewed stressed that Constructivism is an epistemology that views of learning rather than teaching and knowledge cannot simply be transformed from teachers to students, it has to be conceived. Some studies reviewed emphasized the readiness of teachers, curriculum, and students for the success of Constructivist strategies. Reviews also enumerated the imported characteristics of the Constructivist approach. A drastic change can be deduced from the review for the role of the teacher in the Constructivist paradigm. Research support

for constructivist teaching-learning techniques has been mixed, with some research supporting these techniques and other research contradicting those results.

5.3 Statement of the Problem

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

5.4 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.

5.5 Hypotheses of the study

- Ho1 There is no significant difference in Pre Achievement test mean scores of Experimental and Control Groups.
- Ho2 There is no significant difference in chapter wise Achievements tests mean scores of Experimental and Control Groups.
- Ho3 There is no significant difference in post-test Achievement mean scores of experimental and control groups.
- Ho4 There is no significant relation in terms of previous standard (X) chemistry knowledge and standard XI Chemistry concepts of experimental and control groups.

5.6 Operationalisation and Explanations of the terms

Operationalisation of the terms

- **Treatment:** Treatment refers to the strategies of teaching which was adapted to teach Chemistry to the eleven standard students. The treatment will include the teaching of Chemistry through Social Constructivist Strategies.

Explanalisation of the terms

- **Social Constructivist Strategies (SCS):** In this study Strategies of teaching chemistry which allow the student to construct their knowledge while working in groups/individual and those which adopted Social Constructivist principles was used in this study: Cooperative Learning, Collaborative Learning, Concept Mapping, and Problem Solving.
- **Traditional Method of Teaching (TMT):** Traditional method of teaching is teacher-centered in which the 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.
- **Constructivist strategy:** Under the study constructivist strategy means to develop a set of knowledge-based on Constructivist strategy (using 5E model) in the subject of Chemistry with support of Instructional methods and material, activity, etc. This Constructivist strategy was used to facilitate by the investigator in terms of the learning of the students along with the lesson planning.
- **Achievement in chemistry:** Achievement in Chemistry in the present study was the total scores obtained by the students on items representing knowledge, understanding, application, and skills in the Chemistry Achievement test constructed by the researcher.

5.7 Delimitations of the study

1. Academic Achievement is delimited to Achievement in Chemistry.
2. 5E model of constructivist approach is considered to develop constructivist lesson plans in the present study.
3. The tool developed by the investigator was not standardized and only the validity and reliability were established.

5.8 Design of the study

In the present study Non-Randomized Two Groups non-equivalent Quasi-experimental: Pre-test Post-test design was used. In this study effectiveness of independent variable, method of teaching (two levels): (1) Constructivist teaching -learning method and (2) traditional teaching method was required to be checked on dependent variable (achievement), thus the researcher decided to use two groups (Convenient sample) non-equivalent Quasi-experimental: Pre-test post-test design. The design of the study is presented as below:

$$\begin{array}{ccc} O_1 & E & O_2 \\ O_3 & C & O_4 \end{array}$$

Where, O_1 and O_3 = Pre-test

O_2 and O_4 = Post-test

E = Experimental group (Constructivist Strategy)

C = Control group (Traditional Strategy)

5.9 Population

The study was carried out in Anand Taluka in the state of Gujarat. There are 21 Gujarati medium schools with higher secondary classes in Anand Taluka following Gujarat State Board Syllabus (data as per Anand DEO office, 2019). All class XI students of Gujarat formed the population of the study.

5.10 Sample and sampling techniques

In the presented study, samples were selected by 'Convenient Sampling Technique'. As the researcher decided to work at the higher secondary level of school, the researcher has selected the students of standard XI from the sample science stream schools from Anand Taluka.

As the present study was experimental one, the researcher had decided to select two schools from the population. The researcher selected Convenient sampling technique in the selection of school. Gujarati medium schools with higher secondary classes and following Gujarat state board syllabus that are ready to provide facilities for implementing the developed Constructivist learning strategy.

5.11 Tools for Data Collection

To verify the hypotheses of the study, the researcher needed to use valid and reliable instruments. The following are the research tools that were used to collect the necessary data.

Table 5.2: Table showing tools used for data collection

Sr. no.	Variables	Tools used	Constructed by	Validity	Reliability	
					Split half	Cronbach's alpha
1.	Achievement in Chemistry	Achievement Test -1	Researcher	Face Content	0.84	0.92
2.		Achievement Test -2	Researcher	Face Content	0.97	0.94
3.		Achievement Test -3	Researcher	Face Content	0.93	0.91
4.		Achievement Test -4	Researcher	Face Content	0.95	0.95
5.		Achievement Test -5	Researcher	Face Content	0.89	0.93
6.		Achievement Test -6	Researcher	Face Content	0.94	0.95
7.	Reactions of students on SCS	Student's reaction scale (SRS)	Researcher	Face Content	-	-

5.12 Constructivist Strategy

Sr. no.	Contain topics	Constructivist Strategy	Activity
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
2	Hydrocarbon	Concept mapping	Concept Mapping
3	Equilibrium	Problem solving	Maths number, line with ball and stick model demonstration & discussion
4	Environmental chemistry	Cooperative and Collaborative	Peer Presentations and discussion

5.13 Data Analysis

- 1) The Mann Whitney U-test was used to find the significant difference between the pre-test, post-test, pre-test – post-test means of experimental and control groups on Achievement in Chemistry.
- 2) Percentage was used to find the Reaction of students from reaction scale after post achievement test (6).

5.14 Hypotheses testing

Table 5.2 Testing of hypotheses

Sr. no.	Hypotheses	U-value	Z – value	Rejected/Not Rejected ($p < 0.01$)
1	There is no significant difference in pre-test Academic Achievement mean scores of Experimental Group and Control Group.	410.5	3.17	Rejected
2	There is no significant difference in Achievement Test mean scores at end of the chapters of Experimental Group and Control Group.	370.0	3.59	Rejected
		410.5	-2.88	
		438.0	-0.84	
		444.5	-2.81	
3	There is no significant difference in post-test Achievement mean scores of experimental and control groups.	451.5	-2.74	Rejected
4	There is no significant relation in terms of standard X chemistry knowledge (pre-test) and standard XI Chemistry concepts (post-test) of experimental group and control group.	111.5	-5.72	Rejected
		595.5	-2.56	Rejected

5.15 Major Findings of the Study

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

5.16 Discussion

The present study shows that the Reactions of students exposed to Constructivist learning strategy are showing 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.

Achievement tests (2-5) scores of different constructivist strategy (i.e. cooperative, collaborative, problem solving and concept map) shows better learning environment and motivation in students. Constructivist learning strategies are greater than mean score of learning by traditional method. Final Achievement test mean score of students exposed to Constructivist learning strategies are greater than mean 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.

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 strategies 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.

In the Traditional classroom setup, students are seated on bench in one rectangular room, black board sticks on one of the walls, Teacher generally use lecture method for teaching, and student learns as passive receptor. But in the constructivist classroom setup, students done

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.

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.

5.17 Educational Implications of the study

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 proves to be practical and acceptable to students.
- Constructivist strategy learning can be used as a supplement to large group classroom teaching. It is easier to monitor 5 - 6 students in groups than 50 - 60 individuals in class.
- 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.
- The teacher should closely monitor involvement of all kind of students especially the achieving students to make sure everyone shares and benefits the group learning.
- Teachers need to structure the lessons and curriculum for constructivist strategy.
- The study has important implications for teacher education. Given the current widespread use of constructivist strategy at all levels, it is imperative that pre-service teachers understand how to structure and monitor meaningful learning experiences for students.
- Teacher educator should be given importance to train them for developing lesson plans for constructivist strategy and environment.
- Development of specific characteristics among learners should be part of effective co-operative lesson planning, Pre service and in service teachers should be trained and guided for framing objectives focusing on various aspects of development of specific characteristics of learners under their care.

- Observation and recording of Individual/Group behaviour should be given importance and sheets for it to be planned beforehand. Observed and recorded should be equipped with proper training to take the responsibility of their roles.
- 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.
- Group tasks should be designed and communicated to students in ways that make them believe that they are linked in such a way that one cannot succeed unless everyone succeeds. The tasks should engage students more actively in their learning experiences.
- 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.
- Meaningful content in constructivist lessons is critical for the success of all students. For students to succeed within their groups, careful consideration regarding group heterogeneity must be in conjunction with roles that ensure active and equal participation.
- Students in heterogeneous classroom team try to solve complex cognitive tasks and the progress of the lower achieving students does not occur at the expense of the higher achievers or vice versa. So constructivist strategy learning is recommended for fostering students reasoning and communication.

5.18 Conclusion

This study shows that constructivist strategy learning can enhance students' readiness to work with self and 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. Group work can fail if we do not take into account the social interactions among Students and the competencies developed within the classroom context. Implicit learning by observing others working and sometimes observing ourselves acts a valid resource for developing a new perspective for both teacher and taught. A better understanding of their classroom culture leads to developing successful and without boundary constructivist strategy structures across syllabus and standards.

Before embarking on the journey of transmission, transaction and transformation through Constructivist learning strategy pedagogy, in this synopsis researcher has given importance to Constructivist strategy practitioner having sound knowledge of following:

- Basic Assumption of knowledge construction
- Aspect of Constructivist learning
- Types of constructivist learning groups
- Constructivist learning structures
- The Shifting Role of Instructor during Constructivist Learning

As the term suggests, transmission orientation views teaching as the transmission of prescribed bodies of knowledge. A transaction orientation is through dialogue between teacher-student and is open to students contributing their knowledge to the learning process. The transformation orientation gives student control over their learning and to enhance their self-motivation and self-direction, with the teacher acting as co-learner.

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. Constructivist strategy provides an environment to learners wherein they understand other person or situation and enables them to resolve difficulties and create an environment where creative ideas generate new knowledge and problem solving.

5.19 Recommendations for Further Research

No research work is complete and final in itself, there is always a scope for further to break new grounds. The findings of the present study convince the investigators for the need of continuation of research in this field. In the light of the findings and conclusion of this research, the following recommendations are hereby presented;

- This research is followed at Higher Secondary level of education. So, analogous study can be conducted on different level of education i.e., university education, teacher education, technical education, mechanical education, medical education etc. where competences, attitudes and achievements needed to be investigated.
- The present study is conducted on the schools affiliated to Gujarat Secondary and Higher Secondary Education Board only. So, the other similar researches can be carried out with the students of CBSE Board and ICSE Boards also or other state education boards.
- This experimental study has been done in Gujarati medium only. So, this study can be conducted in different mediums of schools (Hindi, English & other languages), different boards (State, CBSE, ICSE) and different areas (rural, urban & semi-urban) and different sectors (government or private).
- A comparative study can also be carried out in different approaches of Constructivist learning i.e., cooperative - jigsaw, team-based, and Inquiry based learning etc.
- Taking Constructivist based teaching-learning approach as independent variable, effect on dependent variables such as Creativity, Attitude towards different subject (Physics, Mathematics, Biology & other Social Science, Commerce etc.), Interest; students Learning Styles, Retention, Perception towards subject and Motivation in particular subject can be investigated.
- It is suggested to the researchers that research on Effect of Constructivist Approach on performance of Special need students can also be conducted.

- Perception of Teachers towards Constructivist Approach is evaluated and mixed method (qualitative cum quantitative method) can be followed for this suggestion.
- This study also recommended the researchers that they can find out the significance of Information communication technology (ICT) in Constructivist Approach.
- It is also suggested to the researcher that they can adopt Attitude towards Chemistry as an Independent variable and can-do correlational study with variables like, learning outcomes, interest, motivation and problem-solving ability in Science.
- As constructivist approach of Chemistry teaching significantly affects students' achievement (learning in terms of knowledge, comprehension, application and analysis), chemistry laboratory competence and also attitude towards chemistry. Therefore, it can be highly suggested to mentors for using this approach in classrooms as one of the many strategies to motivate students.
- Since, effective learning depends on good pedagogy used and a good pedagogy includes a teacher as a guide who only instructs and facilitates to learner for ownership of learning and provide support to the students not disposed the matter. So, it is necessary for administration, management, teacher and also student to apply the constructivist approach in their institutions.