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Effect of constructivist learning approach on the achievement of students in chemistry

[1] Dr. Sakshi, [2] Dr. Sushma Gupta
[1] Principal, SD. Institute of Education (For Girls), Ambala Cantt, Haryana, India
[2] Associate Professor, Sohan Lal DAV College of Education, Ambala, Haryana, India

Abstract
The present study investigated the effect of constructivist learning approach on the achievement of students in chemistry. The study was conducted on a sample of 120 students studying in class IX of MDDAV senior secondary school, Ambala. For the study, pre-test post-test control group design was used. For the purpose of the study an intervention programme based on constructive learning approach (5E Model) and achievement test in chemistry developed by the investigators were used. t-test was used to compare pre-tests and post-tests of control and experimental groups. The results of the study revealed that before giving intervention programme both the groups were equivalent. There was a significant difference between achievement of students in chemistry of experimental and control group and significant difference was also found between the experimental group before and after intervention programme. This implies constructive learning approach was effective in enhancing the achievement of students in chemistry.

Keywords: constructive learning approach, achievement, students

Introduction
Constructivism is a theory of learning, which developed from the work of Piaget. It is a theory based on observation and scientific study about how people learn. Piaget (1971) [11] described constructivism as a system of explanations of how learners, as individuals adapt and refine knowledge. It is based on the belief that knowledge is not a thing that can be given by a teacher or absorbed from books in the room rather it is constructed by learners through active mental processes. Learners are the builder of the knowledge and meaning. It is a learning strategy whereby the learner synthesizes new understanding from previous learning and new information. The theory suggests that learners create their own understanding based upon the interaction of what they already know and the phenomena or ideas with which they come into contact. It transforms the learner from a passive recipient of information to an active participant in the learning process. In addition, learning that builds on what students already know leads to an increase in not only retention, but in interest and motivation as well (Forbes *et al*. 2001) [7]. This approach allows the learners to have more control over their own learning, to think analytically and critically, and to work collaboratively (Devi, 2012) [6].

The constructivist classroom facilitates presentation of material in a constructivist way and engages students in an active collaborative learning. The prime task of a teacher in the constructive learning environment is to translate information to be learned into a format appropriate to the learner's current state of understanding. The teacher in the constructive learning approach sets up problems and monitors student exploration, guides student inquiry, and promotes new patterns and ways of thinking. He helps the students to formulate and test their ideas, draw conclusions and inferences, and share their knowledge in a collaborative learning environment. He acts as a facilitator who coaches, prompts and helps students develop and assess their understanding, and thereby their learning. As always guided by the teacher, students construct their knowledge actively rather than mechanically ingesting knowledge from the teacher or the textbook. In a nutshell it can be said that a constructivist teacher with constructivist teaching method lead pupils from 'memorization of facts to understanding, textbook-based learning to hands-on learning, content of abstractions to content of real world problem, lecture style instruction to interactive style of instruction, teacher-imposed information to pupil's self-discovery information, and product-oriented learning to process- oriented learning.

Need of the study
The importance of science teaching or learning has been recognized by many researchers and teachers during the past two decades. Many Science Educators have advocated an inquiry-based approach to learning science in which students are given opportunities to actively build scientific knowledge by asking overarching questions, planning strategies, exploring solutions, constructing new knowledge, and reflecting on their own inquiry process (Linn, 2000) [10]. The National curriculum framework (NCF) developed by the National Council of Educational Research and Training in 2005, recommends a paradigm shift from rote memory to learning by understanding (Devi, 2012) [6]. It suggests that schools should facilitate the process of knowledge construction and help them to become independent thinkers capable of solving their everyday problems. Students should be able to acquire experiences and learn by themselves, and apply what they learn to various situations over their course of

worldly lives. Zemelman, Daniels, and Hyde (1993) [15] stated that learning in all subject areas involves inventing and constructing new ideas. They suggested that constructivist theory be incorporated into the curriculum, and advocated that teachers create environments in which children can construct their own understandings. A constructivist learning environment frees teachers to make decisions that will enhance and enrich students' development. Constructivism unlike the conventional method of teaching involves exploration of students' pre existing ideas and their construction or reconstruction accordingly using various child centered strategies of teaching. Many studies have been taken up on constructivist approach in the teaching learning process. Thakur and Mishra (2013) [12] studied the effect of constructivist classroom environment on achievement of students in science at secondary level. Result revealed that there was a significantly positive effect of constructivist classroom environment on achievement of students and the effect of constructivist classroom environment on achievement of boys was not significantly different from girls. Sridevi (2013) [13] concluded 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. Bimbola and Daniel (2010) [3] 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. The researchers recommended that integrated science teachers should incorporate constructivist-based teaching strategy in their methods of teaching. Chinwe and Chinyere (2010) [5] revealed that constructivist instructional approach was more effective in facilitating students' achievement in ecological concepts. Michael (2008) found in his study that the constructivist based learning environment was a significant factor for improvement of students' environmental literacy.

This innovative approach has emerged as a very powerful model for not only in developing cognitive abilities but also in modifying attitudes, increase self-confidence and decision making ability among the students. But there appears a gap between the educational practice and theory of constructivism. Most of the schools and teachers in the Indian society are using their traditional teaching learning methods and a less emphasis is placed on incorporating constructivism in the classroom. Moreover, a very less number of studies have been conducted in the state Haryana of India, therefore, an effort has been made by the investigators to find out the effect of constructivist learning approach on the achievement of students in chemistry at Ambala district of State Haryana.

Objectives

1. To study the effectiveness of constructive learning approach on the achievement of students in chemistry
2. To develop an instructional programme based on constructive learning approach.
3. To find the difference in the achievement of students in chemistry of experimental group and control group before intervention programme.
4. To find the difference in the achievement of students in chemistry of experimental group and control group after intervention programme.
5. To find the difference in the achievement of students in chemistry of experimental group and control group before and after intervention programme.

Hypotheses

1. There exists no significant difference between achievement of students in chemistry of experimental group and control group before intervention programme.
2. 2 There exists no significant difference between achievement of students in chemistry of experimental group and control group after intervention programme.
3. 3 There exists no significant difference between achievement of students in chemistry of experimental group before and after intervention programme.

Research Methodology

The study in hand aimed to study the effect of constructive learning approach on the achievement of students in chemistry. Keeping in view the nature, objectives and main purpose of the study experimental method was used by the investigator.

Design of the study

For the present study, pre-test post-test control group design was used. It involved two groups of students, experimental and control group. Intervention programme was given to experimental group, whereas no treatment was given to control group.

The study was conducted in three operational stage, viz. 'pre-test', 'intervention programme' (treatment) and 'post test'. The figurative representation of the design of the study is shown in figure 1.

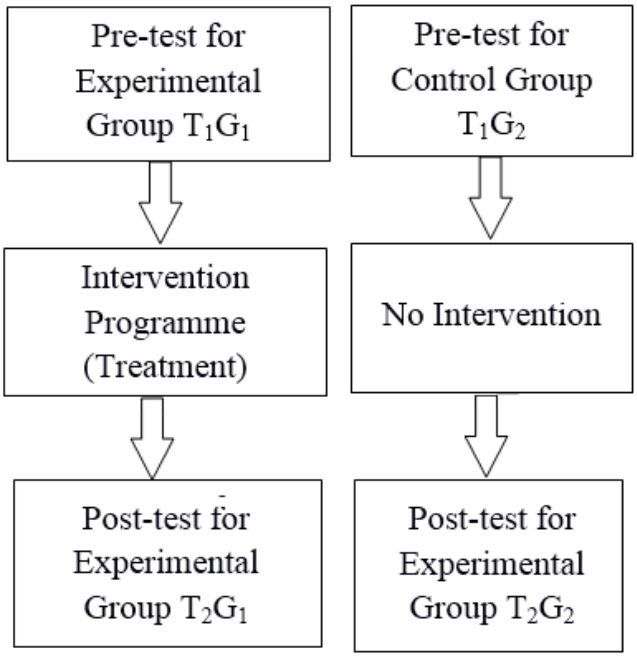

Fig 1: Design of the Study

Here

- T_1G_1 implies measurement of achievement of students in chemistry of Experimental group through the "Achievement Test" before the treatment.
- T_1G_2 implies measurement of achievement of students in chemistry of Control group through the "Achievement Test" before the treatment.
- T_2G_1 implies measurement of achievement of students in chemistry of Experimental group through the "Achievement Test" after the treatment.
- T_2G_2 implies measurement of achievement of students in chemistry of Control group through the "Achievement Test" after the experiment.

Sample

In the study, a sample of 120 students studying in class IX in MDDAV Senior Secondary School of Ambala was drawn randomly. Intelligence Test was administered on all 120 students and the students having comparable intelligence (80 students) were selected for experiment. A pre-achievement test in chemistry was administered on all 80 students. On the basis of the scores of pre achievement test in chemistry, the students were divided into two groups i.e., experimental and control group consisting of 40 students in each group.

Variables

Independent Variables

As the effect of constructive learning approach was to be studied, the method of teaching or teaching through constructive learning approach was used as an independent variable.

Dependent Variables

In this study, achievement of students in chemistry was taken as the dependent variable. This variable was measured twice during the course of the study-first before beginning the experimental treatment, i.e., at the pre-test stage and then after completing the experimental treatment, i.e., at the post-test stage.

Intervening Variables

In the study, there are many intervening variables that have been controlled by the investigator, e.g., age, class, teacher, intelligence and background of the students.

Tools Used

The investigator used the following tools

1. Tandon's group test of Intelligence for Children developed by Dr. R.K Tandon.
2. Intervention programme based on Constructivist Learning Approach: 5E model (Engage, Explore, Explain, Elaborate, and Evaluate) developed by the investigators.
3. Achievement test in chemistry developed by the investigators.

Statistical Techniques

The following statistical techniques were employed to analyze the data obtained from the experimental and control groups to test the hypotheses:

1. Descriptive statistics: Mean and Standard Deviation
2. Inferential Statistics: "t-test" for measuring the significance of difference between the performance of experimental and control groups.

Results

Table 1: Difference of Means in the Pre-test Scores of Experimental and Control Group Students on achievement in chemistry.

Group	N	Mean	S.D.	t-ratio	Level of Significance
Experimental Group (Pre-Test)	40	9.58	2.58	0.14	Not Significant
Control Group (Pre-Test)	40	9.5	2.67		

It is revealed from table 1 that the mean scores of pre-test of experimental group and control group on the achievement in chemistry is 9.58 and 9.5 with SDs 2.58 and 2.67 and the calculated value of `t' i.e. 0.14 is less than the tabular value of `t' at 0.05 level of significance. So the calculated value of `t' is not significant. Hence, the hypotheses-1 framed earlier was accepted. It means there is no significant difference between achievement of students in chemistry of experimental group and control group before intervention programme.

Table 2: Difference of Means in the post-test Scores of Experimental and Control Group Students on achievement in chemistry

Group	N	Mean	S.D.	t-ratio	Level of significance
Experimental Group (Post-Test)	40	16.98	3.59	5.66	Significant at 0.01 Level
Control Group (Post-Test)	40	13.3	1.94		

It is revealed from table 2 that the mean scores of post-test of experimental group and control group on achievement in chemistry is 16.98 and 13.3 with SDs 3.59 and 1.94 and the calculated value of `t' i.e. 5.66 is greater than the tabular value of `t' at 0.01 level of significance. So the calculated value of `t' is significant. Hence, the hypotheses-2 framed earlier was rejected. It means there exists a significant difference between achievement of students in chemistry of experimental group and control group after intervention programme. The mean of experimental group (16.98) is more than the control group (13.3), this shows that experimental group have better achievement in chemistry than control group after the intervention programme.

Table 3: Difference of Means in the Pre-test and Post-test Scores of Experimental Group on achievement of students in chemistry

Group	N	Mean	S.D.	t-ratio	Level of Significance
Experimental Group (Pre-Test)	40	9.58	2.58	10.57	Significant at 0.01 Level
Experimental Group (Post-Test)	40	16.98	3.59		

It is revealed from table 3 that the mean scores of pre-test and post-test of experimental group before and after the intervention on achievement in chemistry is 9.58 and 16.98 with SDs 2.58 and 3.59 and the calculated value of `t' i.e. 10.57 is greater than the tabular value of `t' at 0.01 level of significance. So the calculated value of `t' is significant.

Hence the hypotheses-3 framed earlier was rejected. It means there exists a significant difference between achievement of students in chemistry of experimental group before and after intervention programme. This shows the instructional material developed for giving intervention programme was effective in enhancing the achievement of students in chemistry.

Discussion of results

From the analysis of the results it is clear that

1. Before giving intervention programme both the groups were equivalent. So the effectiveness of the intervention programme can be easily predicted.
2. There exists a significant difference between achievement of students in chemistry of experimental group and control group after intervention programme. It reflects that the intervention programme was quite effective.
3. There exists a significant difference between achievement of students in chemistry of experimental group before and after intervention programme. It shows that the intervention programme was effective.

The results of the study were similar with the results of Akanwa and Ovute (2014) [1] who revealed that constructivist approach had a significant effect on both the achievement and interest of SSS physics students. Bogar, Kalender and Sarikaya (2012) [4] also revealed that there is a significant difference in favour of the experimental group who was taught by constructive education version over the control group regarding to averages of academic achievement scores. Achievement test scores of experimental group were found higher than the control group after instructional intervention. Similar results were found in the study of Thakur and Mishra (2013) [12] who revealed significantly positive effect of constructivist classroom environment on achievement of students in science and the effect of constructivist classroom environment on achievement of boys was not significantly different from girls. Similarly, the results are in agreement with the study of Udogu and Njelita (2010) [14] who found that experimental group performed better than the control group which indicated that the constructivist based method (GLM) is very effective in enhancing meaningful learning among students in chemistry.

Hence constructive learning approach is an effective learner-centered environment where students construct knowledge through critical thinking, manipulations, primary resources and hands on activities with the teacher as a facilitator. Consequently, if this approach could be used by the teacher, there will be an improvement not only in the achievement but retention, problem solving, critical thinking and decision making will also improve and it will develop a positive interest in the subject chemistry.

Educational Implications

Constructivist teaching is learning-centric where both pupil and teacher learn through their past knowledge and previous experiences, reflection, meta-cognition and resolving cognitive conflicts (Beyer, 1985). Pupils learn through construction of knowledge. Teacher learns being reactive to pupils' responses and ideas. The present piece of research has its implications for administrators, the curriculum framers, the teachers and the students. Learning theory of constructivism incorporates a learning process wherein the students gain their own conclusions through the creative aid of the teacher. The best way to plan teacher activities, lesson plans, and study skills for the students is to create a curriculum which allows each and every student to solve problems by themselves and the teacher monitors and flexibly guides the students to the correct answer. Therefore, curriculum framers should incorporate the problems or the learning activities that transforms theory of constructivism in to educational practice. The theory and concepts of the constructivist teaching be communicated to administrators, teachers and student teachers of all grades and disciplines through on supportive professional development activities. The trainers in constructivist professional development sessions should model learning activities which the teachers can apply in their own classrooms or that can provide first hand experiences to the teachers.

The prime responsibility of teachers is to create a collaborative problem-solving environment, where students are allowed to construct their own knowledge. They should initiate group discussions and debates allowing students to share their own thoughts and opinions. They should build a bridge between new knowledge and students' previous knowledge, which can improve students' ability of solving problems. They should use the problems that are important to students, not those that are primarily important to them and the educational system. The students should be exposed to data, primary sources, and the ability to interact with other students so that they can learn from the incorporation of their experiences. Teachers should treat students with a kind and considerate attitude, providing a democratic environment for students' learning.

Lastly we can say that if educational institutions intend going beyond the laboratory of academics and aim at becoming a laboratory of creating pedagogy of learning together with content mastery and joyful learning, developing empathy, understanding and compassion, and transforming a 'well formed mind' to a 'well filled-in mind', then constructivist approach can be one of the most relevant and practical approaches to both theories of and practices in education.

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