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Effects of Teaching Chemistry through Concept Formation Teaching Model on Students' Achievement

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Abstract

The study was aimed to investigate the effectiveness of concept formation teaching model over traditional method on Class IX students' achievement. It was an experimental study in which concept formation teaching model was compared with traditional method.

For experiment, sample size was 290. One hundred and forty three students in experimental groups and one hundred and forty seven students in the controlled groups were selected because the classes were taken "as is". Pre-test-Post-test Nonequivalent-Groups Design was used. Experimental groups were taught through concept formation teaching model and controlled groups were taught through traditional method for three months. Pre-test and post-test were administered to experimental and controlled groups at the beginning and end of the experiment. 31 lesson plans were made on the format of direct instruction from chapter No. 7 to 10 of Chemistry textbook for Class IX published by Punjab Textbook Board.

To determine the effects of teaching Chemistry through concept formation teaching model on achievement of Class IX students in the subject of Chemistry, the significance of difference between the mean achievement scores of experimental and controlled groups was tested at .05 level by applying *t* Test (Paired Samples Test). Data analysis reveals that the girls of experimental groups were better in pre-test at the beginning of the experiment than boys. The results of the study indicated that concept formation teaching model was more effective as compared to traditional method. Furthermore, concept formation teaching model appeared to be favorable for both boys and girls for the understanding of Chemistry concepts.

Key Words: Concept Formation Teaching Model, Traditional Method, Direct Instruction, Principles

1.1 **Introduction**

Teaching is not merely reduced to telling or transferring the subject matter to students; it is planning and guiding a student for maximum learning. Teaching is a dynamic and well-planned process whose objective is to acquire maximum learning outcomes. For this, a variety of teaching methods are present. A large number of methods are devised from time to time to make the teaching of science real and effective. However, if a teacher wants to produce desirable outcomes to improve the quality of instruction, appropriate teaching method that place more emphasis on thinking, understanding and learning should be used.

Drills, repetition, recall of memory, fixed curriculum, strict classroom discipline, formalized instructional patterns, recognition of facts, rote memorization for habit formation, reproduction of learned concepts and fixed standards to be achieved by all pupils are the criteria to assess the students after giving the logically organized subject matter. The process of compulsion, rigid control, formality, fear and tension are the bases of classroom activities. Generally preparation of adult life, mental discipline, transfer of training, acquiring knowledge for its sake, seeking truth and perfection, and habit formation is done by education.

To address the present situation of teaching, there is a need to explore such teaching methods which facilitates students' maximum learning. The responsibility of the teacher is to use students' time in an effective way and it is only possible when students' learning is based on thinking, understanding and learning. For maximum learning and personality development, proper stimulation, direction and guidance is necessary. The principle aim of teaching is the total growth and development of the child and this may be possible by are informality, freedom, encouragement on creative expression, life like situations in the classroom and provision of opportunities for developing initiative and curiosity among students.

This is the responsibility of science teachers to teach their subject as effectively as possible for achieving the pre-determined objectives of teaching science. One of the basic purposes of teaching Chemistry is to provide a base on which students to explore new things and this is possible when they have clear concepts. The appropriate teaching method is a tool to clarify the concepts. A method is not merely a devise used for transferring and communicating subject matter to students but it actually links the teachers and pupils in an organic relationship with the constant mutual interaction. The students' concepts may clear by applying good methods and bad methods may debase it. Good methods play a great role in the development of concepts.

Concepts can be thought of as information about objects, events and process that allows us to:

a) differentiate various things or classes;
b) know relationship between objects; and
c) generate ideas about events, things and processes (Siddiqui, 1991).

1.1.2 Promoting Conceptual Change

Cognitive Development and Science Learning

Nersessian (2008) stated that from childhood through adulthood, ordinary and scientific reasoning and representation processes lie on a continuum, because they originate in modes of learning which evolution has equipped the human child with for survival into adulthood. The cognitive activity of scientists is potentially quite relevant to learning. But again, there are quite difficult questions that need to be addressed in exploring and testing this hypothesis, such as how maturation might complicate learning. Further, in addition to the similarities, there are significant differences that need to be addressed. For example, in cognitive development, change seems just to happen but in education it requires explicit teaching and in science it requires explicit and active investigation. In the scientific case conceptual change is truly creative. Exploring the fundamental questions about the nature and processes of conceptual change in science, cognitive development and learning in a collaborative undertaking promises to yield richer, possibly unified accounts of this aspect of human cognition.

Promoting Conceptual Change

Zirbel (2008) said that if we wish the student go beyond the conceptual change, then we are requiring the student not only to willingly change his opinion but also to integrate the newly acquired knowledge into his neural thinking network to the degree that it can readily be used to construct further concepts upon that whole knowledge.

During the process of conceptual change what happens in the student's mind is a reorganization of his thoughts, the creation of new ideas and the rewiring of old ones. This process is difficult to provoke and requires the student to work hard at this. It is suggested that a good instructor can help with the process of conceptual change. But his task goes beyond clearly explaining the new theory; ideally he plays the role of a facilitator. He might confront the student with the problem (so that the student becomes dissatisfied with his prior belief), prompt the student to not only to regurgitate the new theory but also explain it in his own words and provide further examples of where to apply the new theory. Throughout this process, a good instructor would also be understanding and supportive to the student and challenge the student at the right moment (Zirbel, 2008).

Concept Teaching

Conceptual change learning results in better conceptual understanding by the students. Consistent evaluation and clarification of conceptions helps students develop metaconceptual awareness; that is, they come to understand how they develop their beliefs. The unique features of conceptual change instruction are as follows.

1. Students make their conceptions explicit so that they become aware of their own ideas and thinking; and,
2. Students are constantly engaged in evaluating and revising their conceptions.

The goal of teaching for conceptual change is for students to adopt more fruitful conceptions while discarding the misconceptions they bring to the learning environment. Students are more likely to rid themselves of conceptions that they have evaluated than those that they have not examined at all (Davis, 2001).

Tennyson and Cocchiarella (1986) suggested a model for concept teaching that has three stages: establishing a connection in memory between the concept to be learned and existing knowledge; improving the formation of concepts in terms of relations; and facilitating the development of classification rules. The declarative and procedural aspects of cognition are acknowledged by this method.

1.1.3 Concept Formation

Concept formation is the process of integrating features to form ideas by the recognition that some objects or events belong together while others do not. Once the objects or events have been grouped according to a particular categorization scheme, a label is given to the group. The end result of concept formation activities is the connections among the common characteristics of a concept. (http://www.sasked.gov.sk.ca/docs/policy/incel/section_3.html#concept_formation)

The concept formation is based on stimulation, direction and guidance. In it, more emphasis is on thinking and less upon memorizing, more on understanding and less on merely accumulating facts and more on learning through genuine interest and less on learning through coercion (Edutechwiki, n.d.).

The concept formation is done through definition and word. Definition is a tool for specification and categorization of important characteristics of the concept and this is the basis of integration. It also specifies the method of differentiation, which means that everything is not encompassed by the concept. The word is a cognitive trigger for the concept by which the concept is stored and referenced later when there is a need. (http://www.solohq.com/Objectivism101/Epistemology_Fundamentals.shtm)

There are numerous approaches to form concepts but only one direct teaching approach has been selected for developing concept formation teaching model.

1.1.4 Direct Teaching and Concept Formation

"What" to teach (i.e., the design of the curriculum) and "how" to teach (i.e., specific teaching techniques) is the focusing are of direct teaching. Specifically, it gives the due weight age to teaching behaviors and organizational factors (i.e., the "how" to teach) (Gagnon and Maccini, 2007).

Direct instruction is a highly structured approach to teaching procedural skills, characterized by teacher modeling and student practice. Direct instruction is particularly effective for teaching procedural skills, which are forms of content that have three essential characteristics:

1. They have a specific set of identifiable operations or procedures;
2. They can be illustrated with a large and varied number of examples; and
3. They are developed through practice (Eggen and Kauchak, 1997).

According to Sadker and Sadker (2003), direct teaching emphasizes the importance of a structured lesson in which presentation of new information is followed by guided discovery, elaboration, inductive and deductive reasoning, experiential learning, student practice, weekly and monthly reviews, and teacher feedback. In it, the teacher acts as the strong leader and facilitator who structures the classroom and sequences subject matter to achieve the pre-determined goals.

1.1.5 Principles of Concept Formation

Use of Advance Organizer

An advance organizer is an introductory statement of a relationship to encompass all the information that will follow (Woolfolk, 1998).

The teachers can use advance organizers as a tool to convey large amount of meaningful material in an efficient manner. This is a bridge technique that utilizes the student's prior knowledge to introduce a new concept. The strength of advance organizers is that they give a preview of what is to come. The big picture is presented before details are explored. The student then has a "hook" upon which to hang new concepts. A structure is also established to show how ideas and concepts fit together (Phoenix, 2006).

Use of Guided Discovery

By this, students personalize the concepts under study; create an understanding that cannot be matched by other method of instruction. The teacher must guide the students toward the discovery by providing appropriate materials, condusive environment and allotting time for students to discover (Labush, 2005).

Use of Elaboration

Elaboration is the addition of meaning to new information through its connection with already existing knowledge (Woolfolk, 1998). It is a process whereby the learner expands upon the information given to them during a lecture, reading assignment etc. It is an act of empowerment, addition of extra material, refinement and expansion of previous knowledge. (http://web.ics.purdue.edu/~rallrich/learn/elab.html)

Use of Guided Practice

The guided practice is related to the teaching and overt behaviour in which student's first attempts with new learning are guided for accuracy and successful learning. Teachers must closely monitor the student performance during the instruction. Mistakes need to be corrected if seen by the teacher (Combs, 2008).

Use of Inductive Reasoning

Generalizations are drawn from particulars, principles are framed from observations and rules are made from instances or examples (Sharma, 1988).

Use of Deductive Reasoning

In deductive method, rules, principles and conclusions are applied to particular cases (Sharma, 1988).

Use of Experiential Learning

The experiential learning is based on the notion that understanding is not a fixed or unchangeable element of thought but is formed and re-formed through experiences (Fry, Ketteridge and Marshal, 2004).

1.1.6 Concept Formation Teaching Model

Researcher adopted direct teaching (Sadker and Sadker, 2003) for developing concept formation teaching model and extracted these steps by reviewing the literature.

Researcher modified direct teaching, principles of concept formation (Huitt, 2003), books and lesson plan format used in different schools, colleges and universities. The researcher has identified instructional objectives, previous knowledge, introduction, presentation, closure/conclusion, generalization, evaluation, management of classroom and home task in lesson planning for effective teaching:

1.2 Methodology

1.2.1 Sample for Experiment

A sample of 290 students of Class IX from three selected Government High Schools for Boys and Girls of Rawalpindi city studying Chemistry subject were selected for experiment. Out of 290 students of these three selected schools, 143 students of experimental groups were taught through concept formation teaching model and 147 students of control groups were taught through traditional method (Table I).

1.2.2 Design of the Study

"Pretest-Posttest Nonequivalent-Groups Design" was selected for study consisting of two groups: namely experimental group and control group. An achievement test was administered to experimental and control groups before and after teaching as pre-test and post-test respectively. The experimental and control groups were taught through concept formation teaching model and traditional method respectively.

The researcher repeated the experiment at the same time in three different schools of Rawalpindi city with the time difference of one hour to find out the effects of concept formation teaching model on Chemistry to Class IX.

1.2.3 Research Instruments

An achievement test was designed in the subject of Chemistry on the basis of Bloom's Taxonomy of Educational Objectives for measuring the knowledge, understanding and application level. It contained 80 multiple-choice items from the content of chapter No. 7 to 10 of the Chemistry textbook for Class IX recommended by the Punjab Textbook Board.

In order to teach the experimental groups by concept formation teaching model, the lesson plans of chapter No. 7 to 10 of Chemistry textbook for Class IX of the Punjab Textbook Board were developed on the format of direct instruction. The lesson plans were checked and approved by the experts.

1.2.4 Analysis of Data

Mean, standard deviation and *t*-test (Paired Samples Test) were used for data analysis (Table II). Significance was tested at .05 level as the criterion for the rejection of null hypotheses. Predictive Analytics Software (PASW) was used for statistical analyses.

1.3 Discussion

This study supports the other research studies i.e. Unlu, 2000; Yavuz, 2005; Baser, 2006 and Salami, 2007. Their results showed that interaction between gender difference and treatment did not make a significant contribution in the variation of academic achievement. The findings of the present study also proved that there was no significant mean difference between male and female students with respect to understanding Chemistry concepts.

1.4 Conclusion

1. In experimental groups and control groups of all the three schools, girls showed better performance on pre-test than boys.
2. In experimental and control groups of all the three schools, boys and girls showed same performance on post-test.

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TABLE I

Sample for Experiment

For conducting experiment			
Schools	Groups		
	Experimental Group	Control Group	
School I	53	55	
School II	48	50	
School III	42	42	
Total	143	147	290

TABLE II

Significance of difference between mean achievement scores of boys and girls on pre-test and post-test

Group	*t*	df
Boys and Girls (pre-test)	-4.42	288
Boys and Girls (post-test)	-.01	288

df=288 Table Value of t = 1.97

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