Effects of Problem solving strategy on students' achievement in Chemical Equilibrium

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Abstract

The purpose of this study was to investigate the teaching through problem based learning in chemical equilibrium for Standard XI. Chemical equilibrium is fundamental to the understanding of acid- base behaviour, oxidation-reduction reactions and solubility. The complete composition of Chemicals and all the compositions in compound reactions and mixtures at equilibrium are discussed in detail. Problem solving strategy considered for Chemical equilibrium contents taught easily with deep understanding in a short period, enabling one to understand it while ensuring important elements are taking into account. In the Constructivism, Problem solving means students had to share their knowledge, express their ideas and experience with each other while searching a solution to the problem and work together in small groups toward a common problem. Problem solving is an educational approach to teaching and learning that involves groups of learners working together to solve a problem, complete a task and create a Conclusion. Problem solving activities are vary widely, but most center on students' exploration or application of the course material, not simply the teacher's presentation or explication of it. Chemical equilibrium concepts achievement test was administered to all students of experimental group and control group, and result was significant.

Key Words: Problem based learning, Problem Solving, Chemical Equilibrium, Chemistry Education, 5E's model.

Introduction

Problem solving approach is a constructivist approach. Teacher develop a learning strategy using problem solving approach and Teacher work as facilitator in learning place, so students can construct their own meaning and understanding by constructivist learning environment. Teachers continually encourage students and role models as reflective practitioner of teaching learning process. (Collis and Lacey). It is cognisant of the situation that the employment of learner centered pedagogy is emphasized in National Curriculum framework of 2005 and National Education policy of 1986. The Policy statement refers frequently to the employment of learner centered approach, active learning and problem solving approach in different contexts.

National and regional education personnel and literatures are advocating for teachers to facilitate students learning in the classroom that encourage them to be actively engaged in constructing understanding, and meaning making. 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. 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. Empirical evidence indicated that teachers teaching in Secondary schools were no scope for student to show his/her ability much utilizes in classroom. So, students are not able to express his/her knowledge and ability at higher secondary school. The approach of teaching in the schools that was included in the study was not found to be different from traditional approach in which classes are usually driven by teachers' talk. Although constructivist teaching approach has been well documented in literature, investigations regarding teachers teaching approach explain that situations in classroom predominantly goes against the best practices recommended by constructivist.

The purpose of this study was to investigate the effectiveness of problem solving strategy for chemical equilibrium at higher secondary school. Many students at all levels struggle to learn equilibrium concepts in Chemistry, but are often unsuccessful. One possible answer is that many students do not construct appropriate understandings fundamental concepts of chemical equilibrium from the very beginning of their studies, Therefore, they cannot fully understand the more advanced concepts that build upon the fundamentals. So, that student's getting achievement low and losing interest towards chemical equilibrium and chemistry subject.

Chemical Equilibrium

A preconception stems the label "equilibrium" being used in chemistry as well as in some everyday life balancing situations such as transforming physical state of matters, synthesis of compounds, bicycle riding, or weighing balance. The label "equilibrium" acquires attributes that are characteristic of these situations. The concept of "chemical equilibrium" includes a label that is known to students attending chemistry classes and for which they have a preconception. Attributes of equality in general, equality of two sides, stability, and a static nature become associated with the concept of equilibrium. The chemical equilibrium state describes concentrations of reactants and products in a reaction taking place in a closed system, which no longer change with time. In other words, the rate of the forward reaction equals the rate of the reverse reaction, such that the concentrations of reactants and products remain fairly stable, in a chemical reaction. Equilibrium is denoted by the ⇌ symbol in a chemical equation. Phenomena that reach chemical equilibrium appear natural macroscopically as stable and static systems. On the other hand, on the microscopic level the system is dynamic not only because of molecular movement but also because the process of breaking and creating bonds go on with the net result of zero. Attributing macroscopic qualities to the microscopic level leads to misconceptions in the understanding of the concept 'chemical equilibrium'. Bergquist and Heikkinen (1990) have pointed out that equilibrium is fundamental to the understanding of acid- base behaviour, oxidation-reduction reactions and solubility. Mastery of the concepts associated with equilibrium facilitates mastery of the other chemical concepts.

Characteristics of Chemical Equilibrium

1) Equilibrium is possible only in a closed system at a given temperature.
2) Both the opposing processes occur at the same rate and there is a dynamic but stable condition.
3) All measurable properties of the system remain constant.
4) When equilibrium is attained for a physical process, it is characterised by constant value of one of its parameters at a given temperature.
5) The magnitude of such quantities at any stage indicates the extent to which the physical process has proceeded before reaching equilibrium.

Teaching-Learning Strategy

The difference between groups was that controlled group was taught by traditional method while, experimental group was instructed by problem based learning method.

The traditionally **-** designed chemistry instruction was based upon lessons employing lecture method to teach concepts of Chemical equilibrium. Teaching strategies depend upon teacher explanations, discussions and textbooks. The teacher treated the entire class as a unit, wrote notes on the blackboard about the definition of different terminology and drew diagrams related to geometry. After the teacher explanation, the concepts were discussed, recapitulated by the teacher's questions. The direction of communication in the classroom was from teacher to student. Here the teacher is the focal point of discussion and dispenser of the knowledge.

Problem solving strategy **-** In experimental group, before the treatment, groups were formed in which three-four students in one group; these had different learning styles and academic performance. Then, students were instructed to use wood's model steps: problem solving model. During the treatment, students worked in small groups and deal with ill structured problems. Every student of the group had some responsibilities. Students were supposed to participate actively in the group discussion. They had to share their knowledge, express their ideas and experience with each other while searching a solution to the problem. Each of them had to be sensitive to the needs and feelings of other group members. Apart from the group work, each student had to conduct an independent study and must be able to represent, communicate and evaluate his/her learning at both individual and group levels. During the sessions, the teacher organised the groups and created a purposeful and co-operative atmosphere. The teacher ensured that students had control of the discussion. When guidance was needed, the teacher asked open-ended, very general questions and gave ample opportunity to students to focus on the goal. The teacher encouraged critical thinking. The experiment lasted for four weeks and it was expected that this period was long enough. After four weeks of treatment post-test was administered in both experimental group and control group.

Wood's Problem solving model

For experimental group, before the treatment, groups had different learning styles and academic performance. Students were instructed to using wood's model steps as follows:

Step 1 – Define the problem or task
- Point out Exactly things trying to do or solve as a group.

Step 2 – Analyse the Issues
- Point out the issues or details concerning the problem or task.
- Break down the problem or task into its smaller parts

Step 3 – Establish Criteria
- What does a good decision or solution consist of?
- Some of the criteria may be part of the group contract. Examples: feasible, realistic, no extra cost (time or money), …

Step 4 – Generate Possible Solutions
- Brainstorm a list of ways to solve the problem
- Do not evaluate the possible solutions, just write them all down.

Step 5 – **Evaluate Solutions**
- Compare the possible solutions you generated in step 4 to the criteria for a good decision you established in step 3.
- Create a revised list of those solutions that meet the criteria.

Step 6 – Choose and Implement the Best Solution(s)
- Which solution or solutions is the best?
- What will the group do to make sure this solution(s) is/are carried out?
- Example: even if you decide to email, who will email who at what time of day?
- What will the group do to check back and be sure the plan is working?

Step 7 – Develop a Plan to monitor the solution
- Monitor Students' work carried out as plan in group.

Research Methodology

In the present study Non-Randomized Two Groups Design quasi-experimental: Post-test only design was used. In the present study effectiveness of independent variable, method of teaching (two levels): (1) Constructivist learning and (2) traditional teaching method was required to be checked on dependent variable (achievement), thus the researcher decided to use two groups post-test only design (Best & Kahn, 2009). Wood's Problem solving model was used as treatment strategy for teaching chemical equilibrium. The design of the study is presented as below:

E X O_1
C - O_2

Where,

X = Treatment
O_1 and O_2 = Post-test
E = Experimental group
C = Control group

Objectives and Hypotheses

The major purpose of this study was to investigate the effect of using problem solving method in teaching chemical equilibrium at Higher Secondary level Chemistry.

Objective: To compare the achievement of students taught by problem solving method and students taught by traditional method.

Null Hypotheses: There is no significant difference between the achievement of the controlled and experimental group in post-test.

Population and Sample

All students studying at eleven Standard in government and private high schools Guajarati medium of Gujarat state taken as the population of the study. Convenient sampling technique was used. Standard XI Twenty- four students of Sadabhavana Vidyalaya, Surat, Gujarat as experimental group and thirty- two A. V. Patel High School, Surat, Gujarat as control group, were taken as the sample of the study. Both group made equal by achievements marks in science and mathematics of standard X Gujarat Secondary and Higher secondary board.

Tool for the Study

A self-developed Achievement test was used as an instrument. The researcher developed a test after reviewing the related literature and consultation with experts. The test included 5 questions containing multiple choice questions, 5 one line questions, 6 short answer questions and long answer questions to measure students 'academic achievement. All the items in the test based on Environmental Chemistry from Standard XI chemistry textbook. The test was constructed in such format that it covered the areas of knowledge, comprehension, application level and Higher Order Thinking (HOT) level. Chemistry achievement test was used post treatment test. The scale was standardized with reliability coefficient 0.742 which shows high reliability. Reliability is ensured using test-retest method. The instrument was pilot tested with 10 students in a school not participating in the study but within the same area of study. Validity is ensured as content validity. The Content validity of the items was assessed by experts. Experts hold position as Chemistry teacher in School and lecturer in Education College.

Data Collection and Data analysis

Intervention of the study was implemented between 10th to 25th august, 2018. Data was collected through per achievement test and post achievement test. Pre Achievement test was based on previous standard chemistry concept and Posttest based on Standard XI chemistry unit (i.e. chemical equilibrium). Data was analyzed thought mean, standard deviation and Mann Whitney U-test. Manna Whitney U-test calculated by online statistics calculator.

Group	N	Mean	SD	Mann Witney U-test value	z-Value	p-value (Level of significance)
Experimental group	24	16.46	3.67	233.5	-2.4835	p = 0.01314 ($p \leq 0.05$)
Control group	32	14.19	3.20			

Interpretation: A result shows that significance difference between mean scores of Experimental group (16.46) and Control group (14.19) in academic achievement. Standard deviation deference between experimental group (3.67) and control group (3.20) is less. This shows that achievement marks nearly same within group. Mann Witney test U-value is 233.5 and the Z-Score is -2.4835. The p-value is 0.01314. The result is significant at $p < 0.05$ but not significant at $p < 0.01$ level.

Major Findings

- There is a significant difference between mean score of the experimental group and the control group in academic achievement.
- There is an easy way to learn and enrich knowledge through Problem solving strategy of higher secondary school students.

Conclusion and Discussion

For acquisition of results quantitative research method was used in this study. The data collected were analysed using mean, standard deviation and U-test. It was found that there was a significant difference between the academic achievement of the students taught through traditional method and problem solving method. It was also found that the academic achievement of the students was better who were taught through problem solving method as compare to the students who were taught through traditional method. On the basis of these findings in this study, the following conclusions were drawn:

- Students taught through problem solving method achieved better than those taught by traditional method.
- There exists a significant difference in the achievement of Chemistry students taught through problem solving method and traditional method.
- Difference between the achievements level is due to problem solving strategy, otherwise both group have equal basic knowledge of Chemistry.

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