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Enhanced Appreciation and Understanding of Chemical Equations through Simple Teaching Methods: An Experimental Study

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Abstract

The present study envisages learning and understanding of chemical equations among students through simple teaching methods in classrooms. Experimental method of investigation is designed on the basis of the problem, assumption and hypotheses formulated and it also warrants a psychometrically sound design, procedure, tools and execution. This experimental study was conducted in two classes of standard XI for a period of 30 days. One section of 30 students, called control group was taught by traditional method and the other section of 32 students, called experimental group was taught by simple methods. The results of the statistical analyses show a significant difference between experimental and control group students pertaining to academic achievement in Chemistry. The gain scores of students in experimental group pertaining to academic achievement in Chemistry are found to be significantly higher than the students in control group.

Keywords: Chemical Equations, Simple Teaching Methods, Experimental Study.

1. Introduction

Quality of education has been the focus of discourses and reforms in education, globally**.** Even though traditional teaching methodologies exist in most educational settings, alternative techniques are also available to educators. Techniques that incorporate higher levels of thinking and problem solving should be considered. At the classroom level, greater attention is being paid to process-variables, such as teacher and student behaviors, as determinants of quality and quantity of teaching and learning. In Science teaching and learning, considering the nature and content of Science as well as the classroom environment, the teacher is seen as playing the crucial role of harnessing all resources and evoking student activity for classroom success**.** Chemical reaction is one of the most important topics in learning Science concepts. In order to know the reactions the students must have fluent approach to writing of chemical equations. These concepts are taught in high school and higher secondary school levels. The term 'academic performance' has been described as the scholastic standing of a student at a given moment. It refers to how an individual is able to demonstrate his or her intellectual abilities. This scholastic standing could be explained as the grades obtained in a course or groups of courses taken. Thus, in predicting academic performance, the use of grades in examinations and reported that grades could serve as prediction measures and as criterion measures. Fluency in writing chemical equations is a very important topic for any student studying or intending to study Chemistry.

The method of writing chemical equations through simple teaching methods as an experimental study has been done. The students from two different sections of same standard from N.K.T. National Girls Higher Secondary School from were taken as an experimental and control group as each. Both the groups were given a pre-test and simple method of teaching has been applied to section A and the traditional method has been applied to section B. After the teaching is over, a post test was conducted and the results were analyses by statistical analysis.

Chemistry education (or chemical education) is a comprehensive term that refers to the study of the teaching and learning of Chemistry in all schools, colleges and universities. Topics in Chemistry education might include understanding how students learn Chemistry, how best to teach Chemistry, and how to improve learning outcomes by changing teaching methods and appropriate training of Chemistry instructors, within many modes, including classroom lecture, demonstrations, and laboratory activities. There is a constant need to update the skills of teachers engaged in teaching Chemistry, and so Chemistry education speaks to this need. The main problems have been that these learners are mostly rote learners and that they do not automatically apply knowledge across disciplines. It is thus evident that the learners have to change their mode of learning from surface learning to deep learning in order to attain a high level of success. Another problem identified was that the learners struggle to form/understand theoretical concepts, mostly because they are English Second Language learners and all the courses and textbooks are in English. Research in education helps the teachers to become more efficient in their tasks. For effective teaching, mastery over the content matter alone is not suffice, the teacher should have a sound knowledge in choosing and using a particular instructional method, for a certain learning activity among a given group of learners. Here comes the need of educational research. Research economizes effort, prevents wastages, increases efficiency and dignifies the work of the teacher.

2. Review of related Literature

Chemical reaction is one of the important topics in learning Science concepts because it is important to a wide variety of reactions, for example, acid and base, Oxidation and Combustion (Eilks et al., 2007; Chairman et al., 2007). Not surprisingly the subject of chemical reaction has been studied by a widely diverse group of researchers (Nakhleh,

1992, Stavridou and Solomonidou, 1998; Eilks, Mollering and Valanides, 2007; Chairman et al., 2007). These concepts are taught in both secondary and Higher Secondary levels. At secondary levels basic concepts and at higher secondary level, the topic of chemical equations is taught again in Chemistry. A chemical reaction is very important topic for any student studying or intending to study Chemistry. It is a topic that forms the basics of Chemistry. Several researchers (Pfundt, 1982) stated that students do not often consider chemical reactions as a complete transformation of the matter itself, but only as a change in its appearance or as a change in the state of matter.

The topic of chemical reactions is often reported as difficult subject for learning and teaching. One of the reasons is that students cannot visualize chemical reactions. Ahtee and Varjola (1998) found that the students had difficulties with terms in Chemistry. Chemical reaction concepts such as oxidation and combustion reaction in early Chemistry lessons are the important topics that students should understand before further studies in more advanced topics.

In Thailand, there is little research study on investigating student understanding and alternative conceptions in the concept of chemical reaction. Some educational research studies found that traditional strategies do not help the student to develop a clearer understanding in Science concepts, especially abstract concepts. Some researchers used some techniques in order to change student concepts, in other words teaching for conceptual change. There are three examples of research study in the concept of chemical reaction. Dahsah (2007) used inquiry technique for teaching in the concept of stoichiometry and related topics. The results have shown that inquiry helps students to develop a clearer understanding of stoichiometry concepts and enhance their solving numerical problems. Moreover, some research studies found that conceptual change approach was effective in providing teaching and learning about matter and suggested as a tool to life (Pimtong, 2006). According to Artdej et al. (2010) who used two tier multiple choice diagnostic instrument to investigate Thai grade 11 students' understanding of Chemistry concepts. The results have shown that the developed experiments encouraged students to confront their alternative conception, and could help them change their understanding towards a scientific understanding. Other research studies have shown that learner centered helped students to develop Science learning achievement on chemicals in daily life and problem solving skills (Koocharoenpisal, 2005). In order to improve learning and teaching in Science content, the knowledge of learning and teaching theories are important to frame this work.

To support Constructivist approach, there are many strategies recommended to Science classroom, both active and interactive, to explore student's knowledge (Peters, 2000). The inquiry is one of the most effective teaching and learning strategies to investigate students in learning Science based on Constructivist (Tobin, 1990; Lawson, 2001). There are many different aspects of inquiry-based learning in all subjects. Inquiry can be approached by schools, administers, teachers, parents, students very differently.

Additionally, inquiry - based instruction is advocated as a means for developing such understanding, although there is scant direct evidence that it does (Sandoval, 2005). Farenga, Joyce, Dowling (2002) proposed that inquiry was the basic learning process of identifying a question, designing an investigation, collecting data, developing a hypothesis and communicating the results.

There are four levels of inquiry strategy. Confirmation, students use the question and procedure from the teacher to answer the question, structured, students investigate questions where the teacher provides the procedure, teacher questions by designing their own procedure, and open inquiry, students topics, selecting questions and designing procedure by themselves (Rezba et al., 1999)

Additionally, Colburn (2000) proposed inquiry - based instruction in four forms : structured inquiry, the teacher provides students with a hands - on problem to investigate, as well as the procedures, and materials but does not inform them of expected outcomes, guided inquiry, the teacher provides only the materials and open inquiry, this strategy is similar to guided inquiry, with addition that students also formulate their own problem to investigate, learning cycle, students are engaged in an activity that introduces a new concept and follow guided inquiry procedures, then the teacher discusses their finding.

In Science education, the common aim is to develop effective curriculum that can help students learn Science subject in the most appropriate way (Donovan, and Bransford, 2005). The inquiry is one of the most effective teaching and learning strategies based on the constructivist (Lawson, 2001). This approach is well known to promote students investigation and development of their Science concepts relevant to everyday life.

At present inquiry has been widely used. It is the instructional method in classroom and their effectiveness. Sanger (2007) compared the Chemistry content Knowledge of elementary teaching majors enrolled in an inquiry-based course and Science majors enrolled in traditional lecture-based courses and found the elementary teaching majors also improved their interest and confidence in teaching Science in the elementary school setting. These results suggest that both sets of teaching majors would benefit more from inquiry-based Science courses than lecture-based course. Clark (1996) has shown that an inquiry based instruction is a learner-centered that assures that the students are active learners and develop critical thinking as well as positive attitudes towards Science.

3. Statement of the Problem

The problems focused in the review of related literature were stimulations for the present researchers to focus on simple techniques of enabling learning of chemical equations with a more convenient and easy methodology. This thinking resulted in the present study with a research question as follows:

Are there simpler methods of teaching chemical equations for better understanding and appreciation?

The present study aims at improving academic achievement in Chemistry through simple teaching methods. The specific objectives are:

(i) To prepare a plan of action to teach through simple teaching methods.

(ii) To investigate the possible significant difference between the pre-test and post-test scores of academic achievement in Chemistry among standard XI students in Experimental and Control Groups.

(iii) To investigate the possible significant difference between the gain scores of academic achievement in Chemistry among standard XI girls in Experimental and Control Groups.

Thus the problem can be stated as:

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4. Hypotheses

The following hypotheses have been framed for the present study:

(i) There is no significant difference between the pre-test and post-test scores of academic achievement in Chemistry among standard XI students in Experimental and Control Groups.

(ii) There is no significant difference between the gain scores of academic achievement in Chemistry among standard XI girls in Experimental and Control Groups.

5. Method of Investigation

The method of investigation has been designed on the basis of the problem, assumptions and hypotheses formulated and it also warranted a psychometrically sound design, procedure, tools and execution; the following is a brief description of how such methodology was evolved. The investigation was planned to verify hypotheses using suitable tools and appropriate statistics for data processing.

5.1 Research Design

The present study envisages the effect of simple teaching method and academic achievement in Chemistry among standard XI students using a pre and post experimental design. The design has been drawn as follows:

Groups	Sample	Pre-test Measures	Teaching	Post-test Measures
Experimental Group	30 Students	Academic Achievement in Chemistry	Simple Teaching Method	Academic Achievement in Chemistry
Control Group	32 Students	Academic Achievement in Chemistry	Traditional Instructional Strategy	Academic Achievement in Chemistry

This design was tested with the following experimental procedure.

E = A ---------- S ----------B

C = A ---------- T ----------B

Where E = Sample chosen for the Experimental Group

C = Sample chosen for the Control Group

A = Pre-test measures of Academic Achievement in Chemistry

B = Post-test measures Academic Achievement in Chemistry

S = Simple Teaching Method

T = Traditional Method of Instructional Strategy

This instructional treatment was conducted over four weeks in the academic year 2013-2014 in N.K.T. National Girls Higher Secondary School. Two sections of standard XI were enrolled in the study. The classes were selected randomly.

First, topics in standard XI Chemistry text book were selected and a pre-test was conducted to estimate the academic achievement in Chemistry among these students and to check if there is any significant difference between the two groups with regard to their academic achievement in Chemistry.

Next, drawing on relevant research, all activities were developed by the researcher. Lesson plans for the procedure were based on Gardner's (1993, 1999) suggestions on teaching for a deep learning.

In the next step, the students in the Control Group were instructed only with traditionally designed learning material. Most of the time, the teacher presented the topics and the students listened to their teacher and answered the questions asked by their teacher. At the same time they carried out activities in their text-books.

However, the instructions for the Experimental Group varied. Lesson plans were prepared with various activities based on simple method teaching.

5.2 Sample selected

The study has been aimed at the population of standard XI students in state board schools. For the purpose of the present study 62 students of standard XI studying in N.K.T. National Girls Higher Secondary School was selected by obtaining random sampling technique.

5.3 Tools used for the study

Every descriptive type of research employs one or more tools for collecting valid and reliable data. The major types of tools of research are the questionnaire schedule, test inventories and scales. In the present study a tool was constructed. Chemistry Achievement Test was constructed by the investigators to assess the academic achievement in Chemistry of standard XI students.

6. Analyses and Discussion

The data collected from the students are subjected to analyses of variance, interpreted and discussed.

6.1 Analyses of Variance

The analysis of variance commonly referred to by the acronym ANOVA, at its lowest level is essentially an extension of the logic of t-tests to those situations where comparison of means of three or more samples, called

independent groups concurrently becomes essential. The following set of tables (Table-3) exhibits the analysis of variance among standard XI students experimental and control groups with regard to pre-test scores of academic achievement in Chemistry.

Table-1: Statistical Analysis of Means of Pre-test Scores of Academic Achievement in Chemistry among Standard XI Students in Experimental and Control Groups

Variable	Sample Size	Mean	SD	SEM	SED	CR
Experimental Group	30	11.23	3.12	0.57	0.88	0.44^{NS}
Control Group	32	11.63	3.78	0.67		

NS – Not Significant
SD-Standard Deviation
SEM-Standard Error of Mean
SED-Standard Error of Difference
CR-Critical Ratio

In Table-1, the mean and standard deviation of pre-test scores of achievement in Chemistry are 11.23 and 3.12 respectively in the experimental group and 11.63 and 3.78 respectively in the control group among standard XI students in pre test scores. The critical ratio value is 0.44, which is not significant. It is evident that the standard XI students do not have any significant difference in pretest scores between control group and experimental group towards achievement in Chemistry.

Table - 2: Statistical Analysis of Means of Pre and Post-test Scores of Academic Achievement in Chemistry among Standard XI Students in Experimental Group

Variable	Sample Size	Mean	SD	SEM	SED	CR
Pre-test	30	11.23	3.12	0.57	2.42	9.37**
Post-test	30	33.87	12.87	2.35		

**Significant at 0.01 level
SD-Standard Deviation
SEM-Standard Error of Mean
SED-Standard Error of Difference
CR-Critical Ratio

In Table-2 the mean and standard deviation of academic achievement in Chemistry are 11.23 and 3.12 respectively in the pre-test and 33.87 and 12.87 respectively in the post-test among standard XI students in experimental group. The critical ratio value is 9.37, which is significant at 0.01 level.

It is evident that the standard XI students in experimental group are significantly better in their post-test scores compared to their pre-test scores towards academic achievement in Chemistry.

Table-3: Statistical Analysis of Means of Pre and Post-test Scores of Academic Achievement in Chemistry among Standard XI Students in Control Group

Variable	Sample Size	Mean	SD	SEM	SED	CR
Pre-test	32	11.63	3.78	0.67	0.96	0.07^{NS}
Post-test	32	11.69	3.88	0.69		

NS – Not Significant
SD-Standard Deviation
SEM-Standard Error of Mean
SED-Standard Error of Difference
CR-Critical Ratio

In Table-3 the mean and standard deviation of academic achievement in Chemistry are 11.63 and 3.78 respectively in the pre-test and 11.69 and 3.88 respectively in the post-test among standard IX students in control group. The critical ratio value is 0.07, which is not significant. It is evident that the standard XI students in control group are not significantly better in their post-test scores compared to their pre-test scores towards academic achievement in Chemistry.

Table-4: Statistical Analysis of Means of Post-test Scores of Academic Achievement in Chemistry among Standard XI Students in Experimental and Control Groups

Variable	Sample Size	Mean	SD	SEM	SED	CR
Experimental Group	30	34.10	12.44	2.27	2.31	9.44**
Control Group	32	12.31	3.89	0.69		

**significant at 0.01 level

In Table-4, the mean and standard deviation of post-test scores of academic achievement in Chemistry are 34.10 and 12.44 respectively in the experimental group and 12.31 and 3.89 respectively in the control group among standard XI students. The critical ratio value is 9.44, which is significant at 0.01 level. It is evident that the experimental group students are significantly better compared to control group students of academic achievement in Chemistry among standard XI students.

6.2 Discussion on the Analysis of Variance with regard to the Pre and Post-test Scores of Academic Achievement in Chemistry among Standard XI Students

The efficient and effective way of learning depends upon the prior knowledge and method of study of the

students. Method of study is important as they influence the academic achievement of students. Academic achievement is also a major goal, which every individual is expected to perform in all cultures. Academic achievement is a key mechanisms through which adolescents learn about their talents, abilities and competencies which are an important part of developing career aspirations, academic achievement and career aspirations in adolescence are often correlated.

Many researchers proposed that prior knowledge is one of the factors that affect teaching learning Science. There are several research studies on gender differences in students' learning Science on achievements and attitudes. In the present investigation it is found that there is a difference between pre and post-test scores in the experimental group of achievement in Chemistry. There is significant improvement in academic achievement in Chemistry through simple teaching methods.

In the present investigation it is also found that there is no significant difference between pre and post-test scores in the control group. There is no improvement in pre and post-test scores because the simple teaching method is not used.

In the present investigation it is also found that there is a significant difference between pre and post-test scores in the experimental group of academic achievement in Chemistry. There is significant improvement in academic achievement in Chemistry which is the effect of the simple teaching method.

In the present investigation it is also found that there is no significant difference between the difference between pre and post-test scores in the control group of academic achievement in Chemistry. There is no improvement in pre and post-test scores of academic achievement in Chemistry because the simple teaching method is not used.

7. Conclusion

In fact language is an excellent phenomenon. Chemistry is a language of equations. Also human beings can alone speak. Through the method of communication man can do wonders. Without language one cannot exchange the views of each other. In a way the simple method of teaching Chemistry is the method of inspiring the students to develop interest in Chemistry (language of equations). From the tooth paste we use in our daily life to the milk we drink at night is full of chemicals we come across our life. So to be creative in Chemistry the students must have the thirst for Chemistry which will create a positive attitude and interest in Chemistry through these simple teaching methods.

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