African Research Review

An International Multi-Disciplinary Journal , Ethiopia

Vol. 4 (2) April, 2010

ISSN 1994-9057 (Print) ISSN 2070-0083 (Online)

Effect of Constructivist - Based Instructional Model on Students' Conceptual Change and Retention on Some Difficult Concepts in Chemistry *(Pp. 219-229)*

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Abstract

A quasi-experimental, non-equivalent group control design involving two intact classes were used to determine the effect of constructivist-based instructional model-Generative Learning Model (GLM) on students' conceptual change and knowledge retention in chemistry. Effect of GLM on gender is also monitored. Performance of students taught with the above instructional model was compared with those taught with Expository Method (EPM). The sample for the study consisted of 170 SSII Chemistry students from four secondary schools purposeful selected from all the secondary schools in Idemili South Local Government Area of Anambra State. Students from two schools – (one male and the other female) were randomly assigned to experimental group while the other two schools one male and the other female was assigned as control group. A Teacher Made Achievement Test in Chemistry Tests (TMATC) were used. Three sets of these tests were developed 1, II and III. Pre-test was administrated to both groups to determine their entry level. At the end of the treatment Post-test was administered to both groups to determine their achievement after treatment.

The third test was administered after an interval of four weeks to measure students' knowledge retention. ANCOVA statistical tool was used to analyze the data collected using pre-test as a co-variant. From the findings, it was very clear that experimental group performed better than the control group. This is an indication that the constructivist based method (GLM) is very effective in enhancing meaningful learning among students. Recommendations were made based on the findings.

Keywords – Constructivist – based instructional models, conceptual change, retention, Generative Learning Model.

Introduction

The globally emerging goals in the context of social and economic reforms have led to redefining of the nation's priorities in order to enhance productivity. A nation with plans or aspirations for economic development and technological advancement cannot afford to neglect the development of human as a resource for productivity (Obioma, 2004). This is why in the present age of science and technology much emphasis has been laid on that science is essential for one to cope in this modern age. This not withstanding, today's work force requires people who could think and have acquired the necessary content knowledge and skills in science and technology (Oladumi 2002). It has become clear that the greatest challenge among others that will probably face Nigerians will be that of survival in the midst of numerous challenges in an intensive competitive world, which is completely dominated by the great might of science and technology. Hence Ogunmadu (2006) maintained that for any nation including Nigeria to attain sustainable development, there is need to recognize science education for her citizens. In the same vein, Mbah (2007) pointed out that science and technology education is one of the most powerful instrument for enabling all members of the society to face new challenges and play roles as productive members of the society.

The importance of skilled manpower development of any nation cannot be over-emphasized especially when it relates to the use of science education for the achievement of national objectives. Using science and technologies as a tool, (FRN 2004), stipulates and harmonized the nation's broad goals of secondary school education as to prepare the individual for

* Useful living
* Higher education

Chemistry is one of the three main branches of pure sciences that deals with composition, properties and use of matters (Ababio, 1988). The objectives of teaching chemistry in our secondary schools as identified by Baja, Teibo, Onwu and Obikwere (1999) include amongst others:

i. To provide students with the basic knowledge in chemistry concepts and principles through efficient selection of content and sequence.

ii. To provide to students adequate foundation for a post secondary chemistry course.

Current research work has shown that teachers mode of presentation of various science concepts affect achievement (Akinsete 2007). Researches in psychology and education such as developmental psychology, cognitive and social psychology indicated new insight into and understanding about the learning process, and acquisition of knowledge and skills in various subject areas.

The basic nature of the learner in school includes:

* A learner is active in his/her environment and learns through his/her activities in the environment.
* A learner is curious and explorative in the environment, and enjoys exploring his/her environment.
* The experiences, observation and activities of the learner in the social and physical environment form the background of which new learning can take place (Njoku, 2007).

Udogu (1999) in her study, pointed out that

* Children construct a set of ideas, explanations and expectations from moment of birth.
* Learners come to science class with these ideas.
* Students' idea are often different from those of scientists.
* Students' pre-conception are strongly held and resistant to extinction.
* Traditional method of instruction will not lead to substantial conceptual change.

Hence Ausubel (1968) warned that what a child already knows is the only single factor that affects learning.

Umobi (2007) in her study indicated that science (Chemistry) learning is a constructive process and according to Abell (1989) it involves a process of conceptual change. Posner (1982) suggested that if students are going to change or drop their ideas;

* They must become dissatisfied with their existing conception.
* The scientific concepts must appear plausible.
* The scientific conception must appear intelligible.
* The scientific conception must be useful in a variety of new situations.

With the above assertion, chemistry teachers therefore have the challenge to present relevant classroom activities that can facilitate conceptual change, allow understanding, and recognize individual differences amongst students. Kyle and Abell (1989) maintained that Generative Learning Model (GLM) which is constructivist based will substantially provide this opportunity. The main tenet of the constructivist's theory is that children use their prior-knowledge to construct new learning.

Generative Learning Model (GLM) is a teaching learning model that substantially provides students opportunity for active participation in the learning process rather then empty cup to be filled. It is the capacity of enabling the students to construct meaning through interaction. It has four phases which give the students chance and potential to modifying misconceptions thus enabling students explain elaborately or defend their positions to others.

The problem that necessitated this study is the fact that most chemistry concepts generally are abstract in nature there-by making their comprehension relatively difficult coupled with the fact that formal expository method of instruction often left many of the misconceptions held by some student sun-changed with the result that poor performance is recorded each year in the external examinations.

It therefore becomes necessary to ascertain experimentally the efficacy of constructivist-based GLM bringing about an enhancement performance and knowledge retention in chemistry students.

Purpose of Study

1. To find the effect of constructivist based GLM type and expository methods on students' conceptual change in difficult concept in chemistry.

2. To determine the influence of this model and expository method on students retention in difficult concepts in chemistry.

Research Questions

The following research questions were formulated to guide the study.

1. What are the means and standard deviations of post-test scores of students taught chemistry using GLM and those taught using EPM?
2. What are the means and standard deviations of post-test scores on knowledge retention of students taught using GLM and those taught EPM.

Null Hypotheses

The following null hypotheses were stated at 0.05 significance level.

1. There is no significant difference between the mean scores of students taught with GLM and those taught using EPM.
2. There is no significant difference between the mean scores on knowledge retention of students taught with GLM and those taught EPM?

Methodology

The study is a quasi-experiment consists of pre-test, post-test non-equivalent experimental and control group design.

The population was all SS II chemistry students in all the secondary schools in Idemili South Local Government Area of Anambra State. Out of the 27 schools, 4 schools were purposefully selected based on schools with large number of students a total number of 170 SSII students constitute the sample of the study. Two male and two female schools were used for the study. One male and one female schools were randomly assigned to treatment who received instruction based on GLM for four weeks and served as superior group while the other two schools (one male and one female schools] received instruction based on EPM and served as control group.

Three teacher-made tests were constructed in some difficult chemistry concepts namely:

* Electrolysis
* Redox reaction

* Calculations involving masses
* Mole concept
* Energy changes during chemical reaction
* Chemical equilibrium

These were used as the instrument for this study. The tests were I, II and III made up of 40 multiple-choice questions of four options A – D and two essay questions. Test I was used for pre-testing to ascertain their previous knowledge. Test II served as post-test (achievement) measure. Test III was used to measure knowledge retention. Test I, II & III are the same content but rearranged in the three versions.

The test was content validated by two experts in measurement and evaluation and two experts in chemistry department. The reliability coefficient yielded 0.84 using split-half, odd-even reliability techniques and Pearson's product moment correlation.

Procedure

- **Pre-test session**

Before subjecting the groups to treatment, pre-test was administered to both experimental and control groups to determine the groups previously knowledge.

- **Treatment session**

In all the topics mapped out for this study, the experimental groups were made to construct meaning from the concepts and activities provided through teacher guidance using GLM which has four phases.

Phase I: Here, teacher identifies through investigation using thought provoking questions, learner's prior knowledge, ideas (misconceptions) that would conflict with the new learning task with a view to eliminating the misconceptions based on the topics were eliminated from the learner.

Phase II: Here, teacher uses divergent questions to establish a context in which students are allowed to explore a concept and using the situation or opportunities to clarify their views.

Phase III: Here teacher facilitates the exchange of ideas over views and challenges students to compare ideas including the evidence for the scientists perspective through presentation of scientific explanations, experimentation

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with clarity, and use models to give concrete illustration. Teacher also treats concepts with greater details to ensure that misconceptions were cleared.

Phase IV: This is the application phase. Here teacher uses "if" "what" questions (If Δ G is zero what will happen to a chemical reaction?) to enable students think and talk about the new problem in relation to their previous findings.

The control group receives instructions through normal expository (lecture) method.

The above listed opportunities were not given to this group. This teaching lasted for total of eight weeks of two periods of 80mins per week.

Finally, all the groups were post-tested with Test II and four weeks after the post-test, test III was administered to measure knowledge retention. The treatment and administration of the tests were done by the researchers in the selected schools who presented themselves as helping teachers. This is done in order to avoid jeopardizing the results.

Method of Data Analysis
The research questions were analyzed using mean and standard deviation. The null-hypotheses were analyzed at 0.05 significant level using ANCOVA.

Table 2 provided answer to the research questions and shows clearly that experimental groups performed better than the control group as indicated by the raw scores.

Table 3 showed that experimental group performed significantly better than the control group since F-crit < F-cal (3.07 < 4.14). Null hypothesis No 1 is therefore rejected.

Table 4 showed that experimental group performed better than the control group. Hence Fcal > F critical (4.07 > 3.07) H_0 2 is rejected.

Discussion
The result show that the experimental group performed significantly better than the control group. This was indicated by the value of F cal and Fcritical (see table 2 and 3 above). This proves that constructivist based instructional model, GLM is better and more efficacious than the EPM. This is in line with what Kyle and Abell (1989) observation, that children construct meaning and that learning involves a process of conceptual change. The above result also

tallied with what Fosnot (1996) in Igboko and Ibeneme (2006) observed that constructivist's approach help learner to construct their own knowledge and meaning from their experiences.

In accordance with the GLM, students now need opportunities to apply their knowledge in a new situation and this has helped them in the retention of knowledge gained. The problem solving context teachers will present, will allow them to develop and make sense of their natural world. This model has revealed how children learn science concepts especially the difficult ones and how to teach for conceptual change and is in agreement with most of other constructivist-based models like PEDDA.

Conclusion

If teachers are to improve student's chemistry conceptions, they must recognize that

- Students come to class with their own ideas.
- These ideas often differ from those of scientists.
- These misconception are held tenaciously and resistance to change.
- Traditional method of teaching sometimes left unchanged these misconceptions.

With these in mind, teachers of chemistry should provide a learning environment that engages students in an active search for new knowledge and enable them modify their existing cognitive structure by employing GLM which has the potential to draw out misconception in students.

Recommendation

1. The constructivist-based Instructional model (GLM) has positive effect on students' conceptual change hence teachers should be encouraged to employ it more in the teaching chemistry.
2. Teachers of should try as much as possible to use this model in the teaching of difficult concepts in chemistry.
3. Chemistry teachers should be encouraged to use the method to facilitate in students the exchange of ideas, views and challenge students to compare ideas including those of the scientific perspective.

4. Teacher of chemistry should always use this model to ascertain students' prior ideas, expectations and explanations before instruction.

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Table I: Distribution of subject by treatment and gender

Gender	Experimental Group EP	Control Group CP	Total
Male	$E_1 = 46$	$C_1 = 40$	86
Female	$E_2 = 41$	$C_2 = 43$	84
			170

Table 2: Presentation of means and standard deviation scores of both E & C groups on pre-test, post-test and post-test after four weeks

Type of test	E_1	E_2	C_1	C_2
Mean pre-test	7.41	8.11	7.36	8.03
S.D	3.04	2.71	2.05	3.00
Mean post-test	49.30	48.30	37.61	36.83
S.D	5.11	4.97	4.07	3.77
Mean post-test after four weeks	46.31	47.91	35.21	36.17
S.D	4.09	384	3.09	2.99

Table 3: ANCOVA Summary of post-test scores of Experimental & Control Groups on effect of methods on achievement

	Between	**Within**	**Total**
Sum of square Y	3951.36	30205.74	34157.10
Sum of square X	202.68	28764.18	28966.86
Sum of products	98.87	14810.67	14908.94
Degree of freedom	K – 1 = 1	N–K =168	169
Adjusted sum of square Y	54.91	2227.68	
Degree of freedom for adjusted sum of squares	1	N–K–1=167	168
Variance	54.91	13.26	

$F = \frac{54.91}{13.26} = 4.14$ F-critical = 3.07

Table 4

ANCOVA summary of post-test scores of Experimental & Control Groups on knowledge retention

	Between	**Within**	**Total**
Sum of square Y	3782.61	31086.33	34868.94
Sum of square X	231.91	28655.10	28887.01
Sum of products	87.93	14636.19	14724.12
Degree of freedom	K – 1 = 1	N–K =168	169
Adjusted sum of square Y	51.84	2139.84	
Degree of freedom for adjusted sum of squares	1	N–K–1=167	168
Variance	51.84	12.74	

$F = \frac{51.84}{12.74} = 4.07$

Fcal = 4.07

F critical = 3.07