

ENHANCING THE TEACHING OF CHEMISTRY CONCEPTS IN SECONDARY SCHOOLS THROUGH THE USE OF PROJECTS

P.O. Okonji; R.E. Okonji and I.I. A. Awili

Abstract

This study was carried out to investigate the effect of using projects in teaching chemistry concepts on the achievement and retention of students. Students' achievement and retention were measured for student takers and non-takers at the end of the course. Data were analysed for a total of 75 students representing 25 who were taught using project method and 50 others taught using traditional teaching methods. Significant gains in achievement and retention were observed for student takers suggesting that the use of project method in teaching chemical concepts can enhance understanding, retention and transfer of learning. The paper also made some useful suggestions for the way forward.

Introduction

Today's world has been described as that of science and technology. The aim of education is to inculcate in the child the spirit of enquiry and creativity through exploration of nature and the local environment. Teaching invariably aims at achieving some objectives, which typically manifests as instructional products or methods. Therefore in science, particularly chemistry education, it is important that the right teaching approach be given adequate attention.

Students' performance in the sciences, especially chemistry, has been so poor that the number selecting chemistry at the West African school Certificate (WASC), examination is decreasing yearly (WAEC Reports, 1999), and parent and teachers have been unhappy over the phenomenon. It has been observed that students have problems in understanding basic chemical concepts which are necessary for the understanding of the subject matter. This has been attributed to the lapses in the method of teaching chemistry (Olawuni, Omowale, Ajibade, and Adeoyem, 1995). Consequently it becomes imperative that a new way of presenting some of these concepts be developed. To this end the designing of simple projects of chemical nature by the students should be explored (Ikoku, 1983).

Project work is supported to present opportunities for the development of the curious and inventive powers in the student as well as improve the learning of chemistry. It is the intention¹ of this study to ascertain the authenticity of this view.

Statement of the Problem

The problem of this study is to find out the effect of using projects in the teaching of some chemical concepts on students' achievement and retention.

Purpose of the Study

The poor performance of students in WAEC examination has been attributed to the method of teaching the basic concepts among other things. Hence the main purpose of this study is to examine the effectiveness of the use of projects in teaching chemical concepts. Specifically the study aims at determining the effect of projects on students' achievement and retention.

Significance of the Study

As a result of the importance of science and technology, science educators are working hard to attain the goal of effective science, particularly chemistry education. It is therefore hoped that this study will arouse the interest of the students and develop in them the much needed confidence to study and understand chemistry thus stimulating them to study it. The study is also expected to help teachers effectiveness appreciate the use and effect of projects in teaching chemistry, encourage them to actually want to try the method out and help curriculum planners see the need to give projects their proper place in chemistry curriculum.

Scope of the Study

The focus of the study was on saponification. The students were to apply this concept in the manufacture of soap using local and common materials found around.

Hypotheses

The following hypotheses were postulated:

- There is no significant difference ($e < 0.05$) in mean scores of the achievement of students taught chemical concepts using projects teaching method and those taught using the traditional classroom teaching method.
- There is no significant difference in the means scores of the incidence of retention among students taught chemical concepts using projects teaching method and those taught using the traditional classroom teaching method.

Literature Review

Chemistry is the study of the structure and composition of various forms of matter, the transformations and processes they undergo and the phenomenon they exhibit under various conditions. Education has been defined in various ways by different authors. Okafor (1989), defined education as the process of acculturation through which the individual is helped to attain the development of his potentials and their maximum activation when necessary according to right reason and to achieve his perfect self-fulfillment. Professor Fafunwa in his write-up in the Guardian, Thursday, January 3, 2008 said "Education is what you have left after you have forgotten all about schooling". This definition implies that education has a part to play in students' retention and achievement in life.

Chemistry education may therefore be defined as the study of the interrelationships between chemistry as a discipline and the application of educational principles to its understanding, teaching and learning.

The objectives of chemistry at the senior school Certificate Examination syllabus (2004-2008), are:

- Build upon the knowledge acquired in integrated science or general science at the junior secondary (.IS), level;
- Provide students with basic knowledge in chemical concepts and principles through efficient section { if content;
- Enable students to appreciate the scientific method which involves experimentation, accurate observation, recording, deduction and interpretation of scientific data;
- Enable students to develop laboratory skills, including an awareness of hazards in the laboratory and the safety measures required to prevent them;
- Create an awareness of the interrelation between chemistry and other discipline;

- Show chemistry and its link with the industry, environment and everyday life, in terms of benefits and hazards.

It becomes imperative for the senior secondary (SS), chemistry teachers to be well grounded in chemistry education. The teacher needs to be taught and trained to be able to relate subject matter to everyday experiences and occurrences in the homes and the environment and inculcate the spirit of independent enquiry in the students.

The Importance of Chemistry Education

The most obvious distinction between the developed and the developing nations is in their levels of technological development. The study of chemistry leads to advancement in technology since it is a core subject for its development. The knowledge of chemistry is very important for the development of abundant raw material resources which is the bases for the industrial and economic development and growth of any nation.

Chemistry plays very important role in our every day life activities. Every aspect of medicine, engineering and agriculture can be explained by chemistry. For example in the production of

structural materials chemistry finds a place in the discovery of methods of extracting new materials used in the production of building, engineering and domestic articles. Therefore the importance of chemistry can be seen from its ability to provide new products as well as methods for predicting the effects or behaviour of particular substances under given conditions. Also the desirable side effects, such as environmental pollution, which may result from indiscriminate use of otherwise beneficial products can be detected and eliminated not the knowledge of chemistry through.

Chemistry in the Nigerian Education System

The teaching of chemistry in Nigeria SS class has not been very effective due to a number of problems. These problems include, among others, too much workload due to understaffing, poor motivation for enthusiastic work, poor library and laboratory facilities leading to the inability of teachers to backup their teaching with experiments. The big problem now is how to arouse the students' interest in chemistry education. There is the need to encourage the students to utilize chemical principles to explain common phenomenon as well as for solving human problems in various fields of science. This is expected to yield better result than the wide spread method of lecture and chalk which places the teacher in the position of authority as both subject master and controller of student behavior.

Meaning of Projects

Project can be defined as a method of teaching that places responsibility on the individual or group of pupils carrying out learning activities with the teacher playing only a supervisory role. In the secondary schools it can also mean a long term assignment given to a student or groups which involves the application of some skills learnt from unit/units of lesson/lessons to solve a real life problem. This could involve production of some commodity or object.

Effect of Projects on Students' Achievement

In most developing and under-developed countries like Nigeria, the traditional instructional method of dictated notes, listening and passivity of students is still very much in use. This method is unfortunately inadequate especially for science subjects where the understanding of basic concepts and principles is necessary. Thus, the general education objectives of teaching chemistry are hardly achieved when one takes a critical look at performances in examinations. Looking at the poor methods of teaching this study calls for students to be allowed to find out things for themselves, make inferences, make predictions, formulate models and integrate data. Carlson and Ullivan (1999), revealed that the use of project work did not only increase students' interest in the study of engineering but also resulted in students achieving higher GPA scores. They demonstrated that project work motivates students highly and offers them an opportunity to develop their creative ability. This implies that teaching of chemistry as an enquiry, in addition to transmitting concepts, principles and facts, has the responsibility of conveying a realistic image of chemistry and its nature. Hence it could be used to evaluate as well as improve the cognitive and psychomotor skills of students through practice and help from other people. This can help the teacher to establish areas of strength and weakness of students and generate data for counseling and guidance as well as creates an atmosphere in which curiosity is aroused, imagination stimulated, interest generated, viewpoints enlarged and learning attitudes changed. The overall effect will be improvement in students' achievement.

Effect of Projects on Students' Retention

One of the aims of school instructions is to expand the knowledge of learners and prepare them for future challenges. It is the responsibility of teachers to encourage learners to acquire and retain the knowledge imparted in school for future use in meeting the challenges of life. One way to encourage students' retention is to teach them subject-matter that will be meaningful to them since it will be better learned and easy to retain. Another way of improving memory and enhancing retention could be the development of clear concepts with the help of various types of audio-visual materials as well as hands-on (using projects), method of learning. In these methods the students are encouraged to participate actively in the learning processes. This ensures that the learning-experiences acquired will be remembered (retained), for a longer period.

Eshiet (1986) showed that recall of information was easier and better when such information had been communicated through a practical or gained discovery approach. Therefore the use of project work is expected to enable students gain and retain more knowledge since the concepts learned will stick better in the memory. It is for these reasons, according to Flourney (2004), that a call made by some students in Georgia for the replacement of traditional practical examinations with hands-on activities in the form of projects.

Methodology

Research Design

This is an experimental study. It will test the effectiveness of using projects in teaching chemical concepts of saponification, soap making, to some (SS) students.

Area of Study

The study was conducted in Ajaokuta Local Government Education Area (LGEA) of Kogi State.

Population

This comprised the senior secondary class three (SS 111) students within Ajaokuta LGEA. There were approximately one thousand, two hundred students.

Sample and Sampling Method

Two out of the eight secondary schools within the LGEA were selected through random sampling.

Instruments

A chemistry achievement test (CAT) was developed with the cooperation of the chemistry teachers in the selected schools.

Validation of Instruments

There was face validation as well as content validation. The instrument was submitted to experts in chemistry education as well as in measurement and evaluation to vet. They were asked to rate the suitability of the projects in terms of language expression, skills and concept involved. The validity of the marking scheme was obtained by determining the correlation of scores awarded by two scorers to the same tests given to students from schools outside the two selected for the study. The scorer's reliability coefficient was determined using Pearson's moment measure of correlation r , and was found to be 0.94. **Analysis of Data**

Three different groups of 25 students each were taught the process of soap making using three different teaching methods. Group I (project Group) was taught using project technique, Group 2 (standard Group), was taught using traditional method of demonstration in the laboratory and Group 3 (control Group), was taught without using any instructional material. The data collected was analysed by method of mean scores, standard deviation and analysis of covariance (ANCOVA) as shown in the tables below.

Table 1: Mean Scores and standard Deviations of Pre-test for Students

Group	Sample No.	Mean Scores	Standard Deviation
1	25	38.60	18.91
2	25	40.4	13.56
3	25	38.48	11.93

Table 1 shows that there was no significant difference among the mean scores of the three groups. This implies equal background knowledge of the subject-matter.

Table 2: Mean Scores and Standard Deviations of post-test Students

Group	Sample No.	Mean Scores	Standard Deviation
1	25	72.60	12.41
2	25	64.20	10.23
3	25	53.44	17.52

It can be observed from table 2 that the difference between the mean scores of Groups 1 and 3 is 19.08 while between Groups 2 and 3 it is 10.76. This represents a 77,23% improvement in students' performance due to the use of projects.

Tables 3: Mean Scores and Standard Deviations of Retention Test (Retest), for Students

Group	Sample No.	Mean Scores	Standard Deviation
1	25	70.00	13.54
2	25	62.28	14.20
3	25	51.60	19.29

Table 3 shows that Group 1 has the highest mean score value (72.60), followed by Group 2 (64.20) for the retention test. The difference between the mean scores of Groups 1 and 3 is 18.40 while between 2 and 3 is 10.68. This is due to the method of teaching used. There is no significant difference between the mean scores of pre-test and re-test for group 1 implying that project method of teaching can enhance students' ability to retain what they are taught.

Table 4: Analysis of Covariance of Pre-test and Post-test for Groups

Source of Variation	Adjusted Sum of Squares	Degree of Freedom	Adjusted Squares	Mean	F-Calculated	F-Critical
Adjusted Between Groups	8450.73	2	4225.30		24.59	3.44
Adjusted Within Groups	12198.97	71	171.82			
Total	17790.09	73				

From the above table the calculated F-ratio (24.59) was higher than the critical value (3.44) at 5% significance. This shows that there is a significant difference in students' performance due to the teaching method. The first hypothesis was therefore rejected.

Table 5: Analysis of Covariance of Pre-test and Post-test for Groups

Source of Variation	Adjusted Sum of Squares	Degree of Freedom	Adjusted Squares	Mean	F-Calculated	F-Critical
Adjusted Between Groups	7904.39	2	3952.40		30.31	3.44
Adjusted Within Groups	9258.91	71	130.41			

Total	17163.30	73			
-------	----------	----	--	--	--

The table above shows the analysis of covariance for post-test and retest scores. The calculated F-ratio (30.31) was higher than the critical value (3.44) at 5% significance.

This means that there was no significant difference in students' retention due to (he teaching. This led to the rejected of the second hypotheses.

Result of Study

The results showed a significant difference in the achievement and retention of students taught using the method of projects in teaching chemical concepts. These results are in agreement with the work of Eshiet (1986), Kvam (2000), and Agboola and Oloyede (2007).

Recommendations

Based in our findings we make the following recommendations:

- Chemistry should be taught through the guided discovery method with increased emphasis on use of projects. This will facilitate learning retention and sequential transfer of the learned material thus making chemistry and indeed science more functional in its teaching;
- Workshops and seminars should be organized regularly where teachers could share idea on how to develop specific concepts for use in teaching chemistry as well as other scientific concepts;
- Students should be encouraged to use locally available or improvised materials in carrying out projects;
- The unit in SS chemistry curriculum on industrial chemistry should be properly implemented using project method of teaching since the unit deals directly with studying chemistry for self-reliance;
- Science teachers should be encouraged to work harder on their teaching techniques to include the use of projects as this enhances understanding, retention and transfer of learning.
- Theoretical work must be backed up with sound forms of projects or activity-oriented exercises to ensure improvement in acquisition and retention of knowledge.
- Chemistry as well as other science teachers should be compensated for enthusiastic work as this will encourage them to develop improved teaching techniques.

Conclusion

The result of this study showed that students' performance (achievement) and retention were better when taught using the project method instead of the traditional methods. Students achieved more and retained more when they were allowed to manipulate apparatus than when they observed and listened. Therefore the study of chemistry and science can be made more meaningful and enjoyable for the students when what (hey learn is related to their concrete experiences by allowing them to carry out project work.

References

- Agboola, O. S. & Oloyede, E.O (2007). Effects of project, inquiry and lecture demonstration teaching methods on senior secondary students" achievement in separation of mixture *Education Research and Review* 2(6), 124-132.
- Eshiet, L.E. (1986). Using demonstration method in the teaching of the concept of diffusion of gases. *Journal of Science Teachers Association*, 24(1), 18-23.
- Flournoy, B.H. (2004). Increasing middle grade students' interest in science through infusion of technology and hands-on science teaching. *Georgia Journal of Science*, retrieved from the internet at [hnp://facstaff.gpc.edu/~jaliffigQjsci62l,ktm](http://facstaff.gpc.edu/~jaliffigQjsci62l,ktm).

- Ikoku, C. (1983). The school chemistry curriculum and its relevance and its relevance to society. *West African Journal of Education* 17(3), 475-486.
- Carlson, L.E. and Sullivan, J.F. (1999). Hands-on engineering learning by design in the integrated and learning programme. *International Journal of Engineering Education* 15(1), 20-31.
- Kam, P.H. (2000). The effect of active learning methods on students' retention in engineering statistics. *The American Statistician* 54(2), 136-140.
- Okafor, F.C. (1989). Difficult concepts in chemistry as perceived by chemistry students in Onitsha educational Zone. *An Unpublished Thesis*, University of Nigeria, Nsukka.
- Ohmimi, O.M., Oimnvala, A.O., Ajibade, S.A. and Adeoye, B.O. (1995). Effects of some improvised and standard materials on students' achievement and retention in some selected chemistry concepts in Ilesha L.G.A. *An Unpublished Thesis*, University of Nigeria, Nsukka.