USING MINERAL ORE DEPOSITS AS A TEACHING RESOURCE ON THE CONCEPTS OF CATIONS & ANIONS IN COLLEGES OF EDUCATION CHEMISTRY

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Abstract

The purpose of the study was on the use of mineral ore deposit (limestone ore) and its application in the teaching of the concept of Cations and Anions in qualitative analysis in chemistry. A total of 120 NCE I chemistry students were involved in the study using intact classes. This number was made up of 73 males and 47 females drawn from the two colleges of Education in Cross River State of Nigeria. Two (2) research hypotheses were formulated and a research question to guide the study. The instruments used in gathering data for the study were achievement test in chemistry (ATC) and chemistry retention test (CRT). A non-randomized pretest-posttest control group design was adopted for the study. Kuder-Richardson formula-21 was used to establish the reliability of achievement test in chemistry (ATC). It had a reliability coefficient of 0.83. Data collected were analyzed using Analysis of Covariance (ANCOVA). From the findings, it was observed that the chemical components of mineral ore deposit (limestone ore) were effective in teaching the concept of cations. Also, from the findings, mineral ore deposit (limestone ore) had a significant main effect on students' performance and retention. It was therefore recommended that chemistry lecturers should explore the use of local resource materials within their immediate environment to teach various concepts in chemistry.

The relevance of science and technology to national aspirations and economy explains to a large extent, the huge commitments and support which most nations make to scientific and technological developments (Olagunju, 2000; Iroegbu&Ige, 2003). Modern development is no longer possible outside the framework of science and technology hence the need to teach science especially chemistry, effectively in schools and colleges of education.

Extensive use has been made of the rich deposit of mineral ores like limestone ores of Ewekoro in Ogun State, Nkalagu in Enugu State and Nfamosing in Cross River State in the areas of agriculture and cement production. It could also serve as a potential resource in the teaching of certain concepts in chemistry curriculum of the colleges of education as well as senior secondary school chemistry curriculum (Ige, 2000).

In the National Commission of Colleges of Education Curriculum, chemistry occupies a unique position, because it serve as one of the pre-requisites to the study of Agricultural Science, (DM) Basic Science and Technical Education etc.

Dareng (2000) opined that science teaching now shifts more emphasis to practical, exploratory and experimental work, there is therefore every reason for teachers and learners to explore the immediate environment especially in teaching science subject such as chemistry.

Balogun (2005) advised that in developing learning and teaching materials, the use of learners environment and locally available resources should be used in providing first hand science experience, thus creativity and innovation has not only become a permanent feature of the educational system, but also a handy tool in science which is dynamic .

The use of local materials in science teaching implies the utilization of the scientist's environment, which is a practice in improvisation (Inyang 2010). He advocates the use of local materials in chemistry education. He admitted that Nigerian teachers are yet to devise school-based experiments to illustrate, justify or explain the usage of such materials. He further stressed the values for such experiments not only for teaching chemistry in colleges of education but also application in cement industries.

It is pertinent to emphasize that there is urgent need for chemistry educators to re-examine their present methods of teaching chemistry with a view to adopting an approach that involves largely experimental methods in which effective utilization of available local materials could be used. Though some work have started, it is not yet exhausted since about 57.1% of College of Education chemistry topics can be taught using local resources (Inyang, 2000). Since science is better learned through the process approach, it is important for science teachers to look for teaching and learning resources beyond the normal classroom.

When an electric current is passed through an electrolyte, the free ions lose their random movement. The positive ions become attracted to the cathode which is negative electrode and are known as cations, example are Potassium ion (K^+), Calcium ion (Ca^{2+}) Magnesium ion (Mg^{2+}), Zinc ions (Zn^{2+}) etc. the negative ions move towards the anode (positive electrode) and are called anions, examples are Tetraoxosulphate(VI) acid (SO_4^{2-}) Trioxonitrate(V) acid (NO_3^-) chloride ion (Cl^-) etc.

Results from research studies carried out on resource materials suggest that, it yields greater interest and more positive attitudes (Awolola, 2000). Emphasis on practical activities in science classroom stems from the fact that science (Chemistry) is a practical subject in nature and its progress therefore depends on practical activities and experimentation. It is also true that when learners learn in ways that are natural to them, it brings better academic performance, improves self-esteem and self-confidence. Thus, the use of mineral ore deposits in teaching the concepts of Cations and Anions is an innovation and creativity in science teaching (Nyenwe, 2002).

On this ground, the need to use mineral ore deposit like limestone ore as a resource in teaching the concepts of cations and anions in chemistry is in support of Eshiet (2006) that the environment provides a situation that helps learners to acquire experiences that enhance learning in the affective, psychomotor and cognitive domains.

Statement of the Problem

Qualitative and quantitative analysis are abstract concepts in which students persistently perform poorly (WAEC, 2010 and 2011).

Effective and meaningful teaching and learning of abstract scientific concepts like cations and anions requires active students' involvement in the teaching-learning process through meaningful and relevant hands-on-activities. The harsh economic realities experienced in Nigeria today, coupled with the high cost of standard commercial equipment and chemicals needed for experiments and the increase in enrolment in our schools have made it virtually difficult for the teaching sector to provide enough essential science facilities in our schools, thereby leaving our laboratories as mere demonstration and practical examination centres.

Enoahwu and Umeoduagu (1999) observed that 74% of the needed facilities and chemicals for science teaching were either in short supply or non-existent due to high cost or non-availability of such materials in the market. It is therefore not uncommon to see schools with large students population not utilizing any aid in teaching or during practical classes. This results in poor interest of students in science and consequently high failure rate.

Studies however have shown that improvisation-sourcing, selection and deployment of relevant instructional elements of the teaching/learning process in the absence of shortage of standard or accredited teaching learning elements can always help in filling the gap, especially when the materials are drawn from the learner's local environment (Ekong 1987 and Eshiet 1996).

It may imply that conventional materials and reagents used in the teaching of chemistry may not have helped in enhancing student's academic performance and retention. Therefore it becomes inevitable to try out other learning resources that could enhance effective teaching and learning of chemistry. The problem of this study is how can student's performance and retention in chemistry be enhanced? Will mineral ore deposits (limestone ore) be effective in facilitating student's performance and retention in the concepts of cations and anions in qualitative chemistry? This study sought to use experiments in qualitative analysis and improvised materials in enhancing the teaching and learning of cations and anions. It seeks to provide an example of the utilization of local materials (mineral ore) in the teaching of cations and anions in chemistry.

Purpose of the Study

The purpose of this study was to investigate whether teaching the concept of cations and anions in qualitative chemistry to NCE chemistry students in tertiary institutions using mineral ore deposit (limestone ore) as a teaching resource has advantage on their performance compared to conventional reagents and materials.

The study was designed to achieve the following specific objectives;

1. To determine the chemical components and suitability of mineral ore deposits (limestone ore) in Mfamosing in teaching the concepts of cations and anions.

2. To compare the performance of students taught using mineral ore with those using standard materials and reagents as resources in teaching the concept of cations and anions in qualitative chemistry.

3. To compare the effects of using mineral ore and standard materials and reagents as resources in teaching the concept of cations and anions on students retention in qualitative chemistry.

Hypotheses/Research Question

The study specifically tested one research question and the following null hypotheses at 0.05 level of significance.

Research Question

1. What are the chemical components of mineral ore deposits? And how is it suitable as a teaching resource?

Hypotheses

Ho_1 : There is no significant difference in the mean performance scores of chemistry students taught the concept of cations and anions using mineral ore deposits and those taught using standard materials and reagents as resources.

Ho_2 : There is no significant difference in the mean retention scores of chemistry students taught the concept of cations and anions using mineral ore deposit and those taught using standard materials and reagents as resources.

Research Methods

Research Design

The research design adopted for the study was a non-randomized pretest-posttest control group design.

Sampling and Sampling Technique

A total of 120 students took part in the study using intact classes. Out of a population of 230 students comprising male and female students in the 2012/2013 session in colleges of education in Cross River State. This was made up of 73 males and 47 females. Purposive sampling technique was used to select the colleges from among other colleges. Thecriteria were:

i. College must be co-educational
ii. College must possess well equipped chemistry laboratory
iii. College must have accredited NCE programmes by the National Commission for College of Education
iv. College must have well-staffed and experienced chemistry teachers.

Four (4) colleges met the above criteria two (2) colleges among those that met the above criteria were selected by balloting. The two colleges were randomly assigned to experimental and control groups. These were FCE Obudu and COE Akamkpa. They were 72 students in the experimental group and 48 students in the control group.

Instruments and Validation

Two researcher made achievement test in chemistry (ATC) and chemistry retention test (CRT) were the instruments used for the study. A total of fifty (50) multiple choice items were constructed on the concepts of cations and anions for both instruments used. The instruments were faced and content validated by two chemistry experts. Reliability of the instruments was determined using Kuder-Richardson's formula 21. A reliability index of 0.83 was obtained. The tests were used to determine the performance and retention of students in the concepts using mineral ore deposits (Limestone ore) and standard materials and reagents and teaching resources.

Research Procedure

Chemistry lecturers in each College served as research assistants to teach each group and were trained for one week on the use of the teacher's instructional guide for conduct of experiments that were used for teaching the concept of cations and anions. This was however done in three phrases. Firstly, lecturers were briefed on the modalities of the guide and resource materials to be used for the lesson. Secondly, the researcher demonstrated the experiments using the resource materials and finally the research assistants were asked to teach some students that will not take part in the main lesson using the resource materials.

A pretest was administered on the two groups (experimental and control) for one hour and results used as covariates. After the administration of pretest, the teaching of the concepts cations and anions was done by the research assistants within a period of four (4) weeks in each college using the teacher's instructional guide on experimental detection of cations and anions developed by the researcher. The experimental group was taught the concept using mineral ore (limestone ore) as resource material, while the control group was taught the concept using standard reagents and material. The posttest was administered immediately after treatment to all the groups. Two weeks after the posttest had been given, the retention test was administered.

The fifty multiple choice-questions consisted of three distracters and one correct option; and lettered A-D. The instruments were scored by the researcher immediately after its administration. Each correct answer scored one mark.

The entire exercise was activity based and focused on the identification of metallic radicals or cations. Cations to be identified were calcium ion (Ca^{2+}) Copper II ion (Cu^{2+}) Magnesium ion (Mg^{2+}), Zinc ion (Zn^{2+}) Aluminum ion (Al^{3+}) and Lead ion (Pb^{2+}). Experimental activities were conducted using suitable reagents like sodium hydroxide (NaOH), Ammonium hydroxide (NH_4OH) Potassium iodide (KI) Trioxonitrate(V) acid (HNO_3), Hydrochloric acid (HCl).

Method of Data Analysis

The data collected were analyzed using Analysis of Covariance (ANCOVA) using pretest as covariates. All hypotheses were tested at 0.05 level of significance.

Results

Research Question 1

What are the chemical components of mineral ore deposits? And how is it suitable as a teaching resource?

This was tested using Atomic Absorption Spectrometry (AAS). The results obtained indicated that limestone ore contains metallic oxides and elements in various percentages as indicated below.

Table 1: Percentage Composition of the Constituent Mixture Present In Limestone Ore Sample M (Mfamosing)

OXIDES/ELEMENTS	%COMPOSITION
Na_2O	1.75
K_2O	0.45
CuO	0.1
ZnO	1.015
MnO	2.35
MgO	19.5
PbO	1.001
Fe_2O_3	49.3
$CaCO_3$	90.65
S	1.5
P_2O_5	2.65
SiO_2	25.6
Al_2O_3	0.152

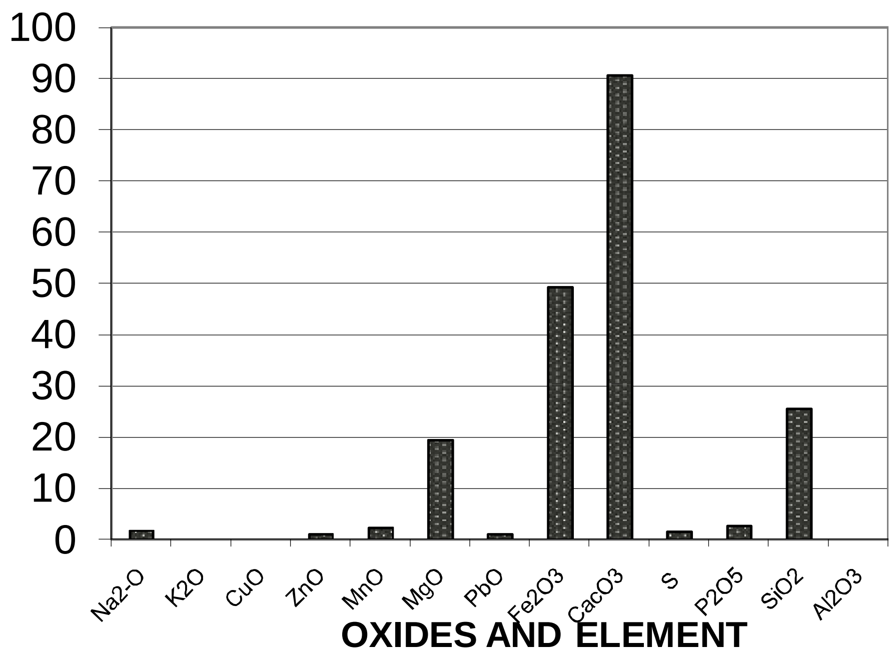
All elements and oxides were determined using atomic absorption spectrometry (AAS).

Make - UNICAM
Type - 939/959
Lab - ALSCON
Laboratory
Location - Ikot Abasi

A bar chart summary of the results on table 1 shows that calcium trioxocarbonate(IV) has the highest percentage composition of 90.65%.

This means that limestone ore is predominantly composed of $CaCO_3$. The observed trend is in agreement with Murray (1980).

Figure 1: Bar Chart Showing the Relative % Distribution of the Oxides and Elements in Sample M (Mfamosing)



Hypothesis one

Ho_1 : There is no significant difference in the mean performance scores of chemistry students taught the concept of cations and anions using mineral ore deposits and those taught using standard materials and reagents as resources.

Table 2: Covariance Analysis (ANCOVA) of Students' Pretest Performance Classified by Resource Materials with Pretest Scores as Covariate

Source	Sum	Df	Mean	F	Sign.	Deci
Corrected Model	6625.	2	3312.	92.0	0.000	*
Intercept	40957	1	40957	113	0.000	*
Pre-test	24.78	1	24.78	0.69	0.409	NS

Resource Materials	6426.	1	6426.	178.	0.000	*
Error	4212.	117	36.01			
Total	48159	120				
Corrected Total	10837	119				

*=significant at 0.05 level of significance

NS = Not significant at 0.05 level of significance

As shown in table 2, the calculated probability value (F-value) 0.000 of the main effect of resource materials was less than the declared Probability value (alpha level) 0.05. Therefore, the null hypothesis was rejected. This implies that there exist a significant difference in the mean performance scores of chemistry students taught the concept of qualitative analysis using limestone Ores and those taught using conventional materials and reagents as resources.

Table 3: Multiple Classification Analysis (MCA) of the Posttest Scores of Students Taught with Limestone ore and those taught with Standard Materials

Grand Mean = 32.55	N	Unadjusted		Adjusted for Independent variable Covariates	
Variable + Category		Dev'n	Eta	Dev'n	Beta
Resource Material					0.63
Limestone Ore	64	3.23		3.01	
Standard Materials	56	-3.69		-3.45	
Multiple R, Squared = 0.56					

Table 3 shows that students taught with limestone ore performed significantly better than those taught with Standard materials. Table 3 also indicates a multiple regression index of R = 0.75 with a multiple regression squared of R2 = 0.56. This implies that 56% of the total variance in the performance of students in Chemistry is attributable to the influence of the resource material used for teaching the concept of cations and anions.

Hypothesis Two: There is no significant difference in the mean retention scores of chemistry students taught the concept of qualitative analysis using limestone Ores and those taught using conventional materials and reagents as resources.

This hypothesis was tested using the results in table 4.

Table 4: Covariance Analysis (ANCOVA) of Students' Retention Scores Classified by Resource Materials with Pretest as Covariates

Source	Sum of Squares	Df	Mean Square	F	Sign.	Deci
Corrected Model	3706.71[a]	2	1853.35	63.2	0.000	*
Intercept	30615.35	1	30615.35	104	0.000	*
Pre-test	11.85	1	11.85	0.41	0.526	NS
Resource Materials	3601.65	1	3601.65	122.	0.000	*
Error	3426.42	11	29.29			
Total	355435.00	12				
Corrected Total	7133.13	11				

*=significant at 0.05 level of significance

NS = Not significant at 0.05 level of significance

As shown in table 4, the calculated F-value 0.000 of the main effect of resource materials was less than alpha level 0.05. Therefore, the null hypothesis was rejected. This implies that there exist a significant difference in the mean retention scores of chemistry students taught the concept of qualitative analysis using limestone Ores and those taught using conventional materials and reagents as resources.

Discussion of Results

Chemical analysis of the components of the mineral ore (limestone ore) showed that it was a mixture of elements and oxides in various concentrations or percentages. The constituents mixtures composed of Na_2O, $CaCO_3$, ZnO, Fe_2O_3, PbO, S, P_2O_5, CuO, MnO, MgO, SiO_2 and Al_2O_3, with this result, metallic elements present are calcium (Ca) Zinc (Zn) Magnesium (Mg) Lead (Pb), Copper (Cu), Iron (Fe), Aluminum (Al) and Silver (Ag). It was therefore a suitable resource material in teaching the concept of cations.

In activity 1 which was identification of calcium ion (Ca^{2+}) and Magnesium ion (Mg^{2+}) in the sample. A dirty white precipitate was obtained which was insoluble in excess sodium hydroxide solution confirming Ca^{2+} and Mg^{2+} ions. This was in agreement with the works of Ojukuku (2001), emphasizing that all basic metallic radicals (cations) are identified by the formation of precipitates on the addition of a suitable reagent to the solution of the substance.

In activity 2 which was identification of Aluminum ion (Al^{3+}) and Zinc ion (Zn^{2+}) in the sample. A white precipitate was obtained soluble in excess ammonia solution, confirming the presence of Zinc ion (Zn^{2+}).

In activity 3, Copper II ion (Cu^{2+}) was also confirmed with the formation of a deep blue colouration and so also Iron II (Fe^{2+}) forming a dark green precipitate, insoluble in excess sodium hydroxide solution.

The results of hypothesis one showed that a significant difference was found to exist between the performances of students taught the concept of cations and anions using Mineral ore (limestone ore) as a resource material and those taught using standard materials. Findings resulting from the testing of this hypothesis as presented in table 1 showed that the resource material (mineral ore) had a significant main effect $P < 0.05$. This is because the calculated probability value (P-value) 0.000 of the main effect was less than the declared probability value (178.49)

The results also showed that 56% of the total variance in the performance of students in chemistry was attributed to the influence of the resource material used in teaching the concept of cations and anions. This might be due to the fact that using local materials from the environment as resource in teaching, provides concrete basis for conceptual thinking and thus facilitates better and proper understanding of chemistry concepts. Also, using local materials from the environment as a resource for teaching enhances students' interest and attitude towards the subject due to the nature of activities in the class. The above findings appeared consistent with those of Nworgu (2003) and Alonge (2001) that resource materials from the environment were effective in enhancing achievement.

The results of hypothesis two showed that a significant difference was found to exist in the mean retention scores of chemistry students taught the concept of cations and anions using mineral ore (limestone ore) and those taught using standard materials and reagents as resources. As shown in the table, the calculated P-value .000 of the main effect was less than the declared probability value (122.98). The above findings appeared consistent with those of Nworgu (2003), Obi (2000) and Ezeliora (2001). These studies pointed out that resource material from the environment were effective in enhancing performance and retention in science.Concrete objects provide concrete basis for conceptual thinking and thus facilitate better and proper understanding of chemistry concepts.

Conclusion

Based on the results of the study, it can be concluded that Mineral ore deposit (limestone ore) also facilitates student's performance and retention in the concept of cations and anions in qualitative analysis.

Recommendations

Based on the results of the study, the following recommendations were made:

i. Chemistry lecturers/teachers should explore the use of limestone ore in teaching various concepts in chemistry.
ii. Textbook authors should draw examples like mineral ore from

the environment in presenting materials and activities in their books.

iii. Lecturers/Science teachers should endeavour to use resources from the environment alongside standard materials and chemicals in teaching various concepts in chemistry.

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