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Chemical Analysis of Improvised Limestone Ore Concentrate: A Resource for Teaching the Concept of Qualitative Analysis in Practical Chemistry

Ugbe, Agioliwhuugbe Ph.D[1], Charles Igiri Egonyi[2]

[1]Chemistry Department, Cross River State College of Education, Akamkpa, Nigeria

[2]Department of Integrated Science, Cross River State College of Education, Akamkpa, Nigeria

Abstract: ***The study on chemical analysis of improvised limestone ore concentrate in the teaching of qualitative analysis, through the deployment of materials within the learners immediate environment was undertaken to find a solution to persistent shortage of learning resources for the teaching of chemistry in secondary schools. A total of one hundred and twenty (120) senior secondary (III) chemistry students were involved in the study. This number was made up of 62 females and 58 males from four secondary schools in Ogoja Educational zone of Cross River State of Nigeria. Four research hypotheses and three research questions were formulated to guide the study. The instruments used in gathering data for the study were chemistry achievement test (CAT) and chemistry retention test (CRT). A non-randomized pretest-posttest control group design was adopted for the study. Kuder-Richardson formular-21 was used to establish the reliability of chemistry achievement test and the reliability showed a reliability coefficient of 0.82. Data collected were analyzed using descriptive statistics, one-way analysis of variance (ANOVA) and analysis of covariance (ANCOVA). From the findings, it was observed that improvised limestone ore concentrate is a suitable sample in teaching the concept of qualitative analysis in practical chemistry. It was also observed that improvised limestone ore concentrate had significant main effect on students' performance and retention in the concept of qualitative analysis in practical chemistry. There was no significant difference in the performance of male and female students when taught the concept of qualitative analysis using improvised ore concentrates. Conclusions from the findings led to the recommendations that chemistry teachers should adopt local resource within their environment to teach various concept in chemistry.***

Keywords: improvised resources, qualitative analysis, retention, academic performance, Gender

1. Introduction

The relevance of science and technology to National aspirations and economy explains to a large extent, the huge commitment and support which most nations make to scientific and technological developments. (Olagunju, 2010: Iroegbu & Ige, 2003). This is because one of the indices of global leadership is a nation's capacity to employ modern technologies to meet its national needs. Modern development is no longer possible outside the framework of science and technology hence the need to teach science effectively in schools.

Although the history of improvisation in science teaching as reported by Osuagwu (1982) was meant to help needy schools in war-torn countries improvise for their needs after World War II (UNESCO Report, 2000). Improvisation is now imperative due to the absence or shortage of science equipments and materials as well as being a driving force for teachers and students to utilize their cognitive, affective and psychomotor domains in the study of science. Improvisation is a way of widening inquiry, curiosity, creativity and productive application of intellect. It reduces the bad attitudes of some teachers dodging topics due to absence or insufficient science equipment or materials.

One of the pioneer researchers and advocate of the use of local materials in chemistry education is Alonge(2003) who had admitted that we are yet to devise school-based experiments to illustrate, justify or explain the usage of materials. He noted that little or no use has been made of locally available material resources or chemicals in chemistry teaching. Reasons for non-utilization could be deduced from the following: ignorance on the part of the teachers, resourcefulness and fear of accuracy in the course of chemistry experiments involving the use of local materials. (Etuk, 2012).Balogun (2005) advised that in developing learning and teaching materials, the use of learner's environment and locally available resources should be used in providing first hand science experience.Results from research studies carried out on resource materials suggest that, it yields better retention and transfer of more positive attitudes (Awolola, 2000). Resource play an important role in boosting the teaching and learning of science as they serve to stimulate thinking and concretize student learning (Ige, 2008)

Osiyale (2018) defines resources as all persons and things capable of conveying information, values, processes, experiences and techniques that could be used to actively engage the students in the learning process. In the school system, there are five types of resources namely:

1) Human resources which include teachers, student and non-academic staff
2) Physical resources such as school buildings etc.
3) Materials resources like chalk, blackboard, textbooks, laboratory, equipment and teaching aids.
4) Financial resources such as fees, subvention, capital and recurrent expenditure and levies.
5) Time resource such as school calendar time for practical classes, assignment and project. (Eshiet, 1993).

These resources become integrated for effective communication of science directly or indirectly for the achievement of set objectives in any teaching and learning situation. Thus science teaching can only be meaningful if backed up by necessary resources to enhance skill development.

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, self-confidence and improves basic skills. Thus the use of improvised limestone ore concentrates in teaching qualitative analysis is in line with the current curriculum innovation (Nyenwe, 2002).

Enoahwa and Umeoduagu (2013) observed that 74% of the needed facilities and chemicals for science teaching were either in short supply or non-availability of such materials in the market. It is therefore not uncommon to see school with large students' population not utilizing any aid in teaching or during practical classes, this results in dwindling interest of students in science and consequently high failure rate. WAEC examiners report (2017 and 2018) have shown failure rate in chemistry to be 32.33% and 56.1% respectively. To tackle this problem Ezendu (2000) observed that the best way to help the students to learn is to teach them with the local material they are familiar with.

Studies have confirmed the effectiveness of the use of local materials as a resource in science teaching in general and chemistry in particular. Akusoba (2005) pointed out that the value of laboratory work, as a means of involving students in concrete experience with objects and concepts cannot be over-emphasized.Students also interpret data as well as appreciate the nature of science.

2. Statement of the problem

Chemistry is a science built on the foundation of experiments and experimental observation (Weisman, 2002). During the last two decades, science educators have advocated that the process of science should be taught as an integral part of the science curriculum. They had argued that acquisition of science skills should be a major goal of science education especially that the search for scientific knowledge is process oriented. (Awodi, 1994. Gagne, 1968).

According to Archibong (2017), any science teaching strategy in which students are involved in activities, be it exercise, laboratory work or 'let' find out exercise is conceptualized as activity approach and should be encouraged. The need for science teachers especially chemistry to be highly creative and resourceful by using learning materials within the local environment is imperative. The deficiency in the teaching of chemistry concepts could be traced to lack of teaching and learning resources in our classrooms, (Nwosu, 2000). Also chemistry teachers have not been able to utilize learning resource within their environment to enhance teaching and learning of practical chemistry. (Umoren, 2002).

Students have difficulties with practical chemistry and their performance at external examinations has continued to dwindle year by year in Nigeria. This poor performance may be due to inadequate teaching facilities and learning materials.Studies have shown that improvisation through sourcing, selection and deployment of relevant instructional elements of the teaching learning process in the absence or shortage of standard or accredited teaching learning materials can always help in filling the gap especially when the materials are drawn from the learner's local environment. (Eshiet, 2002).

Conventional or standard reagents and materials used in teaching practical chemistry may not have helped in enhancing students' academic performance in practical chemistry. Therefore it become inevitable to try out other learning resources that could enhance effective teaching and learning of practical chemistry. The problem of the study is how can students' performance and retention be enhanced in practical chemistry? Will improvised limestone ore concentrates also be effective in facilitating students' performance and retention in practical chemistry? This work seek to provide an example of the utilization of local materials in the teaching of qualitative analysis in practical chemistry.

3. Purpose of the Study

The study was designed to achieve the following specific objectives:

1) To determine the suitability of improvised limestone ore concentrates in teaching the concept of qualitative analysis in practical chemistry.
2) To determine the extent to which the use of improvised limestone ore concentrates in teaching the concept of qualitative analysis enhances students' performance in practical chemistry.
3) To compare the performance of students taught using improvised limestone ore concentrates with those using standard instructional materials as resources in teaching the concepts of qualitative analysis in practical chemistry.
4) To compare the effect of using improvised limestone ore concentrate and standard instructional materials as resources in teaching the concept of qualitative analysis on student's retention in practical chemistry.
5) To determine the influence that will have on gender on the performance of chemistry students on the concept of qualitative analysis when taught using improvised limestone ore concentrates and standard materials as resources.

Research questions

Inorder to guide the study, the following research question were raised in the study.

1) To what extent are chemistry teachers aware of the use of improvised limestone ore concentrate as a resource material for teaching the concept of qualitative analysis in practical chemistry?
2) To what extent is the improvised limestone ore concentrates suitable in teaching the concept of qualitative analysis in practical chemistry?

3) What differences exists among the mean performance scores of chemistry students taught the concept of qualitative analysis using improvised limestone ore concentrates and those taught using standard materials as resources?
4) What differences exists among the mean retention scores of chemistry student taught the concept of qualitative analysis using improvised limestone ore concentrate are those taught using standard material.
5) What differences exists between the mean performance scores of male and female chemistry students taught the concept of qualitative analysis using improvised limestone ore concentrates and those taught using standard materials?

Research Hypotheses

The study specifically tested the following null hypotheses at 0.05 level of significance.

1) Improvised limestone ore concentrate is not a suitable mixture of chemical substances for use in teaching concept of qualitative analysis
2) There is no significance difference in the mean performance scores of chemistry student taught the concept of qualitative analysis using improvised limestone ore concentrates and those taught using standard materials.
3) There is no significance difference in the mean retention of chemistry students taught the qualitative analysis using improvised limestone ores and those taught using standard material.
4) There is no significance difference in the mean performance scores of male and female chemistry students taught the concept of qualitative analysis using improvised limestone core concentrate and those taught using standard materials as resources.

Research methods

Research design

The research adopted a non-randomized pretest-posttest control group design.

Area of study

The study was conducted in Ogoja Educational Zone, which cover schools from Ogoja, Yala, Obudu and Obanlikwu Local Government Areas.

Population

The population was all the senior secondary school chemistry students in Ogoja Educational zone of Cross River State. This class was chosen because the students had registered chemistry as a subject in their senior secondary school examination and also with National Examination council (NECO). A total of 1,200 student representing all SS III chemistry students in schools of Ogoja educational zone of cross river state made up the population.

Sample and sampling technique

Purposive sampling technique was used to select schools from the target population. The criteria were:

1) Schools that are currently presenting candidates for the senior schools certificate examinations
2) Schools that have teachers in chemistry with at least three years teaching experience.
3) Schools that have chemistry laboratory for practical.

Eight schools met the above criteria. A random sampling technique through the use of balloting was carried out to select four schools among those that met the above criteria. The four schools were randomly assign to treatment and control groups on the whole one hundred and twenty students (120) made up the sample size of the study.

Instruments and validation

Two researchers made chemistry achievement test (CAT) and chemistry retention test (CRT) were the instruments used for data collection. A total of (25) multiple choice items were constructed on the concept of qualitative analysis for chemistry achievement test and retention test. The instruments were faced and content validated by two chemistry lecturers in University of Uyo.

Reliability of the instrument were determined using Kuder-Richardson formula -21. A reliability index of 0.82 was obtained, and on the basis of the high reliability index the instruments were deemed suitable to be used in conducting the research.

Research procedure

The following procedure was followed for the administration of the instruments. Permission was obtained from the schools principals as well as the chemistry teachers in each of the schools used for the study. Chemistry teachers in each of the schools formed the research assistants and were trained on the use of resource materials using the teacher's instructional guide.Pretest was administered prior to treatment to all the two groups and the results were used as covariate measures.

After one week, the concept qualitative analysis using improvised limestone ore concentrates as a resource was taught by the research assistants to the experimental groups from a well- articulated and validated lesson package developed by the research. The control group was taught using standard materials. The teaching was done for four weeks of double periods of chemistry practical per week. One week later, posttest was administered to the two groups (experimental and control) for one hour using twenty five item test. Three week after the posttest had been given the retention test was administered which was a reshuffled version of chemistry achievement test. (Posttest)

Method of data analysis

The data collected were analyze using descriptive statistics andanalysis of covariance (ANCOVA) using pretest scores as covariates. All hypotheses were tested at 0.05 level of significance.

4. Results and Discussion

The research questions were answered using mean and standard deviations.

Research question one
What differences exists between the mean performance scores of male and female chemistry students taught the concept of qualitative analysis using improvised limestone ore concentrates and those taught using standard materials?

Table 1: Summary of Mean, Mean gain and standard deviation of pretest and posttest scores of experimental and control groups by types of resources materials and gender

Gender	Resource material	N	Pretest scores		Posttest scores		Mean gain
			$\bar{X}$	SD	$\bar{X}$	SD	Scores
Male	Improvised limestone ore concentrates & standard materials.	30	18.33	3.86	36.60	4.27	18.27
		34	18.00	3.38	29.11	3.00	11.11
Female	Improvised limestone ore concentrates & standard materials	28	18.50	3.91	35.35	3.99	16.85
		28	18.00	3.73	28.96	3.00	10.96

As shown in table 1 it was observed that the mean post-test scores of male and female chemistry students taught with improvised limestone ore concentrates were greater than the mean posttest scores of male and female chemistry students taught with standard in the teaching of the concept of qualitative analysis. From the same data, it was observed that the mean gain scores of male and female chemistry students taught with improvised limestone ore concentrates were greater than the mean gain scores of male and female chemistry students taught with standard materials.

Research question two (2)
What differences exist among the mean performance scores of chemistry students taught the concept of qualitative analysis using improvised limestone ore concentrates and those taught using standard materials as resources?

Table 2: Mean and standard deviation scores of students taught using improvised limestone ore concentrates and those taught using standard materials

Group	N	Pretest		Posttest		Mean
		$\bar{X}$	SD	$\bar{X}$	SD	gain
Experimental	62	24.66	7.98	69.81	5.67	45.15
Control	58	22.95	7.25	54.97	6.32	32.02
Total	120	23.83	7.65	62.63	9.54	38.80

As shown in table 2 the mean gain (45.15) of the experimental group (students taught improvised limestone ore concentrates) is greater than the mean gain (32.02) of the control group (students taught with standards). This indicates that students taught using improvised limestone ore concentrates as a resource performed better than their counterparts taught using standards.

Research Question 3
What differences exists among the mean retention scores of chemistry students taught the concept of qualitative analysis using improvised limestone ore concentrate and those taught using standard?

Table 3: Mean and standard deviation score of experimental and control group

Group	N	Pretest		Posttest		Mean
		$\bar{X}$	SD	$\bar{X}$	SD	Gain
Experimental	62	24.66	7.98	59.24	4.94	34.58
Control	58	22.95	7.25	48.14	5.85	25.19
Total	120	23.83	7.65	53.89	7.74	30.04

Table 3 showed that the mean gain (34.58) of the experimental group is greater than the mean gain (25.19) of the control group. This indicates that students taught using limestone ore concentrate as a resource retained better than their counterpart taught using standards.

Testing of Research Hypotheses
The following hypothesis were tested of 0.05 level of significance.

Hypothesis one
Improvised limestone ore concentrate is not a suitable mixture of chemical substance for use in teaching the concept of qualitative analysis

Table 4: Analysis Result of Metallic ion concentration in improvise limestone ore

Improvised limestone	Ca^{2+}	Zn^{2+}	Mg^{2+}	Al^{3+}	Cu^{2+}	Pb^{2+}	Ag^{+}	Fe^{2+}
Ore concentrate	1006.36	6.94	475.26	1.634	5.81	2.30	003	234.61

Make: UNICAM
Type: 939/959
ALSCON Laboratory
Location: IkotAbasi

Table 4 shows the metallic ion concentration of the ore concentrates. Chemical analysis of the ore concentrates reveals that it contains metallic ions of various concentration with this result the null hypothesis which stated that improvised limestone ore concentrate is not a suitable mixture of chemical substance for use in teaching the concept of qualitative analysis was rejected.

Hypothesis (II)
There is no significant difference in the mean performance scores of chemistry students taught the concept of qualitative analysis using improvised limestone ore concentrates and those taught using standard materials.

Table 5: Analysis of Covariance (ANCOVA) of the performance of students taught with improvised limestone ore concentrates and those taught with standards using pretest as covariates.

Source of variation	SS	DF	MS	F	Decision at P<.05
Pretest	512.79	1	512.79	44.10	*
Main effect	1220.56	1	1220.56	104.98	*

Explained	1733.34	2	866.67	74.54	*
Residual	1360.36	117	11.63		
Total	3093.70	119	24.00		

Significant P<.05alpha level.
Critical F- value =3.12.

Table 5 shows that the resource material main effect was significant at P<.05. The calculated F-value 104.98 was greater than the critical F-value 3.12. Therefore, the null hypothesis what stated that there is no significant difference between the performance of students taught the concept of qualitative analysis using improvised limestone ore concentrate and those taught using standard as resources was rejected. This implies that there existed a significant difference between the mean performance scores of students taught with improvised limestone ore concentrate and those taught with standard materials.

Hypothesis (III)
There is no significant difference in the mean retention scores of chemistry students taught the concept of qualitative analysis using improvised limestone ore concentrates and those taught using standard materials.

Table 6: Covariance Analysis (ANCOVA) of student'sretention scores classified by resource materials with pretest as covariates

Source	Some of square	DF	Mean square	F. sig of. f	Decision
Corrected model	3706.71	2	1853.35	63.29 .000	*
Intercept	30615.35	1	30615.35	1045.41.000	*
Pretest	11.85	1	11.85	0.41 .526	NS
Resource materials	3601.65	1	3601.65	122.98 .000	*
Error	326.42	117	29.29		
Total	355435.00	120			
Corrected total	7133.13	119			

*= significant at .05 level of significance
NS=Not significant at .05 of significance

As shown in table 6, the calculated F-value .000 of the main effect of resource materials was less than alpha level of .05.Therefore, the null hypothesis was rejected. This implies that there exist a significant difference in the mean retention score of chemistry student taught the concept of qualitative taught using improvised materials

Hypothesis (IV)
There is no significant difference in the mean performance scores of male and female chemistry students taught the concept of qualitative analysis using improvised limestone ore concentrates and those taught using standard materials as resources.

Table 7: One way analysis of covariance of the mean performance of male and female student taught with ore concentrates using pretest as covariates

Source of variation	SS	DF	MS	F	Decision at P<.05
Pretest	195.04	1	195.04	12.31	*
Main effect	15.65	1	15.65	0.99	NS
Explained	210.96	2	105.34	6.65	*
Residual	966.25	61	15.84		
Total	1176.94	63	18.68		

Significant atP<.05 alpha level
Critical F- value =3.99.

Table 7 shows that the gender main effect was not significant at P<.05**.** The calculated F-value, 0.99 was less than the critical F-value, 3.99. Since the calculated F-value was less, the null hypothesis which stated that there is no significant difference in the mean performance score of male and female chemistry students taught the concept of qualitative analysis using improvise limestone ore concentrates and those taught using standard material as resources was accepted. This implies that there existed no significant difference in the mean performance of male and female chemistry students taught using different resource materials.

5. Discussion of Result

The results were discussed under the following headings provided.

Laboratory findings
Investigation of the metallic ion concentration of the improvised limestone ore concentrates reveals that it consists of the following metallic ions: $Ca^{2+,}$ Zn^{2+} Mg^{2+}, Al^{3+}, Cu^{2+}, Pb^{2+}, Ag^{+}, and Fe^{2+}. This is in agreement with the earlier works of Maxwell (2013) emphasizing that all mineral salts contains metallic ions for detection in qualitative analysis.

Suitability of improvised limestone ore as a resource material
To what extent is the improvised limestone ore concentrate suitable in teaching the concept of qualitative analysis in practical chemistry?

As shown in table 4, findings resulting from the testing of this hypothesis revealed that the improvised limestone ore is a mixture of metallic ions composed mainly the cations in various concentrations. This finding agrees with the previous works of Murray (2001).

Effectiveness of resource materials on students' academicperformance and retention
There is no significant difference in the mean performance scores of chemistry students taught the concept of qualitative analysis using improvised limestone ore concentrates and those taught using standard materials

Findings from the testing of the hypothesis as presented in table show that the resource material (improvised limestone ore) had a significant main effect at P<.05. This is because the calculated 104.98 was greater than the critical F-value of 3.12.

The above finding appeared consistent with those of Nworgu (2000) Ezerliora, (2005). These studies pointed out that resource materials from the environment were effective in enhancing achievement and interest in science. (Chemistry) concrete objects provides concrete basis, conceptual thinking and this facilitate better and proper understanding of chemistry concepts.

Effect of gender on resource material
There is no significant difference in the mean performance scores of male and female chemistry students taught the

concept of qualitative analysis using improvised limestone ore concentrates and those taught using standard materials as resources.

The results of the findings as revealed in table 7 shows that gender main effect was not significant at $P<.05$ alpha level. As the calculated F-value 0.99 was less than the critical F-value 3.99. The finding shows that male and female students performed equally. This might be due to the enthusiasm exhibited by both male and female students who showed equal zeal when they were taught with improvised ore concentrate.

This is in line with previous studies carried out by Meziobi(2009) who posited that there was no significant difference between the achievement levels of boys and girls in the learning of selected science concept

6. Conclusion

On the basis of the findings in the study it can be concluded that improvised limestone ore concentrate was a suitable sample for use in teaching the concept of qualitative analysis in practical chemistry. Also there existed a significant difference between the performance of students taught with the ore concentrates improvised as a resource and those taught with standard. Results also indicated that there existed no significant difference in the performance of male and female students when taught with different resource materials

7. Recommendations

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

1) Chemistry teachers should explore the use of local resource materials within their immediate environment to teach various concepts in chemistry.
2) Seminars/workshops should be organized for chemistry teacher to appraise them with limestone ore concentrate in the learning and teaching of chemistry.

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