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Chemical Analysis Of Ore Crude Mixture And Its Application In Teaching The Concept Of Separation Of Mixtures In Practical Chemistry

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Abstract: ***The purpose of the study was on the chemical analysis of ore crude mixtures and its application in teaching the concept of separation of mixtures in practical chemistry. A total of 120 NCE I chemistry students were involved in the study. This number was made up of 73 males and 47 females drawn from two Colleges of Education, Akwa Ibom and Cross River States of Nigeria. Three research hypotheses and four research questions were formulated to guide the study. The instruments used in gathering data for the study were Achievement Test in Chemistry (ATC), Chemistry Retention Test (CRT) and Cognitive Ability Test (CAT). 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). The reliability coefficient of ATC and CAT were 0.83 and 0.78 respectively. Data collected were analyzed using descriptive statistics and Analysis of Covariance (ANCOVA) and Scheffe post-hoc analysis was used to obtain the direction of significance. From the findings, it was observed that the chemical component of ore crude mixtures were effective in teaching the concept of separation of mixtures in practical chemistry. It was also observed that ore crude mixture had significant main effect on students' performance in the concept of separation of mixtures in practical chemistry. Cognitive ability levels had significant effect on students' performance and retention in the concept of separation of mixtures in practical chemistry. The results showed that students with high reasoning ability level performed significantly better than average and low ability level students. Conclusion from the findings led to the recommendation that chemistry lecturers should explore the use of local resource materials within their immediate environment to teach various concepts in practical chemistry.***

Keywords: Ore Crude, Mixture, Separation of Mixture, Cognitive Ability Levels

I. INTRODUCTION

Extensive use has been made of the rich deposit of ore crude mixtures of Jos, Nkalagu and Itakpe iron ore mixture in steel development, agriculture and also cement production. It could also serve as a potential resource in the teaching of science concepts in the chemistry curriculum.

The present age of science and technology lays much emphasizes on the teaching of science, stressing the importance of science teaching in a nation which is poised for technological advancement. Fafunwa (2000) remarked that whether we like it or not, we are living in a worlds culture and any country that overlook this significant truism does so at its own peril. The present inadequacy and in some serious situations near absence of teaching aids, laboratory equipments, reagents and chemicals are well known to us. Nwoji (2000) showed from empirical study that such essential facilities like chemicals, specimens, radio, television, models etc. are not available in schools. She further observed that even where some of these can be obtained, the teachers are not competent in using them.

Dareng (2003) opined that science teaching now shifts more emphasizes 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 practical chemistry. In the words of Okebukola (1997) making science learner -friendly means processing or packaging science in a way that learners will find an encounter with the subject attractive enough to make them thirst for another encounter. He further said that is seen as fewer students choose to study science subjects when compared to arts and social science subjects. Thus, science especially chemistry should be exploring to obtain result and as a child explores, he acquires the scientific skills and attitudes that will result to meaningful learning.

Salau (2003) suggested that the problem of poor performance in schools and in public examinations seems to loom larger and larger because science is still being taught in abstract level by some teaches. Odor and Azeke (2002) are of the opinion that teachers should not use their inadequacies or lack of equipments as an alibi to indulge in poor teaching. The use of local materials in making the learning of science delightful is stressed by Murray (2001). It is believed that if local materials are effectively used, it will motivate the learners depending on how the learners perceive and pays attention to the local materials used.

Balogun (2002) advised that in developing learning and teaching materials the use of learner's environment and locally available resources should be used in providing firsthand science experience. Based on this, improvisation and substitution in science teaching in Nigeria became more urgent and relevant. Thus innovation in science teaching-learning is normal and a continuous process. Many science educators like Alonge (2013) and Eshiet (1996) had advocated the use of local materials in science teaching they further stressed that the use of local materials in science teaching implies the utilization of the scientist environment which is a practice in improvisation. It is a way of widening inquiry, curiosity, creativity and productive application of intellect.

The importance of separations in chemistry cannot be over emphasized, in determining the composition of a chemical sample, it is frequently necessary to separate some or all of the components before attempting their quantitative measurement. Emphases 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 ores mixture in teaching separation of mixture is in line with the current curriculum innovation Nyenwe (2002).

On this ground, the need to use ore crude mixture as a resource in teaching the concept of separation of mixtures in practical chemistry is in support of Dareng (2003) that the environment provides a situation that helps learners to acquire experiences that enhance learning in affective, psychomotor and cognitive domains.

STATEMENT OF THE PROBLEM

The concept of separation of mixture and separation techniques has been an area of great concern to the chemist, because the entire environment is made up of chemical substances that need separation for man's benefit.

Chemistry as a science course is activity-based and the suggested method for teaching it, which is guided – discovery is resource-based NPF (2014). This suggests that the mastery of chemistry concepts cannot be fully achieved without the use of learning materials in teaching chemistry. So the teaching of chemistry without learning materials will certainly result to poor achievement and lack of interest in the subject.

Researchers like Nwosu (2001) and Agusiobo (2000) stated that there are inadequate teaching resources for the teaching of science subjects or courses in both public secondary and tertiary schools in Nigeria.

Effective and meaningful teaching and learning of scientific concept like separation of mixtures 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 and large increase in students enrolment in our schools have made it virtually impossible for the government at the state levels and other stakeholders in the teaching sector, to provide essential science facilities in our schools thereby leaving our laboratories as mere demonstration and practical examination centres where available.

There is deficiency in the teaching of chemistry in Nigeria schools and this could be traced to lack of effective teaching and learning resources in our classroom, Nwosu (2001). Also science teachers have not been able to utilize learning resources within the environment to enhance teaching and learning of science Umoren (2002).

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 elements can always help in filling the gap especially when the materials are drawn from the learner's local environment Eshiet (1996).

It may imply that conventional materials and reagents used in teaching of chemistry may not have helped in enhancing students' 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 students' performance and retention in practical chemistry be enhanced? Will ore crude mixture also be effective in facilitating students' performance and retention in the concept of separation of mixtures in practical chemistry? This work seeks to provide an example of the utilization of local materials in the teaching of separation of mixtures in practical chemistry.

PURPOSE OF THE STUDY

The purpose of this study is to investigate whether teaching the concept of separation of mixtures in practical chemistry to NCE I chemistry students in tertiary institutions using ore crude mixtures as a teaching resource has advantage on their performance compared to conventional reagents and materials.

The following specific objectives were stated as follows:

- ✓ To determine the concentration and composition of ore crude mixtures in four deposit sites.
- ✓ To compare the performance of students taught using ore crude mixture and standard iron filling and sulphur as resources in teaching the concept of separation of mixtures in practical chemistry.
- ✓ To compare the effects of using ore crude mixture and standard iron fillings and sulphur as resources in teaching the concept of separation of mixtures on students' retention in practical chemistry.
- ✓ To assess the effects of cognitive ability levels (high, average and low) on students' performance in the concept of separation of mixtures in practical chemistry when taught with ore crude mixtures and standard iron fillings and sulphur.

RESEARCH QUESTIONS

In order to guide the study, the following research questions were raised in the study.

- ✓ Would ore crude mixture be suitable in teaching the concept of separation of mixture?
- ✓ Are chemistry teachers aware of the use of ore crude mixture as a resource material for teaching the concept of separation of mixtures in practical chemistry?
- ✓ To what extent can ore crude mixture be compared with conventional iron filling and sulpur?
- ✓ To what extent will the concept of ore crude as a mixture influence students' performance in practical chemistry?

RESEARCH HYPOTHESES

Based on the research questions, the following hypotheses were formulated

- ✓ Samples of ore crude mixtures are not suitable resource materials of chemical substances for use in teaching the concept of separation of mixtures.
- ✓ There is no significant difference in the performance of students when taught the concept separation of mixture using ore crude mixture as a resource compared to a mixture of iron fillings and sulphur.
- ✓ There is no significant difference in the mean performance scores of chemistry students with high average and low cognitive ability levels taught the concept of separation of mixture using ore crude mixtures and those taught using conventional materials and reagents as resources.

II. RESEARCH METHODS

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

SAMPLE AND SAMPLING TECHNIQUE

The sample of the study was one hundred and twenty (120) students drawn from the population of year 1 NCE Chemistry students in Colleges of Education in Cross River State and Akwa Ibom State respectively using intact classes.

Purposive sampling technique was used in selecting the Colleges of Education from among other colleges. The criteria are:

- ✓ The college must be co-educational offering Chemistry/Education with other options.
- ✓ The college must possess well equipped Chemistry laboratory.
- ✓ The college must have accreditated NCE programmes by the National Commission for Colleges of Education. (NCCE)
- ✓ The college must have well-staffed and experienced Chemistry lecturers.

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 treatment and control groups

INSTRUMENTS AND VALIDATION

Three researchers made Achievement Test in Chemistry (ATC), Cognitive Ability Test (CAT) and Chemistry Retention Test (CRT) were the instruments used for the study. A total of (50) multiple choice items were constructed on the concept of separation of mixtures for the Achievement Test in Chemistry and Retention Test. Cognitive Ability Test was also constructed to determine the cognitive ability levels of the subjects used for the study. The instruments were faced and content validated by two chemistry experts. Reliability of the instruments were 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 concept using ore crude mixtures and standard materials as 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 teachers instructional guide for conduct of experiments that were used for teaching the concept of separation of mixtures. This was however done in three phases. 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 resources 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 pre-achievement test was administered prior to treatment to all the two groups and result were used as covariates. After the administration of the pre – achievement test, the cognitive ability test was administered to all the groups through the help of the research assistants, and results used to classify students into three groups of ability levels using inter-quartile range.

After the administration of the cognitive ability test, the teaching of the concept, separation of mixtures was done by the research assistants within a period of six weeks in each college using the teacher's instructional guide, the

experimental group was taught the concept using ore crude mixture as resource materials, while the control group was taught using iron fillings and sulphur. The posttest was administered immediately after the treatment to all the groups.

Three weeks after the posttest had been given, the retention test was administered.

The fifty multiple choice-questions consisted of three distractors and one correct option 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 separation of liquids/solids and metallic radicals.

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.

III. RESULTS AND DISCUSSION

Research question 1

Would ore crude mixture be suitable in teaching the concept of separation of mixture?

This was tested using Atomic Absorption Spectrometry, (AAS), the results showed that ore crude contains metallic oxides and mixture of elements in various percentages as indicated below.

OXIDES/ELEMENTS	%COMPOSITION
Na_2O	1.50
K_2O	1.71
CuO	2.30
ZnO	3.01
MnO	2.20
MgO	19.1
PbO	1.30
$Fe2O_3$	40.20
$CaCO_3$	90.51
S	1.20
P_2O_5	2.00
SiO_2	26.1
Al_2O_3	0.50

Table I: Percentage Composition of the Constituent Mixture Present in Ore Sample E (Ewekoro)

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

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

HYPOTHESES

HYPOTHESIS ONE

Sample of ore crude mixtures are not suitable resource materials of chemical substances for use in teaching the concept of separation of mixtures.

The results are presented in table 2

Oxide/ Elements	% Composition
Na_2o	1.75
K_2o	0.15
Zno	1.15
Cuo	0.1
Mno	2.35
Mgo	2.25
Pbo	19.5
Fe_2o_3	1.001
$Caco_3$	90.65
S	49.3
P_2o_5	1.5
Sio_2	2.15
Al_2o_3	25.6

Table 2: Percentage Chemical Composition of Ore Crude Mixture (Itakpe)

Atomic Absorption Spectrometry (AAS).

Make_ UNICAM

Type_ 939/ 959

Table 2 shows the percentage chemical composition of ore crude mixture. Chemical analysis of the ore reveals that it was a mixture of elements and compounds in various compositions. With this result the null hypothesis which stated that ore crude mixture is not a suitable mixture of chemical substances for use in teaching the concept of separation of mixtures was rejected.

HYPOTHESIS TWO

There is no significant difference in the performance of students when taught the concept separation of mixtures using ore crude mixture as a resource compared to a mixture of iron fillings and sulphur.

Source of variation	SS	DF	MS	F	Decision at P<0.05
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**	**23.00**		

** = Significant at P<0.05 alpha level critical F value = 3.12*

Table 3: Analysis of covariance (ANCOVA) of the performance of students taught with ore crude mixture and those taught with iron fillings and sulphur using pretest as covariates

Table 3 shows the resource material main effect was significant at P< 0.05. The calculated F- value, 104.98 was greater than the critical F- value, 3.12, therefore the null hypothesis which stated that there is no significant difference between the performance of students taught the concept of separation of mixtures using ore crude mixtures as a resource material compared to a mixture of iron filings and sulphur was rejected. This implies that there existed significant difference between the performance of students taught with ore crude mixture and those taught with iron filings and sulphur.

However, consequent upon the existence of significant difference in the performance of chemistry students taught with ore crude mixture and those taught with iron filings and sulphur, it was necessary to consider the multiple classification analysis (MCA) of the two levels of the resource materials for teaching, to determine the specific contribution

of the levels of resource materials to the gain in student's performance in practical chemistry.

Grand mean = 32.55	**N**	**Unadjusted**	**Adjusted for independent variable and covariates**	
Variable + category		Dev'n Eta	Dev'n	Beta
		0.68		0.63
Resource material				
Ore crude mixture	64	3.23	3.01	
Iron filings And sulphur	56	-3.69	-3.45	

Multiple R =0.75
Multiple R^2=0.56

Table 4: Multiple classifications (MCA) of the performance of students taught with ore crude mixture and those taught with iron filings and sulphur

Table 4 shows a multiple regression index of R = 0.75 with a multiple regression squared of (R^2) =0.56. This implies that 56% of the total variance in the performance of students in practical chemistry was attributable to the influence of the resource material used for teaching the concept of separation of mixtures.

HYPOTHESIS 3

There is no significant difference in the mean performance scores of chemistry students with high, average and low cognitive ability levels taught the concept of separation of mixture using ore crude mixtures and those taught using conventional materials as resources.

This hypothesis was tested using the results in table 5.

Source	Sum of Squares	df	Mean Square	F	Sign. of F	Decision
Corrected Model	8129.01[a]	6	1354.84	56.52	.000	*
Intercept	39664.00	1	39664.00	1654.58	.000	*
Pre-test	4.31	1	4.31	180.00	.672	NS
Resource Materials	4790.12	1	4790.12	199.82	.000	*
Cognitive Ability	402.05	2	201.02	8.39	.000	*
Resource * Cognitive Ability	611.74	2	305.87	12.76	.000	*
Error	2708.86	113	23.97			
Total	481590.00	120				
Corrected Total	10837.87	119				

**=significant at .05 level of significance*

Table 5: Covariance Analysis (ANCOVA) of Students' Posttest Performance Classified by Cognitive Ability Level with Pretest as Covariate

NS = Not significant at .05 level of significance

As shown in table 5, the calculated F-value (.000) of the main effect of cognitive ability level was less than the declared alpha level (.05). Therefore, the null hypothesis was rejected. This implies that there exist a significant difference in the mean performance scores of chemistry students with high, average and low cognitive ability levels taught the concept of separation of mixtures using ore crude mixture and those taught using conventional iron filings and sulphur as resources.

In order to determine the direction of significance, a Scheffe' Pairwise Comparison test was done and the results are summarized in table 6.

(I) Students' Reasoning Ability	(J) Students' Reasoning Ability	Mean Difference (I-J)	Std. Error	Sign at P<.05
High	Average	.01	1.36	.996
	Low	4.41*	1.51	.004
Average	High	-.01	1.36	.996
	Low	4.41*	1.12	.000
Low	High	-4.41*	1.51	.004
	Average	-4.41*	1.12	.000

**Significant at P < 0.05 alpha.*

Table 6: Summary of Scheffe' Posthoc Comparison of Students' Posttest Scores Classified by Reasoning Ability with Pretest as Covariate

The mean differences shown in table 6 are 0.01 for high and average reasoning ability; 4.41 for high and low ability, and 4.41 for average and low ability. The levels of significance displayed in table 6 indicated that students in high reasoning ability level performed significantly better than their counterparts in low reasoning ability level. Students in average reasoning ability level also performed significantly better than those in low ability level. However, the mean difference between high and average was not significant.

IV. DISCUSSION OF RESULTS

The results of the research findings are discussed here to show the implication for teaching and learning of practical chemistry. The results are discussed under the headings provided.

LABORATORY FINDINGS

Chemical analysis of the composition of the ore crude mixture reveals that it was a mixture of elements and oxides in various concentrations or percentages. The constituent mixture composed of Na_2o, $CaCO_3$, ZnO, CuO, MnO, MgO, PbO, Fe_2O_3, S, P_2O_5, SiO_2 and Al_2O_3.

In activity 1 after the dissolution of the sample substance in distilled water, separation was achieved through filtration separation technique. The insoluble substance mainly calcium trioxocarbonate (iv) $Caco_3$ was left in the filter paper while the solution contained other compounds. This is in line with the works of Ojokuku (2011), emphasizing that all trioxocarbonate (iv) salts are insoluble, except those of sodium, potassium and ammonium.

In activities 2, 3 and 4 separation was carried out using precipitation method of separation followed by filtration. In activity 2, there was a spontaneous reaction when dilute HCl was added to the sample solution, leading to the precipitation of lead chloride ($PbCl_2$), which was subsequently filtered off. Also in activity 3, a blue gelatinous precipitate was formed when dilute HCl was added to the sample solution followed by ammonia solution to give aluminum hydroxide $Al(oH)_3$ which was subsequently filtered off.

SUITABILITY OF ORE CRUDE MIXTURE AS A TEACHING RESOURCE

Samples of ore crude mixtures are not suitable mixture of chemical substances for use in teaching the concept of separation of mixtures.

As shown in tables 1 and 2, findings resulting from the testing of this hypothesis revealed that the ores were a mixture of chemical substances, composed of oxides and elements in various concentrations and percentages. This findings agrees with the previous works of Murray (2001).

EFFECT OF RESOURCE MATERIALS ON STUDENTS' PERFORMANCE

There is no significant difference in the performance of students when taught the concept separation of mixtures using ore crude mixtures as a resource compared to a mixture of iron filings and sulphur.

Findings from the testing of this hypothesis as presented in table 3 show that the resource material (ore crude mixture) has a significant main effect at $P< 0.05$.

This is because the calculated F- value 104.98 is greater than the critical F- value 3.92.

Multiple classification analysis (MCA) as shown in table 4 revealed a multiple regression index of R = 0.75 with a multiple regression squared of $R^2 = 0.56$ implying that 56% of the total variance in the performance of students in practical chemistry was attributable to the influence of resource material used for teaching the concept of separation of mixtures. The above findings 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. Concrete objects provide concrete basis, conceptual thinking and thus facilitate better and proper understanding of chemistry concepts.

Models and resource materials engender student's interest and enhance achievement due to the nature and level of activities in the class, Ezeliora (2005).

EFFECT OF COGNITIVE ABILITY LEVELS ON STUDENTS' PERFORMANCE IN PRACTICAL CHEMISTRY

Another area of concern in this study was to find out the effect of cognitive ability levels on student's performance and retention in the concept of separation of mixture in practical Chemistry.

The result of the investigation as shown in table 5 indicated that, a significant difference was found to exist in the mean performance scores of chemistry students with high, average and low cognitive ability levels taught using ore crude mixture and those taught using conventional materials and reagent as resources.

In order to find the order of effectiveness of cognitive ability levels and direction of significance under investigation, Scheffe Multiple Comparison Test was employed for post hoc analysis as shown in table 6. The result showed that, high cognitive ability level was the most effective in facilitating students' performance in the concept of separation of mixture in Chemistry. This was followed by average cognitive ability level while low cognitive ability level was the least effective in facilitating student's performance in the concept of separation of mixture in practical Chemistry.

The results of the investigation as shown in table 5 indicated that, a significant difference was found to exist in the mean retention scores of Chemistry students with high, average and low cognitive ability levels taught the concept of separation of mixture using ore crude mixture and those taught using conventional iron filings and sulphur. In order to find the order of effectiveness of cognitive ability levels and direction multiple comparison test was employed for the post hoc analysis as shown in Table 6. The result showed that high cognitive ability level was the most effective in facilitating student's retention in the concept of separation of mixture in practical Chemistry. This was followed by average cognitive ability level while low cognitive ability level was the least effective in facilitating students' retention in the concept of separation of mixture in practical Chemistry. However, non-significant difference exists between average and low cognitive ability levels. Hence, resource material (crude ore mixture) was able to bridge the retention gap between low and average cognitive ability levels of Chemistry Students.

The resource materials used (crude ore mixture) enable the students to acquire various scientific skills through hands-on activities and enhances the intellectual and aesthetic understanding of the nature of scientific concepts. Also, high ability learners were more intelligent than the low or average ability learners in solving test in science courses Adeyemo (2012). Intelligence, according to Adeyemo (2012) is the general level of cognitive functioning as reflected in the ability to understand ideas and to utilize abstract symbols in the solution of intellectual problem.

The result is also in agreement with the findings of Inyang and Ekpenyong (2000). Eze (2002) and Orimogunji (2003) that, students ability level is a significant factor in their performance in Chemistry units studied and a significant difference exists between the mean post-test and pre-test scores among students of different ability levels in the learning and understanding of Chemistry concepts. The research is also consistent with the research findings of Emily and Michael (2003) that there was a significant difference between the achievements of high and low ability students. Also, the result is in line with the findings of Adeyemo (2012) that student's ability levels have significant influence on problem solving tasks.

V. CONCLUSIONS

Based on the results of this study, it can be concluded that ore crude mixture also facilitates student's performance in the concept of separation of mixtures in practical chemistry. Also high cognitive ability level is the most effective in facilitating student's performance in the concept of separation of mixture followed by average cognitive ability level and low cognitive ability level.

The use of ore crude mixture as a teaching resource in this study has been found to close the gap between low and

average cognitive ability levels. Hence, the resource materials improve student's performance in the concept of separation of mixtures. Eshiet I. T. (2006). Safety in the Science Laboratory in the concept of separation of mixtures.

VI. RECOMMENDATIONS

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

- ✓ Chemistry lecturers should explore the use of ore crude mixtures to teach various concepts in practical chemistry.
- ✓ Textbook authors should draw examples like ore crude mixture from the environment in presenting materials and activities in their textbooks.
- ✓ Seminars/workshops should be organized for chemistry lecturers to appraise them with the utilization of resources like ore crude in the teaching and learning of practical chemistry.

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