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# Analytical Studies and Identification of Water Pollutants in Quarry and Oil Zones: A Resource for Teaching the Concept of Pollution in Environmental Chemistry

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**Abstract:** ***The purpose of the study was on the chemistry of well water sources and its application in the teaching of the concept of pollution and pollutants. A total of 120 SS 2 Chemistry students were involved in the study. This number was made up of 73 males and 47 females drawn from four (4) secondary schools, 3 research hypotheses and 4 research questions were formulated 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 use to establish the reliability of Achievement Test in Chemistry (ATC). The reliability coefficient of ATC and CRT was 0.76. Data collected were analyzed using Descriptive Statistics and Analysis of Covariance (ANCOVA). From the findings, it was observe that the chemical components of well water sources were effective in teaching the concept of pollution and pollutants in environmental chemistry. It was also observe that well water sources had significant main effect on students' performance and retention in the concept of pollution and pollutants in environmental chemistry. There was also a significant difference in the performance of male and female students when taught the concept of pollution and pollutants using well water sources. Conclusion from the findings led to the recommendation that chemistry teachers should explore the use of local resource materials within their immediate environment to teach various concepts in sciences and indeed chemistry.***

**Keywords:** Pollution, Pollutants, Environmental chemistry, Retention, Academic performance

## 1. Introduction

The major aim of science teaching is to promote the understanding of the concepts being taught with a view of applying knowledge of such understanding in real life situation (Nwagbo, 2001). The National Policy on Education (FRN, 2014) emphasizes that science taught in our schools should be such that it will have meaning and relevance to the needs of the child and society and provide the child the opportunity to explore, interact with and interpret certain scientific processes going on in his environment.

Akpan (2004) consider chemistry as the most important of the physical sciences that directly affects man's everyday life. The chemist work with nature and attempts to unlock nature's secret by seeking answer to many questions that affect man's existence (Koach&Kedd, 2017). Ironically, despite the perceived importance of chemistry in technological development, research reports show that the academic performance of students in secondary schools has been consistently poor especially in chemistry. (Oloyede, 2004) (Ojukuku and Amadi, 2010).

Evidences from the works of (Boujaoude&Barakat, 2000) attributed the poor performance in chemistry to inadequate exposure of students to basic chemistry concepts, the abstract nature of chemistry, its conceptual demands, its relatedness to mathematics, student's attitude towards the subject,instructional materials and incompetent teachers.Nwagbo, (2001) contends that teachers shy away from activity – oriented teaching methods which are known to be effective and rely on the teaching methods that are easy but most times inadequate and inappropriate.

Balogun (2016) advised that in developing learning and teaching materials, the use of learners' environment and locally available resources should be used in providing firsthand experience. By so doing, students will come to appreciate that science is not only studied for the purpose of passing examination, but also as pre – requisite for further courses in which the basic knowledge of science is needed. This will be in line with the new curriculum which emphasizes the development of students problem solving skills, manipulative skills, scientific attitudes, interest and appreciation (FRN, 2014). Based on this, improvisation and substitution in science teaching in Nigeria, becomes more urgent and relevant.

Many science educators like (Alonge, 2003 and Eshiet, 2016) had advocated the use of local materials in science teaching. A checklist of local material and their utilization in chemistry teaching are found in the works of (Iyang, 2017). Ikeobi (2017) says that 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.

The continual change of concentration levels of certain substances in the environment is due mainly to man's activities. For some of those substance like carbon iv oxide, some trace metals like cadmium, mercury, lead and arsenic, their fluxes from anthropogenic sources are approaching and exceeding the natural levels, and this has generated and stimulated a lot of interest in pollution studies.

Pollution is defined by the Webster's Seventh New Collegiate Dictionary (1967) as "defilement, impurity, state of being pullulated, desecrated, profane, make dirty, destroy the purity or sanctity of". GESAMP (Joint Group of Experts on the scientific Aspects of Marine Pollution) defines pollution as:

*Introduction by man, directly or indirectly of substance or energy into an environment resulting in such deleterious effects as harm to living resources, hazards to human health hindrances to marine activities including fishing, impairing of quality for use of sea water and of reduction of amenities? (GESAMP, 1980).* It implies that pollution is caused by introducing into the environment substances and energy which have adverse effects, and pollution may be related to its sources and polluting substances are dispersed through the environment by various processes. These polluting substances (pollutant) disappear into sinks and are affected by receptors.

There are many types of pollution (UNEP, 2002), and the classification depends on what is being polluted or polluting substances. A common type of pollution is air pollution which is prevalent in Urban areas. This is due to the presence in the atmosphere of certain substance like sulphur oxides (SOx) Nitrogen Oxides (NOx), hydrocarbons (HCs) suspended particulate matter (SPM) and carbon II oxide (CO). Water pollution arises as a result of the presence of Nitrate ($NO_3$) from fertilizer run off, gross organic pollutants, sewage and industrial effluents resulting in high Biochemical Oxygen Demand (BOD).

Marine pollution is an interesting type that arises mostly from oil spills. It is predominant and well known especially in the Niger Delta of Nigeria. Chemical pollution is caused by certain substances e.g. Polychlorinated Biphneyls (PCBS), Dichloro – DiphenylTrichloroethane (DDT) (Pb) lead, (Hg) mercury which are potent environmental hazards. Polluting substances resulting in negative effects are called pollutants and sometimes the negative effects are not observable but there is the presence of an undesirable substance(s) which is referred to as contamination. A contaminant can become a pollutant through bio – accumulation and bio magnification.

## 2. Statement of the Problem

The concept of pollution has been an area of great interest in environmental science. The chemist views it in terms of toxicity of pollutants and their concentrations in various forms. Pollutionand pollutants are often abstract concepts which students persistently perform poorly in (WAEC, 2011, 2012).

Effective and meaningful teaching and learning of abstract scientific concepts like pollution and pollutants require active student's involvement in the teaching – learning process through meaningful and relevant hands – on – activities. The harsh economic realities experienced in Nigeria today, couple with the high cost of standard commercial equipments 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 meredemonstration and practical examination centres where available.

Studies however have shown that improvisation-sourcing, selection and deployment of relevant instructional elements of the teaching 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 (Ekong, 2001, Eshiet, 1996).

The problem of this study is how can students' performance and retention in environmental chemistry be enhanced? Will analysis of water pollutants also be effective in facilitating students' performance and retention in the concept of pollution in environmental chemistry? This research seeks to provide an example of the utilization of local materials in the teaching of pollution and pollutants in environmental chemistry.

## 3. Purpose of the study

The purpose of this study was to investigate whether teaching the concept of pollution and pollutants in environmental chemistry to senior secondary school chemistry students using different sources of "well" water as a teaching resource has advantage on their performance compared to standard pollution reagents.

The study was designed to achieve the following objectives.
1) To determine the concentration of pollutants in four different sites of well water.
2) To compare the performance of students taught using well water pollutants and standard sources as resources in teaching the concept of pollution and pollutants in environmental chemistry.
3) To compare the effects of using well water pollutants and standard sources as resources in teaching the concept of pollution and pollutants on students' retention in environmental chemistry.

**Research questions**

In order to guide the study, the following research questions were raised in the study.
1) Would well water samples be suitable in teaching the concept of pollution and pollutants?
2) What differences exists among the mean performance scores of chemistry students taught the concept pollution and pollutants using well water sources and those taught using conventional materials as teaching resources?
3) What difference exist among the mean retention scores of chemistry students taught the concept of pollution and pollutants using well water sources and those taught using conventional material, as teaching resources.
4) What differences exist between the mean performance scores of male and female chemistry students taught the concept of pollution and pollutants using well water and

those taught using conventional materials as teaching resources.

**Research hypotheses**

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

$Ho_1$: There is no significant difference in the mean performance scores of chemistry students taught the concept of pollution and pollutants using well water and those taught using conventional materials as teaching resources.

$Ho_2$: There is nosignificant difference in the mean retention scores of chemistry students taught the concept of pollution and pollutants using well water and those taught using conventional materials as teaching resources.

$Ho_3$: There is no significant difference in the mean performance scores of male and female chemistry students taught the concept of pollution and pollutants using well water and those taught using conventional materials as teaching resources.

**Research methods**

**Research design**

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

**Area of the study**

This was conducted in CalabarEducational Zone of Cross River State. There are three major Educational Zones in Cross River State namely Ikom, Ogoja and Calabar Educational Zone, which covers schools from Calabar south up to central.

**Population of the study**

The population was all the senior secondary two (SSII) chemistry students in Calabar Educational Zone of Cross River State. This class was chosen because the students had chosen chemistry as a subject in their Senior School Certificate Examination (SSCE) or the National Examination Council (NECO). A total of three hundred and fifty (350) students comprising both male and female students made up the population for the study.

**Sample and sampling technique**

The sample of the study was one hundred and twenty (120) students drawn from the population of SSII chemistry students using intact classes.

Purposive sampling technique was used in selecting the schools from among the other schools. The criteria were:

1) Schools that are currently presenting candidates for the Senior Secondary School Certificate Examination (SSCE) or National Examination Council (NECO).
2) Schools that have graduate teachers in chemistry with least three years teaching experience.
3) Schools that have well equipped chemistry laboratories.

Eight schools met the above criteria and 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 assigned to treatment and control groups.

**Instruments and validation**

Two researchers made instruments were used for data collection, namely Achievement Test in Chemistry (ATC) and Chemistry Retention Test (CRT). A total of twenty five (25) multiple choice items were constructed on the concept of pollution and pollutants for the Achievement Test in Chemistry and Chemistry Retention Test. The instruments were faced and content validated by two lecturers in the department of science education. University of Calabar.

Reliability of the instruments were determined using Kuder – Richardson's formula – 21. A reliability index of 0.76 was obtained. The test was used to determine the performance and retention of students in the concept of pollution and pollutants using well water samples and conventional materials as teaching resources.

**Research procedure**

The following procedure was followed for the administration of the instruments. Relevant permission was obtained from the school principal as well as the chemistry teachers in each schools used for the study. Chemistry teachers in each school formed the research assistants.

Pretest was administered prior to treatment to all the two groups and the results used as covariates measures. After one week, the concept pollution and pollutants using well waters as teaching resources was taught by the research assistants to the experimental groups from a well – articulated and validated lesson package developed by the researchers. The control group was taught using standard pollution materials. The teaching was done for four weeks of double periods of chemistry per week. One week later, posttest was administered to the two groups (experimental and control) for one hour using twenty five item test. Three weeks 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 analyzed using descriptive statistics and analysis of covariance (ANCOVA) using pretest scores as covariates. All hypotheses were tested at 0.05 level of significance.

## 4. Result and discussion

**Research question**

The four research questions were answered using mean and standard deviation.

**Research Questions**

**Research Question One**

Would well water samples be suitable in teaching the concept of pollution and pollutants?

**Table 1:** Analysis of well water samples Contaminated Wells

| Contamination characteristics | Well A (Rivers State) | Well B (AkwaIbom State) | Well C (Cross River State) | Well D (Ebonyi State) |
|---|---|---|---|---|
| Potential source of contamination and nutrient parameters | Domestic sewage in drains | Dry battery containageMn and Zn | Lead acid accumulator cells | Quarry effluents |
| Temp $^0$C pH | 25.5 | 25.2 | 26.5 | 25.6 |
| pH value | 7.1 | 6.5 | 6.3 | 7.0 |
| Do mg/l | 4.8 | 5.2 | 4.7 | 6.5 |
| $Po_4^{3-}$ mg/l | 18.4 | 0.5 | 0.8 | 1.5 |
| $No_3^-$ mg/l | 22.7 | 6.0 | 6.3 | 4.0 |
| Mn (ii), Mg/l | 0.05 | 93.4 | 0.14 | 0.05 |
| Zn, Mg/l | 0.10 | 56.2 | 13.20 | 0.3 |
| Total Iron, Mg/l | 0.04 | 0.12 | 0.14 | 0.2 |
| Pb(ii), Mg/l | 0.005 | Trace | 46.30 | Trace |
| Bacteria present | 0.500 | Coliform | Coliform | |
| Per 100ml/sample | Cholera califoron bacteria TNTC | Bacteria T.N.T.C | Bacteria $4.1 \times 10^{-7}$ | Trace |

All nutrient parameters for the four sample, were determined using Atomic absorption spectrometry (AAS).

Make - UNICAM
Type - 939/959
Lab of source VICAM Laboratory

The results of the analysis of water for each well showed clearly the effects of the contaminants. Well A (Rivers State) was contaminated by domestic sewage and oil spillage by speepage hence the values for Virbro cholera and coliform containments were too numerous to count. (T.N.T.C). The values for phosphate and nitrate were also high for wells B and C. Mn, Zn and Pb were found to be present – Well D (Ebonyi State). Analysis of their well water reflected high values for the metals.

**Research Question Two**

What differences exists among the mean performance scores of chemistry students taught the concept of pollution and pollutants using well water sources and those taught using conventional materials and reagents as sources? This research question was answered using mean and standard deviation as presented in table 2.

**Table 2:** Mean and Standard Deviation Scores of Students Taught Using Well Water Sources and those taught using Conventional Materials and Reagents

| Group | N | Pretest | | Posttest | | Mean Gain |
|---|---|---|---|---|---|---|
| | | X | SD | X | SD | |
| 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 using well water sources) is greater than the mean gain (32.02) of the control group (students taught using conventional materials and reagents). This indicates that students taught using well water sources as a resource performed better than their counterparts taught using conventional materials and reagents.

**Research Question Three**

What differences exists among the mean retention scores of chemistry students taught the concept of pollution and pollutants using well water sources and those taught using conventional materials and reagents as sources?

Mean and standard deviation was used in answering this research question as presented in table 3.

**Table 3:** Mean and Standard Deviation Scores of Experimental and Control Group

| Group | N | Pretest | | Posttest | | Mean Gain |
|---|---|---|---|---|---|---|
| | | X | SD | X | SD | |
| 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 | 53.87 | 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 indicate that students taught using well water sources as a resource retained better than their counterparts taught using conventional materials and reagents.

**Research Question Four**

What is the mean performance scores of male and female chemistry student taught the concept of pollution and pollutants using well water sources and those using conventional materials and reagents as resources. Mean and standard deviation was used in answering this research question as presented in table 4.

**Table 4:** Mean and Standard Deviation Scores of Experimental and Control Group Based on Gender

| Group | Gender | N | Pretest | | Posttest | | Mean Gain |
|---|---|---|---|---|---|---|---|
| | | | X | SD | X | SD | |
| Experimental | Male | 38 | 25.29 | 8.19 | 69.32 | 5.59 | 44.03 |
| | Female | 24 | 23.67 | 7.70 | 70.58 | 5.85 | 46.91 |
| Control | Male | 35 | 22.66 | 6.73 | 56.63 | 5.98 | 33.97 |
| | Female | 23 | 23.39 | 8.10 | 52.43 | 6.09 | 29.04 |
| Total | Male | 73 | 24.03 | 7.59 | 63.23 | 8.58 | 39.92 |
| | Female | 47 | 23.83 | 7.82 | 61.70 | 10.91 | 37.67 |

Table 4 showed that the mean gain (46.91) of female students in the experimental group was greater than the mean gain (44.03) of their male counterparts in the same group while in the control group, the mean gain (33.97) of male students was greater than the mean gain (29.04) of their female counterparts. On the, whole the table showed that the mean gain (39.92) of male students was greater than the mean gain (37.17) of their female counterparts.

**Testing research hypotheses**

The following three hypotheses were tested at 0.05 level of significance.

Hypothesis one

**Hypothesis One:** There is no significant difference in the mean performance scores of chemistry students taught the concept of pollution and pollutant using well water sources and those taught using conventional materials and reagents as resources.

This hypothesis was tested using the results in table 5.

**Table 5:** Covariance Analysis (ANCOVA) of Students' Pretest Performance Classified by Resource Materials with Pretest as Covariate

| Source | Sum of Squares | Df | Mean Square | F | Sign. of F | Decision |
|---|---|---|---|---|---|---|
| Corrected Model | 6625.04[a] | 2 | 3312.52 | 92.00 | .000 | * |
| Intercept | 40957.91 | 1 | 40957.91 | 1137.50 | .000 | * |
| Pre-test | 24.78 | 1 | 24.78 | 0.69 | .409 | NS |
| Resource Materials | 6426.97 | 1 | 6426.97 | 178.49 | .000 | * |
| Error | 4212.83 | 117 | 36.01 | | | |
| Total | 481590.00 | 120 | | | | |
| Corrected Total | 10837.87 | 119 | | | | |

*=significant at .05 level of significance

NS = Not significant at .05 level of significance

As shown in table 5, the calculated probability value (F-value) .000 of the main effect of resource materials is less than the declared Probability value (alpha level) .05. Therefore, the null hypothesis is rejected. This implies that there exist a significant difference in the mean performance scores of chemistry students taught the concept of pollution and pollutants using well water sources and those taught using conventional materials and reagents as resources.

**Hypothesis Two:** There is no significant difference in the mean retention scores of chemistry students taught the concept of pollution and pollutants using well water sources and those taught using conventional materials and reagents as resources.

This hypothesis was tested using the results in table 6.

**Table 6:** Covariance Analysis (ANCOVA) of Students' Retention Scores Classified by Resource Materials with Pretest as Covariates

| Source | Sum of Squares | Df | Mean Square | F | Sign. of F | Decision |
|---|---|---|---|---|---|---|
| Corrected Model | 3706.71[a] | 2 | 1853.35 | 63.29 | .000 | * |
| Intercept | 30615.35 | 1 | 30615.35 | 1045.41 | .000 | * |
| Pre-test | 11.85 | 1 | 11.85 | 0.41 | .526 | NS |
| Resource Materials | 3601.65 | 1 | 3601.65 | 122.98 | .000 | * |
| Error | 3426.42 | 117 | 29.29 | | | |
| Total | 355435.00 | 120 | | | | |
| Corrected Total | 7133.13 | 119 | | | | |

*=significant at .05 level of significance

NS = Not significant at .05 level of significance

As shown in table 6, the calculated F-value .000 of the main effect of resource materials was less than alpha level .05. Therefore, the null hypothesis is rejected. This implies that there exist a significant difference in the mean retention scores of chemistry students taught the concept of pollution and pollutants using well water sources and those taught using conventional materials and reagents as resources.

**Hypothesis Three:** There is no significant difference in the mean performance scores of male and female chemistry students taught the concept of pollution and pollutants using well water sources and those taught using conventional materials and reagents as resources. This hypothesis was tested using the results in table 10.

**Table 7:** Covariance Analysis (ANCOVA) of Students' Posttest Scores Classified by Gender with Pretest as Covariate

| Source | Sum of Squares | Df | Mean Square | F | Sign. of F | Decision |
|---|---|---|---|---|---|---|
| Corrected Model | 6902.543[a] | 4 | 172.64 | 50.43 | .000 | * |
| Intercept | 40152.18 | 1 | 40152.18 | 1173.35 | .000 | * |
| Pre-test | 34.54 | 1 | 34.54 | 1.01 | .317 | NS |
| Resource Materials | 6640.76 | 1 | 6640.76 | 194.06 | .000 | * |
| Gender | 58.49 | 1 | 58.49 | 1.71 | .194 | * |
| Resource Materials* Gender | 224.96 | 1 | 224.96 | 6.57 | .02 | * |
| Error | 3935.32 | 115 | 34.22 | | | |
| Total | 481590.00 | 120 | | | | |
| Corrected Total | 10837.87 | 119 | | | | |

*=significant at .05 level of significance

NS = Not significant at .05 level of significance

As shown in table 7, the calculated probability value (F-value) .194 of gender was less than alpha level .05. Therefore, the null hypothesis was rejected. This implies that there exist a significant difference in the mean performance scores of male and female chemistry students taught the concept of pollution and pollutants using well water sources and those taught using conventional materials and reagents as resources.

## 5. Discussion of Result

The results of the research findings were discussed under the following subheadings.

a) Chemical components of well water sources
b) Effect of teaching resource materials on students' performance and retention in environmental chemistry.
c) Effect of gender on students' performance and retention in environmental chemistry.

1) Chemical components of well water sources: Chemical analysis of the components of the well water sources showed clearly the effects of the contaminants ranging from oil spillage to phosphates and nitrates. The constituents mixture of contaminants comprise of oxides and elements in various concentrations. $Po4^{3-}$, $No_3^-$, Mn, Zn, Fe and Pb.
2) Effect of resource materials on students' performance and retention in environmental chemistry. The result of investigation as shown in table 5 implies that a significant difference was found to exist in the mean performance scores of chemistry students taught the concept of pollution and pollutants using well water sources and those taught using standard pollution materials. Findings resulting from the testing of this hypothesis as presented in table 5 showed that the resource material (well water sources) had a significant main effect of P<.05. This is because the calculated probability value (P – value) .000 of the main effect was less than the declared probability value (178.49). Also the results of the investigation as shown in table 6 indicated that a significant was found to exist in the mean retention scores of chemistry students taught the concept of pollution and pollutants using well water sources and those taught using standard pollution materials as resources. Findings resulting from the testing of the hypothesis as presented in table 6 show that the calculated P-value .000 of the main effect was less than the probability value (122.98). The above findings appeared consistent with those of Nworgu (2003), Obi (2000)and Ezeliora (2001). These studies pointed out that resources from the environment were effective in enhancing performance and retention in science. Concrete objects provide concrete basis for conceptual thinking and thus facilitates better and proper understanding of environmental chemistry concepts. This study is also in line with the works of Eshiet (1996) that the environment is the largest and most complex laboratory ever imagined. Natural man – made fixtures and field activities are available everywhere in the environment. The entire environment is a mixture of several substances that can be used in teaching certain concepts in science.
3) Effect of gender on students' performance and retention in environmental chemistry: Another are of concern in this study was to investigate the effect of gender on students' performance and retention in the concept of pollution and pollutants in environmental chemistry after being taught with well water sources and standard pollution materials. The results of investigation as shown in table 7 indicated a significant difference in the mean performance scores of male and female chemistry students taught the concept of pollution and pollutants using well water sources compared to standard pollution materials. As shown in the table, the calculated P – value. 194 is less than the alph.05, also the results of investigation as shown in table 7 indicated that there is a significant differences in the mean retention scores of male and female chemistry students.

The result is consistent with the research findings of Wambugu and Changeiyo (2018) that gender had a significant influence on students' performance in chemistry. They noted that every learner both male and female must be given the opportunity to display his/her manipulative ability once they are taught with the same resources materials. This is because good performance of students depends on their interest as well as the technique used by the teacher and the types of resource materials involved. This study is also in line with the findings of Popoola (2010) that a significant gender difference exists in the performance of male and female students in science and mathematics.

## 6. Conclusion

Based on the results of the study, it can be concluded that well water sources also facilitates students' performance and retention in the concept of pollution and pollutants in environmental chemistry, gender has a significant effect on students' performance and retention in the concept of pollution and pollutants in environmental chemistry.

## 7. Recommendations

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

1) Chemistry teachers should explore the use of various well water sources in teaching various concepts in environmental chemistry.
2) Science teachers should endeavor to use resources from their environment alongside conventional materials in chemistry.
3) Seminars/workshops should be organized for chemistry teachers to educate them on the utilization of resources like well water sources in the teaching and learning of environmental chemistry.

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