Innovations

Using ethno-chemistry approach to improve students' achievement in chemistry: A case study of senior secondary school students in Delta State

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Abstracts

The major crux of this study is to determine the effect of ethno-chemistry approach on students' achievement in chemistry. Three research questions and their corresponding hypotheses were raised and formulated, respectively. The study design was the pretest–post-non-equivalent control group quasi-experimental design. Sample size consisted of one hundred and twenty-five senior secondary school 11 chemistry students in Delta state. The instrument for data gathering was the Separation Technique Achievement Test (STAT). Proper validation and reliability were done before it was utilized. The collected data were tested using mean, independent sample t-test and analysis of variance. The study findings include; (i) significant difference in the achievement scores between ethno-chemistry and lecture groups' students, (ii) non-significant difference in mean achievement scores between the male and female students taught using ethno-chemistry, (iii) a non-significant interaction effect of method and sex on students' achievement in chemistry. Therefore, it was concluded that ethno-chemistry is a good alternative for teaching chemistry and recommended that the method be used in teaching all chemistry students irrespective of school type based on sex.

Keywords: *1. Ethno-Chemistry; 2.Approach; 3. Students Achievement; 4.Chemistry; 5.Senior Secondary School Students.*

Introduction

From the social constructivism viewpoint, meaningful learning occurs when an interaction or interface exists between learners themselves, their environment, and their past knowledge. According to Ausubel's theory of meaningful learning, learners meaningfully learn if what is to be learnt is related to what is previously known. What is previously known serves as a scaffold to the new knowledge. Observation and experience have

exposed that the methodology employed or applied in science teaching in general and chemistry, in particular, is devoid of the premises stated by the theory. This fact is buttressed by the persistent poor performances of chemistry students yearly recorded by WAEC and NECO chief examiners report. In addition, the research of O'dwyr (2012) showed that chemistry is a complex or difficult subject for all students at all levels. Ugwu and Diovu (2016) believed that the abandonment or relinquishment of society's indigenous or home-grown knowledge and practices in science teaching, and learning makes chemistry abstract. Ugwu (nd) believes that the solution to this problem is that, indigenous or home-grown knowledge and practices should be employed to deliver the chemistry curriculum concept because the usage of indigenous knowledge, this type of teaching strategy may enhance the comprehension of the chemistry concept. This teaching strategy which applies indigenous knowledge is called ethno-chemistry. Ethno-chemistry is the usage of practices of particular cultural/ethnic groups due to their dealings with environmental problems/challenges and activities utilising their ideology (Ajayi, Achor and Agogo, 2017). Said-Ador (2017) believed that integrating ethno-chemistry practices into the school programme or curriculum may help preserve and appreciate students' cultural heritage quality and provide meaningful learning. Literature has shown the usefulness of ethno-chemistry in chemistry teaching. When the ethno-chemistry method is employed in chemistry teaching, most chemistry concepts will no longer be seen as abstract, and significant learning will occur.

According to Sigh and Bit well (2016), indigenous or local chemically related practices may make unfamiliar chemistry concepts familiar to students. They gave the following as some of the practices that could be utilised in chemistry concepts teaching: fermentation of corn or maize grains in the traditional production of alcohol may be utilised when teaching the production of ethanol by fermentation in organic chemistry, distillation phase in same ethno-chemical practice may be utilised when teaching students distillation technique of separating liquid from a soluble solid. Also, the traditional or local practices of black-smiting can be employed when teaching iron extraction in the blast furnace. More so, the traditional process of making table salt (NaCl) can be used when teaching the preparation of soluble salt such as zinc sulphate from zinc granules and dilute sulphuric acid, and this, according to him, can also be utilised when teaching filtration technique or procedure of separating an insoluble/undissolvable solid from a liquid. Moreover, charcoal burning knowledge and skill can be employed when teaching incomplete and complete combustion.

Similarly, Ajayi (nd) also suggested that in the mixture separation stage of brine, brine production traditionally can be utilised to teach standard mixture/blend separation approaches or techniques such as filtration and decantation. In this study, the following practices were utilised to teach the following separation techniques: filtration, decantation and sieving. For sieving, the process of filtration of grinded cassava for the production of cassava flacks was used for decantation, the process of producing raw starch was utilised,

and the process used by Sigh and Bitwell (2016). Since this approach has been said to bring about skills like skills of organisation, communication, presentation, group participation and creativity (Siwale, Sigh and Hayumbu, 2020) and also challenges learners to learn through interaction with the environment (Kurumeh and Opera, 2018), it, therefore, becomes necessary to ascertain the effect of ethno-chemistry on secondary school students achievement in chemistry. Based on this, the study investigated the effect of ethno-chemistry teaching strategy on secondary school students' achievement in chemistry.

Statement of the Problem

The primary aim of developing any curriculum at any level of schooling/education is to promote and stimulate effective learning and to give teachers direction for the successful implementation of the academic programmes or curriculum through adequate lesson delivery. The implementation stage is the final stage of curriculum planning. This stage is crucial as it determines the success or failure of a particular curriculum. The way to accomplish success in this final stage is using an effective teaching strategy that will bring about effective learning. Therefore, the study problem is: what effect will the use of ethno-chemistry as a teaching strategy have on students achievement? Will its effect vary with sex?.

Research questions

1. What difference exists in students achievement mean scores between those instructed with ethno-chemistry and those instructed with lecture method?
2. What difference exists in students achievement mean score between female and male students instructed with ethno-chemistry?
3. Is there an interaction effects of method and sex on achievement score?

Hypothesis

H_{01}: There is no significant statistical difference in student's achievement mean scores between those instructed with ethno-chemistry and those instructed using the lecture method.

H_{02}: There is no significant statistical difference in students achievement mean scores between female and male students instructed with ethno-chemistry.

H_{03}: There is no significant statistical interaction effect of method and sex on achievement score.

Methodology

This study was quasi-experimental. It is a pretest-posttest non-equivalent control group study. No randomisation of subjects into groups; instead, intact classes were used. The pretest score is the students' scores before treatment and the posttest scores are their scores

after treatment. With the pretest scores, the equivalence of the groups was determined. The study's independent variable is ethno-chemistry teaching strategy and lecture teaching method. Sex was an intervening variable, and achievement was the dependent variable. The sample size of the study consisted of 125 SSII (63 males and 62 females) chemistry students with 72 students in the experimental group (38 males and 34 females) and 53 students in control groups (with 25 males and 28 females) in four senior secondary schools sampled from 17 mixed schools in Ethiopia East and 15 secondary schools in Udu Local Government Areas of Delta State. The sampling technique employed in selecting the schools was the simple random sampling technique (Balloting) using the drawing with replacement strategy. The chemistry teachers of the sampled classes taught the classes. two classes were experimental/treatment classes, and the other two were control

The following were the instruments used

(1). Separation Technique Achievement Test (STAT).

(2). Teacher training manual for the application of ethno-chemistry strategy

(3). Model lesson notes and plan for using ethno-chemistry strategy and the lecture method**.**

Separation Technique Achievement Test (STAT).

The Separation Technique Achievement Test (STAT) was used as the study data gathering instrument. The Separation Technique Achievement Test (STAT) is comprised of two sectors. Sector A encompasses questions about students' bio-data, while sector B has 40 items drawn from four separation techniques (Sieving, filtration, decantation and distillation). The items on section B were picked from West Africa Examination Council (WAEC) and University Matriculation Examination (UME) questions from 1990-2019. Each question in section B requires one answer to be chosen by the respondent. i.e. The appropriate answer for the options chosen. The scoring of the STAT was over 40.

Validity and Reliability of the Separation Technique Achievement Test (STAT).

The instrument's content validity was done using a specifications table that indicated that the content areas were rightly represented.

Table of specification

Objectives

(Blooms taxonomy)

Content	**Knowledge 15%**	**Comprehension 25%**	**Application 25%**	**Higher order 35%**	**Total No of items**
Sieving 20%	2	2	2	2	8
Filtration 30%	3	3	3	3	12
Decantation	2	2	2	2	8

20%					
Distillation 30%	3	3	3	3	12
Total	3	5	6	6	40

This instrument was correctly validated, and reliability was determined before using it. A specification table was applied to ensure that the cognitive domains were rightly represented. Using Kuder Richardson (k21) formula, an r-value of 0.82 was obtained for its reliability, with this result, this instrument is considered reliable.

Treatment Procedure

Step 1: Training of the Treatment/Experimental (ethno-chemistry) group teachers

To sensitize the teachers to be engaged for the treatment/experimental groups on applying ethno-chemistry for teaching, the teachers were trained using the training manual, and the following steps were taken.

Step A: Introduction of the main/key concepts: students explain the concept to learn or study. The aim was to determine their prior instructional knowledge on the concept to be instructed or taught.

Step B: Introduction of the cultural practice: Students are given the cultural practices material and their main study material.

Step C: Explanation by students: Students explain what they read from cultural/local practice materials and relate it to the main concept to be studied.

Step D: Identify relevant features of cultural practice material with the main concepts: students are to compare the two materials read by revealing the relationship and differences or variances between the concept in the study materials and cultural practice material.

Step **E: Indication of where there is no relationship:** Students identify where there is a limitation of the failure of the cultural practices to explain between the main concepts. The aim is to prevent students' misconceptions.

Step **F**: **Drawing of Conclusion:** The teacher explains the concepts taught, considering students' assumptions and misconceptions that would have occurred from using the cultural practices. Teachers ask questions, answer students' questions to ascertain students' understanding, and summarise the lessons.

Step 2: Students Pretesting

The students used for the control and treatment/experimental groups were given the separation technique achievement test by the investigator as the pretest. The completed separation technique achievement test was collected from them as the pretest. The pretest score was used to ascertain the equivalence of the groups and their entry achievement. After the pretesting, the investigator distributed the reference materials containing the

topic to be taught to the students of both groups, and the ethno-chemistry enhanced text was given to the treatment/experimental group students only. This extract contains the topic taught during the period of this research. The teachers' also used the extracts for their teaching.

(b). **Control Group- Lecture Approach/Method.**

The lecture method steps:

Step 1: The teacher asks questions to determine students pre-instructional knowledge on concepts instructed or taught

Step II: The teacher explains concepts instructed or taught.

Step III: The teacher asks students questions to ascertain their levels of understanding

Step IV: Teacher answers students' questions

Step V: The teacher summarizes the lesson.

Step IV: Post testing

At the end of the experiment/study which lasted for eight weeks, one day each was spent collecting data from each school at the expiration of treatment. Before the students were tested, the researchers appealed to the science teachers to assist in conducting the test. At the expiration of one hour, the instrument was retrieved from the students as an immediate posttest score. Data collected were scored and analysed.

Results and Discussion

RQ 1: What difference exists in students achievement mean scores between those instructed with ethno-chemistry and those instructed with lecture method?

Table 1 shows descriptive statistics of mean of students' achievement scores as measured by the Separation Technique Achievement Test (STAT) between the ethno-chemistry and Lecture method groups. With a mean score of 30.42 and a standard deviation of 6.07, the ethno-chemistry group students scored higher marks than their counterparts, who recorded a mean of 27.74 with a standard deviation of 3.39. The mean difference or variance between the ethno-chemistry group and the lecture group is 2.63. This shows that there exists a difference. To ascertain if the difference was significant, H_{01} was tested.

H_{01}: There is no significant statistical difference in students achievement mean scores between those instructed with ethno-chemistry and those instructed using the lecture method.

Table 2 shows statistical test of the difference between the ethno-chemistry group and the lecture group achievement mean scores of students as measured by the Separation Technique Achievement Test (STAT) at pretest. The difference in mean between achievement mean scores is not significant. This is because the calculated sig value of 0.54 is higher or greater than the critical sig value of 0.05. This shows a non-significant

difference or variation between the two sets of students at pretest. With this, the independent sample t-test became the appropriate statistics to test H_{01} as shown in Table 3. Since there was no significant difference at pretest, as shown in Table 2, an independent sample t-test was applied to test $H_{01,}$ as presented in Table 3

Table 3 indicates the t-test statistics of the difference/variation between ethno-chemistry and lecture method students achievement mean scores as measured by the separation technique achievement test. The difference in mean between the ethno-chemistry and control group students achievement scores, as presented in Table 3, is significant. This is because the calculated sig value of 0.004 is less or lower than the critical sig value of 0.05. This shows a significant statistical difference/variation in the achievement mean scores between students instructed with ethno-chemistry and those instructed with lecture methods. With this, the $H_{01,}$ which says that there is no significant statistical difference/variation in the achievement mean scores between students instructed with ethno-chemistry and those instructed in the control group, was rejected.

RQ 2: What difference exists in students achievement mean scores between female and male students instructed with ethno-chemistry?

Table 4 reveals the descriptive statistics of the achievement mean scores of female and male students instructed with ethno-chemistry as measured by the separation technique test based on sex. With a mean score of 29.61, the male students scored low marks than their female counterparts, who recorded a mean of 31.32. The difference in mean scores between the females and the males' achievement scores is 0.04. To ascertain if the difference/variation was significant, H_{02} was tested

H_{02}: There is no significant statistical difference in students achievement mean scores between female and male students instructed with ethno-chemistry.

Table 5 shows the difference/variation between female and male students instructed with entho-chemistry as measured by the separation technique achievement test. It shows that the difference/variation in mean between the female and male students in the treatment/experimental group, as observed in table 3, was not statistically significant. The calculated sig value of 0.233 is higher/greater than the critical sig value of 0.05. With this, $H_{02,}$ which states that there is no significant statistical difference in students' retention scores between female and male students instructed with ethno-chemistry, is retained.

RQ 3: Is there an interaction effect of method and sex on achievement score?

Table 6 shows descriptive statistics of the achievement mean scores of female and male students instructed with ethno-chemistry and lecture method as measured by the separation technique test based on sex. With a mean score of 29.61, the male students

scored low marks than their female counterparts, who recorded a mean of 31.32. The difference/variation in mean scores between the female and male achievement scores is 0.04, while for the lecture method groups, male students had a mean score of 21.16, and females had a mean score of 29.25. This shows that there is interaction effects. To ascertain if the interaction effects is significant, $H0_3$ was tested.

H_{03}: There is no significant statistical interaction between method and sex on achievement scores.

Table 7 indicates no significant statistical interaction of method and sex on students achievement since the calculated sig value of 0.734 is greater than the critical sig value of 0.05. With this, $H0_3$, which states that there is no significant statistical interaction effect between method and sex on achievement, is retained.

Discussion

The first finding showed a significant statistical difference/variation in students' achievement mean scores between ethno-chemistry and lecture groups. This observed difference which favoured the ethno-chemistry group could result from using a series of cultural/local practices that students were familiar with during the teaching/learning process. The cultural practices used acted as a scaffold for the new knowledge, which aided their achievement, thereby positively affecting their performance. This finding/result is in line with that of Siwale, Sigh and Hayumbu (2001), Ajayi, Achor and Agogo (2017), who found positive effect of ethno-chemistry on the achievement and retention score of students, respectively.

The study's second finding showed a non-significant difference in students mean scores between the female and male students instructed using ethno-chemistry. This indicates that ethno-chemistry is not gender-biased. All the students benefitted equally from the learning process irrespective of their sexes. This finding concurs with Agboro-Eravwoke (2020), Mobark and Arabia (2014), whose studies showed no significant statistical difference in students achievement based on sex.

The third finding of the study demonstrated non-significant interaction effects of method and sex on students' achievement. This indicates that the student's performance is solely based on the strategy and not on their different sexes. This finding concurs with Ajaja and Eravwoke (2012) and Theresann and Lydia (2015), who discovered no significant statistical interaction effects between method and sex on students achievement.

Table 1. Descriptive statistics showing students achievement after instruction based group

Groups	N	Mean	Mean diff	Standard Deviation
Ethno-chemistry	72	30.42		6.07
			2.68	
Lecture Method	53	27.74		3.39

Table 2: Independent sample students'-test statistics showing the difference between achievement scores of the ethnochemistry and Lecture group students at Pre-test at post-test

Groups	**N**	**Mean**	**Mean Diff**	**Std. Deviation**	**df**	**Sig (2tailed)**
Ethno-chemistry						
	72	14.36		3.62		
			0.38		123	0.54
Lecture						
Method group		53	14.75	3.46		

Table 3: Independent sample students'-test statistics of difference between ethnochemistry and lecture method group students' achievement scores.

Groups	**N**	**Mean**	**Mean Diff**	**Std. Deviation**	**df**	**Sig (2tailed)**
Ethno-chemistry						
	72	30.42		6.07		
			2.68		123	0.004
Lecture						
Method group		53	27.74.75	3.39		

Table 4: Descriptive statistics showing experimental students achievement scores based on sex

Sex	N	Mean	Mean diff	Standard deviation
Male	38	29.61		5.75
			0.04	
Female	34	31.32		6.36

Table 5: Independent sample statistics showing ethno-chemistry students achievement scores based on sex

Sex	N	Mean	Mean diff	Standard deviation	df	sig.(2tail)
Male	38	29.61		5.75		
			0.04		70	0.233
Female	34	31.32		6.36		

Table 6: Descriptive statistics showing interaction effects of method and sex on achievement

Groups	**Sex**	**N**	**Mean**	**Mean diff**	**Standard deviation**
	Male	38	29.61		5.75
Ethno-chemistry				0.04	
	Female	34	31.32		6.36
	Male	25	27.16		3.88
Control				2.09	
	Female	28	29.25		2.86

Table 7: ANOVA statistics showing the interaction effects of method and sex on students' achievement

Source	Type 111 sum of Square	df	Mean Square	F-cal	Sig
Corrected Model	288. 070	3	96.023	3.697	0.014
Intercept	102971.129	1	102971.129	3964.044	0.000
Groups	231.715	1	231.715	8.920	0.003
Sex	59.999	1	59.999	2.310	0.131
Method*Sex	3.003	1	3.003	0.116	0.734
Error	3143.130	121	25.996		
Total	110596.000	125			
Corrected Total	3431.200	124			

Conclusion/Recommendation

Since the method was found to influence students achievement scores positively, it is was established that ethno-chemistry is a good alternative for the teaching of chemistry and also suggested that teachers should be adequately trained to acquire the skills of usage of ethno-chemistry and encouraged to practice and use it in the instruction or teaching of chemistry. It is recommended that the method/approach be used in teaching all chemistry students irrespective of school type based on sex.

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