

Effects of Ethnochemistry Instructional Strategy on Secondary School Students' Achievement in Chemistry in Onitsha Education Zone

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Abstract

The study investigated the effects of ethnochemistry instructional strategy on secondary school students' achievement in chemistry. Two research questions guided the study and three hypotheses were tested. The design of the study was quasi-experimental. The population of the study was 2,345 senior secondary school year two (SS2) chemistry students, out of which 94 were involved in the study. The instrument for data collection was Chemistry Achievement Test (CAT) validated by experts and which had a reliability coefficient of 0.73 established using Kuder-Richardson formula 20. The finding of the study revealed that there was significant difference in the mean achievement scores of the students in favour of ethnochemistry instructional strategy and gender had no significant influence of students' achievement. The researchers recommended that chemistry teachers should critically analyze cultural practices of the school community and relate them to chemistry learning.

Keywords: Ethnochemistry, Acid, Base, Water, Achievement

Introduction

Chemistry is the branch of science that deals with the study of matter, identification of the substances of which matter is composed; the investigation of their properties and the ways in which they interact, combine, and change as well as the use of processes to form new substance. The knowledge of chemistry is essential to students in other field of study such as biology, geology, physics and therefore is central to the study of science (Nwanze, Izuegbunam, Pius, Emerhiona & Okoli, 2018). It is thus perceived as ancient science and activity-oriented subject. Research has shown that chemistry is generally a difficult subject for all levels of student despite the fact that its study is closely associated with nature and the physical world around us (O'dwyr, 2012). The study of chemistry also requires students to possess good level of science process skills to be able to conduct experimental verification into natural phenomena. These challenges have been reflected in the achievement of secondary school chemistry students which over the years is greeted with several appalling remarks from Chief Examiners.

The reports of the West African Secondary School Certificate Examination (WASSCE) Chief Examiner's show that from 2007-2012, the percentage of students who obtained a credit pass in chemistry was below 50% except in 2010. The reports further revealed a continual decline in the achievement of students from 2013 to 2016 from 72.34% to 57.74% of the percentage number of students with credit passes and further decline below 50% in 2018 and 2019. Studies have continued to show that instructional approach has remained the most implicated factor for students' poor achievement in chemistry (Okoli & Nwanze, 2018; Enekwechi, Okeke, Nwanze & Chikwendu, 2019; Konyefa & Nwanze, 2020). The implication of instructional approach as the major problem of students is because the mastery of chemistry concept may not be achieved without the adoption of effective instructional strategies that could link chemistry learning to reality and nature.

The study of chemistry is foreign and of euro-centric origin making its study problematic for students because it seems unreal and abstract (Oluwatosin, Emmanuel & Peter, 2017). Oluwatosin et al. asserted that chemistry teachers need to begin chemistry instructions from students' previous knowledge as an intervention to engage students in meaningful learning. They further asserted that chemistry students' previous knowledge that may be of significant relevance to learning is the inclusion of indigenous knowledge and cultural and domestic practices with scientific background. Such ethnochemistry practices are believed among researchers to lay the basis for reflective thinking and to instill a sense of ownership of the concepts (Ann, 2012; Oluwatosin, et al., 2017). The effects of the inclusion of ethnochemistry practices as a strategy during chemistry instructions on students' achievement is however, not widely known. There is the need for further empirical investigation into the effects of ethnochemistry instructional strategy on students' achievement.

Ethnochemistry instructional strategy in this study involved the situation of chemistry learning within the chemically related cultural and community practices and indigeneous knowledge (Indra & Bitwell 2016). It is a strategy of instruction that engages the students with discussions and analysis of chemically related real life experiences in the socio-cultural practices of their immediate community (Fasasi, 2018). Ethnochemistry instructional strategy may bear potential boost on students' achievement in chemistry as students are actively engaged in the learner process. It also enables the teacher to deal with misconceptions which the students bring to class and which may impede science learning (Abonyi, Achimugu & Njoku, 2014; Abonyi, 1999). Ethnochemistry instruction affords students the opportunity to be cognitively active during instruction, facilitating meaningful understanding and fair retention of learning materials (Fitria & Wisudawati, 2018). It may help students to gradually increase their learning of chemistry concepts as the teacher progresses in the scientific analysis of their ethnochemistry practices unlike the conventional instructional approaches common among chemistry teachers (Okwara & Upu (2017).

In a Nigerian cultural setting including the cultural settings of the study area, responsibilities are often assigned by gender. For instance, such cultural practices as hunting, fishing are reserved for males and sieving, cooking, washing reserved for females. The assignment of responsibilities and roles in cultural practices may lead to gender dichotomy in the understanding of some chemistry concept when ethnochemistry practices are integrated in the learning process. This because the nature of different ethnochemistry practices may influence understanding of different chemically related concepts. For example, females who often are assigned with domestic chores may gain understanding in hard water and use of detergents when washing while males who may often be engaged in palm wine tapping may gain better knowledge in acid and bases given the fermentation process of the wine. Also, research studies on the influence of gender on academic achievement have remained inconclusive. Some study result revealed significant influence of gender on achievement (Ugwu & Diovu, 2016) while others found no significant influence of gender on achievement. The need to further investigate the influence of gender in such a study as this is therefore a worthwhile quest. The study investigated the therefore, effects of ethnochemistry instructional strategy on the achievement of secondary school students' in chemistry. The study specifically sought to determine the:

1. mean achievement scores of students taught chemistry using ethnochemistry instructional strategy and those taught using conventional method.
2. the difference between the mean achievement scores of male and female students in chemistry.

3. the interaction effect of teaching methods and gender on students' achievement in chemistry.

Research Questions

1. What are the mean achievement scores of students taught chemistry using ethnochemistry instructional strategy and those taught using conventional method?
2. What are the mean achievement scores of male and female students in chemistry?

Hypotheses

1. There is no significant difference between the mean achievement scores of students taught chemistry using ethnochemistry instructional strategy and those taught using conventional method?
2. There is no significant difference between the mean achievement scores of male and female students in chemistry.
3. There is no significant interaction effect of teaching methods and gender on achievement of students in chemistry.

Method

The design of the study was quasi-experimental. The pretest posttest non-equivalent control group design with a 2x3 factorial design was used. The study was carried out in Onitsha Education Zone of Anambra state. The population of the study was 2,345 senior secondary year two chemistry students. The total sample size for the study was 94 SS2 chemistry students. First, Ogbaru local government council was purposively selected out of the three local government council under Onitsha Education Zone. The reason was because the other two local government councils namely: Onitsha North and South were mainly urban. On the second stage, purposive sampling was used to select two schools that are distant apart but has similar characteristics such as cultural similarities and common indigenous occupations. In each of the selected school, chemistry students in SS2 were involved in the study. The experimental group school had 43 students (18 males, 25 female) while the control group school had 51 students (32 males, 19 females).

The instrument for data collection was chemistry achievement test (CAT) developed by the researchers on the concepts of acid and bases and water. The test items were construction with four answer options lettered A-D. A table of specification was used to ensure that contents taught were adequately covered. The instruments and instructional plans were validated by experts in the Departments of Science Education and Educational Foundations, Faculty of Education, Nnamdi Azikiwe University, Awka. The reliability of the instrument was established using Kuder-Richardson formula 20. The instrument was administered once to 25 SS2 chemistry students in a school in Onitsha Education Zone not used for the study. The generated scores were used to compute the reliability which gave a coefficient of internal consistency of 0.73.

The study was carried out by first briefing the regular chemistry teachers in the schools used for the study who were engaged as research assistants. They were briefed on the purpose of the study, the instructional plans and strategy, administration of instrument and data collection. CAT was administered as pretest prior to the treatment without any feedback on students' scores/achievement or corrections. The experiment was carried out under the supervision of the researchers with the experimental school taught acid, base and water using ethnochemistry instructional strategy. In the ethnochemistry classroom, students were first presented with the objectives of instruction after stating the topic. A brief explanation of the topic was given, followed by presentation of cultural practices such as palm wine tapping, cassava and corn

fermentation, gin production, water purification techniques, hard and softwater uses. Indigenous knowledge of these practices that have significantly relationship with the concepts taught were used as the focus of classroom discussion with students presenting their own cultural and indigenous knowledge and the teacher analyzing them in relation to the concepts of chemistry. The main objective at that stage of instruction was to identify relevant cultural practices and knowledge that were compactible with science of chemistry especially acid, base and water and the principles common to both their practices and chemistry as science. The teacher summarized the instruction by relating the cultural practices to the concepts of acid, base and water using questioning technique to evaluate the objectives of instruction at each step.

The students in the conventional group classroom were taught the same concepts of acid, base and water but no mention was made of cultural practices and indigenous knowledge relevant to their learning. At the end of the treatment, the students in both groups were given posttest and their scores collated for analysis. Data generated from the study was analyzed using mean, standard deviation and analysis of covariance (ANCOVA). The decision rule for the hypothesis was: reject null hypothesis when p-value is less than 0.05 and do not reject null hypothesis when p-value is greater than 0.05.

Results

Table 1: Mean Achievement Scores of Students taught Chemistry using Ethnochemistry Instructional Strategy (EIS) and Conventional Method (CM)

Source of Variation	N	Pretest Mean	Posttest Mean	Gain in Mean	Pretest SD	Posttest SD
TPIS	43	31.09	55.44	24.35	6.97	7.17
CM	51	34.80	48.22	13.42	9.22	6.59

Table 1 reveals that the students taught chemistry using ethnochemistry instructional strategy has gain in mean achievement score of 24.35 while those taught using conventional method has gain in mean achievement score of 13.42. In the posttest, students taught using ethnochemistry instructional strategy had a less homogeneous score (7.17) than those taught using conventional method (6.59).

Table 2: Mean Achievement Scores of Male and in Chemistry

Strategy	Gender	N	Pretest Mean	Posttest Mean	Gain in Mean	Pretest SD	Posttest SD
EIS	Male	18	29.94	52.72	22.78	7.64	7.81
	Female	25	31.92	55.68	24.76	6.48	8.36
CM	Male	32	31.75	46.72	14.97	8.58	7.86
	Female	19	37.26	49.74	13.48	9.45	6.54

Table 2 shows that male students taught using ethnochemistry instructional strategy has gain in mean achievement score of 22.78 while the females have gain in mean achievement score of 24.76 where the males taught using conventional method has gain in mean achievement score of 14.97 and the females a gain in mean achievement score of 13.48.

Table 3: ANCOVA on test of Significant Difference in the Mean Achievement Score of Students taught Chemistry EIS and CM

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	2122.556 ^a	4	530.639	10.577	.000	
Intercept	7658.960	1	7658.960	152.663	.000	
Pretest	934.143	1	934.143	18.620	.000	

Method	1011.355	1	1011.355	20.159	.000	S
Gender	84.429	1	84.429	1.683	.198	NS
Method * Gender	.668	1	.668	.013	.908	NS
Error	4465.061	89	50.169			
Total	251694.000	94				
Corrected Total	6587.617	93				

Table 3 shows that at 0.05 level of significance, 1df numerator and 93df denominator, there was a significant main effect of the treatment on students' achievement in chemistry $F(1,93) = 20.159$. Therefore, the null hypothesis was rejected. Thus, there is a significant difference between the mean achievement scores of students taught chemistry using ethnochemistry instructional strategy and those taught using conventional method. in favour of ethnochemistry instructional strategy.

Table 3 also shows that at 0.05 level of significance, 1df numerator and 93df denominator, there was no significant main influence of gender on students' achievement in chemistry $F(1,93) = 1.683$. Therefore, the null hypothesis was not rejected. Thus, there is no significant difference between the mean achievement scores of male and female students in chemistry.

Table 3 further shows that at 0.05 level of significance, 1df numerator and 93df denominator, there was no significant interaction effect of teaching methods and gender on achievement of students in chemistry $F(1,93) = .013$. Therefore, the null hypothesis was not rejected. Thus, there was no significant interaction effect of teaching methods and gender on students' achievement in chemistry. The plot of interaction is shown in Figure 1.

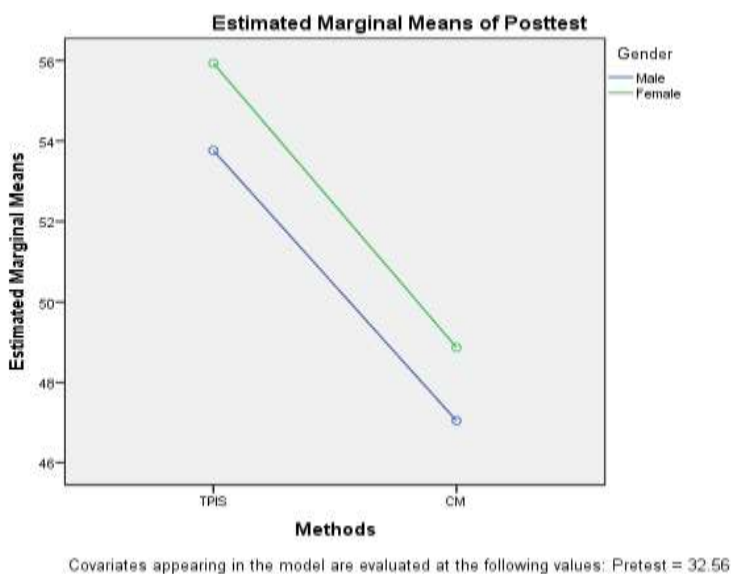


Figure 1: Plot of interaction effect of teaching methods and gender on students' achievement in chemistry

The plot of the interaction effect of teaching methods and gender was not significant and ordinal.

Discussion

The finding of the study revealed that there was a significant difference between the mean achievement scores of students taught chemistry using ethnochemistry instructional strategy and conventional method in favour of ethnochemistry instructional strategy. The observed result of

the study could be attributed to the fact that learning chemistry through ethnochemistry instructional strategy presents students with learning experiences that are close reality. In the ethnochemistry classroom, learning was situated within the learners' cultural background enabling students to understand the concept more properly. The analysis of the cultural practices and ideologies relative to the chemistry concepts of acid and bases and water reduced the cognitive load common with learning abstract concepts which is a common issue in chemistry learning. The teacher therefore, by relating the concepts to the cultural activities, practices and ideologies of the students brought the learning within the confines of students' existing scientific knowledge.

The improvement in chemistry achievement among students in the enthochemistry group could also be explained from the arising interest in chemistry instruction due to discussions about their cultural practices in relation to chemistry. Students' interest led to active participation in the learning process and became an incentive that drove their motivation to learn and understand the concept of acid and bases and water. The analysis and comparism drawn between their cultural knowledge and practice and the standard scientific understanding of the concept facilitated better understanding of acid and bases and water. Thus, students' learning was meaningful to them leading them to seek deeper understanding into the concept with a great appreciation of their cultural background knowledge and practices. The finding of the study lends credence to the finding of Oluwatosin et al. (2017) that students taught chemistry using ethnochemistry instructional approach achieved significantly higher than the students in the control group. The finding of the study also supports the finding of Okwara and Upu (2017) and Peni (2011) that the experimental group taught using ethno-science enriched instructional approach had a significantly higher mean achievement score than their counterparts in the control group.

The findings of the study further revealed that gender has no significant influence on the achievement of the students in chemistry and there was no significant interaction of teaching methods and gender on the achievement of the students in chemistry. The result of the students showed that students irrespective of gender were carried along during the instruction. The findings of the study a in line with the findings of Abonyi (1999) that although ethnosience based instructional package was superior to conventional approach, gender had no significant influence and no significant interaction effect of teaching methods and gender was observed. The finding of the study also is in line with the findings of Ugwu and Diovu (2016) gender has no significant influence on achievement and no interaction of teaching methods and gender was observed but students taught with integration of indigenious knowledge and practices had higher mean achievement score than their counterpart.

Conclusion

The findings of the study showed that ethnochemistry instructional strategy significantly improved achievement in chemistry. It can therefore be concluded that relating the learning of chemistry concepts to the indigenious knowledge and cultural practices of the students facilitates proper understand of the concepts and results to better achievement.

Recommendations

The following recommendations were made based on the findings of the study.

1. Chemistry teachers should seek an understanding into the scientific relevance of the cultural practices and knowledge of the immediate community of their schools and relate chemistry teaching and learning to those knowledge and practices.

2. Critical analysis of cultural practices and indigenous knowledge relevant to chemistry should be done during chemistry instruction with a view to bring students to the knowledge of those that are compatible with science and therefrom widen their understanding of chemistry.

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