



Culturally Responsive Teaching: Exploring the Effect of Ethno-Chemistry on Students Interest and Academic Achievement in Odukpani and Akampa Local Government Area, Nigeria

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Abstract

The research investigated the impact of ethno-chemistry on student's interest and academic achievement in Odukpani and Akampa local Government Areas, Nigeria. Quasi-experimental pre-test post-test research method was used. two research questions and hypotheses guided the study. The study population comprised of 1,594 senior secondary two chemistry students and a sample size of 124 learners was chosen from the population utilizing simple random technique. The instrument for gathering data was a researcher made chemistry achievement test (CAT) having reliability index of 0.72 using kuder Richardson R-21 and student interest questionnaire (SIQ) with reliability index of 0.89 using Cronbach alpha reliability estimate. Data received was analysed with descriptive and ANCOVA statistics. The result indicated a statistically significant difference in mean achievement and interest scores of student taught chemistry with ethno-chemistry approach group having a higher mean gain score than those taught with the conventional approach. It is recommended that science instructors explore integrating ethno-science approach as a means enhancing academic achievement and interest in science.

Keywords: Ethno-chemistry, achievement, interest, culturally responsive teaching

Introduction

The significance of chemistry in the social and economic development of any country is substantial, and Nigeria is no exception. The knowledge and skills in chemistry are applied across nearly all sectors of the economy. Chemistry helps students understand the phenomena occurring in the world around them and its contribution to enhancing the quality of life on Earth (Manahan, 2022). The chemistry curriculum includes numerous difficult concepts, which are essential for advanced study in both chemistry and other scientific fields. Given the critical impact of chemistry in technological advancement, it's imperative that the subject is taught in a way that fosters a deep understanding and sustained interest among students (Vachliotis, Salta, & Tzougraki, 2021). Studies, indicates that chemistry is generally perceived as a challenging subject by learners at all educational stages (Alake, 2024), a perception that is reflected in their

consistently poor performance in the subject.as evidence in West Africa Examination Council chief examiners report (WAEC, 2020-2023). An analysis of student achievement in chemistry from 2020 to 2023 reveals that the percentage of students achieving a credit pass ranged between 44.16% and 46.16%. Between 2020 and 2021, the proportion of students obtaining a credit pass remained below 50%, with the exception of 2010, where it reached 50.7%. From 2021 to 2023, there was a consistent decline in the percentage of credit passes, decreasing from 72.34% in 2013 to 62.49% , 60.6% , and 57.74% . The period from 2020to 2021 recorded some of the poorest performance levels among students in chemistry.

The poor performance of student in chemistry is associated to a number of factors some of which include, lack of laboratory apparatuses and reagents as well as inadequacy of laboratory facilities, high cost of

laboratory installation and maintenance, students' attitude towards science subjects including chemistry and teachers knowledge of instructional pedagogies and the failure of teachers to choose and utilize teaching contexts, and strategies that are familiar to students is a key factor influencing achievement and interest in chemistry (Apata, 2020). Sanusi, Sunday, Oyelere, Suhonen, Vartiainen, & Tukiainen (2024) noted that in many African science lessons, local cultural skills and artifacts are rarely employed as instructional examples. Rather, European artifacts and methods are often employed as instructional resources, which are unfamiliar to students, making chemistry more challenging. This approach limits students' understanding, as their motivation to learn is driven more by the need to pass national examinations than by genuine knowledge acquisition. In response to the persistent underperformance of Nigerian students in chemistry, researchers have explored various factors to address this issue, one of which is the implementation of ethno-instructional strategies, as re-examined in this study. According to nEgolum, and Onuigwe, (2023), the strategy of teaching chemistry in Nigeria is completely out of phase with the background and local environments of students. This is because the instructional strategies, equipment and the language used in teaching are foreign to the students. Egolum, and Onuigwe, (2023) posited that the strategies being foreign in nature, has no bearing with Nigerian culture and purely derived from Eurocentric culture. The consequence of this is that, students are forced into Rote learning and low achievement in chemistry remains prevalent issues in Nigeria. Assafuah-Drokow (2023) argued that the instructional methods currently employed in chemistry teaching are often inappropriate and uninspiring, particularly for students in rural areas. The teaching methodology used by educators significantly influence students' comprehension, interest, attitudes, and overall performance, especially in science subjects like chemistry. Effective teaching requires the application of diverse instructional strategies that can engage students actively in the learning process.

Berhe, Tesfemariam, & Weldemichae (2024) emphasized that, teachers must chose appropriate strategies that stimulate students' interest and encourage active participation for learning to be meaningful and effective in chemistry,. The theory of meaningful learning, proposed by Ausubel (1963), serves as a theoretical foundation for this study. It suggests that for learning to be meaningful, there must be interaction

between the learner's pre-existing knowledge and the new material being introduced. For new knowledge to be effectively acquired, it has to collaborate with learner's existing previous knowledge, which often consists of indigenous knowledge and practices gained through personal experiences and interaction with the environment.

The term "ethno" refers to members of a cultural group who are identified by shared traditions, symbols, codes, and myths that help form and understand concepts (Timol, 2020). Ethno-chemistry involves studying chemical concepts as they appear within specific cultural contexts. Indra and Bitwell (2018) describe ethno-science as a practice rooted in a particular culture, encompassing the study of chemical concepts prevalent across various cultural settings. The ethno-chemistry instructional approach (ECIA) integrates diverse cultural practices that illustrate the chemical knowledge of cultural groups. It emphasizes teaching chemical concepts that are identifiable across different cultures, thereby making chemistry education more relatable and engaging for students (Ahmad, & Halliru, 2022). When teaching chemistry, the instructor makes use of the students' culture, customs, and prior experience in situations and activities in their environment. In organic chemistry, fermentation is taught as a method for producing ethanol using cassava, maize and palm wine in the customary creation of cocktail (Ogogoro) is an option. The refining system of acquiring ethanol from the use of the above substances demonstrates ethno-chemistry in the setting in which the learners built the local distillation equipment, separation of maize grains from husks called shelling and winnowing, use of Aloe vera for bathing, charcoal frequently used for roasting or cooking corn, the charcoal pot is utilized for demonstrating complete and incomplete burning of carbon. The teaching of chemistry through ethno-chemistry instructional strategies can be very helpful to students and nations of the world. Several studies revealed that ethno-chemistry enhanced academic performance in chemistry (Izondeme and Chinelo 2021, Melad 2022 , Wardani et al. 2023, Nwankwo, 2021, Nja et al.,2022 Wiratma, & Yuliamastuti, 2023, Kalebaila, & Hamusonde, 2020, Ahmad, & Halliru, 2022, Konyefa & Okigbo,2021) in their studies observed the significant effect of ethno chemistry in enhancing achievement of learners across the study areas.

Conversely, the findings of Abumchukwu and Achugbu (2021), Ayua et al.,(2023), Upu & Okwara,(2024) showed no significant difference in the

academic achievement of learners taught using ethno-chemistry strategy. Student interest in the learning process has been observed to be a strong determinant in promoting academic success (Bakar et al., 2023). Interest plays an important role in learning. One of the purposes of 21st-century education is to rekindle learners' interest in scientific disciplines, such as chemistry, by addressing and mitigating the factors that contribute to a decline in their engagement with the subject. Research indicates that interest is a fundamental determinant of educational success. Without an interest in chemistry, students are less likely to engage with the material or make efforts to comprehend the concepts being taught. This underscores the idea that one of the most influential factors in students' decision to pursue chemistry and their subsequent academic performance is their level of interest in the subject. Indra and Bitwell (2018), Anari and Inah (2020), Melad (2022), and Ugwu, (2023), observed that students interest in a subject ultimately impact their performance in the subject.

From the reviewed literature it was observed that there exist limited empirical research on the use of ethno-chemistry in Nigeria and in Cross River state in particular also previous studies have indicated that students' interest often does not receive adequate attention in chemistry learning. This research seeks to examine the impact of incorporating chemistry-related cultural knowledge through the use of local examples, enabling students to easily grasp new chemistry concepts. This approach is grounded in the principles of culturally responsive teaching, which posits that when knowledge is framed with the contexts of students' cultural references and social activity, they become meaningful, thereby stimulating interest and enhancing academic performance (Achimugu et al., 2023). According to Alex et al. (2022), the awareness among chemistry teachers of ethno-chemistry as a teaching method remains below expectations. This study aims to add to the limited literature on the effectiveness of ethno-chemistry as an instructional strategy, particularly in improving both academic achievement in chemistry and students' interest in the subject. By integrating indigenous chemically-related practices and local materials, this approach can help make unfamiliar chemistry content more relatable and comprehensible for students.

Research Questions

1. What is the difference in the mean achievement scores of learners

instructed using ethno- chemistry strategy and students instructed with the traditional lecture strategy?

2. What is the mean interest score of learners instructed with ethno-chemistry strategy and students instructed using traditional lecture approach?

Hypotheses

1. The average achievement scores of learners who were instructed with ethno-chemistry compared to learners instructed with conventional approach is not significant.
2. The average interest scores of learners who were instructed with ethno-chemistry compared to learners instructed with conventional approach is not significant.

Research Method

The research employed a quasi-experimental design, utilizing pre- and post-tests within a non-equivalent control framework. The research was carried out in the Odukpani and Akampa Local Government Areas (LGAs) of Cross River State. The study's population comprised 1,997 chemistry students from sixteen public secondary schools, specifically targeting those in Senior Secondary School Two (SS2). A total of 125 SS2 chemistry learners were picked through a multi-stage sampling process, with purposive sampling used to choose two schools within the LGA, this is to ensure homogenous selection of schools that share similar characteristics to explore the concept. These two schools were then designated as treatment and lecture groups, with 53 students in the treatment group and 72 in lecture group.

Data collection was conducted using the Chemistry achievement test (CAT) The CAT consisted of a teacher made test of 30 multiple-choice objective question with 4 response choice, which ensured adequate coverage of topics through a specification table. An instructional plan was also developed using the ethno-chemistry approach, tailored to the subjects being taught. The reliability of CAT was determined using Kuder-Richardson formula 21 (KR-20), resulting in coefficients of 0.72. The Interest Questionnaire, which assessed students' levels of interest in chemistry following their exposure to the ethno-chemistry instructional approach, contained 20 items developed on a four point likerts' scale of strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). The reliability of the instruments was determined with Cronbach's alpha reliability estimate, resulting in

internal consistency coefficients of 0.89 for the Interest Questionnaire.. Both the CAT and the interest questionnaire were evaluated for language clarity, appropriateness for the target students, and effective distractors. The treatment was conducted in two stages. In the first stage, two research assistants were trained on how to utilize ethno materials in teaching chemical concept, and in the second phase, students were taught. Regular chemistry teachers, who had received training, delivered the lessons to both the treatment and control groups. The ethno-chemistry instructional approach was implemented for the treatment group, while conventional methods were used for the control group. During the first week, pre-tests and pre-interest assessments were administered which served as the baseline, followed by the commencement of the instructional intervention.

The experimental group engaged in hands-on activities, such as distilling ethanol from palm wine using locally made equipment, including a bamboo stick served as a Liebig condenser, rubber tubing for a

delivery tube, firewood as a heat source, a pot made of clay served as a round-bottom flask, three large blocks as a tripod stand, and a bowl for receiving the distillate. These activities were designed to produce ethanol, locally known as "ogogoro." Additional lessons included topics on the complete and incomplete combustion of carbon using a coal pot, iron extraction in a blast furnace, and separation techniques such as filtration, dissolution, decantation, refining, and distillation, all of which were integrated into the science curriculum. Instruction lasted for four weeks, with the both groups taught the same content using traditional method.

Following the treatment, post-tests and post-interest surveys were administered. The data generated was analyzed with mean, standard deviation, and analysis of covariance (ANCOVA) at a 0.05 level of significance. The null hypothesis was dropped when the p-value was less than or equal to 0.05 and retained if otherwise.

Results

Table 1: Mean (\bar{x}) and standard deviation of learners' pre-test and post-test scores according to groups

Treatment Groups	N	Pre-test		Post-test		Mean Gain
		\bar{x}	SD	\bar{x}	SD	
Ethno-chemistry Strategy	53	12.83	3.53	56.47	7.58	43.64
Lecture Strategy	72	14.15	2.08	45.83	8.48	31.68

The results in Table 1 revealed that the average pre-test score for learners in the ethno-chemistry group was 12.83, with a post-test score of 56.47, compared to a pre-test average score of 14.15 and a post-test score of 45.83 for the class taught using conventional lecture method. Additionally, the result showed that learners

instructed through the ethno-chemistry approach had higher mean gain score of 43.64, whereas students instructed using lecture strategy had a mean gain score of 31.68. To determine whether the difference in average scores between both classes was statistically significant, the hypothesis was tested.

Table 2: Summary of Analysis of Covariance (ANCOVA) of the learners' post-test scores according to groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	3623.956 ^a	2	1816.478	27.948	.000
Pretest	177.956	1	177.956	2.738	.101
Treatment	3604.175	1	3604.175	55.454	.000
Error	7929.258	122	64.9594		
Total	328377.000	125			
Corrected Total	11562.208	124			

a. R Squared = .314 (Adjusted R Squared = .303)

Table 2 shows that the calculated F-ratio for the instructional methods, at degrees of freedom (df) 1, 122, is 55.454, with a corresponding significance level of .000 alpha. Since this significance level is less than the .05 threshold used for decision-making, it indicates a

significant difference in academic achievement of learners instructed with the ethno-chemistry strategy and student instructed via traditional approach. Consequently, the null hypothesis was dropped.

Table 3: Mean and Standard deviation of student's interest in ethno-chemistry and lecture strategy

Treatment Groups	N	Pre-interest		Post-interest		Mean Gain
		\bar{x}	SD	\bar{x}	SD	
Ethno-chemistry Strategy	53	12.83	3.53	56.57	7.58	43.74
Lecture Strategy	72	14.15	2.08	45.81	8.48	31.66

The results presented in Table 3 reveal that the average pre-interest score for learners in the ethno-chemistry group was 12.83, with a post-interest score of 56.57, compared to a pre-interest mean score of 14.15 and a post-interest score of 45.81 for the conventional lecture group. Additionally, the findings showed that

students instructed using the ethno-chemistry strategy had a higher mean gain of 43.74, while those taught through the conventional method achieved an average gain of 31.66. The significance of the observed difference in average scores of the two groups was assessed through hypothesis testing.

Table 4; Summary of Analysis of Covariance (ANCOVA) of the learners' post-interest scores according to groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2728.527 ^a	2	1364.263	12.923	.000
Intercept	4753.984	1	4753.984	45.034	.000
Pre interest	.000	1	.000	.000	.999
Treatment	2167.857	1	2167.857	20.536	.000
Error	9712.000	122	105.565		
Total	434885.000	125			
Corrected Total	12440.526	124			

Table 4 revealed that the calculated F-ratio for the impact of the methods, at degrees of freedom (df) 1, 122, is 20.54, with a corresponding significance level of .000 alpha. Since this significance level is below the .05 threshold used for decision-making, A significant difference was observed in the interest scores of learners instructed with ethno-chemistry strategy compared to students instructed with the conventional lecture strategy, the null hypothesis was rejected.

Discussion of Findings:

The results from testing the first hypothesis indicated a significant difference in the mean gain scores between learners who were taught chemistry

with ethno-chemistry strategy and those instructed through traditional methods. Students in the treatment group demonstrated superior performance, having a higher mean gain scores, indicating superior performance compared to those in the traditional lecture group. This finding aligns with prior research by Izondeme & Chinelo (2021), Melad (2022), Wardani et al. (2023), Anari et al. (2023), Nwankwo (2021), Nja et al. (2022), Wiratma & Yuliamastuti (2023), Kalebaila & Hamusonde (2020), Ahmad & Halliru (2022), and Konyefa & Okigbo (2021). These studies support the integration of ethno-chemistry concepts in the chemistry classroom, suggesting that it bridges the gap between students' cultural backgrounds and modern or Western science. By connecting learning to the

students' own world, this approach enhances their worldview and provides richer learning opportunities.

Incorporating cultural practices into the chemistry curriculum can make learning more meaningful, as it allows students to draw upon familiar experiences to understand new concepts. This strategy not only facilitates comprehension but also increases student engagement and interest. When cultural elements that are already known to students are used as a teaching tool, they can serve as a guide to direct learners more clearly through the learning process. Consequently, students exposed to cultural practices have been found to develop a better understanding of certain concepts, as these practices offer a context that resonates with their existing knowledge base.

However, it is worth noting that some studies, including those by Abumchukwu & Achugbu (2021), Ayua et al. (2023), and Upu & Okwara (2024), reported no significant difference in academic performance among learners instructed through ethno-chemistry and student instructed by traditional methods. This suggests that the enhancing effect of ethno-chemistry strategies varies depending on other factors, like implementation approach, teaching context, or the students' prior exposure to cultural elements within the curriculum.

The results from testing the second hypothesis revealed a significant difference in the mean interest scores between learners taught with the ethno-chemistry strategy and students taught through traditional strategy. Learners in the ethno-chemistry class demonstrated a higher mean gain in interest scores, suggesting that this teaching approach effectively enhances student engagement. This increase in interest can be attributed to the nature of the ethno-chemistry method, which integrates cultural practices familiar to the students, thereby stimulating and maintaining their interest throughout the learning process.

The findings indicate that a higher level of student interest in chemistry will improve their achievement in the subject. This observation aligns with the research conducted by Melad (2022), Indra & Bitwell (2018), and Ugwu (2023), who also found that incorporation of cultural elements in science teaching can boost student engagement and motivation. However, these results contradict the results of Sutrisno et al. (2020), who reported no significant effect between student interest and academic achievement, despite the ethno-chemistry group's mean interest score being slightly higher compared to the control group.

Additionally, Bryan (2020) emphasized that students tend to find science more meaningful when they feel a personal connection to the subject matter. This connection can be fostered through hands-on activities that allow them to explore scientific phenomena in a practical and engaging way. When teachers actively demonstrate their enthusiasm for the material and relating it to everyday contexts that impact learners, it not only enhances their curiosity but also increases their overall engagement with the science curriculum. Thus, incorporating culturally relevant teaching strategies, such as ethno-chemistry, can play a critical role in fostering student interest and, ultimately, improving their academic achievement.

Conclusion

Ethno-chemistry learning experiences has improved cognitive outcome, making the teaching and learning experience both challenging and engaging for students, which in turn enhances their performance and sustains their interest in chemistry. Incorporating the ethno-chemistry instructional approach in chemistry teaching can act as an onsite laboratory and learning tool, enriching student engagement and highlighting the importance of chemistry by connecting them to the learners' real-life activities. Integrating ethno-chemistry practices in secondary school chemistry curricula promotes contextualized learning for ethnically diverse learners, hence facilitating more meaningful and effective learning.

Recommendation

1. The state Ministry of Education should organize workshops and seminars for high school instructors to train them on utilization of ethno-chemistry strategy in teaching scientific concept.
2. Learners' ought be encouraged to participate in generating knowledge, drawing from their cultural backgrounds, during chemistry lessons. Educators should aim to create a more inclusive classroom environment and avoid dominating the instructional process.

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