



## Effects of Ethnochemistry Based Approach on Chemistry Students' Academic Achievement and Retention in Malumfashi Educational Zone, Katsina State, Nigeria

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### Abstract

This study determined the effectiveness of Ethnochemistry based Approach on Chemistry Students' Academic Achievement and Retention in Malumfashi Educational Zone, Katsina State, Nigeria. Four research questions and four null hypotheses guided the study. The study adopted Nonequivalent Quasi-experimental design in form pretest, posttest, post-posttest, control group. Engaged in the study were 97 students selected from 5501 SSII Chemistry Students. Chemistry Achievement Test (CAT) with test-retest reliability index  $r=0.864$  was used for collecting data after validation by experts. The stated research questions were answered using mean and standard deviation and null hypotheses were tested using ANCOVA (One-way) and Independent samples t-test test at  $P \leq 0.05$  level of significance. The findings of the study revealed that a significant difference exists in the mean academic achievement and retention scores of SSII Students taught Chemistry Concepts using Ethnochemistry based Approach and those taught using Lecture Method in favour of those students taught using Ethnochemistry based Approach. However, the study found no significant difference in the mean academic achievement and retention scores of male and female Students taught Chemistry Concepts using Ethnochemistry based Approach. Based on the findings, it was recommended among others that teachers should incorporate the use of ethnochemistry practices, examples and illustrations for effective chemistry content delivery to enhance students' achievement and retention of Chemistry Concepts for indelible meaningful learning through Ethnochemistry Based Approach.

**Keywords:** Ethnochemistry Based Approach, Academic Achievement, Retention, Chemistry Concepts.

### Introduction

The 21<sup>st</sup> century is characterized by advancements in Science and Technology. As a requisite for Nigeria to appreciate the accelerated development in the 21<sup>st</sup> century, she needs qualitative science education in her schools, especially Senior Secondary Schools. Secondary education is referred to as the foundation on which nation is supposed to invest its instrumental ingredients for attaining higher educational goals as well as national visions (Ashikhia, 2010). Thus, the 21<sup>st</sup>-century learning means that students master contents while producing, synthesizing and evaluating information from a wide variety of subjects and sources with an understanding and respect of diverse cultures (Rich, 2010). However, over the last decades, there have been repeated calls for reformations and innovations aimed at improving Science Education in Nigeria. These calls advocate that there are issues in Science Education in Nigeria that quest for its value-addition and amendment so as to attain the national objectives and goals. The major goal of Science Education as reflected in the National Policy on Education (FRN, 2009) is to develop scientifically literate individuals that are concerned with high competence for rational thoughts and actions for national development. Similarly, it is part of the objectives of Science Education include the need to foster curiosity, enthusiasm, critical reflection and objectivity to

develop students' attitude toward science. This shall enable the students to be able to solve day-to-day problems encountered in their environment by applying the science knowledge and skills gained so as to be confident and independent.

In Nigerian Senior Secondary School, science curriculum composed of three major discrete subjects namely; Biology, Physics and Chemistry. Chemistry is one of the core science subjects taught in Nigerian Secondary Schools. It is a branch of science that deals with the physico-chemical, structural and transformational study of material substances that exist in the universe. It is a popular and mandatory subject among Senior Secondary School Subjects in Nigeria due to its nature, central important position and novel role toward national development. Thus, for Nigerian post primary candidate, credit in Chemistry Examination (SSCE) result is part of the requirement for the study of discipline in Medical/Pharmaceutical Sciences, Health Science and all science and Technology related courses at high educational level.

Yet, literatures have been reporting dissatisfaction and no appreciable improvement with regard to achievements of students in Chemistry (e.g. Olorundare, 2014; Chikendu, et al., 2021). Coupled with the reports from West African Examination Council Chief Examiner in May/June (e.g. WAEC, 2016; 2017; 2018; 2019 & 2020) for senior secondary

school certificate examination in Chemistry indicates a persistent trend of students' unstable performance. However, students' academic achievement is said to be low when there is a negative deviation or weakness in the students' mark under the normal average in a study subject level (Al-Zoubi & Bani-Younes, 2015). This unfavourable remark has been associated with many factors by different researchers to different various factors.

On the other hand, this problem may be associated with the observation of UNESCO (2006) that, in African education system, relevant practices from around the learner which are the vital parts of curricula provision are lacking in classroom instruction and therefore been neglected, the curricula and instructions are full of foreign examples, techniques and ideas without real link between what the students learned in their science classroom and their day-to-day activities and experiences. Instead, they resort to employing purely Western views on the nature of science and instruction. Further evidence asserted by Guido (2013); Abonyi, et al. (2014); Forawi (2015); Ugwu and Diovu (2016); Khaddour, et al. (2017); Ibe and Nwosu (2017); Shumba (2017) shows that, even the textbooks recommended for teaching and learning sciences in Africa (Nigeria inclusive) reflect nothing related to any African cultural phenomenon, illustrations or pictures representing indigenous or local knowledge; often absent or excluded from their classrooms and teaching materials, rather restrict to Western views involving Western examples, phenomenon, pictures and illustrations to their general teaching-learning science. Perhaps, this is why, Hiwatig (2008) narrows the reason for the issue behind student's achievement in science (chemistry inclusive) to lack of regard for the learners' culture which causes mislinkage between learners in their local environment and what they learn in their science classroom which greatly influences their understanding and retention.

Henceforth, it is part of the requirements of learning that, it should be retained. But the retainment should go beyond simple memory rather meaningful memory. Simple memory signifies rote-learning, but meaningful memory signifies meaningful learning. This bring about indelible meaningful learning. This means, rote-learning covers only 'remembering' which the lowest cognition stage is whereas, meaningful learning covers 'remembering', 'understanding' and 'application' stages of the cognition. As such the quest for retention ability of students become a variable of interest to researchers. Researchers were also found curious in search for means either in or outside the classroom by which students ability to regurgitate learned knowledge after

a long period of time could be enhanced (Azuka, 2012). Hence, there are some things that enhance students' retention and some things that retard students' retention. Ideally, any phenomenon, materials or activities in learning situation should improve students' attainment and retention, but those phenomenon that leads to confusion, misinterpretation or misconception among learning activities or materials retard the speed and efficacy and accelerates forgetting (Bichi, 2002 & Muhammad, 2011).

One of the instructional ways of achieving better achievement and retention as a shift to improving science understanding, relevancy could be; science to be taught based on sociocultural context of the learner which involve his cultural and traditional practices, indigenous knowledge and practices and other daily life experiences (Afrianawati, et al., 2016). Indigenous Knowledge (IK) is a broad term that describe various local knowledge exclusively held and practiced by Indigenous people of a given culture or community. It also embraces Indigenous Science (IS) which denotes restrictively indigenous knowledge related to science of a certain culture (Snively & Williams, 2016). The general indigenous or cultural practices that have scientific relevance are referred to by experts in science education (Abonyi, 2002; Fasasi, 2017) as ethnoscience, which is a sub-system of IK that includes an explanation of the natural world, which has practical applications and is used for predictive purposes by a particular people in a particular culture (Hwang, 2013). Ethnoscience is the scientific knowledge that is original in a given culture and is concerned with natural objects and events so that it may have potentially the same branches as Western Science (WS) (Abonyi, 2002). Those branches are in form of several relevant school science disciplines which include among others Ethno-physics, Ethno-mathematics, Ethno-biology, Ethno-chemistry etcetera (Abonyi et al., 2014).

Hence, this study employed Ethnochemistry Based Approach to teaching chemistry as an alternative or modification to the conventional teaching approach. Basically, ethnochemistry is the study of chemical ideas found in any culture, where appreciation of cultural heritage is preserved. It describes the chemical practices of identifiable cultural groups. It comprises of various chemically related cultural and community practices of a particular people (Singh & Chibuye, 2016). For this study, accordingly, *ethno* as hybridized with *chemistry* (i.e. ethno+chemistry) refers to various indigenous, traditional, socio-historico-scientific practices and contextual perceptions of chemistry of

an identified culture of a particular people at a particular environment.

Ethnochemistry based Approach is an instructional method that utilizes the initial chemistry related knowledge and experiences found within the learners' culture and environment to explain new concepts in chemistry classroom. It further involves designing a practical model in balancing local knowledge and western science as a process of learning (Abonyi, et al., 2014). The aim is to connect and smoothen the existing barrier between the school chemistry and local or indigenous chemistry concepts and practices for development. This instructional approach is based on perspectives of the theories of Tree (Cheng, 2002) which highlights the route for fostering local knowledge into global knowledge; Vygotskian Socio-Cultural Theory (Vygotsky, 1978) which establish the relationship between cultural artefacts, cultural meanings, cultural signs (such as languages), activities, interpersonal interactions and cognition; Cultural Border Crossing Theory (Aikenhead, 1996) which explains the nature of various transitions between students belief and school science referred to as cognitive conflict. It is worth of note that, Ethnochemistry Based Approach is beyond the use of native language as a medium of instruction or used of improvised instructional materials developed from local available materials but rather an approach guided by criteria asserted by George (2001) which requires teacher to; first, portray knowledge from students' cultural experiences and day-to-day experiences; then, discover multiple ways of thoughts about the concepts in science and; finally, establish a bridge that will link traditional/cultural knowledge system with conventional science classroom. Implicatively, involving cultural or traditional phenomenon already known and meaningful, familiar with and picturable in the mind of learner signifies its expected potentiality in making the learned concepts meaningful and indelible which ipso facto will enhance retention in the concepts learned.

It was also realized that some Northern Nigerian public secondary schools are of mixed-gender form (i.e. males and females in the same school or classroom). Thus, gender has been identified as one of the factors influencing students' performance in science at senior secondary school level. However, both locally and globally, issue of gender influence in science teaching-learning and research remains inconclusive (Stoet & Geary, 2013). Accordingly, several studies at various level of education have shown different effects of independent variables (e.g. methods of instruction) on dependent variable (e.g. learning outcome, attitude,

etc.) relative to gender. In fact, it has been argued that some teaching methods were found to be masculine or feminine while some have no gender bias. For instance, Adeyegbe (2010) found male students performed generally better than females in Physics, Chemistry and Biology. Similar result was found by Ibrahim, et al. (2016) on pre-degree students. Adigwe (2014) observed that male students have higher academic achievement in chemistry than females. Yet, Okorie and Ezech (2016) found no significant difference in students' achievement in chemical bonding in Chemistry. This indicate the variability of gender differences in students' achievement with method of instruction at a time. Ethnochemistry based approach involves the use of several home-based prior experiences and practices that are associated with gender (males and females) role in society. Therefore, the use of such practices in teaching school chemistry may affect the learning outcome and retention of one gender over the other or otherwise.

Available literatures show the evidence of the impacts of ethnomethodological approach to teaching on academic achievement, interest and retention in mathematics (D'Ambrosio, 2001; Kurumeh, 2004; Abonyi, et al., 2016); academic performance and attitude in physics (Chongo & Baliga, 2019). This suggest that similar results are possible when ethnochemistry is applied in chemistry classroom setting. It can also help students to be aware of the role in which chemistry plays in their everyday lives. In the meantime, Marasinghe (2016) succeeded in the synthesis and introduction of Unit in Chemistry Syllabus of students in Grade 11 and 12 titled 'Traditional Chemical Practices' of ancient Papua of New Guinea. So also, Fasasi (2018) succeeds in developing an instructional framework of ethnoscience for teaching science subjects in Nigeria. Accordingly, the study re-exposed the usability of ethnochemistry in the determined effect of Ethnochemistry based Approach on Chemistry Students' Academic Achievement and Retention in Malumfashi Educational Zone, Katsina State, Nigeria.

### Statements of the Problem

Acknowledging the novel role of chemistry toward the development of humanity and carrier value makes its understanding and attainment (academic achievement) by students (male and female) imperative. This can be pictured form the level of academic achievement and retention of the chemistry concepts learned in a classroom at a time. This also calls for the need of any possible instructional innovation or approach that will enhance chemistry students' achievement and foster concepts



retention. However, in Nigeria, report form summative evaluation bodies on chemistry shows unencouraging results in the research setting. The results analysis by West African Examination

Council over the years (e.g. 2016-2020), shows constant instability in the achievement of students in chemistry as shown in Table 1.

**Table 1. Statistics of the Performance of Public Senior Secondary Schools' Candidates in the WASSC Examination (May/June in Chemistry 2016-2020) in Malumfashi Katsina State**

Academic Year	Total Number of Students Sat	Students with Distinction & Credit A <sub>1</sub> -C <sub>6</sub>	Percentage Pass (%)	Percentage Failure (%)
2016	25,122	14,505	57.74	42.26
2017	21,717	11,612	53.47	46.53
2018	23,916	7,188	30.06	69.94
2019	24,619	10,138	41.18	58.82
2020	22,538	9,585	42.53	57.47

**Source:** Department of PRS, Ministry of Education, Katsina State, Nigeria (2020)

In this study, this problem is related with the negligence of teachers in integrating relevant cultural and indigenous practices and experiences from around the students in teaching chemistry concepts. This claim is backed by the declarations made by Ugwu and Diovu (2016); Khaddour, et al. (2017); Ibe and Nwosu (2017); Shumba (2017) in their separate researches report the exclusion of students' culture in the nature of teaching and science (Chemistry) content of Africa (Nigeria) which in turn lead to underachievement. Thus, students' academic achievement is a function of retention of the concepts learned, which means retention is imperative.

However, an alarming bell of unimpressive students' retention learned concepts was toll by (Ogbeba & Ajayi, 2016) and variation of rate of retention across gender (Ajayi & Angura, 2017). Similarly, Arokoyu and Aderonm (2018) observed that student considered chemistry as difficult subject which led poor retainment of the concepts learned which in turn manifest in their poor academic achievement in the subject. They further explain that, chemistry teachers adopt "examination focused teaching" in which fundamental concept that have relevant simple analogues in the student background experience and environment are not utilized. Consequently, student possess low retention, adopt "read-and-pass learning style" and inability to explain simple natural phenomenon around them with which meaningful knowledge can be built from. This requires the role of teacher to determine the learners' prior knowledge and conception before a new knowledge or concept is taught. In this regard, Ethnochemistry based Approach as the teaching strategy involving cultural and local practices, objects and activities which were already familiar, daily practiced, memorized and picturable in the mind of

learners suggest its viability in enhancing achievement and retention ability of learners.

### Objectives of the Study

The objectives of this study were to:

1. Determine the effect of Ethnochemistry based Approach on SSII Students' academic achievement in Chemistry concepts.
2. Examine the gender difference in academic achievement of students taught Chemistry Concepts using Ethnochemistry based Approach.
3. Compare the retention ability of SSII students taught Chemistry Concepts using Ethnochemistry Based Approach and those taught same concept using Lecture Method of Teaching.
4. Find out gender difference in retention ability of SSII Students taught Chemistry Concept using Ethnochemistry based Approach.

### Research Questions

The following research questions guided the study:

1. What are the mean academic achievement scores of Senior SSII taught Chemistry Concept using Ethnochemistry based Approach and those taught same concepts using Lecture Method of Teaching?
2. What are the mean academic achievement scores of male and female students in Chemistry concepts when taught using Ethnochemistry based Approach?
3. What are the mean retention scores of SSII students taught Chemistry Concepts using



- Ethnochemistry based Approach and those taught same concepts using Lecture Method?
4. What are the mean retention scores of male and female students in Chemistry concepts when taught using Ethnochemistry based Approach?

### Hypotheses

The following null hypotheses are formulated and tested at  $p \leq 0.05$  level of significance:

**H<sub>01</sub>:** There is no significant difference in the mean academic achievement scores of SSII Students taught Chemistry Concepts using Ethnochemistry Based Approach and those taught using Lecture Method.

**H<sub>02</sub>:** There is no significant difference in the mean academic achievement scores of male and female SSII Students taught Chemistry Concepts using Ethnochemistry based Approach.

**H<sub>03</sub>:** There is no significant mean difference in the retention ability of SSII Students taught Chemistry Concepts using Ethnochemistry based Approach and those taught using Lecture Method.

**H<sub>04</sub>:** There is no significant difference in the retention scores of male and female SSII Students taught Chemistry Concepts using Ethnochemistry based Approach.

### Methods

This research adopted non-equivalent Quasi-experimental control group research design in form of pre-test, post-test, and post-post-test. This is according to Kerlinger and Leer (2005) that the design involves two groups, one group is assigned as experimental and the other group is controlled. The population of the study targeted all Students in Public Senior Secondary Schools Two (SS II) under Malumfashi Zonal Education Quality Assurance (MZEQA) who are offering Chemistry as a subject. The Government Public co-educational Schools were selected for use in this study because of their homogeneity, prior experiences, socio-cultural background, curriculum and population. Records of Students Returns of February 2021 of 2020/2021 Session show that the schools comprise a total number of Five Thousand Five Hundred and One (5501) SSII students offering Chemistry as a subject. Out of which 3311 were males and 2190 were females with an average age of 17 years.

This study employed a Multi-Stage Sampling procedure for the selection of schools for the study. The 1<sup>st</sup> stage involved a selection of co-educational schools based on their accessibility, convenience and

to cater for gender variable involved in the study through Convenience Sampling Technique. The sample size of the study consisted of 97 SSII Chemistry Students. This is composed of 75 Males and 22 Females. The 2<sup>nd</sup> stage involved selection of Experimental School and Control School. The two schools were selected through Simple Random Sampling Technique and were assigned Experimental and Control Schools. Each of the two schools selected has two arms of Science Classes (A & B). In each of these two schools, an intact class was selected randomly and used so that no student was exempted or left out and to avoid the disturbance of the school classes structure. The selected intact classes comprise of Fifty-two (52) students (Males=42 & Females=10) for Experimental Group and Forty-five (45) students (Males=33 & Females=12) for Control Group.

The instrument used for data collection was Chemistry Achievement Test (CAT). The test items were adapted from West African Examination Council (WAEC), National Examination Council (NECO) and Joint Admission and Matriculation Examination (JAMB) 2000-2020 past question papers to measure the students' achievement and retention in the Chemistry Concepts taught. The concepts include: Separation Techniques, Catalysis, Combustion, Acid, Base and Saponification. The CAT has two sections (A & B) with Section 'A' elicits for Biodata (Name of School, Class & Gender) of the respondent, while Section 'B' composed of Thirty-five (35) Multiple Choice Questions of which respondents are expected to provide the correct answer to each item. Each item is associated with four options (A, B, C & D) of which one option is correct and the remaining three serves as distracters. The CAT was used on the Experimental and Control Groups at pre-test, post-test and post-post-test (retention test). The items in CAT were constructed to suit the six cognitive levels based on Blooms' Taxonomy for the Cognitive Domains. The instruments and instructional plans were validated by experts in the Departments of Science and Technology Education, Department of Pure and Industrial Chemistry, Bayero University Kano and Department of Science and Vocational Education, Umaru Musa Yaradua University, Katsina, Nigeria. The CAT was pilot tested on the G.S.S Danrimi SSII Chemistry Students (which is not part of the sample) twice with the interval of two weeks. Test-retest Method was used to assess the reliability of the CAT. Pearson Product Moment Correlation Coefficient (PPMCC) statistical tool was employed for analysis. The reliability coefficient of CAT was found to be  $r = 0.864$  which indicates high stability and acceptable for data collection in this study.



At the schools visited, the data collection begins with orientation session which involve introduction of researcher, stating the aim of the research for participant's consent, and training of the regular chemistry teachers who served as research assistants. With granted permission, the researcher pre-tested the students using CAT from both Experimental and Control Groups before any treatment.

After the pre-test, for Control Class, the research assistant taught the Chemistry Concepts (Separation Techniques, Catalysis, Combustion, Acid, Base and Saponification) to the students for the duration of six (6) weeks, forty-five (45) minutes per week using conventional Lecture Method. Thus, Lecture Method involves teaching topic(s) in a regular chemistry class where teaching and learning activities are mainly teacher-centered with students as passive listeners and note-takers. Whereas, for experimental class, the treatment involved teaching of the same Chemistry Concepts for the same duration using Ethnochemistry Lesson Plans. The Ethnochemistry Lesson Plan was developed by the researcher in accordance with Ethnochemistry based Approach adapted from (Fasasi, 2018). Ethnochemistry Instructional Guide Framework is a six steps sequence of a logical operations with the first stage begins with the teacher's task of introducing the concept to be taught to the students briefly. Here, the chemistry teacher is required to discuss the relevant ethnochemistry practices or beliefs, expressions and other relevant prior knowledge. Secondly, the teacher is required to sought responses from students and contribute to in the teaching dialect. Thirdly, after those

ethnochemistry/local practices and expressions were identified and discussed, the teacher is to present the new science concept to be taught. The fourth stage involve drawing comparisons between the newly introduced concept and the relevant ethnochemical practices. This is done through negotiation and interpretation. Fifthly, the students are required to interact with some relevant instructional materials including culturally related materials (where available and necessary) with teacher's guide. The sixth stage involve evaluative activities which allows teacher to evaluate the lesson through asking relevant question related to the concept taught and allow the students to respond to the asked questions.

After the six (6) weeks teaching (Treatment Session), the Experimental and Control Groups, post-test was administered using reoriented and reordered CAT to both groups (for gain determination, if any). Two consecutive weeks later, CAT's items were re-oriented and re-reordered and administered to both Experimental and Control groups (for retention determination, if any). The CAT scripts were marked by the researcher according to the groups (i.e. EG and CG) using appropriate Marking Scheme. The four research questions were answered using Mean and Standard Deviation(SD) whereas hypotheses one and three were tested using ANCOVA (one-way) and hypotheses two and four were tested using an Independent Samples t-test at 0.05 level of significance ran with Statistical Package for Social Science Software Version 20.0.

## Results

Presentations in this section are based on research questions and hypotheses:

**Table 2: Pretest and Posttest Mean Achievement Scores and Standard Deviations of the Experimental and Control Groups**

Groups	N	Pretest Scores		Posttest Scores		Mean Gain
		Mean( $\bar{x}$ )	SD	Mean( $\bar{x}$ )	SD	
Experimental	52	10.33	3.43	26.25	7.44	15.92
Control	45	10.11	2.87	19.98	5.25	9.87

Table 2 shows the Pretest, Posttest means, Standard Deviations and Mean Gain scores of the experimental and control groups. The result shows that the students in the experimental group had pretest mean achievement score of 10.33 and posttest mean achievement score of 26.25 with gained mean achievement score of 15.92, while those in control group had pretest mean achievement score of 10.11, posttest mean achievement score of 19.98 with gained

mean achievement score of 9.87. This indicates that, academic achievement of students taught chemistry concepts with Ethnochemistry based Approach improved better than those taught using lecture method. However, the standard deviation 3.43 (experimental group) and 2.87 (control group) for pretest indicates less dispersal of the scores around the mean score compared to 7.44 (experimental group) and 5.25 (control group) for posttest.

**Table 3: Result of One-way ANCOVA of the Mean Academic Achievement Scores of Chemistry Students in the Experimental and Control Group**



Sources of Variance	Sum of Squares	df	Mean Square	F	p-value	Remark
Corrected model	970.263 <sup>a</sup>	2	485.132	11.368	.000	
Intercept	3921.600	1	3921.600	91.893	.000	
Pretest	21.218	1	21.218	.497	.482	
Groups (Treatment)	938.274	1	938.274	21.986	.000	Significant
Error	4011.510	94	42.676			
Total	57824.00	97				
Corrected Total	4981.773	96				

Table 3 shows One-way Covariance Analysis (ANCOVA) of the pretest posttest on the main effect of the treatment (Ethnochemistry based approach) on the students' academic achievement. The result produced an F value of 21.986 and p-value of 0.000 showing the effect of the treatment was significance.

This is because, the p-value 0.000 is less than alpha value of 0.05 level of significance. This dictated that, only the treatment (Ethnochemistry based Approach) accounted for the difference in the post-test achievement scores of the students. Therefore, the null hypothesis One is hereby rejected.

**Table 4: Mean and Standard Deviations of Achievement Scores of Male and Female Chemistry Students in Experimental Groups**

Group	Gender	N	Pretest Scores Mean( $\bar{x}$ )	SD	Posttest Scores Mean( $\bar{x}$ )	SD	Gain in Mean
Experimental	Males	42	10.50	5.87	25.69	7.88	15.19
	Females	10	10.45	2.84	28.60	4.87	18.15

Table 4 shows the Pretest, Posttest means, Standard Deviations and Gain in Mean scores of the male and female students in the experimental group. The result shows that the male and female students in the experimental group had pretest mean achievement score of 10.50 and posttest mean achievement score of 25.69 with gained mean achievement score of 15.19, while those in control group had pretest mean achievement score of 10.45 and posttest mean achievement score of 28.60 with gained mean

achievement score of 18.15. This indicates that, academic achievement of female students taught chemistry concepts using Ethnochemistry based Approach improved better than their male counterpart. However, the standard deviation 5.87 (males) and 2.84 (females) for pretest group indicate less dispersal of the scores around the mean score compared to that of 7.88 (males) and 4.77 (females) for posttest.

**Table 5: Independent Samples t-test of the Mean Academic Achievement Scores of Male and Female Chemistry Students in the Experimental Group**

Group	Gender	N	Mean ( $\bar{x}$ )	SD	t-cal	df	p-value	Remark
Experimental	Males	42	25.69	7.882	1.115	50	.270	Insignificant
	Females	10	28.60	4.766				

Table 5 shows the posttest scores Independent Samples t-test analysis of the males and females SSII students in the Experimental group. It revealed that, there was no statistically significant difference in the academic achievement scores of male and female

SSII Students taught Chemistry Concepts using Ethnochemistry based Approach as the t-cal = 1.115, at df = 50 and the p-value = 0.270 which is greater than alpha value of 0.05 level of significance. Therefore, the null hypothesis Two is hereby retained.

**Table 6: Posttest and Post posttest (Retention test) Mean Achievement, Mean Loss Scores and Standard Deviations of the Experimental and Control Groups**

Groups	N	Posttest Scores Mean( $\bar{x}$ )	SD	Retention test Scores Mean( $\bar{x}$ )	SD	Mean Loss
Experimental	52	26.25	7.44	24.98	7.49	1.27



<b>Control</b>	45	19.98	5.25	16.27	5.19	3.71
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Table 6 shows the Posttest, Post posttest means, Standard Deviations and Mean loss scores of the experimental and control groups. The result shows that, the mean scores of posttest for experimental and control group were 26.25 and 19.98 respectively. Whereas, the retention mean scores for experimental group and control group are 24.98 and 16.27 respectively. This gives the mean loss between Posttest and retention test of 1.27 for experimental

and 3.71 for Control group. This indicates that, retention ability of students taught chemistry concepts with Ethnochemistry based Approach improved better than those taught using lecture method. However, the standard deviation 7.44 (experimental group) and 5.25 (control group) for posttest indicates less dispersal of the scores around the mean score compared to 7.49 (experimental group) and 5.19 (control group) for retention test.

**Table 7: Result of One-way ANCOVA of the Mean Retention Test Scores of Chemistry Students in the Experimental and Control Groups**

Sources of Variance	Sum of Squares	df	Mean Square	F	p-value	Remark
<b>Corrected model</b>	5556.282 <sup>a</sup>	2	2778.141	822.903	.000	
<b>Intercept</b>	17.679	1	17.679	5.237	.024	
<b>Pretest</b>	3724.434	1	3724.434	1103.200	.000	
<b>Groups</b>	140.929	1	140.929	41.744	.000	Significant
<b>Error</b>	317.347	94	3.376			
<b>Total</b>	48399.000	97				
<b>Corrected Total</b>	5873.629	96				

Table 7 shows One-way Covariance Analysis (ANCOVA) of the main effect of the treatment (Ethnochemistry based approach) on the students' retention ability. The result produced an F value of 41.74 and p-value of 0.000 showing the effect of the treatment was significance. This is because, the p-value 0.00 is less than alpha value of 0.05 level of

significance. This translates that the students in the experimental group (taught using Ethnochemistry based approach) retained chemistry concept taught better than those in control group (taught using Lecture method). Hence, the null hypothesis Three is hereby rejected.

**Table 8: Mean, Mean Loss and Standard Deviations of Posttest and Retention test Scores of Male and Female Chemistry Students in Experimental Group**

Group	Gender	N	Posttest Scores		Retention test Scores		Mean Loss
			Mean( $\bar{x}$ )	SD	Mean ( $\bar{x}$ )	SD	
Experimental	Males	42	26.25	3.41	25.99	4.46	0.26
	Females	10	19.98	5.32	19.52	7.84	0.46

Table 8 shows the Post-test, retention test mean, Standard Deviation and Mean loss scores of male and female students in the experimental group. The result shows that, the mean scores of posttest scores for male and female students were 26.25 and 19.98 respectively. Whereas, the retention test scores for male and female students were 25.99 and 19.52 respectively. This gives the mean loss between Posttest and retention test of 0.26 for experimental

and 0.46 for Control group. This indicates that, retention ability of both male and female students taught chemistry concepts with Ethnochemistry based Approach improved with negligible mean loss irrespective of gender. However, the standard deviation 3.41 (males) and 5.32 (females) for posttest indicates less dispersal of the scores around the mean score compared to 4.46 (males) and 7.84 (females) for retention test.

**Table 9: Independent Sample t-test of the Mean Retention Scores of Male and Female Chemistry Students in the Experimental Group**

Group	Gender	N	Mean( $\bar{x}$ )	SD	t-cal	df	p-value	Remark
Experimental	Males	42	24.43	7.84	1.092	50	0.280	Insignificant
	Females	10	27.30	4.46				

Table 9 shows the retention test scores Independent Samples t-test analysis of the males and females SSII students taught chemistry concepts using

Ethnochemistry based Approach. It turns out that, there was no statistically significant difference in the retention ability of male and female SSII Students



taught Chemistry Concepts using Ethnochemistry based Approach as the  $t$ -cal = 1.092, at  $df = 50$  and the  $p$ -value = 0.280 which is greater than alpha value of 0.05 level of significance. Hence, the null hypothesis four is hereby accepted.

### Discussion

The result from the research question and testing of hypothesis One indicated that the experimental group who were taught chemistry concepts using Ethnochemistry based Approach achieved significantly better than those in the control group who were taught same concepts using Lecture method. This indicates that Ethnochemistry based Approach is more effective in enhancing chemistry students' academic achievement in chemistry concepts than the conventional lecture method of teaching. This could be attributed to the fact that, the use Ethnochemistry based Approach involve incorporation of cultural and indigenous knowledge and practices which are very close to the students in their community or at home to explain the concepts of chemistry that are new to the students. This provide the basis by which all learners could be taken together and since they possess similar background knowledge. This finding is in consistent with the findings of (Abumchukwu, et al., 2021; Siwale, et al., 2020; Idah, 2018; Ajayi, et al., 2017; Ugwu & Diovu, 2016; Singh & Chibuye, 2016; Emendu & Udogu, 2013) who in their separate studies found and reported that, students taught chemistry concepts through the Ethnochemistry based approach have higher academic achievement than the students taught same chemistry concepts through conventional method like discussion, lecture and demonstration method of teaching. This can further be attributed to the fact that these conventional approaches to teaching, the students cultural background was not ascertained while teaching the chemistry concepts.

The result from the Research Question and Null Hypothesis Two revealed that, even though a meager difference exists descriptively between the academic achievement of male and female chemistry students taught chemistry concepts using ethnochemistry based approach. However, the difference was not statistically significant. This finding also indicate that all students are been carried along during the lesson right from their background knowledge up to the interaction with instructional materials (if any) irrespective of their gender differences. This finding could also be supported by the assertion of (Abumchukwu, et al., 2021) that 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, the role of adding potash in cooking beans and the use of ashes powder in a sour milk 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 etcetera. Also, this finding is consonance with the findings of (Abumchukwu, et al., 2021; Idah, 2018; Ugwu and Diovu, 2016; Singh and Chibuye, 2016; Peni, 2011) who in their separate studies found and reported that, gender has no significant influence on achievement and no interaction of teaching methods and gender was observed but students taught with integration of indigenous knowledge and practices had higher mean achievement score than their counterpart. But the findings of Mukuka (2019) contradicts the finding of this study in terms of gender; the study revealed the existence of significant difference in academic achievement of male and female students taught Ecology concepts using Ethnobiology-Discussion method in favour of male students. Mukuka further associated the reason of the difference with societal underestimation of females' potential and lack of courage in the part of female students in learning science which contributes to female' low achievement.

From the finding of Research Question Three proved that Students from experimental group retained chemistry concepts taught using Ethnochemistry based Approach better than those taught same concepts using lecture method. In addition, Null Hypothesis Three was rejected based on one-way ANCOVA analysis which confirms that significant difference exists in the retention scores of students taught chemistry concepts using Ethnochemistry based Approach and those taught using Lecture. This indicates that the potentiality of Ethnochemistry based Approach to teaching chemistry concepts in enhancing retention ability of students. The approach is potential in making the learned concepts meaningful and indelible. This could be associated with the fact that, Ethnochemistry based Approach involve cultural or traditional phenomenon already known and meaningful, familiar-with and picturable in the mind of learner. Hence meaningful memory is ascertained. This finding is in line with that of (Ajayi, et al., 2017; Peni, 2011; Emendu and Udogu, 2013) who in their separate studies found and reported that, students taught amidst their cultural knowledge retained the learned concepts more than their counterpart who were taught same concepts using conventional lecture method. Similarly, Ann (2012)

asserted that students will have higher retention capacity when they are allowed link their already existing culture knowledge in learning science concepts through cultural learning style than when they become passive learners as obtained in the use of traditional method like discussion or lecture method.

The findings from Research Question Four indicates that male students retained chemistry concepts better than female students after being exposed to Ethnochemistry based Approach with small value of mean difference. In the t-test analysis, Null Hypothesis Number Four was also rejected signifying that no significant difference exists in the retention scores of male and female students taught chemistry concepts using Ethnochemistry based Approach. This could be associated to fact that, both males and females engage in one responsibility or the other at homes and in their communities. Most of the ethnochemistry practices employed in this study during the treatment session to teach relevant chemistry concepts that are new to the students are soundly familiar to both male and female students right from home. This makes learning of those concepts taught meaningfully retained irrespective of gender difference. This finding is in conformity with the findings of (Emendu & Udogu, 2013) who found and reported that there is no statistically significant difference in the retention ability of male and female students taught using culturally related knowledge and day-to-day activities. They further explain that, such kind of approach to teaching and learning chemistry helps in bridging the gap between abstract and theoretical concept and real-life experiences which make learning more concrete and meaningfully retained. But, the finding of Peni (2011) contradicts the finding of this study based on retention ability based on gender. The study reported female students have had better retention of concepts than their male counterparts. This was further backed by the fact that female students interact more with the cultural practices than the male especially in domestic chores and other home-based activities like cooking etc.

### Conclusion

This study was conducted as part of the efforts of educational researchers in promoting the appropriate, relevant and suitable pedagogy in teaching chemistry which will help in addressing issues related to student's academic achievement and retention in Chemistry. Based on the findings of the study, it can be concluded that ethnochemistry based approach is effective in enhancing students' achievement and retention and gender friendly. Henceforth, this teaching approach can be used to

address the present trend of depressed achievement and retention manifested by senior secondary school students in Chemistry.

### Recommendations

1. Government should sponsor researches on exploration of indigenous knowledge relevant to science (ethnoscience). This would provide a means of reviving and preserving the glory of the hidden cultural-scientific and indigenous-scientific knowledge of various cultural tribes of Nigeria for formalisation and incorporation into school curriculum for teaching and learning of science.
2. Science teachers are encouraged to use such teaching approaches as ethnochemistry based approach in teaching school chemistry, ethnobiology in teaching school biology, ethnophysics in teaching school physics etcetera. Hence, chemistry and other allied science subjects should be taught within the learners' cultural background knowledge and should also relates to their day-to-day activities and experiences. The outcome of these approaches could be used to promotes SDGs, UNESCO's Science for All plan, irrespective of learners' gender, ethnicity, age or location.
3. Students should always reflect and relate what they were taught with their domestic and their cultural day-to-day activities. This would foster better understanding, positive attitude and application of the knowledge gained which in turn would enhance retention of the knowledge, and this signifies indelible meaningful learning.

### References

- Abonyi, O. S. (2002). Effects of ethnoscience-based instructional package on students' interest in science. *Journal of the Science Teachers Association of Nigeria*, 37(1&2), 60-68.
- Abonyi, O.S., Achimugu, L.N. & Adibe, M.I. (2014). Innovations in Science and Technology Education: A Case for Ethnoscience based Science Classrooms. *International Journal of Scientific & Engineering Research*, 5(1), 52-56.
- Abonyi, O.S., Ugama J.O., Okafor, G. & Abiam, P.O. (2016). Effects of Ethnomathematics based Instructional Approach on Primary School Pupils' Achievement in Geometry. *Journal of Scientific Research and Reports*, 9(2), 1-15.

- Abumchukwu, A. A., Eke J. A. & Achugbu, C.N.J. (2021). Effects of Ethnochemistry Instructional Strategy on Secondary School Students' Achievement in Chemistry in Onitsha Education Zone. *African Journal of Science, Technology & Mathematics Education (AJSTME)*, 6(1),121-128.
- Adeyegbe, S.O. (2010). Research into SIM Curriculum and School Examination in Nigeria: The State of the Art. The 45<sup>th</sup> Science Teachers Association of Nigeria Annual Conference Proceedings (pp.80-86).
- Adigwe, J.C. (2014). Effect of Mathematics Reasoning Skills on Students' Achievement in Chemical Stoichiometry. *Educational Journal of University of Nigeria*, 23(1), 1-22.
- Afriawanati, S., Sudarmin., and Sumarni. (2016). Model Pembelajaran Kimia Berbasis Etnosains Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *Jurnal Pengajaran MIPA*. 21(1), 46-51.
- Aikenhead, G. (1996). Science Education: Border Crossing into the Subculture of Science. *Studies in Science Education*, 27, 1-52.
- Ajayi, O.V. & Angura, T.M. (2017). Improving Senior Secondary Students' Retention in Electrolysis Using Collaborative Concept Mapping Instructional Strategy (CCMIS). *Greener Journal of Educational Research*, 7(6), 087-092.
- Ajayi, O.V., Achor, E.E., & Agogo, P.O. (2017). Use of Ethnochemistry Teaching Approach and Achievement and Retention of Senior Secondary Students in Standard Mixture Separation Techniques. *International Centre for Science, Humanities and Educational Research Journal*, 3(1), 21-30.
- Al-Zoubi, S.M. & Bani-Younes, M.A. (2015). Low Academic Achievement: Causes and Results. *Theory and Practice in Language Studies*, 5(11), 2262-2268.
- Ann, A. (2012). Improving Students' Retention in Integrated Science Using Cultural Learning Style in Ethiopia. *Ethiopia Journal of Humanities and Education*, 3(2), 23-29.
- Arokoyu, A.A. & Aderonmu, T.S.B. (2018). Conceptual formation, attainment and Retention of Chemistry and Physics Students in Real-Life Phenomena. *International Journal of Scientific Research and innovative Technology*, 5(5): 18-34.
- Ashikhia, D. A. (2010). Students and Teachers' Perceptions of The Causes of Poor Academic Performance in Ogun State Secondary Schools (Nigeria): Implication for Counseling for National Development. Retrieved From <http://Www.Eurojournal.Com/Ejss> on July 11<sup>th</sup>, 2020.
- Azuka, B.F. (2012). Improving the Memory of Students in Mathematics Classroom Towards Better Performance. *ABACUS Journal of Mathematical Association of Nigeria*, 37(1), 65-72.
- Bichi, S.S. (2002). *Effects of Problem-Solving Strategy and Enriched Curriculum on Students' Achievement in Evolution Concept Among Secondary School Students*. (Unpublished Ph.D Dissertation) Ahmadu Bello University, Zaria, Nigeria.
- Cheng, Y.C (2002). Fostering Local Knowledge and Wisdom in Globalized Education. invited Keynote Speech Presented at the 8<sup>th</sup> International Conference Held at Faculty of Education of Chulalongkorn University, 18-21 November 2002, Bangkok, Thailand. The Theme of the Conference is "Globalization and Localization Enmeshed: Searching for a Balance in Education".
- Chikendu, R.E., Obikezie, M.C. & Abumchukwu, A.A., (2021). Challenge of Effective Teaching of Chemistry in the Secondary Schools in Enugu State. *International Journal of Research*, 8(10), 106-117.
- Chongo, E. & Baliga, G.T. (2019). Effect of Ethnophysics-Based Instruction on Students' Academic Performance and Attitude towards Density, Forces and Heat Transfer in College Physics: A Case of Mufulira College of Education. *Journal of Education and Practice*, 10(20), 14-25.
- D'Ambrosio, U. (2001). What Is Ethnomathematics and How Can It Help Children in Schools? *Teaching Children Mathematics*, 7(6), 308-310.
- Emendu, N.B. & Udogu, M.E. (2013). The Effect of Linking Chemistry Concepts To-Day-ToDay Activities on Students' Achievement and Retention in Chemistry. *IOSR Journal of Research & Method in Education*, 2(5), 7-11.
- Fasasi, R. A. (2017). Effects of Ethnoscience Instruction, School Location, and Parental Educational Status on Learners' Attitude towards Science. *International Journal of Science Education*, 39, 548-564
- OFasasi, R.A. (2018). Development of a Simple Ethnoscience Database and a Framework for Its incorporation into the Science Classroom. in E. Langran & J. Borup (Eds.), Proceedings of Society for information Technology &



- Teacher Education International Conference (pp. 3714-3723). Washington, D.C., United States: association for the Advancement of Computing in Education (AACE). Retrieved on March 18<sup>th</sup>, 2021 from <https://Www.LearntechLib.Org/Primary/P/182785/>.
- Federal Ministry of Education, (2009). *National Policy on Education*, Lagos Federal Government Press.
- Forawi, S.A. (2015). *Science Teacher Professional Development Need in the United Arab Emirates*. In N. Mansour and S. Al-Shamrani (Eds.): *Science Education in the Arab Gulf States* (Pp. 49-68). Rotterdam: Sense.
- George, J. (2001). Culture and Science Education. A look from the Developing World. *An Action Bioscience*. [www.id21.org/education/e31g2.html](http://www.id21.org/education/e31g2.html). Retrieved 7 April 2020. Gerdes.
- Guido, R.M.D. (2013). Attitude and Motivation towards Learning Physics. *International Journal of Engineering & Technology*, 2(11), 20-87.
- Hiwatig, A.D.F. (2008). Ethno-Scientific Teaching Approach, Student Proficiency, and Attitude toward Science and Ethnic Culture. *Education Quarterly*, 66 (1), 3-21.
- Hwang, K. (2013). Educational modes of thinking in Neo-Confucianism: a traditional lens for rethinking modern education. *Asia Pacific Education Review*, 14, 243-253.
- Ibe, E., & Nwosu, A. A. (2017). Effects of Ethnoscience Traditional Laboratory Practical on Science Process and Skills Acquisition of Secondary School Biology Students in Nigeria. *British Journal of Multidisciplinary and Advanced Studies*, 1(1):35-46.
- Ibrahim, S.T., Sabitu, A. & Magaji, T.M. (2016). Comparative Analysis of Gender Performances in Biology, Chemistry and Physics among Pre-Degree Students of Federal University, Dutsinma. *International Journal of Educational Benchmark*, 5(1): 108-118.
- Idah, N.N. (2018). *Effect of Ethnochemistry Teaching Approach on Secondary School Students' Achievement and Interest in Chemistry in Enugu State*. (Unpublished Ph.D Thesis). University of Nigeria, Nsukka.
- Kerlinger, F.N. & Lee, H.Z., (2005). *Foundation of Behavioural Research*. Forth Edition, New York: Harcourt Higher Learning Company.
- Khaddour, R., Al-Amoush, S., and Eilks, I. (2017). The Curriculum Emphasis in Grade-10 Chemistry Textbooks from Seven Cross Regional Arab Countries. *Chemistry Education Research and Practice*, 18, 375-385.
- Kurumeh, M.S. (2004). Effect of Ethno-Mathematics Approach on Students' Achievement in Geometry and Mensuration. *The Journal of Mathematical Association of Nigeria*, 31(1), 35-44.
- Marasinghe, B. (2016). Ethnochemistry and Ethnomedicine of Ancient Papua New Guineans and Their Use in Motivating Secondary School Children and University Undergraduates in PNG. *Universal Journal of Educational Research*, 4(7), 1724-1726.
- Muhammad, S.A. (2011). *Effects of inquiry Teaching Method on Academic Performance, Retention and attitudes Towards Chemistry Among Diploma Students of Kano State Polytechnic*. (Unpublished M.Ed Thesis). Ahmadu Bello University Zaria, Nigeria.
- Mukuka, E.M. (2019). Does Ethno-Biology Improve Pupil's Understanding in Ecology? A Case of Lubuto Secondary School in Ndola District. *Global Scientific Journals*, 7(9): 972-1065.
- Ogbeba, J., & Ajayi, O.V. (2016). Effect of Hands-On Activities on Senior Secondary Chemistry Students' Achievement and Retention in Stoichiometry. *International Centre for Science, Humanities and Educational Research Journal*, 2(2), 54-59.
- Okorie, E. U. & Ezech, D. N. (2016). The Effect of Gender and School Location on Students' Achievement in Chemistry. *Mediterranean Journal of Social Sciences MCSER Publishing*, 7(3), 309-316.
- Olorundare, A.S. (2014). *Theory into Practice: Beyond Surface Curriculum in Science Education*. The One Hundred and Forty-Seventh (147<sup>th</sup>) Inaugural Lecture Presented at the University of Ilorin, Ilorin, Nigeria.
- Peni, H.Y. (2015). *Impact of Ethnoscience-Enriched-Instruction on attitude, Retention and Performance in Basic Science Among Rural and Urban Students in Kano State, Nigeria*. (Unpublished PhD Thesis). Ahmadu Bello University, Zaria.
- Rich, E. (2010). How Do You Define 21<sup>st</sup> Century Learning? *Education Week Teacher PD Source Book*, 4(1), 32-35.
- Shumba, O. (2017). Tackling Educational Quality and Epistemological Access Concerns in Science and Technology Education in Africa:



- The “Learning-as-Connection” Perspective. *African Perspectives of Research in Teaching and Learning*, 1(1), 18-22.
- Singh, I.S. & Chibuye, B. (2016). Effect of Ethnochemistry Practices on Secondary School Students’ Attitude towards Chemistry. *Journal of Education and Practice*. 7(17), 44-56.
- Siwale, A., Singh, I.S. & Hayumbu, S. (2020). Impact of Ethnochemistry on Learners Achievement and Attitude Towards Experimental Techniques. *International Journal of Research and Innovation in Social Science (IJRISS)*, 4(7), 2454-6186.
- Stoet, G., & Geary, D.C. (2013). Sex Differences in Mathematics and Reading Achievement are Inversely Related: within-and across-nation assessment of 10 years of PISA data. *PLOS ONE*, 8(3), 1-10.
- Ugwu A.N. & Diovu, C.I. (2016). Integration of indigenous Knowledge and Practices into Chemistry Teaching and Students’ Academic Achievement. *International Journal of Academic Research and Reflection*, 4(4), 1-12.
- UNESCO (2006). Education for All: The Quality Imperative. EFA Global Monitoring Report. Retrieved on 2<sup>nd</sup> April 2019 from [www.Unesco.Org/Education/Efa/Index.Shtml](http://www.Unesco.Org/Education/Efa/Index.Shtml).
- Vygotsky, L.S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.
- West African Examination Council, (2016, 2017, 2018, 2019, 2020). May/June. Chief Examiners’ Report. Lagos.