Effect of Ethnochemistry Instructional Approach on Secondary School Students' Achievement in Chemistry in Bayelsa State

Konyefa, Bridget Izondeme
Department of Chemistry,
School of Science Education,
Isaac Adaka Boro College of Education,
Sagbama, Bayelsa State,

Prof. Okigbo Ebele Chinelo
Department of Science Education,
Nnamdi Azikiwe University, Awka,

Abstract
The study investigated the effects of ethnochemistry instructional approach (EIA) secondary school students' achievement in chemistry. Two research questions and three hypotheses guided the study. The quasi-experimental design was adopted, specifically the pretest-posttest non-randomized control group was used. The population of the study was 4, 955 senior secondary year two (SS2) students offering chemistry in Yenagoa Education Zone out of which 153 students were selected for the study using purposive and random sampling techniques. The instrument for data collection was Chemistry Achievement Test (CAT) validated by three. The reliability of CAT was established using Kuder-Richardson to be 0.70. Analysis of data for the study was done using mean and standard deviation and analysis of covariance. The result of the study showed that students taught using EIA had higher gains in mean achievement scores than those in the conventional instructional approach. The findings of the study revealed that there was a significant difference between mean achievement scores of students taught chemistry using EIA and conventional instructional approach in favour of EIA. It was concluded that EIA is an effective instructional approach for improving students' achievement. It was recommended that seminars and workshop should be organised by Science Teachers Association of Nigeria on how to plan chemistry lessons using EIA and how to use the approach in teaching chemistry.

Keywords: *ethnochemistry, conventional, chemistry, interest, acid*

Introduction

The importance of chemistry to the nations of the world is indisputable and Nigeria is not an exception. The usefulness of chemistry in relation with other science disciplines has become glaringly clear to all in the face of the severe acute respiratory syndrome coronavirus two (Covid-2) pandemic, which surfaced in the later part of year 2019 (Helen, 2020). The sickness which is now code-named CoVid-19 spread at alarming rate across countries of the world and requires the development of antiviral drugs which can suppress or cure the disease. Drugs are chemical compounds (Teale, Scarth & Hudson, 2012) which have their origin from chemistry.

In recent time, chemical compounds like hydroxylchloroquine and azithromycin a higher version of erythromycin have been recommended for clinical trials by the United States and NAFDAC (Noah & Maggie, 2020; Opejobi, 2020). Alcohol hand-sanitizers which are needed to disinfect and sanitize our hands are being produced today in large quantities by

local residents who have the chemistry know-how and skills. These chemicals and more are needed not just in Nigeria but in the world at large to curb the menace of the pandemic which is throwing every nations of the world into economic and social recession. In the event of the attempt to develop antiviral drugs (chemicals) vaccines or find out any combination of chemicals that could suppress or cure the coronavirus disease, among others, one sees the glaring importance of chemistry in human survival or extinction.

The importance of chemistry notwithstanding, O'dwyr (2012) noted that from the earliest times, chemistry has proved to be generally a difficult subject to all students at all levels. The assertion though old still holds true today, as evidenced in students' achievement in external examinations in chemistry. In Nigeria for instance, students' achievement in chemistry in the West African Secondary School Certificate Examination (WASSCE) has remained abysmal. The Chief Examiner's Reports over the years shows that students continue to manifest various weaknesses in the examinations especially poor knowledge of chemistry concepts. An analysis of students' achievement from 2007-2009, the percentage number of students' made a credit pass in chemistry ranged from 44.16%-46.16%. From 2010-2012, the percentage of students who obtained a credit pass was below 50% except in 2010 with 50.7%. From 2013-2016, there was a persistent decline in the percentage of those who made a credit pass from 72.34% in 2013, to 62.49% in 2014, to 60.6% in 2015 and 57.74% in 2016. From 2017 to 2019, reports on the worst performances of students in chemistry were observed. This is because in 2018, students' highest point of decline was observed.

The poor achievement of students in chemistry is attributed to number of factors. Some of the contributory factors to students' poor achievement in chemistry include among others: the teaching method adopted by chemistry teachers, 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 (Adalinkwu & Iorkpilgh, 2013; Udofia, 2009). Several research studies (Ogbeba & Ajayi, 2016; Ruggaber, 2017) have focused on finding innovative instructional approaches that could improve students' achievement in chemistry. In spite of these studies, students' achievement in chemistry in recent times seem not to be appreciating as expected.

Studies however, have not focused fully on the role of situating or contextualizing chemistry learning within the indigenous knowledge of the students (ethnochemistry instructional approach), in their achievement in the subject. Teachers of chemistry also have not always used traditional knowledge common within the immediate environment of the learning to make chemistry learning easier for students. One of the reasons for the lack of research in these instructional approaches is because teachers and most researchers do not know that poor achievement in chemistry and science in general is caused by cultural clashes that exist between students' life-world and world of modern science (Fasasi, 2018). The fundamental question arising from this idea therefore is: Can achievement in chemistry be improved through ethnochemistry instructional approach?

Ethnochemistry stems from the materials, ideas, beliefs and technology in a given society or environment, that derived from the past and present cultural practice and traditions. The prefix 'ethno' according to Rosa and Orey (2011) denotes a broad term that implies the socio-cultural context and includes language, jargon, codes of behaviour, myths and symbols. Ethnochemistry therefore, are the various chemically related cultural and community practices (Indra & Bitwell, 2016). Kurumeh and Opara (2008) explained that ethno-method of teaching involves situating learning and. problem solving in real life context where the environment is very rich in information with physical materials that serve as a source of manipulative and interactive processes. Ethnochemistry teaching approach therefore means a

teaching approach bordering on teaching chemistry using indigenous chemically related practices and local materials. These indigenous chemically related practices and local materials may be used to make the unfamiliar chemistry content familiar to students.

In the present study, ethnochemistry instructional approach involved the chemistry teacher giving a brief introduction of the chemistry concept to be taught. This was closely followed with a demonstration using local materials from the students' immediate environment or that are used culturally. Then, enumeration and discussion of related common Bayelsan cultural practices which have chemical/scientific relevance was done by the teacher. The teacher asked and encourage the students to list more cultural related ideologies, practices or indigenous knowledge that are related to the concept. Thereafter, the teacher presented the chemistry concept in details comparing them to the related cultural beliefs and practices. The comparism was used as the focus of discuss in the classroom with the teacher identifying areas where cultural beliefs and practices are compatible, modifiable or contradictory with the science of chemistry. The lesson ended with teachers' evaluation of instructional objectives of the lesson after a summary of the important points to in the lesson have been noted.

Ethnochemistry instructional approach is hoped to benefit the chemistry students by helping them sequence teaching/learning processes through previous knowledge of the culture or other indigenous knowledge offering them the opportunity to know more about reality, culture, society and science. It could encourage students to think chemistry within themselves and arrive at a meaningful learning and understanding for improved achievement. It could as well make learning all the more interesting just as materials within their immediate environment are used as instructional materials. According to Aina (2013), the use of local instructional materials in teaching and learning could make the concept more practical and subsequently reduce abstraction. They are cost effective and could be obtained from the immediate local environment of the learning. They are also relatively safe for demonstration especially where students are involved in its production as is intended in the present study. Locally sourced materials also minimize concern about breakages, repair, loss and other mishandling by students. Thus, they can be used frequently in practical exercises and such continuous experiments in a practical oriented science subject like chemistry could improve achievement.

Achievement is the performance outcome which expresses the extent students have accomplished specific goals that are associated with activities in instructional environments such as schools and colleges (Hattie, 2009), it is the outcome of education. Achievement is often determined by administering a teacher made or standardized test. Thus, in this study, achievement is the performance in a school subject expressed as a score, mark or grade in an achievement test. The achievement of a student is often affected by many factors among which the teachers' choice of instructional approach is prominent factors. This is even so with the teaching and learning of chemistry which requires practical/activity oriented instructional approach (Andersson & Gullberg, 2014). In the study, the students' achievement was determined using an achievement test. Good instructional approaches facilitate proper understanding in the students and result in better achievement irrespective of students' location (Atomatofa, 2014).

One of the important factors in students' learning that have not received wide publicity is the school location. School location is simply the geographical setting in which a school is situated (Babatunde, 2015). It is the environment in which a student grows or school is situated (Hornby, 2006). According to Yusuf and Onyeuwotu (2014), the society in which an individual is located can be classified as urban or rural. There is no generally agreed definition of what urban and rural settlements. However, School location means urban-rural setting (Nworgu, Ugwuanyi & Nworgu, 2013). Nworgu et al. noted that a school in the heart

of the government reserved area (G.R.A) or housing estate cannot be compared with a school located in an unsuitable place like motor garage, main street, noisy environment, and nearness to a big market among others. This is because noisy environment is capable of hampering teaching and learning conditions. Long journey to school can be drudgery. These variables have the potentials to influence the students' conceptual understanding. There is the perception that rural dwellers are slow-witted hillbillies with little education and uninformed view about what goes on in the "real world"; whereas, those living in the urban areas are more exposed to modern technology which can aid learning than those in the rural areas.

School locations may also influence academic achievement owing to the characteristics of such location such as infrastructure, electricity, accessibility and internet networks. These features affect the level of the provision of educational infrastructure. Thus, provision of education in rural areas according to Babatunde (2015) is normally fraught with the following difficulties and problems: qualified teachers' refusal of appointment to isolated villages; villagers refusal to send their children to schools because they are dependent on them for help; parents hesitating to entrust their daughters to male teachers; some villagers have few children for an ordinary primary school; lack of roads or satisfactory means of communication which makes it difficult to get books and teaching materials to the school which place difficulties in the way of organizing school transport among others. It can simply be understood that with changed economic incentives the level and distribution of educational services change along with the locational decisions of households. This has direct ramifications for a number of educational policy and finance decisions. Urban Location Models in Urban economics has largely focused on household location and urban form as dictated by accessibility concerns. These have wide implication for schools in rural areas and as results may affect the learning of students in such location. Thus, there is need to examine academic achievement difference among schools located in urban and rural areas.

Purpose of the Study

The purpose of the study was to find out the effects of ethnochemistry instructional approach on secondary school students' achievement in chemistry. Specifically, the study determined the:

1. Difference between the mean achievement scores of students taught chemistry using ethnochemistry instructional approach (EIA) and those taught using conventional instructional approach (CIA).
2. Difference between the mean achievement scores of urban and rural secondary school students taught chemistry using EIA.
3. Interaction effect of instructional approaches and school location on students' achievement in chemistry.

Research Questions

The following research questions guided the study.

1. What is the difference between the pretest and posttest mean achievement scores of students taught chemistry using ethnochemistry instructional approach (EIA) and those taught using conventional instructional approach (CIA)?
2. What is the difference between the pretest and posttest mean achievement scores of students from urban and rural secondary school taught chemistry using EIA?

Hypotheses

The following hypotheses were tested at 0.05 level of significance:

1. There is no significant difference between the mean achievement scores of students taught chemistry using ethnochemistry instructional approach (EIA) and those taught using conventional instructional approach (CIA).
2. There is no significant difference between the mean achievement scores of students from urban and rural secondary schools taught chemistry using EIA.
3. There is no interaction effect of instructional approaches and school location on secondary school students' achievement in chemistry.

Method

The study adopted the quasi-experimental design. The study was carried out in Yenagoa Education Zone of Bayelsa State, Nigeria. The population of the study comprised 4, 955 senior secondary year one (SS1) chemistry students in Yenagoa Education Zone. The sample size for the study was 153 SS1 chemistry students. Experimental group one (ethnochemistry instructional approach group) has 79 students (37 urban, 42 rural) while the control group (conventional instructional approach) has 74 students (36 urban, 38 rural).

The instrument for data collection was Chemistry Achievement Test (CAT) which validated by two lecturers in the Departments of Science Education and of Educational Foundations, Nnamdi Azikiwe University, Awka, and one experienced secondary school chemistry teacher for validation. The reliability of CAT was established using Kuder-Richardson Formula 20 (KR-20). KR-20 was chosen because it is suitable for determining the internal consistency of dichotomously scored instruments. CAT was administered once to 40 SS1 chemistry students in Ogbia Education Zone of Bayelsa state which is not part of the study. The generated scores from the exercise were collated and reliability computations was carried out using the stated formulae. The index obtained for CAT was 0.70.

The general step by step procedures that was taken in teaching the chemistry concepts to the students in the ethnochemistry experimental group is as follows: The teacher in the first step briefly introduced the concept to be taught, with students attention drawn to the contents under the concepts to be learnt and briefly explain them to enable them have a grasp of what they were learning and to know also, what cultural knowledge and practices to present when asked, that is related to the contents.

The brief introduction was followed by the teacher presenting some of the ingenious knowledge and cultural practices through a demonstration with local materials obtained from the students' immediate environment. The teacher asked the students to present other cultural practices or knowledge of such practices that are related to the concepts. A demonstration of some of the cultural practices was done by the students. The teacher explained the practices presented by the students in relation to the concept taught and classify them into three categories namely: compactible with science, compactible with science with modifications and misconception. Under the compactible with science category, the teacher presented only those ethnochemical practices that are compatible with science. In the category for compactible with science with modification, the teacher presents those ethno-related practices that can be modified and made compactible with science whereas in the misconception category, only those cultural ideas and practices that are not compatible with science were presented. Students during this comparism were allowed to state their opinion to make the class more interactive and to further clear misconceptions that may further be made known. Students were also allowed to ask questions on confusing subjects that may form the quorum for discussion at any instance. The teachers' interaction with the students, was with the view to further explore other the cultural practices and indigenous knowledge known to them and emphasized the scientific connotations in each of the cultural practices mentioned by the students.

The teacher summarized the important points of the lesson, emphasizing the misconceptions discovered and evaluated the students' learning by asking questions based on what was learnt. Every class ended with an assignment given to students to enable them explore cultural practices and ingenious knowledge that are related to the next concept to be taught. The conventional group was taught using the conventional instructional approach. It involved presentation of lesson content to the students with in-depth explanation for their understanding. Students were allowed to ask questions about what they understand and get further clarification.

Data generated through the study was analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA). The decision rule was to reject null hypothesis where Probability value (p-value) was less than or equals significance value of 0.05 ($P \leq 0.05$) and not to reject null hypothesis where P-value was greater than 0.05 ($P > 0.05$).

Results

Research Question 1: What is the difference between the pretest and posttest mean achievement scores of students taught chemistry using EIA and those taught using CIA?

Table 1: Pretest and Posttest Mean Achievement Scores of Students taught Chemistry using EIA and those taught using CIA

Group	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gained Mean
EIA	79	24.04	4.85	74.03	6.69	49.99
CIA	74	30.36	2.40	63.51	6.25	33.15
Mean Difference		6.32		10.52		16.18

Table 1 reveals that the students taught chemistry using EIA has pretest mean achievement score of 24.04 and posttest mean interest score of 74.03 with gained mean achievement score of 49.99, while those in the control group taught with conventional instructional approach has pretest mean achievement score of 30.36 and posttest mean score of 63.51 with gained mean 33.15. The spread of scores in the posttest of students in the experimental is slightly higher than that of those in the control group. The difference between the between the mean gained achievement scores of the students is 16.18 in favour of EIA.

Research Question 2: What is the difference between the pretest and posttest mean achievement scores of students from urban and rural secondary school taught chemistry using EIA?

Table 2: Pretest and posttest mean Achievement Scores of Urban and Rural Students taught Chemistry using EIA

Gender	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gained Mean
Urban	37	23.81	4.59	73.32	7.54	49.51
Rural	42	24.24	5.11	74.64	5.86	50.40
Mean Difference		0.43		1.32		0.89

Table 2 reveals that the urban students taught chemistry using EIA has pretest mean achievement score of 23.81 and posttest mean achievement score of 73.32 with a gain in mean scores of 49.51 while the rural students have pretest mean posttest score of 24.24 and

posttest mean achievement score of 74.64 with a gain in mean scores of 50.40. The difference in mean achievement score of the urban and rural students in 0.89 in favour of rural students.

Hypothesis 1: There is no significant difference between the mean achievement scores of students taught chemistry using EIA and those taught using CIA.

Table 3: ANCOVA Test of Significance of Difference between the Mean Achievement Scores of Students taught Chemistry using EIA and CIA

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	4303.662[a]	2	2151.831	51.621	.000	
Intercept	16331.780	1	16331.780	391.787	.000	
Pretest	81.627	1	81.627	1.958	.164	
Method	1972.082	1	1972.082	47.309	.000	Sig
Error	6252.809	150	41.685			
Total	737748.000	153				
Corrected Total	10556.471	152				

Table 3 shows that there is a significant main effect of the treatment on students' achievement in chemistry F (2, 150) = 47.309, P =0.000 < 0.05. Therefore, the null hypothesis is rejected meaning that there is a significant difference between the mean achievement scores of students taught chemistry using ethnochemistry instructional approach (EIA) and those taught using conventional instructional approach (CIA) in favour of EIA.

Hypothesis 2: There is no significant difference between the mean achievement scores of students from urban and rural secondary school taught chemistry using EIA.

Table 4: ANCOVA Test of Significance of Difference between the Mean Achievement Scores of Urban and Rural Students taught Chemistry using EIA

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	183.117[a]	2	91.558	1.699	.190	
Intercept	20017.641	1	20017.641	371.444	.000	
Pretest	164.936	1	164.936	3.061	.084	
Location	23.309	1	23.309	.433	.513	Not Sig
Error	4095.744	76	53.891			
Total	434961.000	79				
Corrected Total	4278.861	78				

Table 4 shows that there is no significant main influence of location on students' achievement in chemistry F (2, 76) = 0.433, P =0.513 > 0.05. Therefore, the null hypothesis is accepted meaning that there is no significant difference between the mean achievement scores of students from urban and rural secondary schools taught chemistry using EIA.

Hypothesis 3: There is no interaction effect of instructional approaches and school location on secondary school students' achievement in chemistry.

Table 5: ANCOVA for Testing the Interaction Effect of instructional approaches and school location on secondary school students' Achievement in chemistry

Source	SS	df	Mean Square	F	Sig.	Decision
Corrected Model	4411.225[a]	4	1102.806	26.560	.000	
Intercept	15410.428	1	15410.428	371.139	.000	
Pretest	57.347	1	57.347	1.381	.242	
Method	1996.110	1	1996.110	48.074	.000	
Location	105.951	1	105.951	2.552	.112	
Method * Gender	3.096	1	3.096	.075	.785	Not Sig.
Error	6145.246	148	41.522			
Total	737748.000	153				
Corrected Total	10556.471	152				

Table 5 shows that there is no significant interaction of instructional approaches and school location on secondary school students' achievement in chemistry F (4, 148) = 0.075, P =0.785 > 0.05. Therefore, the null hypothesis is accepted meaning that there is no interaction effect of instructional approaches and school location on secondary school students' achievement in chemistry.

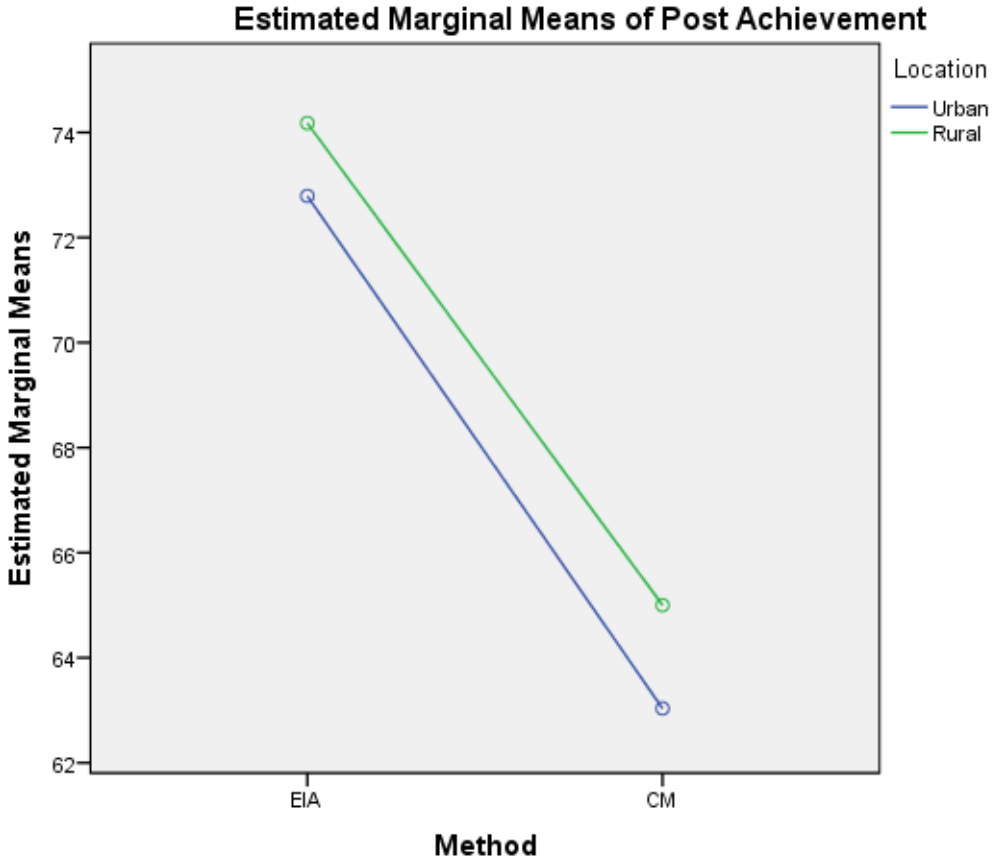

Figure 1: Plot of interaction effect of instructional approaches and school location on secondary school students' achievement in chemistry.

The plot of interaction effect of instructional approaches and school location on secondary school students' achievement in chemistry is not significant and ordinal. This shows that

effect of the instructional approaches did not change when location was put into consideration.

Discussion

The findings of the study also revealed that there was a significant difference between the mean achievement scores of students taught chemistry using ethnochemistry instructional approach (EIA) and those taught using conventional instructional approach in favour of EIA. This finding of the study may have resulted from the fact that the adoption of EIA enabled the students to link the concepts taught to the day to day activities in their immediate environment. This way, students understood the concepts better, established a strong connection between theory and practice and reduced the abstract ideas associated with the science of chemistry. By relating the learning with the cultural understanding of the students, they were able to interpret chemistry concepts in the light of their prior understanding, removing their misconceptions and holding a better conception of chemistry.

The whole process of learning in EIA enabled students to construct their own knowledge since the concepts were well understood. Students were able to cognitively see chemistry as it is, imaging it and apply it to their various home and community practices. The use if EIA also made the students to understand chemistry in their native language given the import of the indigenous knowledge and cultural practices. Getting to borrow certain terminologies from their culture to explain chemistry concept drove the learning home leading to better achievement.

The finding of the study lend credence to the finding of Oluwatosin, Emmanuel and Peter (2017) that students taught mixture separation techniques using ethnochemistry approach had significantly higher mean achievement scores than those taught using discussion method. The finding of the study is in line with the findings of Abonyi (1999) revealed that the ethnoscience based Instructional package is superior to the conventional approach in facilitating modern science concept formation in learners. The finding of the study lend credence to the findings of Ugwu and Diovu (2016) that students taught with integration of indigenous knowledge and practices had higher mean achievement score than their counterpart. The finding of the study is also in line with the findings of Omenka and Kurume (2004) that ethnomathematics approach was more effective in facilitating students' achievement in geometry and mensuration.

Conclusion

The findings of this study showed that students taught chemistry using EIA had significantly higher achievement scores than those taught using CIA. It is concluded that EIA is an effective instructional approach for improving students' achievement in chemistry.

Recommendations

The following recommendations are made in the light of the findings of the study:

1. Textbook writers should incorporate cultural practices and realities that are compatible with science so as to make the learning of chemistry and its understanding easier for students. This may also reduce the level of abstraction in the learning of chemistry.
2. Seminars and workshop should be organised by Science Teachers Association of Nigeria on how to plan chemistry lessons using EIA and how to use the approach in teaching chemistry.

References

Abonyi, O.S. (1999). *Effect of an ethnoscience based instructional package on students' conception of scientific phenomena and interest in science.* Unpublished PhD dissertation; University of Nigeria, Nsukka.

Adalinkwu, S.A. and Iorkpilgh, I.T. (2013). The influence of instructional materials on academic performance of senior secondary school students in chemistry in Cross River state. *Global Journal of Educational Research, 12,* 33-45.

Aina, K. J. (2013). Instructional materials and improvisation in physics class: Implications for teaching and learning. *IOSR Journal of Research and Method in Education (IOSR-JRME)*, *2*(5), 38–42.

Andersson, K., and Gullberg, A. (2014). What is science in preschool and what do teachers have to know to empower the children? *Cultural Studies of Science Education, 9*(2), 275–296.

Atomatofa, R. O. (2014). Effects of instructional strategies and gender on basic science students' achievement in Nigeria. *Academic Journal of Psychological Studies, 3*(3), 207-217.

Babatunde, A.M. (2015). *Influence of class size, teacher variables and school location on academic performance among senior secondary school students in Kaduna state, Nigeria.* Unpublished master's thesis, Ahmadu Bello University, Zaria.

Babatunde, A.M. (2015). *Influence of class size, teacher variables and school location on academic performance among senior secondary school students in Kaduna state, Nigeria.* Unpublished master's thesis, Ahmadu Bello University, Zaria.

Fasasi, R. (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).

Hattie, J. A. C. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. London: Routledge.

Helen, D. (2020, March 13). First Covid-19 case happened in November, China government records shows-report. *The Guardian.* Retrieved from https://www.theguardian.com/world/2020/mar/13/first-covid-19-case-happened-in-november-china-government-records-show-report on 20 August, 2021

Hornby, A. S. (2006). *Oxford advanced learners dictionary* (7th Edition). Oxford: Oxford University Press. http//www.sitemaker.umich.edu/butler.356/school_environment.

Indra, S.S. and Bitwell, C. (2016). Effect of ethnochemistry practices on secondary school students' attitude towards chemistry. *Journal of Education and Practice, 7*(17), 44-56.

Kurumeh, M.S. and Opara, M.F. (2008). *Innovative teaching approaches of mathematics education in the 21st century*. Makurdi: Azaben Publishers.

Noah, W. and Maggie, H. (2020, March 24). Oracle provifing white house with software to study unproven coronavirus drugs. *New York Times.* Retrieved from https://www.nytimes.com/2020/03/24/us/politics/trump-oracle-coronavirus-chloroquine.html on 20 August, 2021

Nworgu, B.G., Ugwuanyi, C.S. and Nworgu, L.N. (2013). School location and gender as factors in senior secondary school students' conceptual understanding of force and motion. *International Journal of Education Research and Technology, 4*(4), 71-76.

O'dwyer, A. (2012). *Identification of the difficulties in teaching and learning of introductory organic chemistry in Ireland and the development of a second-level intervention programme to address these*. Ollscoil Luimnigh: University of Limerick.

Ogbeba, J. and Ajayi, O.V. (2016). Effect of hands-on activities on achievement and retention of senior secondary school chemistry students in stoichiometry. *Icsher Journal, 2*(2), 54-59.

Oluwatosin, V.A., Emmanuel, E.A. and Peter, O.A. (2017). Use of ethnochemistry teaching approach and achievement and retention of senior secondary students in standard mixture separation techniques. *ICSHER Journal, 3*(1), 21 – 30.

Omenka, J.E. and Kurumeh, M.S. (2013). Gender and Location as Correlates of Achievement in Number and Numeration Using Ethno Mathematics Approach in the Junior Secondary Schools in Benue State. *Greener Journal of Educational Research, 3*(4), 184-190.

Rosa, M. and Orey, D.C. (2011). Ethnomathematics: the cultural aspects of mathematics. *Revista Latino americana de Etnomatemática, 4*(2), 32- 54.

Ruggaber, J (2017). What is the best method for teaching chemistry? Retrieved from https://www.quoracom/what-is-the--best-method-for-teaching chemistry on 20 August, 2021

Teale, P., Scarth, J. and Hudson, S. (2012). Impact of the emergence of designer drugs upon sports doping testing. *Bioanalysis, 4*(1), 71–88.

Udofia, T. M. (2009). Environmental phenomena/experiences: An effective approach to teaching/learning the concept of energy. Linking school chemistry with learners' day – to – day activities. In M. A. Olayiwola and W. S. Umoh (Eds.). Kano: Abioye, Dynamic Printers.

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 & Reflection, 4*(4), 22-30.

Yusuf, R. O. and Onyeuwotu, G. N (2014). Rural-Urban variation in perception of extra lessons among secondary school students in Sabon-Gari local government area of Kaduna state, Nigeria. *Journal of Educational Research and Development, A Journal of the Faculty of Education, Ahmadu Bello University Zaria, 8*(2), 204 – 216.