EFFECT OF ETHNO – SCIENCE ENRICHED CHEMISTRY INSTRUCTIONAL STRATEGY ON SECONDARY SCHOOL STUDENTS' ATTITUDE TO CHEMISTRY IN BAUCHI STATE, NIGERIA

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Abstract

This study investigated the effects of Ethno-science enriched chemistry instructional strategy on secondary school students' attitude to chemistry in Bauchi state, Nigeria. Two research questions and two hypotheses guided the study. A pretest, post-test, control group, quasi-experimental, 2x2 factorial matrix was employed to guide the study towards the accomplishment of the stated objectives. The population of the study comprised of all public senior secondary school students offering chemistry in the 2023/2024 academic session. Multi-stage sampling technique was used at six levels in selecting the sample size of this study. One hundred and ninety-three (193) SS II chemistry students from four intact classes in four senior secondary schools made up the sample for the study. Adapted Attitude to Chemistry Scale (ACS) with Cronbach alpha reliability estimate of 0.83 was used as an instrument for data collection. Mean and standard deviation were used to answer the two research questions and the two corresponding null hypotheses were answered using Analysis of Covariance (ANCOVA) at a 0.05 level of significance. The study found that both instructional methods effectively enhanced students' attitudes towards chemistry, with no significant difference observed in the magnitude of attitude change between ethnoscience enriched chemistry instructional strategy (EEI) and conventional teaching method (CTM). The study concluded that the ethno-science enriched chemistry instructional strategy (EEI) is a viable innovation to the improvement of rural and urban students' attitude towards chemistry. Hence, the study recommended that chemistry teachers should relate learning and instruction to the students' cultural practices and other indigenous knowledge by adopting ethno-science instructional strategy. Similarly, textbooks writers should back their content justifications with appropriate traditional and native illustrations.

Keywords: Attitude, Chemistry, Ethno-science, Instructional Strategy.

Introduction

Science is a prerequisite for every nation that wants to maintain its independence, sovereignty, self-reliance, ensure growth, and have its head held high among civilized countries ((FGN, 2013; FGN, 2012; Ifeyinwa, 2016). This is because science and technology provide the basic tools of industrialization and economic development in the areas of communication, transport, energy, information, pollution and waste control, among others (Ifeyinwa, 2016; Okwara & Upu, 2017, Halliru, 2021). It is an instrument for worldwide effectiveness and profession (Nugraheni, Mulyani &Ariani, 2013; Abonyi, Achimugu & Adibi, 2014; Fomunyam,

2019). Hence, science teaching, learning and its understanding turn out to be imperative (Ahmad, 2017). Science generally, is an organization in which a community of individuals work and are bound together by certain social organizing relation to carry out certain tasks in society.

Chemistry Education is the gaining of knowledge or concepts relevant to chemistry. Chemistry has been identified as a crucial contributing subject in secondary schools in Nigeria as established by the promotion of the harvests in science and technology not only in Nigeria but even at global level. It is because of its significance that it has been made a core-subject amongst the natural sciences and other science related courses in the Nigerian education system (Ayodele, 2018) and has been a pre-requisite subject for offering all-out science-oriented courses in the tertiary institution such as Engineering, Mathematics, Physics, Agriculture, Biology, Geography and Pharmacy. However, even with the magnificence of chemistry and its innovative role to the human life and learning carriers, recent researches advocate students' negative or non-positive attitude toward learning chemistry concepts (Musengimana, et al., 2021). In view of this, teachers are always on the go, searching for a successful and effective delivery, which will enhance attitude among senior secondary school chemistry students (Okwara, & Upu,2017; Halliru, 2021). The inculcation of chemistry skills and attitudes in students can only be achieved through the proper teaching of the subject.

This means that teaching and learning of chemistry and other science and technology subjects should be culturally and environmentally oriented to provide students with adequate foundations, in order to make them capable of solving problems of the contemporary society. (Okwara, & Upu, 2017; Suwaiba and Abdulkadir, 2022). In spite of the importance of chemistry and its educational value, which is relevant to the need of individual learner, economics and technological breakthrough of a nation and the efforts of researchers to improve on its teaching and learning, the attitude of students in the subjects is not very encouraging (Ugwu and Diovu 2016). However, even with the good looks of chemistry and its innovative role of human being and its educational carriers, current studies advocate students' negative or non-positive attitude to learning chemistry concepts.

Therefore, attitude is the most important factor in a subject choice like chemistry. Abudu and Gbadamosi (2014) simply defined attitude as a pointer of likes or dislikes of an individual about something which is built on the individual's knowledge or believed at a certain situation. While attitude towards chemistry denotes curiosity or emotion towards the study of chemistry (Efe & Faith, 2016). It is the students' temperament towards - like or - dislike of chemistry. The development of students' positive attitudes regarding chemistry as a school subject is one of the major responsibilities of every chemistry teacher (Jeannette, Edwige & Philothère 2021). Additionally, there is a direct and positive association between attitude and its associative concepts with academic achievement in chemistry (Ezike, 2018; Cox, 2019; Risa & Pupung, 2019). Precisely, Peni (2015) credited the reason of the occurrence of negative attitudes to chemistry by secondary school students in Nigeria to instruction problems. This shows that there is a connection amongst chemistry students' attitude and with nature of instruction student received in chemistry (Chepkorir, et al., 2014; Musengimana, et al., 2021). Attitude could be

positive or negative and can change from negative to positive or from positive to negative as the case may be (Indra & Bitwell, 2016). However, there have been ongoing endeavours to explore and implement several possible interventions to improve students' attitude in Chemistry (Alshammari, et al., 2015; Zidny, et al., 2020). One of such interventions is to teach the subject beginning from what the student already knows. This brings about meaningful learning (Gregory & Mayer, 2002). As a rejoinder, Igbokwe (2010); Ugwu and Diovu (2016) conducted studies which found that, integration of indigenous gen and local applies found in the students' environment is an innovative pedagogical strategy. It is a model shift from conventional teaching to the integration of appropriate cultural practices, views and understandings to teach and is proved viable to improve academic achievement of students in chemistry. Hence, integration of indigenous gens and applies into chemistry teaching for effective teaching and learning of chemistry and for a better-quality academic achievement was suggested.

Hence, this study employed Ethno-chemistry instructional strategy to teaching chemistry as an innovative instructional strategy to the conventional teaching method. Primarily, ethnochemistry basically means Indigenous Chemistry (IC), Native Chemistry (NC), Original Chemistry (OC) or Traditional Chemistry (TC). It could be defined as all chemically associated activities, processes, techniques, productions, practices, assumptions of a certain people on natural material substances relevant toward its possessions, arrangement, change and terminology (Suwaiba & Abdulkadir 2022). Consequently, ethno as related to chemistry denotes to various native chemically related socio-scientific practices and background perceptions of chemistry of a particular identified culture. It is a sort of chemistry which is influenced by culture of a given society. Ethno-chemistry instructional strategy is an instructional strategy that utilizes the initial chemistry related knowledge and experiences found within the students' culture and environment to explain new concepts taught in chemistry classroom. It further involves designing a practical model in balancing local knowledge and western science as a process of learning (Abonyi, 2014). The aim is to connect and smooth the existing barrier between the school chemistry and local or indigenous chemistry concepts and practices for development. It is worth of note that, ethno-chemistry instructional strategy is beyond the use of native language as a standard of instruction or used of improvised instructional resources established from local obtainable resources. It also aims to innovate teaching learning of chemistry through the process of two-eyed sight. Two eyed seeing allow students to see from one eye with the powers of indigenous ways of knowing and from the other eye with the powers of Western ways of knowing (Mckeon, 2012). This means, ethno-chemistry instructional strategy is like an academic means of transportation that trip student from his home world to the school of Western worldview efficiently and with no problem. In that, the existing gap between students' day-to-day life activities and chemistry taught in their schools can be bridged. This study therefore, explores the effect of ethno-science enriched chemistry instruction on rural and urban secondary students' attitude towards chemistry in Bauchi state,Nigeria.

Statement of the Problem

Due to its importance, the teaching of chemistry should be done in such a manner that students would have developed positive attitude toward the subject. But it was perceived that chemistry teachers over and over again neglect the integration of traditional practices, patterns and plates found in everyday life of the students and surroundings to help during teaching and learning which should serve as previous knowledge and experiences on which the new knowledge could be smoothly and efficiently constructed meaningfully (Adesoji, Omilani, & Francis, 2019). As such chemistry students encounter problem when chemistry is taught through purely western science method to students of culture other than Western. Consequently, this has resulted to the student negative attitude toward chemistry.

However, there are abundant thoughts, views and does derived from daily activities of indigenous Hausa culture which are relevant in teaching and learning chemistry. But unfortunately, these thoughts, views and does are often abhorred and therefore not inclusive in teaching-learning of school chemistry. Against the background of the above discourse, therefore, it is pertinent for chemistry teachers in Bauchi state to give ethnoscience-enriched-instruction a trial; being a teaching approach which focuses on students' background, their cultural setting and practices as well as their immediate environments. Therefore, the problem of academic concern in this study is; what would be the effects of ethno – science enriched chemistry instruction (EEI) on rural and urban secondary school students' attitude toward chemistry in Bauchi state, Nigeria?

Purpose of the Study

The purpose of this study is to determine the effect of ethnoscience - enriched instruction (EEI) on rural and urban secondary schools' chemistry students' academic achievement, attitude and retention. Specifically, the objectives of the study are to:

1. Determine the effect of EEI strategy on attitude of secondary school chemistry students in Bauchi state.
2. Determine the effect of EEI on attitude of secondary school students in chemistry based on school location in Bauchi state.

Scope of the Study

This study examined the effects of ethno-science-enriched-instructional strategy on attitude, among chemistry senior secondary school students in Bauchi state. Similarly, the study was delimited to four public senior secondary schools comprising of two urban and two rural senior secondary school students in Bauchi state. The senior secondary school two (SS II) students were used because they are the most stable senior secondary school level. This is because the SS I students are newly admitted, while the SS III students are getting ready for final senior secondary school certificate examination (SSSCE).

Research Questions

The following research questions are raised to guide the study:

1. What is the difference in attitude mean response of secondary school chemistry students taught using EEI strategy and those taught using CTM in Bauchi state?

2. What is the difference in attitude mean responses of secondary school chemistry students in urban and rural schools taught using EEI strategy in Bauchi state?

Hypotheses

To achieve the stated objectives, the following null hypotheses are stated and tested at 0.05 alpha levels;

1. There is no significant difference in the attitude mean response of chemistry students taught using EEI and those taught using CTM in Bauchi state.
2. There is no significant difference in the attitude of chemistry students in rural - urban locations taught using EEI in Bauchi state.

Methods

The design of the study was pre-test, post-test, control group, quasi-experimental, 2x2 Factorial Matrix as recommended by (Kelinger, 1973) that recommended minimum number of subjects is 30 in each experimental and control for an experimental study. However, 2x2 factorial design allows the researchers to understand the effects of two independent variables (each with two levels) on the dependent variable. The study involves experimental group that were taught chemistry concepts using ethno-science-enriched-instructional strategy (EEI), and a control taught chemistry concepts using the conventional teaching method (CTM)). Both the experimental and control groups consist of subjects from rural and urban schools.

There are three categories of variables in the study. The independent variable (that is method of instruction) manipulated at two levels namely, Ethno science Instructional Strategy (EEI) Conventional Teaching Method (CTM). The dependent variable or outcome variable is the students' attitude. The moderator variable categorized at two levels. That is urban and rural locations (School location) respectively. The population of this study comprised of all senior secondary school students (SSII) in the 2022/2023 academic session in Bauchi state. Accordingly, the total number of (SSII) students that offer chemistry is 20604 from 221 public senior secondary schools spread across the three education zones in Bauchi state. The Sample of the study comprised 193 SS II Chemistry students drawn from four intact classes of the four senior secondary schools selected for the study.

This study employed Multi-Stage Sampling procedure in the selection of schools for the study. The first stage involved the selection of schools based on urban – rural locations, through convenience sampling technique. The sample size of the study consisted of 193 SSII Chemistry Students. These composed of 96 urban and rural experimental group and 97 urban and rural control group respectively. The second stage involved selection of experimental school and control school through simple random sampling technique. Four schools were randomly assigned experimental and control schools. Each of the four schools selected has two arms of science classes (A & B). In each of these four 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 ninety-six (96) subjects (47 urban & 49 rural) for Experimental Group and ninety-seven (97) subjects (54 urban & 43 rural) for Control Group respectively.

The instrument used for data collection was the Attitude to Chemistry Scale (ACS) which was adapted from attitude to science scale developed by Fasasi (2017). The scale has been established for attitude study in Nigerian junior secondary schools and has been proven suitable. The scale was modified to suit senior secondary schools' chemistry students of this study. Consequently, most of the items referring to science or scientists were restructured to read chemistry or chemists while other items were left as they were. The same instrument was administered to Experimental and Control Group before the treatment (pretest) and after the treatments (posttest) to determine students' attitude toward Chemistry. The instruments and instructional plans were validated by experts from Physical Sciences Education Department,

Moddibo Adama, University, Yola. The ACS was trial tested on 40 SSII Chemistry students of Government Secondary school Madara (which is not part of the sample). The reliability of ACS was estimated using the Cronbach alpha reliability estimate. The calculated value was found to be 0.83. The value is acceptable based Cronbach's alpha interpretation that Cronbach's Alpha should not be less than 0.6 and Values above 0.7 are considered acceptable. The analysis was run using Statistical Package for Social Sciences (SPSS).

The experimental procedure was in three periods viz: pre-treatment period, treatment period and post-treatment period. The pre-treatment period entails the introduction of and training of the regular chemistry teachers who served as research assistants. With granted permission, first week was used to pre-test both Experimental and Control Groups before the treatment. The treatment period entails teaching of the Chemistry Concepts (Separation Techniques, Catalysis, Combustion, Acid, Base and Saponification) through effect of ethno – science enriched chemistry instructional (EEI) strategy: The school regular chemistry teacher (research assistants) taught the Chemistry Concepts to the students in Experimental Group using EEI Lesson Plans. The control group was also taught same concepts through the conventional teaching method (CTM) Lesson Plans. This period lasted for the duration of six (6) weeks.

Results

The results are presented according to the sequence of the research questions raised and the hypotheses tested.

Research Question 1

What is the difference in attitude mean response of secondary school chemistry students taught using EEI strategy and those taught using CTM in Bauchi state?

Table 1

Difference in Attitude Mean Response of Secondary School Chemistry Students Taught Using EEI Strategy and those Taught Using CTM.

Group	n	Attitude before treatment		Attitude After treatment		Mean difference
		Mean	S.D	Mean	S.D	
Ethno – Science Instruction	96	3.47	.32	3.72	.43	0.25

Conventional Teaching Method	97	3.56	.49	3.78	.47	0.22

Table 1 presents the results of the analysis comparing attitude mean scores of secondary school chemistry students taught using the Ethno-Science-Enriched Instruction (EEI) strategy and Conventional Teaching Method (CTM). Both groups exhibited positive changes in attitude towards chemistry after the treatment period. For the EEI group, the mean attitude response increased from 3.47 (SD = 0.32) before treatment to 3.72 (SD = 0.43) after treatment, resulting in a mean difference of 0.25. Similarly, the CTM group showed an increase in mean attitude response from 3.56 (SD = 0.49) to 3.78 (SD = 0.47), with a mean difference of 0.22. The results suggest that both instructional methods effectively enhanced students' attitudes towards chemistry, with no significant difference observed in the magnitude of attitude change between the EEI and CTM groups. This indicates that while the EEI strategy integrates ethnoscience elements into teaching, both methods were comparably successful in positively influencing students' attitudes towards chemistry.

Research Question 2

What is the difference in attitude mean responses of secondary school chemistry students in urban and rural schools taught using EEI strategy in Bauchi state?

Table 2

Difference in Attitude Mean Responses of Secondary School Chemistry Students in Urban and Rural Schools Taught Using EEI Strategy.

Group	School Location	n	Attitude before treatment		Attitude After treatment		Mean difference
			Mean	S.D	Mean	S.D	
EEI	Urban	49	3.38	0.17	3.57	0.36	0.19
	Rural	47	3.57	0.40	3.89	0.43	0.32

The Table 2 presents the difference in attitude mean scores among secondary school chemistry subjects in urban and rural schools, who were taught using the EEI strategy. In urban schools, the subjects' mean attitude response before the treatment was 3.38 (SD = 0.17), which increased to 3.57 (SD = 0.36) after the treatment. This resulted in a mean difference of 0.19 in attitude response score following the EEI strategy implementation. Conversely, in rural schools, subjects started with a mean attitude score of 3.57 (SD = 0.40) before the treatment and showed an increase to 3.89 (SD = 0.43) after the treatment, indicating a mean difference of 0.32 in attitude scores. These results suggest that both urban and rural secondary school subjects exhibited improved attitudes toward chemistry after taught using the EEI strategy. Interestingly, while both groups experienced positive changes, rural subjects showed a slightly higher mean

response in attitude compared to their urban counterparts. This indicates that the EEI strategy may be effective in enhancing subjects' attitudes towards chemistry across different school settings, with potentially greater impacts observed in rural areas.

Testing Hypotheses

The following null hypotheses were tested at 0.05 level of significant in this study.

1. There is no significant difference in the attitude mean response of chemistry students' taught using EEI and those taught using CTM in Bauchi state.

Table 3

Summary of ANCOVA of Difference in the Attitude Mean Response of Chemistry Students' Taught Using EEI and those Taught Using CTM.

Source	Type III SumDf of Squares		Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.694[a]	2	.347	1.731	.180	.018
Intercept	45.664	1	45.664	227.690	.000	.545
Pretest of attitude	.522	1	.522	2.602	.108	.014
Teaching methods	.235	1	.235	1.172	.280	.006
Error	38.105	190	.201			
Total	2756.838	193				
Corrected Total	38.799	192				

a. R Squared = .018 (Adjusted R Squared = .008)

A summary of the ANCOVA results in Table 3 indicates that there is no significant difference between the attitude mean response of chemistry students who were taught with EEI and those who were taught with CTM, $F(1, 192) = 1.172$, $p > 0.05$ with a very small effect size as indicated by the Partial Eta Squared value of 0.006. Therefore, the null hypothesis was upheld.

2. There is no significant difference in the attitude of chemistry students in rural - urban locations taught using EEI in Bauchi state.

Table 4

Summary of ANCOVA of Difference in the Attitude of Chemistry Students in Rural - Urban Locations Taught Using EEI.

Source	Type III SumDf of Squares		Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2.549[a]	2	1.274	8.095	.001	.148
Intercept	8.033	1	8.033	51.025	.000	.354

Attitude before	.101	1	.101	.642	.425	.007
School location	1.923	1	1.923	12.212	.001	.116
Error	14.641	93	.157			
Total	1347.611	96				
Corrected Total	17.189	95				

a. R Squared = .148 (Adjusted R Squared = .130)

ANCOVA results presented in Table 4 assess whether there are significant differences in attitudes of subjects in chemistry taught using EEI in rural and urban locations. The results reveal that there is significant difference in the attitude of chemistry students in rural - urban locations taught using EEI, $F(1, 95) = 12.212$, $p< 0.05$ with a small effect size as indicated by the Partial Eta Squared value of 0.116. Therefore, the null hypothesis was rejected.

Summary of Findings

1. Both EEI and CTM strategies were successful in positively influencing students' attitude to chemistry.
2. Both urban and rural secondary school students exhibited improved attitude towards chemistry after being taught using EEI, with greater impacts observed in rural areas although these were not significant.

Discussion of Results

This study investigated the effect ethno-science enriched chemistry instructional (EEI) strategy on secondary school students' attitude in Bauchi state. The findings of this study were discussed in relation to research questions and hypotheses respectively.

The findings from the Research Question one and Null hypotheses number one unveiled that, the use of EEI was found to have significant effect in improving the attitude of SSII students toward chemistry concept over the use of conventional teaching method (CTM), however, the effect size is weak. This, however, does not mean that EEI is not a more effective method of improving students' attitude to chemistry than the CTM. Fasasi (2017) maintained that it is rather possible, with an enormous sample, to have a statistically significant result that is weak (i.e., has a small effect size). The weak effect size is also characteristic of attitude investigation since it takes a long time to effectively change the attitude of individuals towards a thing or subject. The period of treatment is not long enough to bring about a very strong attitudinal change. It is therefore worth observing that if a significant difference is achieved within the small period of instruction, then a greater positive attitudinal change to chemistry concepts is possible on exposure to longer period of EEI.

However, the finding of this study is supported by those of Suwaiba and Abdulkadir, (2022) that the use of ethno-chemistry Instructional strategy was found to have significant positive effect in improving the attitude of students toward chemistry concept over the use of CTM. The finding is also, in concordance with the findings of Siwale, et al., 2020; Chongo and

Baliga, 2019; Singh and Chibuye, 2016; Abonyi, 2014) who in their distinct studies discovered and conveyed that, students taught using cultural and indigenous practices were found to have higher positive attitude toward chemistry concepts than those taught same concepts using CTM. Accordingly, incorporating ethno-chemistry practices in teaching chemistry does influence secondary school students' attitude towards chemistry concepts in Bauchi state.

Null hypothesis two assessed whether there are significant differences in attitudes of experimental groups subjects in rural and urban schools' locations. The results revealed that there is there is significant difference in the attitude of chemistry students in rural - urban locations. This finding is supported by Fasasi (2017) that investigated the effect of Ethno-science instruction and moderating effects of school location and parental educational status on students' attitude to science. A significant main effect of school location was recorded on students' attitude to science with weak effect sizes. With students in rural schools achieving better than those in urban schools. Therefore, EEI promoted students' attitude to chemistry. This indicates that the EEI strategy was effective in enhancing students' attitudes towards chemistry across different school settings, with potentially greater impacts observed in rural areas. In line with the effect of EEI on students in rural schools, this finding is not unexpected since EEI induces greater enthusiasm among students in rural schools. Such enthusiasm would encourage improved attitude towards chemistry thereby bridging the much talked about attitudinal difference towards chemistry between subjects in rural and urban areas in favour of subjects in urban areas.

However, this finding contradicts that of Osokoya and Akuche (2012) in their own study of the effects of school location on students' learning outcomes in practical physics which shows no significant main effect of school location on subjects' attitude towards practical physics.

Recommendations

Based on the findings of this study, the following recommendations are therefore made:

1. Chemistry teachers in Senior Secondary Schools should be encouraged to use ethnoscience enriched instructional strategy (EEI) in teaching concepts in chemistry as it improved students' academic achievement.
2. Chemistry teachers should be encouraged to begin lessons with relevant EEI practices, for that will positively convey and hold students' attitude toward chemistry concepts been taught. This would further inculcate sense of belonging in the mind of the students to feel chemistry is part of them and not an alien subject.
3. With EEI students' attitude to chemistry in both urban and rural schools is positively enhanced; hence it should be encouraged in senior secondary schools.

References

Abonyi, O. S., Achimugu, L. & Adibi, N. M. (2014). Innovations in science and technology education: A case for ethno-science-based science classrooms. *International Journal of Scientific & Engineering Research, 5(*1), 52-56.

Abonyi, S. T. (2014). Effect of experiential teaching approach on students' academic performance. *Journal of Research in Education. 8* (3), 23-34.

Abudu, K.A. & Gbadamosi, M.R. (2014). Relationship Between Teacher's Attitudes and Student Academic Achievement in Senior Secondary School Chemistry. A Case Study of IjebuOde and Odgbolu Local Government Area of Ogun State. *Wudpecker Journal of Educatinal Research, 3*(3), 35-43.

Adesoji, F. A. Omilani, N. A. & Francis, O. A. (2019). Teacher variables and school location as predictors of chemistry teachers' awareness of ethno science practices. *Journal of Education, Society and Behavioural Science, 31*(1), 1-17.

Ahmad, S.S. (2017). The Impact of Context-based Instructional Approach on Students Academic Achievement and Retention of Hydrocarbon Concepts among Science Secondary Students in Kano State, Nigeria. *Journal of Applied Sciences & Environmental Sustainability, 3*(6), 44-58.

Alshammari, A. S., Mansour, N. & Skinner, N. (2015). *The Socio-Cultural Contexts of Science Curriculum Reform in the State of Kuwait.* In N. Mansour & S. Al-Shamrani (Eds.), Science Education in the Arab Gulf States (Pp. 49-68). Rotterdam: Sense.

Ayodele, O.D. (2018). Re-Structuring Secondary School Chemistry Education for Sustainable Development in Nigerian Developing Economy. *African Journal of Chemical Education, 8*(2), 93-111.

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), 14-29.

Chepkorir, S., Cheptonui, E.M., Chemutai, A. (2014). The Relationship Between Teacher Related Factors and Students' Aptitudes towards Secondary School Chemistry Subject in Buret District, Kenya. *Journal of Technology and Science Education, 4*(4): 228-236.

Cox, J. (2019). How to Motivate Students to Love Science. K-12 News, Lessons and Shared Resources by Teachers, for Teachers. *MotivateStudentsLove-Science Educational Leadership. (15),* 327-338.

Efe M. O. and Faith E. A. (2016) Effect of Class Size and Students' Attitude on Academic Performance in Chemistry at Demonstration Secondary School, Ahmadu Bello University Zaria, Nigeria. *Journal of Research & Method in Education, 6*(1), 01-06.

Fasasi, R. A. (2017). The impact of ethnoscience instruction on cognitive achievement in science. *International Journal of Education and Learning, 6*(2), 33-42.

Federal Government of Nigeria (2013). National policy on education. Lagos: NERDC Press.

Federal Republic of Nigeria. (2012). *Nigeria Certificate in Education, Minimum Standards*. Abuja: National Commission for Colleges of Education.

Fomunyam, K.G. (2019). Teaching STEM Education in Nigeria: Challenges and Recommendations. *International Journal of Mechanical Engineering and Technology, 10*(12), 85-93.

Gregory, J. K. & Mayer, E. R. (2002). (eds). *Meaningful Learning*: The essential factor for conceptual change in limited or inappropriate propositional hierarchies leading to empowerment of learners. Florida: Cornell University.

Halliru, A. (2021). Mirroring Weak Bonds in Science and Technology Education Implementation and Innovation in Nigeria Through the Triple Helix Lens. *Bayero Journal of Science, Technology and Mathematics Education, 2*(1), 124-136.

Ifeyinwa, N. O. (2016). Effect of learning activity package on students' achievement and retention in senior secondary school biology. *(Unpublished PhD Thesis)* University of Nigeria. Nsukka.

Igbokwe, C. D. (2010). The Effects of Multicultural Learning Environment on Cognitive Achievement of Pupils in Primary Science. *Journal of Science Teachers Association of Nigeria, 45*(1&2): 9-19.

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

Jeannette, M., Edwige, K. & Philothère, N. (2021) Factors affecting secondary schools students' attitudes toward learning chemistry: A review of literature. *Journal of Mathematics, Science and Technology Education, 17*(1), 1-12.

Kerlinger, F. N. (1973) *Foundation of Behavioral Research.* Holt Rinehart Winston London.

Mckeon, M. (2012). Two-Eyed Seeing into Environmental Education: Revealing its "Natural" Readiness to Indigenize. *Canadian Journal of Environmental Education, 17*: 131-147.

Musengimana, J., Kampire, E. & Ntawiha, P. (2021). Factors Affecting Secondary Schools Students' Attitudes toward Learning Chemistry: A Review of Literature.
EURASIA Journal of Mathematics, Science and Technology Education, 17(1), 1-12.

Nugraheni, D., Mulyani, S., &Ariani, S. R.D. (2013). The effect of vision learning and sets towards learning achievement in terms of the critical thinking ability of class X 2 students in sukoharjo on petroleum material in the 2011/2012 academic year. *Journal of Chemical Education, 2*(3), 34-41

Okwara, O. K., & Upu, F. T. (2017). Effects of ethno-science instructional approach on students' achievement and interest in upper basic science and technology in Benue state, Nigeria. *International Journal of Scientific Research in Education, 10*(1), 69-78.

Osokoya, M. M. & Akuche, U. E. (2012). Effects of school location on students' learning outcomes in practical physics. *Ife Psychologia*. *1*(10), 241-251.

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 Ph.D Thesis). Ahmadu Bello University, Zaria.

Risa T. Pupung P. (2019). The influence of interest and Motivation on College Students' Language and Art Appreciation Learning Outcomes. *Journal of International Education. 11*(2), 130-135.

Singh, I. & Chibuye, B. (2016). Effects of ethno-chemistry practices on secondary school students‟ attitude towards chemistry. *Journal of Education and Practice, 7*(17), 44-56.

Siwale, A., Singh, I. S. & Hayumbu, P. (2020). Impact of ethno-chemistry on learners' achievement and attitude towards experimental techniques. *International Journal of Research and Innovation in Social Science, (4)*8, 534-542.

Suwaiba S. A. & Abdulkadir H. (2022). Effect of Ethnochemistry Based Approach on Secondary School Students' Attitude Toward Chemistry Concepts in Malumfashi Educational Zone, Katsina State, Nigeria. *African Journal of Science, Technology and Mathematics Education, 8*(8), 671-679.

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), 25-29.

Zidny, R., Sjostrom, J. & Eilks, I., (2020). A Multi Perspective Reflection on How Indigenous Knowledge and Related Ideas Can Improve Science Education for Sustainability. *Science and Education. 29,* 145-185.