Main and Interaction Effect of Teaching Method, Gender, and School Location on Students' Achievement in Chemistry in Calabar Education Zone, Nigeria.

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Abstract- ***The study investigated the main and interaction effect of guided inquiry and conventional method on students' academic achievement in Chemistry in Calabar Education Zone, Cross River State of Nigeria. The study adopted a pretest and post-test quasi experimental design. One research question and one corresponding hypothesis guided the study. The population comprised 2,184 SS2 students while a multi-stage sampling procedure was employed to select 127 students for the exercise. Chemistry Achievement Test (CAT) with 50 multiple choice items was used for data collection. Data collected were tested at .05 level of significant using three-way analysis of covariance (ANCOVA). Results of the analysis shows that there is no significant main effect of school location and teaching methods on students' achievement in Chemistry. It equally shows that there exist no significant interaction effect of school location, gender and teaching method on students' academic achievement in Chemistry. Based on the results, it was therefore concluded that there is no significant main effect of guided inquiry and lecture methods on students' interest and academic achievement in chemistry. The interaction between teaching methods and gender as well as school location was not significant for academic achievement and recommendations were made among which is; guided inquiry among other innovative teaching methods should be applied by teachers in the teaching of Chemistry.***

Indexed Terms- ***Main, Interaction, Teaching Method, Academic Achievement and Chemistry***

I. INTRODUCTION

Science and technology are imperious for a viable, liable, and universal growth, and its application guarantees the durability of man's life in finding, novelty and discoveries that have better the worth of his existence. Advanced countries of the world are so termed because of their progress and development in science and technology. Among the science subjects are Biology, Chemistry and Physics (Chinda, 2021).

Chemistry is the science subject that primarily focuses on identifying matter in terms of its physical and chemical properties and its valuability for economic and technological advancement. Perhaps, from these assertions, it is inferable that Chemistry can exert a dominant and decisive influence on the life of individuals in the areas of industry, agriculture, transportation, health and infrastructure as well as in the developmental effort of a nation. According to Ojo (2017), nurturing a well-educated populace in Chemistry, a continuous pipeline of innovative minds capable of addressing global challenges, contributing to scientific discoveries, and propelling societal progress is ensured. Chemistry education thus becomes not only a gateway to understanding the intricacies of the natural world but also a key driver for fostering a scientifically literate and empowered society. Chemistry education has been identified to be one of the major bedrocks for the transformation of a nation's economy. Igboegwu and Okonkwo (2012) viewed Chemistry education as a necessary ingredient for becoming self-reliant, earning a living and contributing towards building sustainable national

development. Samantha (2017) observes that Chemistry education is a pivot through which many individuals could be transformed into entrepreneurship discoveries whose profound impacts could be noticed if carefully utilized for proper everyday learning, being one of the targets of national development.

In present-day society, knowledge of Chemistry and application of its principles have gone a long way in changing the narratives of the subject. Looking at the fundamental characteristics and importance of Chemistry, production of drugs, treatment of contaminated water, among other things to a greater extent is done with the knowledge of Chemistry. One of the good of Chemistry as a subject and a course of study is to produce knowledgeable, highly motivated students and professional and effective teachers of Chemistry who will be able to develop in themselves and students understanding of chemical processes and principles. Other worthy application of Chemistry knowledge for the interest of man include medicine, computer science, pharmacy, among others knowledge of Chemistry is crucial to understanding the world around us, the world inside us, and the world beyond us. It helps us to organize the universe and to see the connections between seemly disparate phenomena. Chemistry gives us powerful tools to express our creativity, to see the world in new ways and change it. Despite the numerous benefits of Chemistry, there still exist some reports of poor academic achievements in public examinations such as NECO and WAEC. This suggests the need for more effective teaching methods that could improve students' academic achievement and sustain interest in Chemistry.

The poor academic achievement in Chemistry have been attributed to many factors, such as teaching methods, improper use of instructional materials, inadequate facilities and teachers' shallow knowledge of the subject matter (Ige, 2010). Akuma (2005) stated that poor teaching method usage among science teachers and Chemistry in particular leads to reduce interest and poor achievement across all levels of education. Akuma added that though there is no method generally accepted in teaching a particular subject but guided inquiry may be of much help in curbing the problem of poor academic achievement in Chemistry among students.

O'Banon (2002) described teaching methods as the way teachers create learning environment to specify the nature of the activity in which the teacher and the learners will be involved during instructional delivery. It is primarily a description of learning objects-oriented activities and the flow of information between the teachers and the learners. The O'Banon stated that inquiry-based learning is one of the teaching approaches which have been of great impact on science achievement and interest.

Guided inquiry has many benefits to knowledge acquisition; these include active participation of learners in the learning process, and helping learners to build self-concept and knowledge, it facilitates retention, sustain interest and also foster transfer of knowledge to new but similar situation. It arouses the interest of learners and promotes intrinsic motivation rather than extrinsic motivation, it contributes to the development of effective thinking, creative expression, critical analysis and local reasoning as well as enhancing academic success (Guitsi, 2008).

Jack (2013) studied guided inquiry and concept mapping as effective teaching methods against lecture method in teaching difficult concepts in Chemistry. Two research questions and two null hypotheses guided the study. The study adopted a non-randomized pretest posttest quasi-experimental design and control group. 251 SS3 chemistry students from the three Senatorial Districts of Taraba State were randomly assigned to experimental and control groups through balloting. Face and content validity of the instrument was ensured with a reliability coefficient of .79. ANCOVA was used to test the hypothesis. Result of the findings showed a significant difference between the achievement of student expose to experimental groups (guided inquiry and concept map) and the control group (lecture method). Also, the study shows that male and female students taught in the two experimental groups differ in achievement in favor of girls and guided inquiry method. Hence, the study found no significant interaction effect of teaching methods, gender and location on students' academic achievement.

Karakuyu (2010) investigated the effect of guided inquiry, concept mapping and expository teaching methods on students' attitude and achievement in Chemistry. The researcher aimed at finding out how gender and location effects on students' academic achievement in Chemistry. The design adopted for the study was a pretest-posttest intact class quasi-experimental with control group. The population consisted 3,686 SS2 chemistry students in Yobe Central. Three schools were purposively selected with 210 Chemistry students forming the study sample. Physics Achievement Test (PAT) was used in collecting data with a reliability index of 0.59 using Kuder Richardson 20. The students were assigned to both experimental and control groups in urban and rural; male and female from urban and rural. Analysis of data was revealed for significant main effect of location, and gender while. Results further showed that there was a difference in performance of those in urban and rural schools in favor of urban; that male students' in-spite of the methods perform better than the female students. More so, there was no significant interaction effect of study variables on students' academic achievement in Chemistry.

Ushie (2014) assessed the effect of guided inquiry, concept maps and discussion methods on students' in Bekwarra Local Government Area of Cross River State. The study aimed at assessing the extent to which the various methods could enhance students' learning outcome in Biology. Three research questions and three null hypotheses helped in directing the study. A pretest-posttest intact class quasi-experimental design was used. The students were subjected to treatment using the methods. In each Schools SS3 A, B, C were used for the three methods in the study area. Biology Achievement Test (BAT) with 30 items was used as instrument with a reliability index of .82 using KR_{20}. Data was analyzed using ANOVA and independent t-test. Results of the study showed that concept maps do not significantly affect students' achievement in urban than those in rural area. The study further showed a main effect of guided inquiry method on students' achievement for both urban and rural schools. Accordingly, the author reported disparity in gender achievement in favor of guided inquiry (male, $\bar{x}$ = 50.181 while female $\bar{x}$ = 38.019). The study also reported a significant interaction effect of guided inquiry teaching method and gender on students' academic achievement in Biology.

Oleabhiele (2011) conducted a search on the effects of guided inquiry and cooperative learning methods on senior secondary school students' achievement in Biology in Ebonyi State. Pretest-posttest intact class quasi experimental design was used. From the intact classes, 150 students were used as sample of the study. All the students were exposed to treatment and control groups; hence, data were collected accordingly. The gathered data were analyzed using mean, standard deviation and ANCOVA. The findings showed that gender seems to have slight main differential effect on male and female mean achievement scores in biology in all case. Results of ANCOVA table proved that guided inquiry was better than demonstration method in boasting students' achievement in Biology. The author found that there is no statistically significant effect of teaching methods, gender and school location on students' academic achievement in Biology.

Mohammed (2015) investigated the effect of guided inquiry strategy in teaching Physics on the achievement of Afif College of Education Students in Saudi Arabia. The aim of the study was to examine male and female students' achievement taught with guided inquiry and conventional method. 56 one-grade students were shared equally to control and experimental groups. The results of the study showed that guided inquiry is important tool in the teaching-leaning process. With the positive significance value, it indicates the difference in achievement between urban and rural schools. It also shows a clear picture of male and female students' achievement after treatment in favor of the male students. The study also proved that a significant interaction effect existed between the teaching method and gender on students' academic achievement.

Musa and Samuel (2019) determined the effect guided inquiry and traditional teaching methods on mathematics students' achievement in western senatorial District of Nasarawa State. Quasi experimental research design was adopted for the study. Four research questions and four hypotheses guided the study. The study population comprised 35,570 SS2 students from 98 co-educational schools. Stratified random sampling technique was used to

select 1600 students from 20 schools. From each school selected, one intact class was purposively selected from urban and rural each. Two instruments namely; Science Achievement Proforma (SAP) and Mathematics Achievement Proforma (MAP) were used to collect information from the students during the 2017/2018 students' mock examination. Data collated were analyzed using descriptive statistics of mean and standard deviation to answer the research questions while the z-test was used to test the hypotheses at .05 level of significance. The findings of the study revealed that male students achieved significantly better in Mathematics than their female counterparts. Also, the findings showed that a significant main difference existed between the achievement of science and mathematics students in urban and rural schools in favor of the urban students. The author maintained that there is no interaction effect of teaching method and location on students' academic achievement. It was recommended that school administrators and teachers should pay close attention to issues that will help rural students measure up with their counterparts in urban through provision of adequate school facilities and using of innovative teaching methods. Such as guided inquiry, jigsaw cooperative method, problem-based learning and game-based learning.

From a theoretical perspective, this level of differentiation for characterizing the content structure of students' interest in science remains too rough and beyond the classifications at hand, e.g. from Science Education. In addition to a differentiation of contents and themes, others aspects like contexts or areas of application can help to describe profiles of interest in science. The background provided so far shows that, although there is endorsement that secondary school students' perform low in sciences and Chemistry inclusive, it is not clear whether guided inquiry teaching approach and gender, have any effect on students' interest and achievement in Chemistry in Calabar Education Zone of Cross River State, Nigeria. Therefore, this study seeks to determine the effect of guided inquiry teaching method on students' achievement in Chemistry with gender and school location as the moderator variables.

II. PURPOSE OF THE STUDY

The purpose of this study was to examine the effect of guided inquiry on students' interest and achievement in chemistry in Calabar Education Zone of Cross River State. Specifically, the study sought to;

1. Investigate the main and interaction effect of teaching method, gender and location on students' academic achievement in chemistry.

Research questions

1. What is the main and interaction effect of teaching method, gender and location on students' academic achievement in chemistry?

Research hypotheses

One research hypothesis guided this study:

1. There is no significant main and interaction effect of teaching method, gender and school location on students' academic achievement in Chemistry.

III. METHODOLOGY

This study adopted a pre-test and post-test intact class quasi experimental design. According to Isangedighi (2012), this design was developed to provide alternative means of examining cause and effect relationship in situations that are not conducive for experimental control. The population of this study comprised 2,184 SS2 Chemistry students in 87 public secondary schools in the study area. The study comprised one hundred and twenty-seven (127) senior secondary two Chemistry students. Male constitutes 78 while female consisted 49. All the students with at least 70% attendance took part in the study. Chemistry Achievement Test (CAT) was used for data collection. The CAT is designed with 50 multiple choice items covering the topics used in this study. This study was conducted during the 2024/2025 academic year. Data collected were tested at 0.05 level of significant using mean, standard deviation and ANCOVA. The hypothesis is restated as follows;

There is no main and interaction effect of teaching method, gender and school location on students' academic achievement in Chemistry. To test the hypothesis, three-way ANCOVA was adopted with teaching methods (Guided inquiry and Conventional), gender and school location as factors, and students,'

post treatment Chemistry achievement test as dependent variable and pre-treatment as covariate. The f-ratio was used to test for the significance of the effect of teaching method. The results obtained are presented in Table 1.

Table 1
Three-Way ANCOVA of Students' Academic Achievement: Location by Teaching Method by gender

Source	Sum of Square	df	Mean-square	F	Sig
Corrected Model	426.98	8	53.37	1.09	.37
Intercept	15665.36	1	15665.36	321.03	.00
Covariate	14.31	1	14.31	.29	.59
Method	126.27	1	126.27	2.59	.11
Location	6.43	1	6.43	1.32	.72
Gender	118.18	1	118.18	2.42	.12
Method*Location	2.04	1	2.04	.04	.84
Method*Gender	50.50	1	50.50	1.04	.31
Location*Gender	91.233	1	91.23	1.87	.17
Method* Location*Gender	99.418	1	99.42	2.04	.16
Error	5758.04		118	48.80	
Total	216486.00		127		
Corrected Total	6185.02		126		

Results not significant at 0.05 level

Results from Table 17 shows the p-values (.37, .59, .11, .72, .12, .84, .31, .17 & .16) associated with the computed F-values (1.09, .29, 2.59, 1.32, 2.42, .04, 1.04, 1.87, & 2.04) for corrected model, covariate, methods, location, gender, method and location, method and gender as well as location and method, location and gender were found to be higher than 0.05. Only the p-value (.000) associated with the computed F-value (321.03) is less than the chosen 0.05. Because of the results, the null hypothesis is not rejected for corrected model, covariate, methods, location and gender as well as their interaction between methods, gender and location on students' academic achievement but was retained for intercept. The results also show that there is no significant main effect of school location and teaching methods on students' achievement in Chemistry. It equally shows that there exist no significant interaction effect of school location, gender and teaching method on students' academic achievement in Chemistry. However, there is no significant relationship between the variables under study.

IV. DISCUSSION OF FINDINGS

The analysis of data for hypothesis one shows no significant main and interaction effect of teaching methods, gender, and school location on students' academic achievement in chemistry. This is because the p-values and computed f-values associated needed for significant at 0.05 were greater, as such the null hypothesis is rejected for the main and interaction effects. The report of the present study is in synergy with the studies of Karakuyu (2010), and Musa et al (2019) though with minor landings. They reported a significant main effect but no significant interaction effect of methods, gender and location on achievement. Similarly, Metz (2004) also added that location is not a good predictor of academic achievement even when gender and teaching methods are considered as factors. The founds do not consolidate the studies of Jack (2013), Ushie (2014), Oleabhiele (2011), and Musa et al (2019). These authors categorically stated that disparity in gender and location play a significant role in the academic pursuit of male and female as well as ome reported in favor of rural all taught with guided inquiry and traditional teaching strategies. These inconsistencies

in results of the previous and present studies may be as the result of high level of commitment on the part of the teachers (research assistants) and the respondents. This zealousness not minding gender and location may be attributed to the no significant results of the present study. Another factor could be the fact that most of the reviewed literatures were done outside the shores of Calabar Education in particular and Cross River State at large. Since the number of chemistry students in Calabar Education Zone has always been few as compared to those for Biology and Physics, it may have been the reason for competition amongst the students of both sexes and without location as bias.

CONCLUSION

Resulting from the analysis of the collected data, it was concluded that there is no significant main effect of guided inquiry and lecture methods on students' interest and academic achievement in chemistry. The interaction between teaching methods and gender as well as school location was not significant for academic achievement.

RECOMMENDATIONS

1. Guided inquiry among other innovative teaching methods should be applied in the teaching of Chemistry.
2. There should be no gender-based discrimination in the study of Chemistry by students.

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