

## EFFECT OF INTERACTIVE LECTURE METHOD ON STUDENTS' ATTITUDE TOWARDS CHEMISTRY IN SENIOR SECONDARY SCHOOL IN KOGI STATE

Audu, Ojodomo Noah<sup>1</sup>, Omale, Ojoarome Victor<sup>2</sup>; Achimugu, Lawrence<sup>3</sup>,  
<sup>1, 2 & 3</sup> Department of Science Education, Prince Abubakar Audu University,  
Anyigba, Kogi State, Nigeria.

<sup>1</sup>Email: [audunoah10@gmail.com](mailto:audunoah10@gmail.com); Phone No: +2349051343303.

<sup>2</sup>Email: [victoromaro2016@gmail.com](mailto:victoromaro2016@gmail.com); Phone No: +2347059157378

<sup>3</sup>Email: [lawachi@gmail.com](mailto:lawachi@gmail.com); Phone No: +2347082629330.

### Abstract:

*The study investigated the effect of interactive lecture method on students' attitude towards chemistry in senior secondary school in Kogi State. Three research questions and three hypotheses were formulated to guide the study. Descriptive survey design was adopted for the study. A sample of 200 SS1 students were drawn from a population of 11,091 using multi-stage sampling technique as sample for the study. The instrument used for data collection was Chemistry Attitude Scale (CAS,  $r=0.72$ ). Mean and standard deviation were used to answer the research questions, while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The findings of the study revealed that: there is significant difference between the attitude of students exposed to interactive lecture method and those exposed to conventional lecture method. There is also a significant difference between the attitude of male and female students exposed to the interactive lecture and conventional lecture methods. The study further revealed that there is no significant interaction effect of treatment and gender. Based on the findings, it was recommended among others that chemistry teachers should adopt use of interactive lecture teaching method to teach chemistry in order to improve students' attitude in chemistry since interactive lecture has proven to be effective. Furthermore, Chemistry teachers who have not adopted the use of any innovative teaching method such as guided discovery recommended by national chemistry curriculum are also encouraged to use interactive lecture method since it has been proven that it is better than conventional lecture method.*

**Keywords:** Interactive lecture, conventional lecture, attitude, chemistry.

### Introduction:

Chemistry is one of the fundamental science subjects taught at the senior secondary school level in Nigeria. As a core discipline, chemistry plays a vital

role in understanding various aspects of life and is essential for the study of technology, medicine, pharmacy, nursing, engineering, food technology and more. The significance of chemistry extends beyond academics, as it impacts daily life, health, quality of life, and nutrition. The development and manufacturing of medicine, for instance, rely heavily on chemistry. It can be deduced from the above that chemistry is one of the science subjects that deals with the forms, structure and the changes the substances around us undergoes. It is a branch of physical science that explores the composition, structure, properties, and transformations of substances (Gongden, 2015; Achimugu, 2023).

In Nigeria, senior secondary school students widely choose chemistry as a subject in the Senior School Certificate Examination (SSCE) and National Examination Council (NECO) due to its relevance and interest. However, despite the fact that chemistry is crucial to a country's socioeconomic and technical advancement, secondary school students in Nigeria have negative attitude towards chemistry (Achimugu, 2016). Attitude is a tendency to respond positively or negatively toward a particular learning task, situation, or object (Ormrod, 2013). One crucial component of the educational process that is highlighted by this description is the function that attitude plays in learning. According to Ormrod (2013), motivation, behavior, and academic performance can all be impacted by attitude. That is, a positive outlook can result in higher drive to learn, more desirable actions, and better grades. An attitude can also be defined as a disposition or emotion toward a topic or educational activity. A student's desire and willingness to learn may be affected, and it may be beneficial or bad. Apathy, nervousness, and boredom are traits of a negative attitude, whereas interest, curiosity, and the joy of learning are traits of a positive attitude. It's crucial to remember that attitudes can be altered through intervention in order to improve exceptional academic performance. Achimugu et al. (2023) claim that students who have a positive attitude toward chemistry perform better in the subject, whereas those who have a negative attitude toward chemistry perform worse academically. It suggests that because it encourages involvement and effort, a positive outlook can result in improved performance. In other hand, having a positive outlook can boost motivation, which in turn can improve performance.

The significance of teaching chemistry in Nigerian senior secondary schools is likewise emphasized by Onuwuakpa and Nweke (2000). It is concerning to see, nonetheless, since research and findings have indicated poor performance in secondary school chemistry and other science courses. Every year

when WAEC or NECO reveals the annual results of the students' performance, there is a lot of uproar, particularly in the science courses (Salami et al., 2012). Chemistry has continuously had one of the worst and lowest scores throughout the years on the senior school certificate examination (SSCE), which is administered by WAEC and NECO. In previous years, the West African Examination Council (WAEC) in Lagos, Nigeria, specifically the test development division, stated that students were performing poorly in chemistry.

Studies have shown that chemistry teachers predominantly use conventional teaching methods with lecture being the most commonly used method (Achimugu, 2016; Atusa & Abdullahi, 2015). Although traditional lectures have been heavily criticized, they can be improved by proper planning, encouraging student participation through questioning and discussion, and combining them with other methods. The Interactive lecture method involves combining lectures with other techniques like enriched, enhanced, improved, questioning, discussion and student centered lecture strategy to promote active students' participation. A good chemistry teacher ensures a two-way communication pattern and shared responsibility by asking questions and encouraging students to ask their own questions (Achimugu, 2018). This method aims to disseminate information and achieve educational objectives through learning. The discussion in the class is intended to be give-and-take between teacher and students, helping students apply critical thinking in various situations.

Studies have shown that interactive lecture methods improve students' attitude in chemistry compared to traditional lecture methods (Matazu & Ismail, 2023; Bello *et al.*, 2020; Haruna *et al.*, 2022; Bello, 2015). These studies recommend that educators should focus on reforming traditional instructional methods and using interactive lecture method in their classroom interactions. Specifically, the studies found: no significant difference in the mean attitude ratings of students taught chemistry using interactive lecture and conventional lecture methods (Suleiman, 2016); no significant differences in attitude between male and female students exposed to different instructional methods, no significant interaction between gender and teaching methods. Overall, these studies suggest that interactive lecture methods can improve students' attitude in chemistry among senior secondary school students.

Researchers have recommended that teachers should adopt innovative teaching methods to improve teaching and learning in science and enhance

student attitude (Abu, 2023; Ogochukwu & Stephen, 2022). Overall, innovative teaching methods like guided inquiry are powerful approach to science education that promotes active learning, critical thinking, and collaboration, leading to improved student outcomes (Ekwueme, 2024). For these reasons, innovative teaching method like interactive teaching method was recommended for effective implementation of the senior secondary school chemistry curriculum in Nigeria. Research outcomes and findings obtained from studies conducted by many science educators and researchers in Nigeria had shown that many chemistry teachers do not utilize guided inquiry or any other innovative teaching methods recommended in the national curriculum rather was discovered that many of them were not willing to give up their old practices of using conventional lecture method (Ochu & Haruna, 2014; Fatokeen *et al.*, 2019). To create changes and innovations in the teaching, educators have come up with the idea of interactive lecture method which may be easy for science teachers to accept and adopt for their classroom interaction pattern. However, there is need to compare the effectiveness of interactive lecture method and conventional method. Hence, this study is therefore geared towards the effects of interactive lecture method on students' attitude towards chemistry in senior secondary school in Kogi State.

### **Research Questions**

The following research questions were generated to guide the study:

1. What is the difference between the attitude rating of students taught chemistry using interactive lecture and those taught using conventional lecture teaching methods?
2. What is the difference between the attitude rating of male and female students taught chemistry using interactive lecture teaching method?
3. What is the interaction effect of teaching method and gender on the attitude rating mean scores of students in chemistry?

### **Hypotheses**

The following hypotheses were formulated to guide the study and were tested at 0.05 level of significance:

**H<sub>01</sub>:** There is no significant difference in the attitude rating mean scores of students taught chemistry using interactive lecture and conventional lecture teaching methods.

**H<sub>02</sub>:** There is no significant difference in the attitude rating mean scores of male and female students taught chemistry using interactive lecture and those taught using conventional lecture teaching methods

**H<sub>03</sub>:** There is no significant interaction effect of teaching method and gender on the mean attitude ratings of students in chemistry.

### Methodology

The study employed a descriptive survey design, specifically the pretest-posttest non-equivalent control group design proposed by Kerlinger (1973). The subjects underwent a pretest to determine their initial ability level. Then, the students were taught using either the interactive lecture or guided inquiry teaching methods. After the treatment, a posttest was administered to assess the effect of the teaching method. In this design, intact classes were randomly selected and assigned to either the experimental groups (Gp<sub>1</sub>) or the control group (Gp<sub>2</sub>). The design can be illustrated as follows:

Gp<sub>1</sub> (Experimental Group): Pt<sub>1</sub> → X<sub>1</sub> → Pt<sub>2</sub>

Pt<sub>2</sub> = Posttest for all groups

Gp<sub>2</sub> (Control Group): Pt<sub>1</sub> → C → Pt<sub>2</sub>

X<sub>1</sub> = Treatment with Interactive lecture teaching method

Where:

C = Control group.

Pt<sub>1</sub> = Pretest for all groups

The study's population consists of all the 11,091 senior secondary one (SS1) chemistry students in the 254 government secondary schools, with 5,916 males and 5,175 females. The sample size is 200 SS1 chemistry students. The study adopted a multi-stage sampling technique to select schools from the population. Firstly, purposive sampling technique was used to select 12 schools from the target population that had well equipped chemistry laboratories, qualified chemistry teachers and had one arm of co-educational chemistry class since gender was a moderating variable. The 12 schools that met the above criteria were subjected to the third stage of sampling involving the use of simple random sampling technique by balloting to select two schools in all. Fourthly, simple random sampling by throw of coin was used to assign the two schools with their intact classes to each of the two teaching methods.

The instrument used for data collection was Chemistry Attitude Scale (CAS), which contains 25 items rated on 4 point Likert type of SA: Strongly Agree (4), A: Agree (3), D: Disagree (2),

and SD: Strongly Disagree (1). This Chemistry Attitude Scale (CAS) was developed by the researcher based on extensive review of literature on students' attitude towards Chemistry and education in order to identify key factors influencing attitude and existing attitude scale. The researchers conducted both face and content validity checks. One expert in science education and two experts from the department of educational foundations all from the faculty of education, Prince Abubakar Audu University, Anyigba validated the instrument's face validity. Content validity was ensured using a table of specification. The reliability of the Chemistry Attitude Scale (CAS) was determined through a pilot test on 25 students, yielding a reliability index of 0.72 using the Kuder-Richardson formula (KR-20). Two regular chemistry teachers (research assistants) were trained for two hours daily for four days. Data analysis was carried out involving the use of mean and standard deviation to answer research questions and ANCOVA to test hypotheses at a 0.05 significance level.

## Results

The results were presented according to the research questions and hypotheses that guided the study.

### Research Question One

What is the difference between the attitude rating of students taught chemistry using interactive lecture and those taught using conventional lecture teaching methods? **Students Taught**

**Table 1: Pretest/Posttest of the Standard Deviation of Attitude Rating of Chemistry Using Interactive Lecture (IL) and Conventional Lecture Method (CLM).**

Group	Sample (n)	Pre-attitude		Post-attitude		Mean gain
		Mean	Std. D.	Mean	Std. D.	
IL	65	2.25	0.388	3.68	0.221	<b>1.43</b>
CLM	66	2.20	0.447	3.40	0.213	<b>1.20</b>
<b>Mean Difference</b>		<b>0.05</b>		<b>0.28</b>		<b>0.23</b>
<b>Total</b>	<b>131</b>					

Table 1 shows that the attitude rating of students taught chemistry using interactive lecture was 2.25 with standard deviation of 0.388 during pre-attitude. It also shows mean value of 3.68 with standard deviation of 0.221 in post-attitude. The mean attitude ratings of students taught chemistry using conventional lecture method was 2.20 with standard deviation of 0.447 during pre-attitude. In post-attitude the mean value was 3.40 with standard deviation of 0.213. Table 2 further reveals that the mean gain of students taught chemistry using interactive lecture was 1.43, while those taught using conventional lecture method had a mean gain of 1.20. The mean difference between the groups was 0.23 in favour of students taught using Interactive lecture method. The closeness of the SD varies in the two groups indicate that the respondents were homogenous in their responses to the items.

### Research Question Two

What is the difference between the attitude rating of male and female students taught chemistry using interactive lecture and those taught using conventional lecture teaching methods?

**Table 2: Pretest/Posttest of the Attitude Ratings of Male and Female Students Taught Chemistry Using Interactive Lecture and Conventional Teaching Methods**

Methods	Gender	N	Pre-Attitude		Post-Attitude		Mean gain
			Mean	SD	Mean	SD	
Interactive	male	31	1.75	0.50	3.51	0.182	1.76
Lecture	female	27	1.54	0.45	3.01	0.80	1.47
Total		58					

Result in Table 2 showed the influence of gender on attitude ratings of students' taught chemistry using interactive lecture and conventional teaching methods. Result for interactive lecture method showed that the male students had pre-test mean attitude rating scores of 1.75 with standard deviation of 0.50 and a post-test mean attitude rating scores of 3.51 with standard deviation of 0.182, while the female students had a pre-test mean attitude ratings of 1.54 with standard deviation of 0.45 and a post- attitude rating of 3.01 with standard deviation of 1.47. Result showed that the male students had higher mean attitude rating than their female counterparts with mean gain of 1.76 while the female students had mean gain of 1.47 resulting to a mean difference of 0.29 in favour of the male counterpart.

### Research Question Three

What is the interaction effect of teaching method and gender on the mean attitude ratings of students in chemistry?

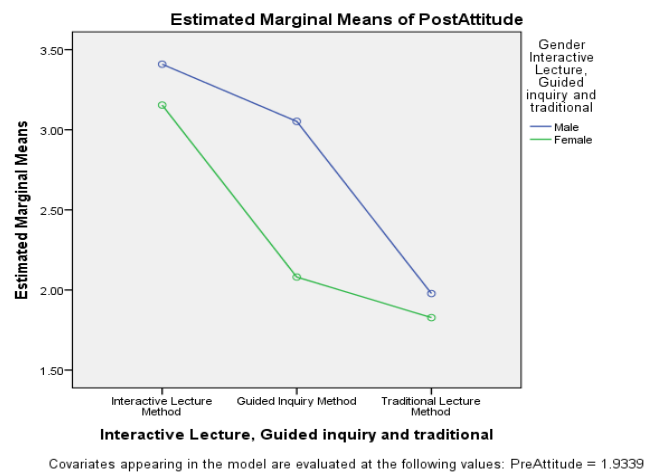


Figure 1: Profile plot interaction effect of Interactive Lecture and Gender Attitude Rating.



In Figure 1 the profile plot graph shows the interaction effect of methods and gender on the mean attitude rating of students in Chemistry. The interaction pattern shows that the plot of male and female students did not intersect on any of the methods. This indicates that there is no interaction effect between methods and gender on attitude ratings in Chemistry.

### Test of Hypotheses

**H<sub>01</sub>:** There is no significant difference the mean attitude rating of students taught chemistry using interactive lecture and conventional lecture teaching methods.

**Table 3: ANCOVA Result of the Difference in the Attitude Ratings of Students Taught Chemistry using Interactive Lecture (IL) and Conventional Lecture Methods (CLM)**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1.255 <sup>a</sup>	2	.628	4.172	.020	.119
Intercept	29.603	1	29.603	196.754	.000	.760
PreAttitude	.025	1	.025	.166	.685	.003
Strategy	1.185	1	1.185	7.879	.007	.113
Error	9.328	128	.073			
Total	713.690	131				
Corrected Total	10.584	130				

a. R Squared = .119 (Adjusted R Squared = .090)

Table 3 reveals that  $F(1,62) = 7.879$ ;  $p = .007 < 0.05$ . Since  $p < 0.05$ , the null hypothesis was therefore rejected. This implies that there is significant difference in the mean attitude ratings of students taught Chemistry using interactive lecture and conventional lecture methods. Thus, based on evidence from data analysis, interactive lecture method significantly improved the attitude of students more than conventional lecture method. The partial Eta Squared (effect size) of 0.113 indicates that 11.3% of the students' mean attitude towards Chemistry can be attributed to strategy when interactive lecture method was used.

**H<sub>02</sub>:** There is no significant difference in the attitude ratings of male and female students taught chemistry using interactive lecture teaching method.

**Table 4: ANCOVA Result of the Difference in the Attitude Rating of Male and Female Students taught Chemistry Using Interactive Lecture and Method**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2.255 <sup>a</sup>	2	.718	3.125	.030	.120
Intercept	30.600	1	30.600	196.754	.000	.749
PreAttitude	.031	1	.026	.166	.575	.004
Gender	1.086	1	2.185	8.685	.003	.740
Error	9.328	131	.071			



Total	810.690	134
Corrected Total	11.584	133

a. R Squared = .119 (Adjusted R Squared = .090)

Table 4 reveals that  $(F) = 8.685$ ;  $p = .003 < 0.05$ . Since  $p < 0.05$ , the null hypothesis was therefore rejected. This implies that there is significant difference in the mean attitude ratings of male and female students taught chemistry using interactive lecture and guided inquiry methods in favour of the male. Thus, based on evidence from data analysis, interactive lecture and guided inquiry methods significantly improved the attitude of male students more than their female counterpart. The partial Eta Squared (effect size) of 0.740 indicates that 74% of the students' mean attitude towards Chemistry can be attributed to gender when interactive lecture and guided inquiry methods were used.

**H<sub>03</sub>:** There is no significant interaction effect of teaching method and gender on the attitude of students towards chemistry.

**Table 5: Interaction Effect of Teaching Method and Gender on Students Attitude Rating in Chemistry.**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	79.225 <sup>a</sup>	6	13.204	49.953	.000	.608
Intercept	62.305	1	62.305	235.710	.000	.550
PreAttitude	.112	1	.112	.425	.515	.002
Strategy	59.960	2	29.980	113.419	.000	.540
Gender	10.303	1	10.303	38.978	.000	.168
Strategy * Gender	6.714	2	3.357	12.700	.000	.116
Error	51.016	193	.264			
Total	1471.083	200				
Corrected Total	130.240	199				

a. R Squared = .608 (Adjusted R Squared = .596)

Table 5 shows an interaction effect of teaching methods and gender on students' mean attitude ratings. An ANCOVA result reveals that  $F(1, 193) = 12.700$ ;  $p = .000 < 0.05$ , the null hypothesis was therefore rejected. It thus implies that there is significant interaction effect of teaching methods and gender on students mean attitude ratings. The partial Eta Squared (effect size) of 0.116 indicates that 11.6% of the students' mean attitude towards Chemistry can be attributed to the interaction effect of teaching methods and gender.

### Discussion of Findings

The results of the study were discussed under the relevant sub-headings below in line with the research questions and hypotheses that guided the study.

The test of hypotheses one, which shows a significant difference in the mean attitude ratings of students taught chemistry using interactive lecture versus conventional lecture methods in favour of students taught using Interactive lecture method. This could be because the interactive lecture method involves a two-way interaction between the presenter (teacher) and the participants (students); interaction is defined as a student's engagement with the lecture's material or content; it does not necessarily mean that the audience must speak all the time; interactive lecturing implies active participation and involvement by the audience so that students are no longer passive in the learning process; it also implies a dimension of approaching the role of the teacher. When delivering this kind of presentation, the "teacher" usually takes on the role of "facilitator" or "coach," and most of the time, they have to change the lecture material to allow for discussion and the attempt at new methods. Gulchexra et al. (2023) found that the interactive method is based on each student participating in the educational process, free and independent thinking. When used effectively, learning becomes an attitude activity for the student, and skills and abilities are acquired to work independently with the teacher's assistance and cooperation. Students learn new information based on scientific research, research, and experiments. Akhigbe and Adeyemi (2020) and Ardashir and Mosavi (2019) revealed a significant difference in the mean attitude evaluations of students taught chemistry utilizing interactive lectures compared to the traditional lecture approach. This conclusion is consistent with their findings. The results are likewise in line with those of Mbuti (2022), who discovered a noteworthy distinction between the mean attitude evaluations of Tanzanian students taught chemistry through interactive lectures and traditional lectures. The findings' consistency may be attributed to the interactive lecture method's capacity to foster contact and teamwork among Chemistry students, which in turn improves their attitude about the topic by encouraging idea exchange about the concepts covered.

According to this study, male students who were taught chemistry through interactive lecture method had significantly higher mean attitude ratings than female students. Therefore, when teaching chemistry in senior secondary schools, the interactive lecture method considerably enhanced the attitude of male students more than that of their female counterparts, according to data analysis evidence. In other words, the teaching strategy is gender-sensitive and biased against female. Therefore, when employing this teaching strategy, female students need to be supported and led. The results are comparable to those of Brajraj et al. (2019), who discovered a substantial difference in females' attitudes toward science compared to males, favoring male students. The results are also consistent with Dawal's (2021) research, which found that male students' attitudes differed significantly from female students' attitudes. This also supports the findings of Echie and Ihenko (2017), who demonstrated that students' attitudes toward integrated science taught using interactive teaching methods are significantly influenced by gender, favoring male students. The results also align with those of Akhigbe and Adeyemi (2020), who found that male students who were exposed to GR-CLS in a virtual and hands-on laboratory environment had significantly higher mean achievement and attitude scores than female students who were not exposed to GR-CLS. The results, however, contradicted those of Achimugu et al. (2023), who discovered no discernible difference between the mean attitude

evaluation scores of male and female chemistry students. The study design and research subjects employed may be the cause of the discrepancy in the results.

The results show that the interaction between gender and teaching strategy had a statistically significant impact on students' mean attitude evaluations in chemistry. Thus, research suggests that gender and teaching strategy have a significant interaction effect on students' mean attitude evaluations. Thus, the null hypothesis was disproved. The results contradict those of Jack and Zubairu (2022), who found that gender had no significant influence, attitude had no effect, and gender had no interaction effect. The study also disagreed with Chikaoonaka et al. (2023), whose findings showed that the mean attitude ratings of Basic Science students were not significantly impacted by the interaction of gender and teaching technique. Furthermore, the results contradict those of Achimugu and Onojah (2017), who discovered no discernible relationship between gender and teaching strategies and students' attitudes. Differences in the location, subject area, instruments, data collection techniques, and tools may be the cause of the disparities in the results.

### **Conclusion**

The finding of the study showed that interactive lecture method enhanced students' attitude in chemistry when compared with conventional method, the students in interactive lecture significantly did better than those of conventional lecture method. It is also concluded based on the findings that interactive lecture method is not gender friendly in terms of students' attitude in chemistry as it favoured the males. This implies that gender disparity in students' attitude in chemistry exists and chemistry teachers should note this when using interactive lecture teaching methods to minimize the effect on female students. The finding of the study showed that there was no statistically significant interaction effect of teaching methods and gender on students' attitude in chemistry.

### **Recommendations**

Based on the findings of the study, the following recommendations were made:

1. Chemistry teachers should make use of interactive lecture teaching methods to teach chemistry in order to improve students' attitude in chemistry, since interactive lecture has proven to be very effective.
2. Chemistry teachers should encourage to be gender sensitive by guiding the female in order to close the gap between them and the males when using interactive or conventional methods since they are not gender friendly.
3. Workshops should be frequently organized by educational bodies such as National Teachers Institute (NTI) as well as teachers' professional bodies such as STAN to sensitize Chemistry teachers and other educators on the use of interactive lecture and conventional methods to enhance attitude and performance among senior secondary students.
4. Ministry of Education at both the federal and state levels should encourage the use of interactive lecture method among chemistry teachers who are active in the classroom by

funding workshops, conferences and refresher courses for teachers to ensure meaningful teaching and learning.

## References

- Abraham, A. I., Victor, O. O., Endurance, I., Noah, O. A., Grace, O.O. & Egbunu, O. A. (2023). Effect of think-pair-share method on secondary school students' interest and performance in chemistry in Oredo Local Government Area, Edo State. *Journal of Science, Technology and Mathematics Pedagogy*, 1(2) 171-182.
- Abu, A. O. (2023). Effect of inquiry method on students' academic achievement in biology at senior secondary school in Idah Kogi State. *Journal of Science, Technology and Mathematics Pedagogy*, 1(1),30–36. Retrieved from <https://jostmp-ksu.com.ng/index.php/jostmp/article/view/37>
- Achimugu L., Achufusi, N.N., Negedu, S.A. & Salami, D. (2023). Adapting to virtual laboratory teaching strategy during covid-19: its effects on physics students' attitude in Kogi State, Nigeria. *Journal of Science, Technology and Mathematics Pedagogy* 1(1), 97 - 108
- Achimugu, L. & Onojah, P.K. (2017). Comparative effectiveness of convergent and divergent teaching methods on senior secondary students' achievement in stoichiometry. *International Educational Scientific Research Journal* 3(8), 17 - 21
- Achimugu, L. (2016). Principals' assessment of teachers' effectiveness in teaching chemistry at the senior secondary schools in F.C.T, Abuja, Nigeria. *International Journal of Science & Research Publications* 3 (6), 27 – 33.
- Achimugu, L. (2018). Effectiveness of enriched guided discovery and lecture instructional methods on senior secondary school students' performance in chemistry. *Journal of Contemporary Educational Research*, 2(1), 1-20.
- Achimugu, L., Fasanya, A.G., Abdulwaheed, I.O., Joshua, A.O., Ibrahim, S. & Shaibu, A.E. (2013). Assessing strategies for enhancing the integration of cultural practices in teaching and learning of chemistry in secondary schools. *Chemistry Teacher International* 5(1): 11–18 doi.org/10.1515/cti-2022-0050
- Achimugu, L., Mohammed, S.A., Enefu, S.M., Offor, M., ((2024). *Comprehensive Research Methods and Statistics in Education*. Ahmadu Bello University Press Limited
- Achimugu, L., Oguche, M.D., & Igboegwu, N.E., (2023). Improving student's attitude towards practical chemistry using, virtual laboratory package: implications for global security challenges. *Scope* 13(2), 931-989.
- Akhigbe, J. N. & Adeyemi, A. E. (2020). Using gender responsive collaborative teaching strategy to improve students' achievement and attitude towards learning science in virtual and hands-on laboratory environment. *Journal of Pedagogical Research*, 4(3), 241-261.
- Ardashir, F. & Mosavi, A. (2019). Effectiveness of shifting traditional lecture to interactive lecture to teach nursing students. *Invest Educ Enferm* 37(1): 1-12. Published Online 2019 Jan. 6. doi: [10.17533/udea.iee.v37n1a07](https://doi.org/10.17533/udea.iee.v37n1a07) PMID: PMC7871465

- Atsua, T.U & Abdullahi, U. (2015). Effects of guided discovery and lecture methods in teaching economics at senior secondary schools in Benue State, Nigeria. *Nigerian Journal of Educational Research and Evaluation*, 14(3), 68 – 76.
- Bello, M. (2015). *Impact of computer-aided instruction and interactive lecture method on interest and performance in Physics among secondary school students, Zaria-Nigeria*. (Unpublished M. Ed. Thesis), Department of Science Education, Ahmadu Bello University Zaria.
- Brajraj, S., Rakhee, C., Rekha, Y. & Singh, K. (2019). Gender difference in attitude towards science. *International Journal of Education (IJE)* 1(2); 38–46
- Chikaoinkana, C.O. & Ifunanya, M.A. (2023). Interaction effect of gender and teaching method on academic achievement and attitude of basic science students in upper basic education. *Journal of Science Education (JOSCED)*, 4(1). 269-284
- Dawal, B.S. (2021). Gender differences in the attitude and achievement of secondary school students towards stem education in Plateau State. *Kashere Journal of Education (KJE)*, 2(1) 192-200
- Echie. G.G. & Ihenko, S. (2017). Influence of gender on attitude and academic performance of students in integrated science in Obio Akpor Local Government Area of Rivers State. *European Scientific Journal*, 13(10), 272-278.
- Ekwueme, O. U. (2024). Assessment of the effects of problem-solving instructional strategies on students' performance and retention in chemistry with respect to location in Rivers State. *World Journal of Education*, 1(2), 74-79.
- Emaikwu, S. O. (2019). *Fundamentals of research methods and statistics*, Makurdi: Selfers Academic Press Ltd.
- Fatokun, K. V. F., Jimoh, S. B., & Enefure, G. O. (2019). Towards building the gap between research outcomes on innovative teaching strategies and instructional practices by science teachers. In *60th Annual STAN Conference Proceedings* (pp. 65-72).
- Gongden, E. J. (2015). *Comparative effects of two metacognitive instructional methods on gender and problem solving abilities in selected chemistry concepts in Plateau state, Nigeria*. [Doctoral dissertation] Abubakar Tafawa Balewa University, Bauchi.
- Gulchexra, S. M. & Muhridin, M. (2023). Use of interactive methods in chemistry education system. novateur publications. *JournalNX- A Multidisciplinary Peer Reviewed Journal* 9(2), 24-38
- Haruna, B. & Abdul Talib, C. B. (2022). Effect of lecture-enriched wait-time on the performance of average and high ability SSII chemistry students in mole concept. *International Journal of Academic Research in Business and Social Sciences*. 12(7), 738 – 747.

- Jack, G.U. & Zubairu, H.A. (2022). Influence of gender on secondary school students' achievement, retention and attitude in chemistry using 4 mat teaching model. *Journal of Education in Developing Areas*, 29(2), 82-104.
- Lamidi, B. T., Oyelekan, O. S., & Olorundare, A. S. (2015). Effects of mastery learning instructional method on senior school students' achievement in the mole concept. *The Electronic Journal for Research in Science & Mathematics Education*, 19(5).
- Matazu, S. S. A. (2023). Effect of flipped classroom instruction and enhanced lecture method on academic performance in genetics among students with visual-auditory-kinesthetic (vak) learning styles in Gusau, Zamfara State, Nigeria. *Journal of Science, Technology and Mathematics Pedagogy*, 1(2), 1-20.
- Mbuti, E.E. (2022). Effect of interactive teaching on pupils' activeness in learning: a case of primary schools in Korogwe District, Tanzania. *East African Journal of Education and Social Sciences* 3(6)101-108. Doi: <https://doi.org/10.46606/eajess2022v03i06.0241>.
- Ochu, A.N.O. & Haruna P. F. (2014). Challenges and prospects of creativity in a chemistry classroom: The perception of chemistry teacher. *British Journal of Education Society and Behavioural Sciences*. 5(2), 237-243.
- Ogochukwu, C.O. & Stephen, C.N. (2022). Effect of guided inquiry method on senior secondary school chemistry students' academic achievement in Anambra State, Nigeria. *Journal of Educational Research and Policy Studies* 11(1); 151-161.
- West African Examination Council (WAEC) (2023). Statistics Section.