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EFFECTS OF PEER-ASSISTED LEARNING ON NIGERIAN SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN ELECTROCHEMISTRY

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ABSTRACT

The study compared the effects of peer-assisted learning method (PALM) and Conventional Lecture method (CLM) on Nigerian secondary school students' achievement in electrochemistry. Two research questions and two null hypothesis at 0.05 level of significance guided the study. The study employed a quasi-experimental pretest-posttest non-equivalent control group. The population of the study comprised all 5057 Senior Secondary two (SS 2) chemistry students in Awka education zone of Anambra state, Nigeria. A sample size of 110 SS 2 chemistry students were selected and used for the study. A 50-item instrument Electrochemistry Achievement Test (EAT) was used for data collection. The instrument was face validated and reliability coefficient of 0.87 was obtained for EAT using Kuder-Richardson Formula 20 (KR-20). Mean and standard deviation were used to answer the research questions while analysis of covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The findings of this study revealed that students taught using PALM achieved significantly higher mean scores than those taught using CLM ($p < .05$). The study also revealed that there is no significant difference in the mean achievement scores between male and female students taught electrochemistry using PALM. It was recommended among others that chemistry teachers should make use of PALM to enhance meaningful learning of electrochemistry concept.

Key Words: Peer-assisted Learning Method, Conventional Lecture Method, academic achievement, and electrochemisy.

Introduction

Science is the foundation of all technological growth and the basis for the development of a nation. For any country, and especially a developing country like Nigeria, to attain a meaningful level of advancement in science and technology, much priority must be given to the promotion of scientific knowledge and skills. Edoho, Asuquo, Anditung, and Abasi (2020), thus highlighted that science education is imperative for the future of Nigerian societies, ensuring her prosperity by equipping students with essential 21st-century skills. In other words, science education plays a pivotal role in national development, as it equips learners with the scientific knowledge and skills required for technological advancement, industrial growth, and informed decision making in a technology driven society.

Chemistry, as one of the core science education subjects at the secondary school level is an essential tool for technological advancement as its concepts contribute significantly to the development of scientific literacy. Chemistry according to Okoye and Nwankwo (2019) is one of the foundational science subjects, which plays a critical role in equipping learners with essential skills and knowledge for scientific inquiry and innovation. It serve as a foundation for careers in medicine, engineering, pharmacy, and other science related disciplines. The objectives of Chemistry curriculum among others according to Federal Ministry of Education (FME), (2009) are to acquire basic theoretical and practical knowledge and skills which equips learners to fit into this drive and also apply skills to meet societal needs of creating employment and wealth. These objectives reflect the national aspiration to produce scientifically literate citizens capable of contributing meaningfully to societal development and technological advancement. In alignment with global educational trends, these goals emphasize not just content mastery but also inquiry skills, problem-solving skills, and practical application of scientific concepts beyond the classroom.

The researcher however, have personally observed a noticeable gap between these curriculum objectives and actual classroom outcomes within secondary schools in Awka Education Zone of Anambra state, Nigeria. She observed a trend that many secondary school chemistry students begin chemistry lessons with great expectations and a keen interest that is rarely sustained as the subject becomes too abstract and mathematical for them. Students perceive chemistry as cumulative, fearing that missing one concept could lead to confusion. Hence, they demonstrate poor understanding, and consequently their academic achievement in chemistry has not been satisfactory particularly in complex and abstract topics such as electrochemistry. Electrochemistry, a core topic in chemistry have long posed significant challenges to educators and students, especially at secondary school level. It is one of the perceived difficult concepts in chemistry according to Onyi, Njoku and Nwafor (2022); and it involves the transfer of electrons between chemical species and the relationship between electron transfer and electrical currents generated or utilized in these process.

Electrochemistry requires an understanding of oxidation-reduction reactions, electrode potentials, galvanic and electrolytic cells, and the application of Faraday's laws of electrolysis. These topics according to Amponsah, Narh-Kert, Donkor and Commey-Mintah (2023) are not only conceptually demanding but also foundational for understanding scientific and industrial processes. Therefore, understanding electrochemistry is crucial in various industrial processes, including electroplating, metal extraction and the production of gases and compounds such as chlorine gas, hydrogen gas, oxygen gas, and sodium hydroxide pellets as well as production of electrical devices like batteries. Unfortunately, many students struggle to grasp these concepts, leading to poor academic achievement.

The West African Examination Council (WAEC, 2015-2024) chief examiner's report have repeatedly shown that students perform poorly in electrochemistry questions, exhibiting weak conceptual understanding, weak problem-solving skills, inability to solve mathematical problem

effectively and limited ability to apply electrochemical principles. This is reflected in the overall performance in chemistry result conducted by WACE and the Chief Examiner's reports from the analysis of 2015 – 2024 chemistry result have shown a percentage credit pass of 60%, 57.74%, 62.68%, 61.95%, 54.59%, 59.00%, 61.50%, 60.88%, 59.00% and 61.41% respectively. From the result analysis, it is evidenced that the percentage pass over the years is fluctuating and the percentage of those candidate obtaining credit pass often fall below 70%, a level regarded as unsatisfactory for effective scientific manpower development. Despite evidence of persistent underachievement in electrochemistry, empirical studies examining peer-assisted learning at the secondary school level in Nigeria remain limited, creating a gap this study seeks to address.

The difficulties in learning electrochemistry and persistent poor achievement in electrochemistry has been largely attributed to instructional practice dominated by the conventional lecture method in the classroom (Chikendu and Okoli, 2020; Odo and Nwachukwu, 2020). This method is largely teacher-centered and most often emphasizes information transmission rather than active knowledge construction. As a result, students often remain passive with limited opportunities to engage in discussion, problem solving, conceptual and collaborative reasoning. In response to these challenges, science educators have advocated for learner-centered instructional methods that actively involve students in the learning process. Peer-assisted Learning Method (PALM) has emerged as an instructional method that promotes interaction, cooperation and shared responsibility for learning among students.

Rooted in social constructivist theory, PALM is a peer-tutoring program that addresses the different learning needs of every student and for improving their overall learning skills (Etobro and Fabinu, 2018). It is a cooperative learning method that pairs students together and give them the roles of a "coach and a player". Accordingly, Muhammad, Addullah and Osman (2020) view PALM as a learning method that pairs high-performing students with lower-performing ones in a class wide setting with the hope that they work together and function as tutors and tutee under the facilitation of a teacher. Thus, it allows learners to explain concepts to one another, ask questions freely, and receive immediate feedback from peers, thereby facilitating deep conceptual understanding. Moreover, according to Ruegg et al (2017), for peer tutoring to occur, there is need to be a difference in knowledge between two individuals, so that the more knowledgeable individual can act as tutor to the less knowledgeable.

Studies have shown that PALM can enhance students' academic achievement in chemistry and other science subjects. For instance studies conducted by Kalu-Uche and Ogbonna (2021); Orij (2021) on Effect of Peer Tutoring Instructional Strategy on Secondary School Slow Learners' Academic Achievement and Retention in Biology and peer-assisted learning and physics learning outcome of secondary school students respectively have shown that PALM can enhance students' academic achievement and improve retention of knowledge. It is especially effective when combined with structured activities that encourages active participation and mutual support. Despite its potential benefits however, there is still limited research on the application of PALM in teaching and learning electrochemistry at secondary school level. While several studies improved achievement through peer tutoring in science subjects, findings on gender differences remain inconsistent, suggesting the need for further investigation within specific chemistry topics such as electrochemistry.

Some studies indicate that male students achieve better while some other showed that female students outperformed their male counterpart. Azibaolanari, John and Mumuni (2016); and Eze, Obidile and Okotubu (2020) studies reported a significant difference in achievement between male and female students in science in favour of male students. Moreover, Ndukwe (2021) observed that the male students' academic achievement scores were higher than the female students' scores in problem-solving strategy, although, the difference were not statistically significant. On the contrary, Kapitanoff and Pandey (2019); and Toni, Julija and Gordana (2018) in their separate studies reported that female students performed significantly better than their male counterparts. Furthermore, Adedamola (2015) and Akpoghol, Samba and Asemave (2015) contends that gender is not a relevant factor to be associated with achievement in science. According to Ajayi and Ogbeba (2017), studies on gender differences in chemistry achievement therefore continue to yield inconsistence results. This inconsistencies in literature thus suggests the need to explore how gender might moderate the effects of peer-assisted learning in specific content areas such as electrochemistry. It is against this background that this study investigated the effect of peer-assisted learning method and conventional lecture method on secondary school students' academic achievement in electrochemistry in Anambra state, Nigeria.

Research Questions

To guide the study, the following research questions were posed:

1. What are the differences in mean academic achievement scores of students taught electrochemistry with peer-assisted learning and those taught with conventional lecture methods using their pretest posttest scores?
2. What are the differences in mean academic achievement scores of male and female students taught electrochemistry with peer-assisted learning method using their pretest posttest scores?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance

1. There is no significant difference in the mean academic achievement scores of students taught electrochemistry with peer-assisted learning method and those taught with conventional lecture method.
2. There is no significant difference in the mean academic achievement scores of male and female students taught electrochemistry with peer-assisted learning method.

Methodology

The study employed a quasi-experimental pretest-posttest non-equivalent control group design. This design is selected because it was not possible to have a complete randomization of subjects as this would disrupt the normal classroom organization of the schools. Therefore, students in their intact classes were used for the study. This study was carried out in Awka Education zone in Anambra state, Nigeria. The population of the study comprised of all five thousand and fifty seven (5057) senior secondary school two (SS 2) chemistry students in 63 public and mission secondary schools in Awka Education zone. The population is made up of two thousand seven hundred and ninety eight (2798) females and two thousand two hundred and fifty nine (2259) males. The sample for this study was made up of 110 (56 female and 54 male) students

selected from two (2) co-educational schools drawn out of the 63 public and mission secondary schools in Awka Education Zone of Anambra state, Nigeria. The sample size of 110 students drawn from intact classes of the selected schools was considered adequate for a quasi-experimental study and sufficient for meaningful statistical analysis using Analysis of Covariance (ANCOVA). Intact classes from the two selected schools were randomly assigned to experimental and control groups in manner that each has equal and independent chance of being included in the sample. This was done by toss of a coin- head for experimental group and tail for control group.

Instrument for data collection

The research instruments used in this study was Electrochemistry Achievement Test (EAT). The EAT was administered twice, before (pretest) and after (posttest) the experiment. The pretest was used to ascertain the level of electrochemistry achievement at which the students were, before the treatment while the posttest was used to determine the extent of students' electrochemistry achievement after the experiment. Lesson plans were equally developed for the experimental and control groups in the content areas that were taught. Both the instrument and lesson plans were validated by three experts for face validity; two lecturers in the Department of Science Education and one from the Department of Educational Foundations, all from Nnamdi Azikiwe University, Awka, Anambra state of Nigeria. The reliability of EAT was established using Kudder Richardson Formula 20 (KR-20) to be 0.87. The instrument (EAT) was used to generate data for the study at two different times. The EAT was administered on the subjects of the experimental and the control groups as pre-test prior to treatment, and as posttest after treatment. The students' scores from the two different test was duly recorded and used for the data of this study.

Experimental Procedure

This research used students in their intact classes for both experimental group and control group in the two sampled schools. A one week briefing section was given to the regular chemistry teachers who were used as research assistants in the two groups. The briefing for the PALM group focused on the principle of peer-assisted learning, classroom organization, facilitation techniques and lesson delivery. The teacher was provided with PALM lesson plan and was instructed on the consistent implementation of the method throughout the treatment period. On the control group, the focus was on the use of conventional lecture method using the lesson plan provided by the researcher. The study lasted for seven weeks and at the first week, EAT was administered as pre-test to the two groups before the commencement of teaching. The scores obtained from the result was referred to as pre-test scores.

In the PALM group, students were grouped into small heterogeneous peer learning groups of five students in each group with a deliberate mix of at least one more knowledgeable and others less knowledgeable based on their pretest scores. Clear roles such as peer tutor and peer learner were assigned to each group, and these roles were rotated periodically to promote equal participation. In each lesson, the teacher introduced each electrochemistry concepts by stating the objectives of the lesson and giving brief conceptual explanation of the concepts, after which students engaged in peer discussions and collaborative learning activities. Each session lasted 30 minutes, during which peer tutors guided problem-solving activities under teacher supervision. The teacher served as facilitator by monitoring group interactions, providing corrective feedback where necessary and ensuring that accurate scientific explanations were maintained, while direct instruction was minimized. Class discussions were conducted at the end of every lesson to address common difficulties, summarize key points and reinforce understanding.

On the other hand, lesson was delivered through teacher-centered explanations, demonstration and note taking in the control group using the lesson plan. The two groups were taught separately in their respective schools. The teaching exercise continued for five weeks. The researchers monitored the teachers (research assistants) during the teaching process to be sure they do not deviate from the lesson plans. After the treatment, EAT was reshuffled and administered as the post-test in the two groups in the seventh week, which yielded the post-test scores. The researcher scored the pre-tests and post-tests and generated quantitative data, which were analyzed.

Method of Data Analysis

The data collected were analyzed using mean scores, standard deviation scores and analysis of covariance (ANCOVA), this was used to take care of the initial differences in the two groups and to control selection bias. The mean and standard deviation scores were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. In the test of the null hypotheses using ANCOVA, when the p-value was less or equal to the level of significance (0.05), the null hypothesis was rejected. Also, when the p-value was greater than the level of significance (0.05), the null hypothesis was not rejected.

Results

Research Question 1: What are the differences in mean academic achievement scores of students taught electrochemistry with peer-assisted learning and those taught with conventional lecture methods using their pretest posttest scores?

Table 1: Mean and Standard Deviation of Pretest and Posttest achievement Scores of students taught electrochemistry using peer-assisted learning and conventional lecture methods.

		Pretest		Posttest		
Groups	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean difference**
Control(CLM)	54	29.00	6.53	48.07	8.06	19.07
Experimental(PALM)	56	25.43	10.17	56.95	8.73	31.52

The results in table 1 shows that PALM yielded greater achievement mean gain score than the CLM. There is also a positive difference of 8.88 between the post-test mean scores of the two groups in favour of the PALM group. These indicate that students taught using PALM achieved higher than their CLM group counterparts, suggesting meaningful instructional impact. On the other hand, the relatively low standard deviations at both pretest and posttest for the control group indicates that students in the control group had similar level of achievement before and after instruction, with limited variability. On the other hand, the higher standard deviation at the pretest of the PALM group indicates a greater variability in the students' achievement scores before the intervention. However, the standard deviation decreased remarkably after the intervention indicating that their achievement scores became closer to one another and to the mean score.

Research Question 2: What are the differences in mean academic achievement scores of male and female students taught electrochemistry with peer-assisted learning method using their pretest posttest scores?

Table 2: Mean and Standard Deviation of Pretest and Posttest Scores of male and female students taught electrochemistry using peer-assisted learning methods.

			Pretest		Posttest		
Group	**Gender**	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean Difference**
PALM	Male	31	24.97	10.20	56.29	9.63	31.32

Female	25	26.00	10.31	57.76	7.58	31.76

The data in table 2 reveals that, the mean gain achievement score for female students was slightly greater than the male students, showing a negligible difference of 0.44 in favour of female students. Also, the relatively high pretest standard deviation for both male and female students indicates great variability in their initial achievement scores. While the remarkable decrease in the female students' standard deviation indicates a higher improvement in score uniformity among female student than their male counterpart who had a small decrease. This shows that the PALM was equally effective for both genders with a slight advantage in posttest mean and consistency for female students.

Testing the null hypotheses

Null hypothesis 1: There is no significant difference in the mean academic achievement scores of students taught electrochemistry with peer-assisted learning method and those taught with conventional lecture method.

Table 3: ANCOVA Test on Difference between mean achievement scores of students taught electrochemistry with peer-assisted learning and those taught with conventional lecture methods.

Source of variation	Type III Sum of Squares	Df	Mean Square	F	p-value	Partial Eta Squared
Corrected Model	6134.648[a]	2	3067.324	89.528	.000	.626
Intercept	10829.307	1	10829.307	316.081	.000	.747
PRETEST	3970.600	1	3970.600	115.892	.000	.520
GROUP	**3419.618**	**1**	**3419.618**	**99.810**	**.000**	**.483**
Error	3665.943	107	34.261			
Total	314039.000	110				
Corrected Total	9800.591	109				

a. R Squared = .626 (Adjusted R Squared = .619)

The result of the analysis of covariance presented in Table 3 shows that the calculated F-value is 99.810 and the P-value is 0.000. Since the P-value is less than 0.05 set as level of significance at df of 1 and 107, it shows that there is a significant difference between the mean achievement scores of the CLM and PALM groups in favour of the PALM group. The null hypothesis is therefore rejected. Moreover, the partial Eta Squared showed a large effect size of 0.483, indicating that 48.3% of the variance in academic achievement scores were attributed to the instructional methods used. Hence PALM had strong effect on the mean academic achievement scores of students.

Null hypothesis 2: There is no significant difference in the mean academic achievement scores of male and female students taught electrochemistry with peer-assisted learning method.

Table 4: ANCOVA Test on Difference between mean academic achievement scores of male and female students taught electrochemistry with peer-assisted learning method.

Source of variation	Type III Sum of Squares	Df	Mean Square	F	p-value	Partial Eta Squared

Corrected Model	2488.028[a]	2	1244.014	38.720	.000	.594
Intercept	12223.086	1	12223.086	380.443	.000	.878
PRETEST	2458.136	1	2458.136	76.509	.000	.591
GENDER	**8.619**	**1**	**18.619**	**.268**	**.607**	**.005**
Error	1702.811	53	32.129			
Total	185793.000	56				
Corrected Total	4190.839	55				

a. R Squared = .594 (Adjusted R Squared = .578)

The result of the analysis of covariance presented in Table 4 shows that the calculated F-value is 0.268 and the P-value is 0.607. Since the P-value is greater than 0.05 set as level of significance at df of 1 and 53, it shows that there is a no significant difference between the mean achievement scores of male and female students taught electrochemistry using PALM. The null hypothesis is therefore not rejected. Moreover, the partial Eta Squared revealed a very small effect size of 0.005, indicating that 0.05% of the variance in academic achievement scores were attributed to the instructional methods used. Hence PALM had a very small effect on the mean achievement scores of male and female students in PALM group.

Discussion of Findings

The findings of this study revealed that the students in experimental group taught electrochemistry using PALM achieved significantly better than their counterparts in the control group who were taught the same chemistry concepts using CLM. Hence, teacher's use of PALM enhanced students' academic achievement more in electrochemistry compared to the use of CLM. Therefore, there is a significant difference between the mean achievement scores of the CLM and PBLM groups in favour of the PALM group with higher mean score between their pretest and posttest scores.

The findings of this study is in consistent with findings of Awofala and Agbolade (2023) and Nbame 2022) whose individual studies reviewed that peer tutoring enhances academic achievement of mathematics students. The result of this study is in agreement with the findings of Azeez, Omananyi, Kwasi and Abuh (2022) which revealed that the use of peer tutoring instructional strategies have significant effect on students' academic achievement and interest in periodic table of elements. The result of this study is in line with that of Alzahrani and Leko (2018) and Nawaz and Reman (2017), who made a meta-analysis of the academic impact of peer tutoring and found that the performance of students in peer tutoring intervention increased academically. Furthermore, the results of this study is consistent with study conducted by Ansuategui and Miravet (2017), Wolfe (2018), whom examined the effectiveness of collaborative work among higher level students and found that teamwork is an influential factor in promoting their learning.

The outcome of this findings may be attributed to the interactive and cooperative nature of peer-assisted learning, which provide students with opportunities to engage with the subject matter more deeply than in CLM. Students in PALM group thus, learn by explaining concepts to their peers, asking and answering questions, and solving problems together, which reinforces their understanding. Moreover, the collaborative nature of PALM may have reduced cognitive load in electrochemistry by allowing students to verbalize abstract concepts, articulate ideas, confront misconceptions and co-construct understanding, a learning processes often absent in lecture based instruction. A possible

explanation for the effectiveness of PALM is therefore its alignment with social constructivist learning principles; however, the short intervention period, and the use of intact classes may limit the generalizability of the findings.

The result of this study also revealed that gender did not influence students' academic achievement in electrochemistry significantly when taught using PALM. The null hypothesis which states that there is no significant difference in the mean achievement scores of male and female chemistry students who were taught using PALM is therefore not rejected. This is in line with the findings of Godpower-Echie and Ihenko (2017) who revealed a non-significant influence of gender on achievement of Integrated Science students. In a similar study by Edem and Anari (2021), gender was not found to be statistically significant. The findings of this study is in conformity with the study conducted by Gongden (2021) on effects of reciprocal peer tutoring on chemistry students' achievement and retention in chemical kinetics in Jos Metropolis, Nigeria which revealed that there was no significant difference in the achievement of male and female students taught using RPT strategy.

On the other hand, the result of this study disagrees with the findings of Oribhabor (2019) whose study reviewed that there is a significant difference in the Mathematics achievement of the male and female students in favour of the males. Ekwam, Keraro and Ng'eno (2023) study also reviewed a statistical significant gender difference in chemistry achievement in favour of boys. Furthermore, Oyovwi (2019) study indicated a slight significant difference between male and female students exposed to peer tutoring instructional strategy.

The non-significant difference observed in this study in the academic achievement of male and female students in PALM group might be due to the fact that the PALM method of teaching in this study emphasizes collaborative learning through peer tutoring and group work, supportive learning environment where students feel free asking questions and making mistakes. Moreover, PALM unlike competitive or evaluative instructional strategies such as CLM reduces the impact of gender stereotypes in science learning by promoting inclusiveness, mutual respect and trust. In other words, PALM provided a level playing ground, which allow both male and female students to engage, express and learn collaboratively, minimizing disparity often found in traditional instructional approaches. These findings validate the use of PALM as gender inclusive pedagogical strategy for improving science achievement at secondary school level

Conclusion

Based on the findings, this study concluded that PALM enhanced the academic achievement of students in electrochemistry more than the CLM. It is an effective instructional method that can be used to improve both male and female students' achievement equally in electrochemistry at the senior secondary school level in Nigerian schools. Therefore, it was highlighted that gender has no influence on the academic achievement of students exposed to PALM. More importantly, students' academic achievement enhanced because the method is learner-centered and it gives room for learners to share knowledge with his or her peers. PALM offers opportunity for each students to become aware of their strength and weakness. It serves as a motivation toward academic achievement. In general, the PALM has positive influence on the subjects of this study as indicated in their mean achievement scores.

Recommendations

The findings of this study and their educational implications have necessitated the following recommendations:

1. Chemistry teachers should be encouraged to use the peer-assisted learning method in addition to other student-centered strategies in the classroom. Therefore it is highly recommended that the use of PALM be encouraged in all secondary schools in Anambra state and other states in Nigeria.
2. Peer-assisted learning method should be used by the chemistry teachers and other science teachers at large to clear gender differences in the teaching and learning of chemistry, since PALM is gender friendly.
3. Curriculum planners should incorporate into curriculum guides, appropriate content areas where the PALM can be used.
4. Workshops, seminars and conferences on the use of PALM and other innovative strategies should be organized for chemistry teachers.

References

Adedamola, A.K. (2015). Effects of computer assisted instruction on students' academic achievement and attitude in biology in Osun State. Nigeria. *Journal of Emerging Trends in Educational Research and Policy Studies, 6*(1), 69-73.

Ajayi, O.V. & Ogbeba, J. (2017). Effect of Gender on Senior Secondary Chemistry Students' Achievement in Stoichiometry Using Hands-on Activities. *American Journal of Educational Research, 5*(8), 839-842.

Akpoghol, T. V, Samba, R. M. O & Asemave, K. (2015). Effect of problem solving strategy on students' achievement and retention in secondary school Chemistry. *Journal of applied developmental psychology, 12*(6), 71-82.

Alzahrani, T. and Leko, M. (2018). The effects of peer tutoring on the reading comprehension performance of secondary students with disabilities: A systematic review. *Reading & writing quarterly*, *34*(6), 1-17.

Amponsah, K. D., Narh-Kert, M., Donkor, P. B. K. & Commey-Mintah, P. (2023). Effect of Conceptual Transformation on Electrochemistry Performance of High-performing High School Learners in South Africa. *African Journal of Educational Studies in Mathematics and Sciences, 19* (1), 31-46.

Ansuategui, F. J. A. & Miravet, L. M. (2017). Emotional and cognitive effects of peer tutoring among secondary school mathematics students. *International journal of mathematical education in science and technology*, *48*(8), 1185-1205.

Awofala, A. O. A & Agbolade, F.O. O. (2023). Effect of Peer-Tutoring Strategy on Senior Secondary School Students' Achievement in Mathematics. ASEAN Journal for Science Education, 3(1), 1-12.

Azeez, A. A., Omananyi, E.O., Kwasi, B.N., & Abuh, L.O. (2021). Effect Of Jigsaw and Peer-Tutoring Instructional Strategies on Senior Secondary School Students' Academic Achievement and Interest in Periodic Table of Elements in Ankpa Local Government Area Of Kogi State. *Unizik Journal of Educational Research and Policy Studies, 13*(1), 76-90.

Azibaolanari, U., John, W.D. & Mumuni, A.O. (2016). Teaching trajectories and students' understanding of difficult concepts in biology. *World Journal of Education, 7*(1), 44-52.

Chikendu R.E. & Okoli, I.J. (2020). Effects of instructional computer animation on secondary school students' achievement in chemistry in Awka Education zone. *International Journal of Innovative Research and Advanced Studies (IJIRAS), 7*(3), 12-22.

Edem, U.P. and Anari, M.I. (2021). Blended Instructional Strategy and Students' Achievement and Retention in Chemistry in UYO L.G.A, Nigeria. Noble *International Journal of Scientific Research,* 5(3), 22-28.

Edoho, E. A., Asuquo, I. M., Anditung, P. A. & Abasi, A. U. (2020). Improving Senior Secondary School Students' Academic Achievement and Retention in Mathematics and Basic Science using Collaborative Concept Mapping Instructional Strategy (CCMIS). *European Journal of Scientific Research, 156*(1), 108-117.

Ekwam, L., Keraro, F.N. & Ng'eno, J.K. (2023). Gender Differences in Secondary School Students' Achievement in Chemistry in Samburu County, Kenya. *Frontiers in Education Technology, 6*(4), 27-40.

Etobro, A.B. & Fabinu, O.E. (2018). Effects of peer-Assisted learning Strategies as Pedagogical Approaches on Students' Academic Performance in Basic Science. *Asian Journal of Education and Social Studies, 2*(2), 1-8.

Eze, T.I, Obidile, J.I. & Okotubu, J.O. (2020). Effect of gender on students' academic achievement and retention in auto mechanic technology in technical colleges in delta state, Nigeria. *London Journal of Research in Humanities and Social Sciences, 20*(1), 25-32.

Federal Ministry of Education (FME) (2009). National Chemistry Curriculum for Senior Secondary Schools 1-3. Lagos: NERDC.

Godpower-Echie G. & Ihenko, S. (2017). Influence of Gender on Interest and Academic Achievement of Students in Integrated Science in Obio Akpor Local Government Area of Rivers State. *European Scientific Journal, 13*(10), 272-279.

Gongden, E. J. (2021). The Effects of Reciprocal Peer Tutoring on Chemistry Students' Achievement and Retention in Chemical Kinetics in Jos Metropolis, Nigeria. *Journal of Education and Practice*, *12*(24), 100-107.

Kalu-Uche**,** N. & Ogbonna, N. G. (2021). Effect of Peer Tutoring Instructional Strategy on Secondary School Slow Learners' Academic Achievement and Retention in Biology. *Rivers State University Journal of Education (RSUJOE)*, *24* (1), 13-24

Kapitanoff, S. & Pandey, C. (2019). Collaborative testing in statistics: Group interaction, anxiety, and class performance. *Statistic Education research Journal, 17*(2), 51-67.

Muhammad, S.A, Abdullah, A.H. & Osman, S. (2020). Effect of peer tutoring strategy on students' academic performance in a polytechnic linear algebra classroom. *Journal of Advanced Research in Dynamical and Control Systems 12*(3), 415-422.

Nawaz, A. & Rehman, Z.U. (2017). Strategy of peer tutoring and students' success in mathematics: An analysis. *Journal of Research and Reflection in Education, 11*(1), 15-30.

Nbame, L (2022). Effect of Peer Tutoring on Secondary School Student's Performance in Mathematics in Tai Local Government Area of Rivers State. *International Journal of Innovative Education Research 10*(1), 116-123.

Ndukwe R. C. (2021). Effect of Problem-Solving Strategy on Chemistry Students' Performance in Secondary Schools in Abia State. *International Journal of Humanities Social Sciences and Education (IJHSSE), 8*(7), 226-232.

Odo, E.E. & Nwachukwu,J.N. (2020). Effect of Two peer Instructional Strategies on Secondary School Students' Achievement in Science. *American Journal of Educational Research 8*(2), 80-89.

Okoye, F.C., & Nwankwo, C.A. (2019). Comparative Effects of Lecture and Problem-Based Learning Methods on Secondary School Students' Retention in Chemistry in Anambra State, Nigeria. *Journal of Curriculum Studies, 26*(2), 88-98.

Onyi, I.E., Njoku, Z.C. & Nwafor, S.C. (2022). Efficacy of Problem Based Learning in Promoting High Achievement of Students In Chemistry. *Journal of Critical Reviews, 9*(1), 49-57.

Oribhabor, C.B. (2019). The influence of gender on mathematics achievement of secondary school students in Bayelsa state. *African Journal of Studies in Education, 14*(2), 196-206.

Orji, N. O. (2021). Peer-Assisted Learning and Physics Learning Outcomes of Secondary School Students In Abia North Education Zone, Sapientia Foundation *Journal of Education, Sciences and Gender Studies (SFJESGS), 3*(3), 171-176.

Oyovwi, E. O. (2019). Enhancing Academic Achievement of Science Students through Peer Tutoring Instructional Strategy. *Studies in Education, 19*(1), 34-42.

Ruegg, R., Sudo, T., Takeuchi, H. & Yuko, A. (2017). Peer tutoring: Active and collaborative learning in practice. *SiSAL Journal, 8*(3), 255-267.

Toni, M., Julija, M., & Gordana, K. (2018). *Do gender and age impact students' success? College for applied computer engineering* 'Algebra', Zagreb, Croatia.

West African Examination Council, (2021). *Chief examiner's report on Chemistry. http:// www.waecnigeria.org/exams.html.*