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Enhancing Secondary School Students' Achievement in Chemistry Using Collaborative Instructional Strategy

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Abstract: The study explores the impact of a collaborative instructional strategy (CIS) on students' academic achievement in the Aguata Education Zone of Anambra State, Nigeria. The study also delved into the potential effect of gender on students' achievement in chemistry. The pre-test, post-test non-equivalent control group design was utilized in this quasi-experimental study. There were 2,328 senior secondary two Chemistry students in the population. A sample size of 101 Chemistry students (43 males and 58 females) was selected using the purposive sampling technique from two intact classes at two co-educational schools. Using Kendall's Coefficient of Concordance (w), the Chemistry Achievement Test (CAT) reliability index was calculated to be 0.94. While ANCOVA was used to test the hypotheses at 0.05 level of significance, mean and standard were used to answer the research questions. The findings of the study showed that CIS enhances students' achievement in chemistry more effectively than the conventional strategy. Also, gender has no significant influence on students' achievement in chemistry. It was recommended among others that educational stakeholders should hold conferences and seminars to train the teachers on how to use CIS in teaching and learning chemistry. Moreover, CIS should be used to ensure and enhance gender equity in both chemistry learning and other school subjects.

Keywords: Collaborative Instructional Strategy, Chemistry, Gender and Achievement

INTRODUCTION

The Federal Government of Nigeria embarked on the reform of her educational curriculum with special attention to the achievement of Millennium Development Goals (MDGs) and the critical elements of the National Economic Empowerment and Development Strategies (NEEDS). Taking into cognizance the importance of Chemistry, it became imperative that the existing chemistry curriculum should be reformed. This was done with the intention of increasing students' interest in the topic, helping them learn the fundamentals of theory and practice, and helping them meet social needs by using their knowledge of chemistry, among other things, to create income and jobs. This is due to the fact that chemistry, which involves the study of matter, its applications, and reactions, is a subject that is significant in both our daily lives and the growth of nations. This supports the claim made by Ezeudu et al. (2019a) that chemistry provides the majority of a nation's labour force. As a result, chemistry aids in human comprehension of common materials and processes.

Onyi & Nwafor (2022) and Ezeudu et al. (2019b) provided empirical evidence for the low and fluctuating achievement of students in chemistry. This is supported by the Chief Examiners Reports (2017–2021) of the West African Examination Council (WAEC), which show a pattern of inconsistency and a pressing need for improvement in students' achievement in the subject. Low students' achievement in Chemistry has largely been linked to the employment of traditional teaching methods (lecture method) rather than student-centered learning strategies (Odukwe & Nwafor, 2022). Despite the fact that the conventional teaching approach (lecture method) ensures

that students' course material is quickly covered, it also encourages rote learning and turns students into passive learners by preventing them from actively engaging in the learning process. Their success will unavoidably be impacted by this. Chemistry is a science topic that emphasizes hands-on learning and encourages student participation. Therefore, in order to improve student achievement, chemistry teachers must adopt activity-based instructional strategies like the collaboration instructional strategy (CIS), which encourages interaction between the students and the course materials.

A collaborative instructional strategy (CIS) is a method whereby students cooperate in groups to solve academic difficulties and attain their learning objectives. According to Nokes-Malach & Richey (2015), a collaborative instructional technique is one where students participate in small group activities to share their knowledge and experience. Collaborative instruction, according to Ali et al. (2021), "is an instructional strategy in which teachers work together on specific subject". Therefore, in the collaboration strategy, the teacher helps to address a specific problem in order to facilitate the day-to-day instructions. This method encourages students to actively participate in their learning experience and acquire the knowledge required to address societal issues. The teacher acts as a facilitator in collaborative learning and directs the students' learning activities. Group work, a component of a collaborative educational technique, is acknowledged by Liu et al. (2018) as improving student performance, confidence, autonomy in learning, and good feelings while lowering anxiety. Additionally, a collaborative instructional strategy improves students' academic and social skills (Sears & Reagin, 2013), fosters student satisfaction, improves learning outcomes, and develops critical thinking (Mosley et al., 2016), improves students' learning (Fatimah et al., 2020), and supports the development of learners' positive attitudes as well as their confidence and public speaking skills (Ha et al., 2022). From the foregoing, studies show lack of literature on the effect of collaborative instructional strategy on students' achievement in Chemistry in Nigeria and as observed by Johnson et al. (2007), the learning potential of cooperation is underutilized in practice, particularly in science education, therefore Chemistry, like other science subjects, requires the adoption of a collaborative instructional technique to attain a specified learning result, hence, the gap of the study. Furthermore, the study considered the influence of gender on the achievement of students in Chemistry when taught using collaboration instruction strategy. This is necessitated due to some contradictory evidences (Onyi & Nwafor, 2022; Ezeudu et al., 2019b; Aniodoh & Egbo, 2013) and lack of clear trend on the influence of gender on students' achievement in Chemistry. Hence, the main purpose of the study was to determine the effect of collaborative instruction on secondary school students' achievement in chemistry. Specifically, the study determined the: (a) Mean achievement scores of students in chemistry when taught using collaborative instructional strategy and conventional strategy. (b) Influence of gender on the mean achievement scores of students in chemistry

The following research questions were posed to guide the study: (a) What are the mean achievement scores of students taught chemistry using collaborative instructional strategy and those taught with conventional strategy? (b) What is the influence of gender on the mean achievement scores of students in chemistry? Moreover, the following hypotheses guided the study and were test at 0.05 level of significance: (a) There is no significant difference in the mean achievement scores of students taught chemistry using collaborative instructional strategy and those taught with conventional strategy. (b) There is no significant influence of gender on the mean achievement scores of students in chemistry.

METHOD

A quasi-experimental research design was used in the study. In particular, a non-equivalent control group design with pre- and post-tests was adopted. Because the study was conducted using intact classes (non-randomized groups), as the school administrations did not allow the classes to be disorganized for the purpose of the study, this approach was adopted and may constitute a limitation to generalizing the findings of the study. Moreover, Nworgu (2018) stated that quasi experimental research design can be used where random assignment of subjects to experimental

and control is not possible. The 2,328 senior secondary two (SS2) Chemistry students who made up the study's target population came from the 50 public secondary schools in the Aguata Education Zone of Anambra State. 101 SSII chemistry students (43 male and 58 female) were selected for the study's sample size from two intact classes at two coeducational schools in the Zone. The two coeducational schools were chosen using a purposive sampling method. Gender is a variable in the study, hence co-educational schools were chosen to guarantee that male and female students were studying in the same environments. In each of the two sampled schools, two intact classes were split into the experimental and control groups. The control group had 41 students (20 males and 21 females), while the experimental group included 60 students (23 males and 37 females).

Data were gathered using a Chemistry Achievement Test (CAT). The researchers created the 25 multiple-choice objective items that made up the instrument. A test blueprint using the modified bloom's taxonomy of learning which was based on the following Chemistry contents; Acids (36%), Bases (24%), Salts (24%) and pH scales and indicators (16%) and cognitive objectives of Remembering (28%), Understanding (20%), Applying (16%), Analyzing (20%), Evaluating (12%) and Creating (4%) was utilized to determine the test's content validity. Both the experimental group and the control group received the instrument as a pretest and posttest. Three experts, one from the Department of Science Education (Measurement & Evaluation Unit), University of Nigeria, Nsukka, Enugu State, and two from the Department of Science Education (Chemistry Unit), Nnamdi Azikiwe University, Awka, Anambra State, validated the instrument and the lesson plans. Using Kendall's Coefficient of Concordance (w), it was determined that the CAT reliability index was 0.94.

The two sampled schools' regular chemistry teachers underwent training to act as study research assistants. While the chemistry teacher in the control group was exposed to the conventional method of instruction, the chemistry teacher in the experiment group received training using the collaborative instructional strategy. The researchers made any necessary modifications while allowing the research assistants to put what they had learned into practice utilizing their lesson plans. One week was used for this training. Prior to the start of the treatment, the intact classes of the two groups had pre-testing using CAT during the first week. The experiment ran for five weeks, with the student's receiving instruction for four weeks and a post-test the following week. Using SPSS Version 25, the pre- and post-test results from the two groups were combined for data analysis. In order to analyze the data and provide answers to the study questions, mean and standard deviation were used, and analysis of covariance (ANCOVA) was performed to test the hypotheses one and two at a significance level of 0.05. The choice of ANCOVA is to take care of the initial group differences and to eliminate any imbalances the students may have before the experiment. Hence, the pre-test scores served as a covariate to the post-test scores. Figure 1 below depicts a schematic representation of the methodology applied in this investigation.

RESULT AND DISCUSSION

Results

Achievement Of Students Taught Chemistry Using Collaborative Instructional Strategy and Conventional Strategy

Table 1. Achievement Scores of Students' Taught Chemistry with Collaborative Instructional Strategy and Those Taught Using Conventional Strategy

Strategy	Pre-test			Post-test		
	n	Mean	SD	Mean	SD	Mean Gain
Collaborative	60	26.40	8.22	76.67	8.04	50.27
Conventional	41	27.07	7.42	58.24	4.32	31.07

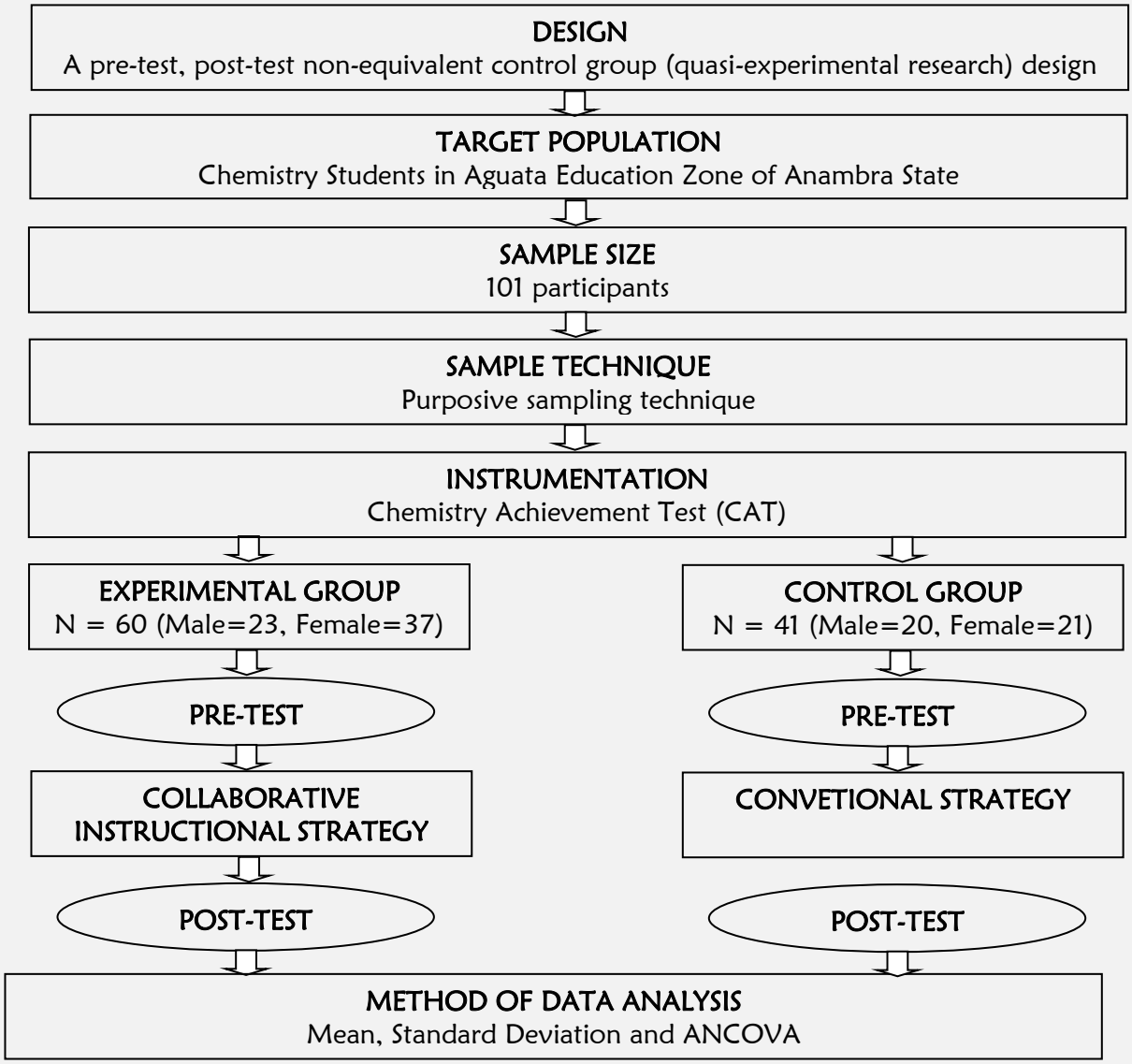

Figure 1. Flowchart Illustrating Methodology Used in The Study

The data presented in Table 1 showed that students who were taught chemistry using the collaborative instructional strategy had mean achievement scores of 26.40 with an 8.22 standard deviation before the test and 76.67 with an 8.04 standard deviation after taking the test. For students that were taught chemistry using CIS, the mean gain was 50.27. The pre-test' mean achievement score for the students taught using the conventional strategy was 27.07, with a standard deviation score of 7.42, while the post-test mean achievement score for the same students was 58.24, with a standard deviation score of 4.32. The mean gain for students who received instruction in chemistry using the conventional strategy was 31.07. This finding shows that students who were taught using a collaborative instructional strategy outperformed those who were taught using a conventional strategy on the achievement test. The achievement of students in Chemistry can therefore be improved more effectively using collaborative instructional strategies.

The result in Table 2 shows that the probability attached to the calculated value of F (169.265) for the effect of collaborative and conventional instructional strategies on students' mean chemistry achievement scores is 0.000. The null hypothesis was rejected because the probability value of.000 is less than the threshold of.05 level of significance (p> .05), indicating that there is a significant difference between the mean achievement scores of students taught chemistry using

collaborative and conventional instructional strategies, favoring the collaborative instructional strategy.

Table 2. Analysis Of Covariance (ANCOVA) Of the Significant Difference in The Mean Achievement Scores of Students Taught Chemistry by Strategy and Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	8282.569[a]	4	2070.642	43.757	.000
Intercept	34335.201	1	34335.201	725.574	.000
PretestCAT	.171	1	.171	.004	.952
Strategy	8009.868	1	8009.868	169.265	.000
Gender	1.765	1	1.765	.037	.847
Strategy*Gender	15.449	1	15.449	.326	.569
Error	4542.857	96	47.321		
Total	496312.000	101			
Corrected Total	12825.426	100			

The Influence of Gender on The Achievement of Students in Chemistry

Table 3. Mean And Standard Deviation of Pre-Test and Post-Test Achievement Scores of The Influence of Gender on Students' Achievement in Chemistry

Gender	Pre-test			Post-test		
	n	Mean	SD	Mean	SD	Mean Gain
Male	43	27.95	7.86	68.19	11.13	40.24
Female	58	25.72	7.81	69.93	11.51	44.21

The result in Table 3 shows that male students taught Chemistry had a post-test mean achievement score of 68.19 with a standard deviation of 11.13 and a mean gain score of 40.24 while the female students had a post-test mean achievement score of 69.93 with standard deviation of 11.51. This shows that the female students achieved slightly higher than their male counterparts, since, there is a difference (mean gain) of 3.97 between the two groups. However, further analysis in Table 2 shows that the probability associated with the calculated value of F (.037) for the influence of gender on mean achievement scores of students in chemistry when taught using collaborative and conventional instructional strategies is .847. Since the probability value of .847 is greater than 0.05 level of significance ($p > .05$), the null hypothesis was not rejected. Hence, gender has no significant influence on the mean achievement scores of students in chemistry.

Discussion

The findings of the study showed that students taught chemistry using collaborative instructional strategy had higher achievement scores than their counterparts exposed to conventional strategy. Further analysis showed a significant difference between the mean achievement scores of students taught chemistry using collaborative and conventional instructional strategies in favor of the collaborative instructional strategy. The reason for the higher achievement may be related to the fact that students were more actively involved in the CIS process as they interact in groups and seek answer with their peers and teachers. The findings agree with those of

Okoli & Ekebosi (2019) and Ali et al. (2021), whose studies revealed that collaborative instructional strategy enhanced students' achievement compared to the conventional method of teaching computer science and mathematics, respectively. The results coincide with those of Ha et al. (2022), who discovered that collaborative instructional strategy lower learners' anxiety and improve their academic achievement. The study by Liu et al. (2018), which asserted that students' involvement in the learning processes through group activities creates positive attitude, improves students' achievement, and boosts confidence, also supports the conclusion that was drawn from this study.

The result of the findings in Table 3 showed that female students had a slightly higher mean achievement scores than their male counterparts. However, further analysis in Table 2 revealed that gender has no significant influence on the mean achievement scores of students in chemistry. As observed by the researchers, this may be because both male and female students explored the learning process. This is in accordance with the findings of Okoli & Ekebosi (2019), who found that employing a collaborative instructional strategy, there was no significant effect of gender on student achievement. Additionally, Onyi & Nwafor (2022) demonstrated that when students were taught using an innovative teaching technique, gender had no significant effect on their achievement. The results, however, are at odds with those of Aniodoh & Egbo (2013), who discovered that female students outperformed their male counterparts in chemistry, and Ezeudu & Obi (2013), who found that male students outscored female students in chemistry.

CONCLUSION AND RECOMMENDATION

Based on the findings from the study, the researchers came to the conclusion that using a collaborative instructional strategy effectively improves students' chemistry achievement. Additionally, it was determined that gender has no significant effect on students' achievement in chemistry. The researchers suggested that, in accordance with the findings of this study, the government and other educational stakeholders host conferences and seminars to train teachers in the use of collaborative instructional strategies in chemistry teaching and learning. Gender equity in chemistry and other learning disciplines should be ensured and improved through the use of collaborative instructional strategies. In order for the technique to be reflected in various curriculum materials, curriculum developers should also adopt a collaborative instructional strategy.

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REFERENCES

Ali, A., Ahmad, N. & Hussain, S. (2021). An Experimental Study of Collaborative Instructional Strategy (CIS) For Teaching Mathematics at Primary Level in Pakistan. *Mathematics Teaching Research Journal, 13*(1), 94-105.

Aniodoh, H. C. O. & Egbo, J. J. (2013). Effect of Gender on Students' Achievement in Chemistry Using Inquiry Role Instructional Model. *Journal of Educational and Social Research, 3*(6), 17-21.

Ezeudu, F. O. & Obi, T. (2013). Effect of Gender and Location on Students' Achievement in Chemistry In Secondary Schools in Nsukka Local Government Area of Enugu State, Nigeria. *Res Humanities Social Science, 3*(15), 30-55. https://www.iiste.org/Journals/index.php/RHSS/article/download/79 42 /7950

Ezeudu, F. O., Chukwudi, S. U., Nwafor, S. C. & Agugu, V. C. (2019a). Effects of Microscale Experiments on Senior Secondary School Students' Achievement and Science Process Skills Acquisition in Practical Chemistry. *Research Journal of Applied Sciences, 14*(2SI), 5322-5332.

Ezeudu, F. O., Nwafor, S. C., Abaeme, O. D., Alabi, A. O., Chukwuka, C. U., Ikuelogbon, E. O. (2019b). Effect of scaffolding And Hand-On Instructional Approaches on Senior Secondary School Students' Achievement and Interest in Chemistry. *Research Journal of Applied Sciences, 14*(5), 170-178. https://doi.org/10.36478/rjasci.2019.170.178

Fatimah, F., Rajiani, S., & Abbas, E. (2020). Cultural and Individual Characteristics in Adopting Computer-Supported Collaborative Learning During Covid-19 Outbreak: Willingness or Obligatory to Accept Technology?. *Management Science Letters, 11*(2), 373-378. https://doi.org/10.5267/j.msl.2020.9.032

Ha T. Y. N., Nguyen, T. B. N., Nguyen, N. L. D. & Tran, T. N. (2022). The Effects of Collaborative Learning on Young ESL Learners' L2 Anxiety and Speaking Performance. *International Journal of Asian Education, 3*(2), 125-137. https://doi.org/10.46966/ijae.v3i2.286

Johnson, D. W., Johnson, R. T.& Smith, K. (2007). The State of Cooperative Learning in Postsecondary and Professional Settings. *Educational Psychology Review., 19*, 15-29. https://doi.org/10.1007/s10648-006-9038-8

Liu, M.-C., Huang, Y.-M., & Xu, Y.-H. (2018). Effects Of Individual Versus Group Work on Learner Autonomy and Emotion in Digital Storytelling. Educational Technology Research and Development: *A Bi-Monthly Publication of the Association for Educational Communications & Technology, 66*(4), 1009–1028. https://doi.org/10.1007/s11423-018-9601-2

Mosley, P., Ardito, G., & Scollins, L. (2016). Robotic Cooperative Learning Promotes Student STEM Interest. *American Journal of Engineering Education, 7*(2), 117-128. https://files.eric.ed.gov/fulltext/EJ1131333.pdf

Nokes-Malach, T. J. & Richey, J. E. (2015). When is It Better to Learn Together? Insights From Research on Collaborative Learning. *Educational Psychology Review, 27*, 645–656. https://doi.org/10.1007/S10648-015-9312-8

Nworgu, B.G. (2018). *Educational Research Basic Issues & methodology*. University Trust publishers, Nsukka, Enugu

Odukwe, O. C. & Nwafor, S. C. (2022). Effect of Guided-Inquiry Method on Senior Secondary School Chemistry Students' Academic Achievement in Anambra State, Nigeria. *Unizik Journal of Educational Research and Policy Studies, 11*(1), 151-161. https://unijerps.org

Okoli, J. N. & Ekebosi, C. A. (2019). Effect of Collaborative Instruction on Secondary School Students' Achievement in Computer Studies in Imo State. *Journal of Science, Technology and Mathematics Education (JSTME), 3(*1), 208-221. https://journals.unizik.edu.ng/index.php/jstme

Onyi, I. E & Nwafor, S. C. (2022). Efficacy of Problem-Based Learning in Promoting High Achievement of Students in Chemistry. *Journal of Critical Reviews, 09*(01), 49-57. https://www.jcreview.com/ad min/Uploads/Files/61d694d54bc2d1.24608275.pdf

Sears, D. A., & Reagin, J. M. (2013). Individual Versus Collaborative Problem Solving: Divergent Outcomes Depending on Task Complexity. *Instructional Science, 41*(6), 1153-1172. https://doi.org/10.1007/s11251-013-9271-8

West African Examination Council (WAEC) (2017-2021). *Chemistry Chief Examiner's Report*. Lagos: WAEC Publications.