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Effect of Generative Instructional Strategy on Secondary School Students' Achievement in Chemistry in Anambra State

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Abstract: This study investigated the effects of generative instructional strategy on secondary school students' achievement in Chemistry. Two research questions guided the study and two hypotheses were tested at 0.05 level of significance. The quasi-experimental design was adopted, specifically the pretest-posttest non-equivalent control group design was used. The population of the study was 4,003 (1,699 males and 2,304 females) senior secondary school year one (SS1) Chemistry students in Anambra State. A sample of 100 SS 1 Chemistry students obtained using purposive sampling technique. The instruments for data collection were Chemistry Achievement Test (CAT) validated by three experts. The reliability of the instrument was established using Kuder-Richardson Formula 20 for CAT which yielded coefficient of internal consistency of 0.81. Data were collected by administering the instruments as pretest and posttest before and after treatment respectively. The data obtained were analyzed using mean and standard deviation to answer the research questions; and Z-test to test the hypotheses. The findings of the study showed that there was significant difference in the mean academic achievement scores of the students taught Chemistry using Generative instructional strategy and those taught Chemistry using conventional lecture method in favour of generative instructional strategy. Moreso, the effect of the instructional strategy and gender on students' achievement was not significant. Based on the findings, recommendations were made that generative instructional strategy enhanced students' achievement in Chemistry. It was recommended that teachers should use generative instructional strategy in teaching and learning of Chemistry. Also, workshops and seminars should be organized by school heads to orient Chemistry teachers on how to effectively use generative instructional strategy in the teaching and learning of Chemistry. The study contributed to knowledge such that it has empirically proved and established that use of generative instructional strategy improves students' achievement in Chemistry more than conventional lecture method. The study also showed empirically that use of generative instructional strategy in teaching Chemistry enhances male and female students' achievement.

Keywords : Achievement, Chemistry, Generative, Instructional Strategy.

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INTRODUCTION

Science and Technology have become indispensable components of modern civilization and are now deeply embedded in the cultural fabric of societies across the globe. This is primarily because the economic vitality and political influence of any nation are largely determined by its scientific innovations and technological advancements (Nwafor et.al, 2023). In Nigeria, the level of scientific development

reflects the extent of our economic and social growth. Ezeliora et al. (2021) opined that a well-developed and properly implemented science and technology education programme will not only produce knowledgeable and skilled manpower for the technology workforce but also usher in sustainable socio-economic growth and political stability in the country. Therefore, there is need to improve and raise the standard of achievement of students in science education especially Chemistry education.

Chemistry, as a core science subject at the secondary school level, plays a pivotal role in the scientific and technological development of any nation. It is foundational to understanding matter, its transformations, and its applications across industries (Adeoye & Alayande, 2024). According to Ibe, (2024), Chemistry serves as a vehicle for achieving the long-term goals of science education because of its instrumental contribution to global technological and socio-economic development. The importance of Chemistry extends to the training of professionals such as scientists, engineers, pharmacists, doctors, and industrial practitioners (Ezeliora et.al, 2021). It is, therefore, regarded as a sine qua non an essential condition for the technological growth and industrial advancement of any country. Its applications are evident in health, agriculture, energy, environment, and numerous aspects of everyday life. However, despite the acknowledged importance of Chemistry, its teaching and learning at the secondary school level face several persistent challenges (Ibe et.al, 2024). Among the most notable issues is the ineffective method of instruction employed by many teachers. Ibe et.al (2021) highlighted poor instructional strategies as a major problem, and this concern is echoed by Nwafor et.al (2023), who attributed students' declining achievement in Chemistry to the continued use of ineffective teaching methods. Such pedagogical shortcomings often result in students finding the subject abstract, difficult, and uninteresting. This unfortunate situation has led to consistently poor academic performance in Chemistry, not only at the secondary school level but also in tertiary institutions (Okoli & Okigbo, 2021). For instance, statistics obtained from the Research Library of the West African Examinations Council (WAEC) Headquarters Office, Lagos show that between 2022 and 2025 in Nigeria, students' performance in Chemistry at the Senior School Certificate level was low, as the percentage pass at credit level and above consistently fell below 50% except in the years 2022 and 2023 when it was 58.71% and 59.90% respectively. From the above statistics (WAEC, 2022–2025), it was observed that the WAEC results of Chemistry students during these years have not shown a consistent upward trend. A deeper analysis of the Chief Examiners' reports indicates that many students continue to struggle significantly with key topics such as Acid and Base reactions, Redox Reactions and Electrolysis. This area, though important topics in Chemistry, remains a major stumbling block for students. One of the major reasons for students' poor performance in acid–base concepts is the abstract nature of the topic. Understanding

acids and bases reactions requires familiarity with different definitions (Arrhenius, Brønsted–Lowry, Lewis), application of pH calculations, interpretation of titration curves, and balancing ionic equations. Many students lack the mathematical skills required for accurate pH calculations and also confuse strong and weak acids/bases with concentrated and dilute solutions. In titration, students often struggle with mole ratio concepts, equivalence points, and proper interpretation of experimental results. Moreover, without practical exposure in laboratories, acid–base chemistry remains purely theoretical for many learners. In schools with limited facilities, students are unable to carry out acid–base titrations, observe colour changes of indicators, or directly experience neutralization reactions. As a result, they depend on rote memorization rather than deep conceptual understanding, leading to persistent poor achievement. To these effects, researchers (Usang & Okoli, 2021; Ibe, 2024, Eze & Obiekwe, 2018) have traced the causes of this consistent poor achievement in Chemistry to a number of factors. These include lack of infrastructure, inadequate laboratory facilities, shortage of qualified teachers, the perception of Chemistry as a difficult subject, lack of opportunities for hands-on experience, and most fundamentally, the instructional strategies used in teaching Chemistry. Evidence from literature and classroom observations suggests that conventional lecture methods dominate classroom teaching, with students playing passive roles in learning. This approach has not provided the needed improvement in students' mastery of Chemistry concepts (Obikezie et.al, 2023). There is, therefore, a need to adopt innovative and learner-centered teaching strategies that can improve students' achievement in Chemistry.

The Generative Instructional Strategy shifts the teacher's role from information deliverer to facilitator, helping students to restructure knowledge, sustain motivation, and achieve better outcomes. This method also supports metacognitive development, as students reflect on their thinking and problem-solving processes (Agustin & Akmam, 2024). The Generative Instructional Strategy in teaching Chemistry, especially topics such as acids and bases, has the potential to improve students' achievement in the Chemistry subject. For example, achievement in Chemistry, which is the focus of this study, is viewed as a very important factor in the teaching and learning of Chemistry. It refers to students' cognitive achievement, which is usually measured in terms of credit, pass, or fail (Nwabasi & Nwani 2020). Over the years, students' achievement has been on a fluctuating decline (Ibe et.al, 2021). This low achievement, as stated by Ilo et.al, (2022), may be attributed to the overuse of traditional approaches to teaching and the non-implementation of innovative methods in science teaching. The researcher observed from available literature that the use of the Generative Instructional Strategy has the ability to create and sustain students' attention and enhance their learning process. The use of this strategy in teaching and learning may lead to academic success, thereby giving students a sense

of achievement (Okeke & Okigbo, 2025; Ahzari et.al, 2024). The Generative Instructional Strategy, which emphasizes students' active involvement in constructing knowledge based on prior experiences, has been identified as a potential solution. It is against this background that this study investigates the effect of the Generative Instructional Strategy on secondary school students' academic achievement in Chemistry in Anambra State, while also considering the influence of gender on these outcomes.

Purpose of the Study

The purpose of the study is to investigate the effect of the Generative Instructional Strategy on secondary school students' achievement in Chemistry in Anambra State. Specifically, the study seeks to determine:

1. The mean achievement scores of students taught Chemistry using the Generative Instructional Strategy and those taught using the Conventional Lecture Method.
2. The mean achievement scores of male and female students taught Chemistry using the Generative Instructional Strategy.

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores of students taught Chemistry using the Generative Instructional Strategy and those taught using the Conventional Lecture Method?
2. What are the mean achievement scores of male and female students taught Chemistry using the Generative Instructional Strategy?

Hypotheses

The following null hypotheses guided the study and were tested at 0.05 level of significance:

1. There is no significant difference in the mean achievement scores of students taught Chemistry using the Generative Instructional Strategy and those taught using the Conventional Lecture Method.
2. There is no significant difference in the mean achievement scores of male and female students taught Chemistry using the Generative Instructional Strategy.

METHODOLOGY

The study employed a quasi-experimental design, specifically the pretest-posttest non-equivalent control group design. The area of the study was Nnewi Education zone in Anambra state.

The population of the study was 4,003 (2,304 females and 1699 males) senior secondary one (SS1) Chemistry students in the forty-six (46) government-owned co-educational secondary schools in Nnewi Education Zone of Anambra State. The

sample for the study was 100 senior secondary school year one Chemistry students. The sample was obtained using purposive sampling technique. Four coeducational schools were selected. From the four schools selected, the schools were randomly assigned to experimental and control groups. Two of the schools were assigned to experimental group consisting of 25 males and 25 females' students who were taught Chemistry concept using GIS and the other two were assigned to the control group consisting of 23 males and 27 females' students who were taught Chemistry concepts using CLM.

The instrument for the study was Chemistry Achievement Test (CAT). CAT which was made of 50 questions on the concepts of acid, bases and acid-base reactions. The test was organized based on table of specification, representing the different levels of knowledge. The CAT consisted of fifty (50) multiple choice items with four options (A-D). Only one option is the correct answer for each test item. Correct response carried 2 marks each, giving a total of 100 marks score. Also, lesson plans were prepared on the concepts of acid, bases and acid-base reactions for the treatment group using think-pair-share instructional strategy. The control group lesson plan was on lecture method of teaching.

The instrument was validated by experts. The reliability of the CAT was established using Kudder-Richardson 20 (KR-20). CAT was administered once to thirty SS1 Chemistry students in a school outside the area of study and the data generated was used to compute the internal consistency which yielded 0.81. The experimental procedure was conducted in two phases. First phase was training of research assistants and the second phase was treatment phase. The experiment lasted for six weeks. The research assistants were the Chemistry teachers from the sampled schools. The training of research assistants took two contact periods with the researcher in each of the groups. During the contacts the research assistants were briefed on the research problems. A training was done for the experimental groups on the use of GIS and how to expose students to its three strategic phases. The research assistants for control group were also trained on how to use conventional lecture method (CLM) to teach the Chemistry concepts to the group. The treatment was conducted first by administering the pretest using CAT. No feedback on students' performance or revision was given. After the treatment, the same instruments used in the pretest were administered as posttest. The data obtained were analyzed using mean and standard deviation to answer the research questions; and z-test to test the hypotheses. The decision rule is that when P value was less than or equal to 0.05, the null hypotheses were rejected and whenever P value is greater than 0.05, the null hypotheses were not be rejected.

RESULTS AND DISCUSSION

Result

Research Question 1

What are the mean achievement scores of students taught Chemistry using the Generative Instructional Strategy and those taught using the Conventional Lecture Method?

Table 1. Students' Mean and Standard Deviation of the Achievement Scores in Chemistry using Generative Instructional Strategy and Conventional Lecture Method.

Group	Method of Teaching	N	Mean	SD
Experimental Group	GIS	50	59.72	24.16
Control Group	CLM	50	44.10	16.27
Mean Difference			15.62	

The results in table 1 indicated that the experimental group with mean of 59.72 performed higher than the control group with mean of 44.10 and mean difference of 15.62. To test whether the difference is significant or not, null hypothesis one (HO_1) was formulated and tested using z-test statistics.

Research Question 2

What are the mean achievement scores of male and female students taught Chemistry using the Generative Instructional Strategy?

Table 2. Students Mean and Standard deviation of the Achievement Scores of Male and Female Student in the Experimental Group

Group (Gender)	N	Mean	SD
Experimental (Male)	25	67.04	19.51
Experimental (Female)	25	52.40	26.45
Mean Difference		14.64	

From table 3, the achievement of females in the experimental group with mean score of 52.40 and standard deviation of 26.45 is lower than the achievement of their male counterparts with mean score of 67.04 and standard deviation of 19.51 with mean difference of 14.64. To find out if the mean difference is significant or not, null hypothesis two (HO_2) was formulated and tested using z-test statistic.

Hypothesis 1

There is no significant difference in the mean achievement scores of students taught Chemistry using the Generative Instructional Strategy and those taught using the Conventional Lecture Method.

Table 3. Z-test Comparison of the Mean Achievement Scores of Experimental and Control Groups

Groups	Method of Teaching	N	Mean	SD	df	t-cal	P
Experimental Group	GIS	50	59.72	24.16			
					49	4.04	0.00
Control Group	CLM	50	44.10	16.27			

*Significant at P≤0.05

The result presented in Table 2 showed that the P-value is 0.00 which is less than the level of significance of α = 0.05 with df = 49. This means that there is significant difference between the post-test scores of the two groups in favour of the experimental group. Thus, the null hypothesis was rejected. This implies that the experimental group taught Chemistry using Generative Instructional Strategy achieved significantly higher than the control group taught the same Chemistry topic using Conventional lecture method.

Hypothesis 2

There is no significant difference in the mean achievement scores of male and female students taught Chemistry using the Generative Instructional Strategy.

Table 4. Z-test Result of Mean Achievement Scores of Male and Female Students in the Experimental Group

Group (Gender)	N	Mean	SD	Df	t-cal	P
Experimental (Male)	25	67.04	19.51			
				24	1.86	0.07
Experimental (Female)	25	52.40	26.45			
Mean Difference		10.58				

*Significant at P≤0.05

The result presented in Table 4 showed that the P-value is 0.07 which is greater than the level of significance at α=0.05 with df = 24. This means that there is no significant difference between the mean achievement scores of male and female students taught using the Generative Instructional Strategy. This implies that the achievement level of male students taught using Generative Instructional Strategy is same with their female counter parts. Therefore, the null hypothesis was accepted.

Discussion

Findings from the study as shown in tables 1 and 2 indicated that the Generative instructional strategy significantly increases students' achievement in chemistry more than the conventional lecture method of teaching. The results of the study show that generative instructional strategy has higher effect on students' achievement in Chemistry than conventional lecture method. The corresponding hypothesis revealed that there was a significant difference between the mean achievement scores of students taught **C**hemistry with Generative strategy and Conventional lecture method**.** Therefore, the two teaching strategies were significantly different in their effects on students' achievement in Chemistry. This implies that generative instructional Strategy was more effective than conventional lecture method. The finding is in agreement with the findings of George et.al (2021), and Agustin & Akmam, (2024) who revealed that students taught generative instructional strategy achieved significantly higher than their counterparts taught with lecture method, and Okeke and Okigbo (2021); Parni & Akmam, (2023) who showed that students taught using generative instructional strategy achieve significantly better than those taught with lecture method. The superiority of generative instructional strategy over the conventional lecture method can be due to the fact that it is a strategy that differentiate instruction by providing students with time and structure for thinking on a given topic, question or problem, helping them to construct individual ideas and share these ideas with at least one other student. Also, while interacting and sharing ideas, students take ownership of their learning and negotiate meanings rather than relying fully on their teachers. Consequently, the learning and knowledge acquired become part of them for easy application to real life. This was also supported by Ezeliora et.al (2021) who noted that the use of instructional strategy had great potential for improving achievement in chemistry and science learning generally. The finding of this study was in contrary to the work done by Obikezie et.al (2021) who reported that demonstrational instructional strategy achieves slightly higher than students taught with generative learning method instructional strategy in Chemistry. This Indicates that students in DIS achieved significantly better in CAT than students in GLM instructional strategy. This may as a result that those students in control group pay attention in all the demonstration done by the teacher. The findings of students in DIS achieving better than the once in GLM may be as a result that Chemistry students in the control group where not carried away by the demonstration of the teacher.

Findings from the study as shown in tables 3 and 4 revealed that the Generative instructional strategy equally enhances both male and female students' achievement in chemistry. This result is in accordance with those of Ogundola et.al (2020) and Moyegun (2022) who showed that gender had no effect on the academic achievement

of students in co-operative learning such as generative instructional strategy. This result indicates that generative instructional strategy favours both male and female students, and the strategy is more effective in enhancing both male and female students' achievement in chemistry. This suggests that when teachers use the right strategies and activities, female students would learn equally as their male counterparts. It can also be deduced that generative instructional strategy bridges the gap in achievement between males and females.

CONCLUSION

This study found a strong positive and significant relationship between Generative instructional strategy and students' academic achievement in chemistry in senior secondary schools. Thus, a conclusion can be made to the effect that academic achievement of students is highly predicated on instructional strategy. This means that generative instructional strategy could reduce the abstract nature of chemistry and enable students develop knowledge and skills, such as listening skill, questioning skill, communication skill, retentive skill and manipulative skill.

Recommendations

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

1. Teachers are encouraged to employ generative instructional strategy more often in teaching and learning of Chemistry in order to ensure meaningful learning of Chemistry.
2. Both practice teachers and student-teachers should be given easy access to capacity building programmes through workshop, conference, seminar, symposium and exhibition on generative instructional strategy.

Contributions To Knowledge

The study contributes to knowledge in the following areas:

1. The study has empirically proven and established that use of generative instructional strategy improves students' academic achievement in Chemistry.
2. The study also revealed empirically that use of generative instructional strategy in teaching Chemistry enhances male and female students' academic achievement.

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