



**RE-IMAGINING CHEMISTRY EDUCATION FOR TECHNOLOGICAL  
ADVANCEMENT AMIDST ECONOMIC MELTDOWN: IMPACT OF DISCOVERY  
METHOD ON STUDENTS' LEARNING OUTCOMES**

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### **Abstract**

This study investigated the impact of discovery learning method (DLM) on students' learning outcomes in chemistry, in light of technological advancement and economic meltdown. Four research questions and four null hypotheses were formulated to guide the study. Using a quasi-experimental research design. The population consists of all SS2 chemistry students in the twenty-nine (29) government owned senior secondary schools in Ogidi education zone in Anambra State. A sample size of 164 SS2 students was randomly selected from four co-educational secondary schools in two local governments in the area. Chemistry Achievement Test (CAT), developed by the researchers, was used as the instrument for data collection. The reliability of the instrument was established using the Kuder-Richardson formula 20. The reliability coefficient obtained was 0.82. While the research questions were answered using mean and standard deviation, the null hypotheses were tested at a 0.05 level of significance using two-way Analysis of Covariance (ANCOVA). The results showed that DLM has a significant impact on students' academic achievement and knowledge retention in Chemistry, with a statistically significant gender impact on students' achievement in Chemistry in favour of males. Furthermore, the discovery method does not have any statistically significant gender impact on students' knowledge retention in Chemistry. Conclusions and recommendations were, however, made.

**Keywords: Economic Meltdown, Discovery Method, Re-Imagining Chemistry Education, Students' Learning Outcomes, Technological Advancement,**

### **Introduction**

Education plays a crucial role in national development, serving as a key agent of sustainable transformation. Oguezie and Osuafor (2021) describe education as a process that guides individuals to develop their potential for personal and societal benefit. Similarly, Nnoli and Muogbo (2025) posited education as a means to cultivate valuable abilities and attitudes in individuals. In today's 'global village', advancements in science and technology drive progress, prompting developing countries like Nigeria to focus on effective science education of her citizens, to produce well-trained scientists and technologists (Orakwue & Okigbo, 2023). This suggests that technology-mediated instruction holds significant potential to enhance national and economic development.



Science is fundamental to the economic and social development of any nation, serving as the foundation for national development (McComas & Clough, 2020). As noted by Nnoli (2024), science embodies individuals' ability to exercise control over the complexities of life through systematic inquiry. This ability is critical for technological advancements, which suggests that effective science education should be designed to be learner-centered, particularly in Nigeria's educational framework. Obidimma and Osuafor (2019) emphasize that science, and chemistry specifically, plays a crucial role in industrial and technological progress, highlighting dynamic nature of science as a quest for knowledge through observation and experimentation.

Chemistry embodies knowledge, scientific attitudes and skills which are vital for human development and nation-building (Nnoli, 2023). The utility nature of chemistry demands the acquisition of the science process skills, knowledge, and science attitudes. Most of the science process skills are complex, such that the acquisition requires several rigorous practical exercises, leading to students' loss of interest in the subject, and consequent contribution to poor performance in some content, namely, organic chemistry, chemical equations, and electrolysis. This indicates the complex and difficult nature of chemistry. The acquisition of science attitudes such as probing, questioning, experimenting, and logical reasoning by the learner through chemistry is so demanding that the provision of an atmosphere to intrigue the learner during chemistry instruction is imperative (Abumchukwu et al., 2020). The exercise involved in chemistry instruction are so challenging that the learner can easily become fatigued and lose interest during chemistry instruction, and subsequently, perform poorly in their academic achievement.

Academic achievement is a task-oriented behavior that measures an individual's academic performance against certain criteria, often involving competition or standards of excellence. According to Ajayi and Ogbeba (2017), it serves as a yardstick to measure learners' success in formal education, assessed through reports and examinations, with various influencing factors. Academic achievement reflects what a student has acquired in terms of knowledge and skills, indicated by academic achievement scores (Orakwue & Okigbo, 2023). In contrast, retention refers to the ability to retain and recall information, which Oguezie & Osuafor (2021) describe as a mental process of storing sensory input in the brain for later use. Retention enables students to remember their learning experiences through recognition and information recall. Retention of knowledge among students is function of the classroom activities associated with the pedagogical approach adopted by the teacher.



The use of discovery learning method occurs mainly when an individual is involved in using their mental processes to mediate and discover some concepts. This implies that the students discover things for themselves (Abumchukwu et al., 2021). The authors further noted that DLM is the mental assimilation by which the student understands chemistry concepts or principles resulting from physical and mental activity. In this method, students are led to find and obtain information through their active efforts. This discovery could be from books, from the use of equipment, experimenting or from the teacher. Nnoli (2024) stressed that DLM is a strategy which enables students to find the answers themselves through a mental process such as observing, measuring, classifying, analyzing and so on. The authors further maintained that there are two types of discovery methods: guided discovery instructional strategy, which involves students in the learning process, guiding and encouraging them to explore and discover concepts on their own by giving a general principle. Consequently, unguided discovery is where students are required to discover both the principle and the solution. DLM is a learner-centered approach that promotes better comprehension for meaningful learning in Chemistry and knowledge retention. Thus, both sexes should have equal opportunity to learn Chemistry using this approach. Therefore, achievement and knowledge retention in Chemistry may be influenced by gender.

Gender is a socially ascribed or culturally constructed characteristic and roles which are associated with males and females in a society. Gender disparity in education is a worldwide phenomenon. The issue of closing the gender gap in technical subjects, sciences, mathematics and vocational subjects has remained elusive. Nwune et al. (2021) opined that many people speculate that the sex of a student, whether female or male, feminine or masculine, is of help in determining the academic achievement of students in a particular subject to enhance education for technological advancement.

Technological advancement is an ongoing process that relies heavily on foundational sciences, such as chemistry, to drive innovation and improve efficiency across various fields (Oguezue, 2025; Ugwuanyi and Okeke, 2020). In the current economic recession, there is a pressing need to enhance educational technology through thoughtful reimagining and improvement strategies. Re-imagining, as defined by Oguezue (2025), involves creating new concepts and perceptions amid an economic crisis. The current global economic downturn, compounded by issues like poor teacher qualifications and inadequate learning environments, has negatively impacted youth interest in education, particularly in the sciences. As noted by Abumchukwu et al. (2021), this decline jeopardizes the future of young citizens pursuing



science-related professions, including medicine, engineering, and agriculture. Since Chemistry plays a vital role in technological advancement and is also one of the core and basic science subjects taught in schools, innovative teaching methods such as discovery learning, co-operative learning, and computer-assisted instruction/learning, which are learner-centred, should be adopted while teaching Chemistry to reduce its abstract nature.

### **Statement of the Problem**

One of the central objectives of education in Nigeria is to promote science and technology as a means of addressing the nation's economic, social, and developmental challenges. As a core science subject, Chemistry is structured to impart essential scientific concepts and skills that are applicable across diverse fields, including agriculture and industry. Despite its relevance, Chemistry education in Nigeria has attracted criticism due to the persistent reliance on conventional, teacher-centered instructional methods, particularly in the delivery of complex concepts. This pedagogical approach often results in poor student achievement and limited knowledge retention. Furthermore, factors such as the global economic recession, inadequate teacher qualifications, and substandard learning environments have contributed to a decline in students' interest in science education. This trend threatens the cultivation of a future workforce equipped for science-based professions and undermines the broader goal of technological advancement. Therefore, there is an urgent need to reimaging Chemistry education through the integration of innovative, learner-centered teaching strategies. Based on this imperative, the present study investigates the effect of DLM on students' academic achievement and knowledge retention in Chemistry at the senior secondary school level in the Ogidi Education Zone of Anambra State.

### **Purpose of the Study**

The study investigated the impact of the discovery method on students' achievement and retention of knowledge in chemistry. Specifically, the study sought to determine the:

1. Mean achievement scores of chemistry students taught with discovery method and those taught with the lecture method
2. Mean achievement scores of male and female chemistry students taught with discovery method
3. Mean retention scores of chemistry students taught with discovery method and those taught with lecture method
4. Mean retention scores of male and female chemistry students taught with discovery method



## Research Questions

The following research questions were formulated to guide the study:

1. What are the mean achievement scores of the students taught using discovery method and those taught using lecture methods, as measured by their pre-test and post-test?
2. What are the mean achievement scores of male and female students taught using discovery method as measured by their pre-test and post-test scores?
3. What are the mean retention scores of students taught using discovery method and that of those taught using lecture method?
4. What are the mean retention scores of male and female students taught using discovery method as measured by their post-test?

## Hypotheses

The following null hypotheses (Ho) were formulated for the study and were tested at a 0.05 level of significance.

- Ho1 There is no significant difference in the mean achievement scores of students taught using discovery method and those taught using lecture methods, as measured by their pre-test and post-test.
- Ho2 There is no significant difference in the mean achievement scores of male and female students taught using discovery method as measured by their pre-test and post-test.
- Ho3 There is no significant difference in the mean scores on the retention test of students taught using discovery method and those taught using lecture method.
- Ho4 There is no significant difference in the mean retention scores of male and female students taught using discovery method as measured by the pre-test.

## Methods

The design of the study was quasi quasi-experimental design. Specifically, the non-equivalent randomized control group, pre-test, post-test design was adopted. This design is suitable to measure students learning outcomes in their intact classes using the intervention strategies. The population consists of all SS2 chemistry students in 29 government owned senior secondary schools in Ogidi education zone in Anambra State. The sample size of the study involved 164 senior secondary school students (SSS 2) chemistry students in Ogidi Education Zone. Using a multistage sampling procedure (purposive and simple random sampling techniques) the sample size was two co-education secondary schools each drawn from two out of three local governments within the zone. Finally, two intact classes were



randomly selected to represent the experimental (discovery learning method) and the control (lecture method) groups.

Chemistry Achievement Test (CAT), developed by the researchers was used as the instrument for data collection. The instrument was designed to measure the cognitive achievement of the student before and after treatment in chemistry. The Chemistry Achievement Test (CAT) made up of 40 items was sectioned A (demographic data) and B (The Achievement questions), with 4 possible answers objectively lettered A-D. Each right answer was awarded 2.5 marks while the wrong or incorrect answer attracted zero (0) mark. The highest possible score was 100 marks, while the lowest possible score was zero. The Chemistry Retention Test has the same parts as CAT, but was reshuffled and administered two weeks after the posttest to check the student's knowledge retention level. Both CAT and CRT were given to both the control and experimental groups at pretest, posttest and delayed posttest. The validity of the instrument was ascertained by three experts in the field, and a reliability (internal consistency) coefficient of 0.82 was obtained using Kuder-Richardson formula 21 (K-21). The two groups namely experiential and control groups were taught chemistry concept (water samples) during their regular school hours. With the help of two research assistants, the data for the study was collected and analyzed using mean and standard deviation. The null hypotheses were tested at 0.05 level of significance using analysis of covariance (ANCOVA). ANCOVA was preferred because of its power to take care of the initial lack of equivalence in the groups since intact classes were used for the study. Decision rules was to reject the null hypothesis if the calculated value was greater than the critical value; otherwise, do not reject the hypothesis.

## Results

**Research Question 1:** What are the mean achievement scores of students taught Chemistry using the Discovery Method and those taught using the lecture method?

**Table 1: The Mean Achievement Scores and Standard Deviation of Chemistry Achievement Test (CAT) of the Subjects.**

Groups		Pre-Test	Post-Test
Experimental Group	Mean	23.27	27.59
	N	81	81
	S.D	4.83	5.25
Control Group	Mean	8.34	14.48
	N	83	83
	S.D	3.27	3.80
Total	Mean	27.44	21.04
	N	164	164



Table 1 shows that for the post-CAT, the experimental group obtains a higher mean achievement score of 27.59 and a standard deviation of 5.25, while the control group has a lower mean achievement score of 14.48 and a Standard deviation of 3.80. This implied that students taught with the discovery method had a higher mean achievement score than students taught with the traditional lecture method.

**Research Question 2:** What are the mean achievement scores of male and female students taught Chemistry using the discovery method?

**Table 2: The Mean and Standard Deviation of Pre-test and Post-test Scores of Male and Female Students taught Chemistry using the Discovery method.**

Gender		Pre-Test	Post-Test	Mean Difference
Male	Mean	24.43	52.03	38.23
	N	43	43	43
	S.D	4.94	7.21	6.08
Female	Mean	22.11	50.95	36.68
	N	38	38	38
	S.D	4.73	7.14	5.94

Table 2 showed that male students taught Chemistry with discovery method had a mean score of 38.23 with a standard deviation of 6.08, while the females had a mean score of 36.68 with a standard deviation of 5.94. This implied that the discovery method of teaching favoured male students more than their female counterparts. The level of significance of the difference in male and female students' academic achievement was tested as hypothesized.

**Research Question 3:** What are the mean scores on the knowledge retention test of students taught Chemistry using the discovery method and those taught using the lecture method?

**Table 3: The Mean Achievement scores and standard deviation in Overall Post Knowledge Retention Scores (POST-RET).**

Groups		Post-Test
Experimental Groups	Mean	28.88
	N	81
	S.D	5.37
Control Group	Mean	11.46
	N	83
	S.D	3.39
Total	Mean	20.17
	N	164
	S.D	4.38



In Table 3, for the post-CRT, the experimental group, that is, students taught using the discovery method, obtain a higher mean of 28.88 and standard deviation of 5.37 while the control group that is, students taught using lecture method has a lower mean retention score of 11.46 and a standard deviation of 3.39. This indicates that students taught Chemistry with the Discovery method had a higher mean knowledge retention score than students taught with the lecture method.

**Research Question 4:** What are the mean retention scores of male and female students taught Chemistry using the discovery method?

**Table 4: Mean and Standard Deviations of the Pre and Post-Knowledge retention Scores of Male and Female Students taught Chemistry using the Discovery method.**

Gender of Students		Pre-Test	Post-Test	Average
Male	Mean	51.08	78.22	64.65
	N	43	43	43
	S.D	7.15	8.84	8.00
Female	Mean	43.45	78.00	60.73
	N	38	38	38
	S.D	6.59	8.83	7.71

Table 4 showed that male students taught with the discovery method had a mean score of 64.65 and a standard deviation of 8.00, while the females had a mean score of 60.73 and a standard deviation of 7.71. In order to make a decision on students' knowledge retention based on the use of the experimental method (discovery method) on gender, hypothesis 4 was tested. Ho 1: There is no significant difference in the mean achievement scores of students taught using the discovery method and those taught using the lecture method.

**Table 5: Analysis of Covariance (ANCOVA) for Testing Ho 1 and Ho 2.**

Source	Dependent variable	Type III Sum of Squares	Df	Mean Squares	F	Sig.
Pre-Cat	Post-Cat	10259.57	1	1465.653	6.747	.0000
Intercept	Post-Test (Achievement)	10316.30	1	10316.30	47.888	.0000
Pre-Achievement (Covariate)	Post-Test (Achievement)	3076.282	1	3076.282	14.161	.0000
Method	Post-Test (Achievement)	6184.753	2	3092.376	14.235	.0000
Gender	Post-Test (Achievement)	486.406	1	486.406	2.239	.136
Method and Gender	Post-Test (Achievement)	367.259	2	183.630	.845	.431



Error	Post-Test (Achievement)	51703.14	160	323.145	-	-
Total	Post-Test (Achievement)	592575.0	164	-	-	-
Corrected Total	Post-Test (Achievement)	61962.70	163	-	-	-

From table 5, a significant effect was observed for teaching method concerning post achievement  $F(2,160) = 14.24 \leq 0.000$ . Therefore, the null hypothesis was rejected. This means that a significant ( $P \leq 0.000$ ) difference exists between the experimental group and the control group. Thus, using Discovery method of teaching to teach Chemistry was effective. Table 5 revealed that gender is a significant factor in students' overall achievement scores on POST\_CAT,  $f(1,160) = 2.24, P \leq .136$ . Therefore, the null hypothesis was rejected. This means that male students' achievement differed significantly from that of female students using the discovery method.

Ho 3: There is no significant difference in the mean scores of retentions of students taught using the discovery method and those taught using the lecture method.

**Table 6: Analysis of Covariance (ANCOVA) Testing Ho 3 and Ho 4**

Source	Dependent variable	Type III sum of squares	Df	Mean square	F	Sig
Pre-Retention	Post-Ret	173397.20	1	2485.314	12.295	.000
Intercept	Post-Test (Retention)	36668.89	1	3666.89	181.40	.000
Pre-Retention (Covariate)	Post-Test (Retention)	5682.116	1	5682.116	28.109	.000
Method	Post-Test (Retention)	12119.32	2	6059.66	29.977	.000
Gender	Post-Test (Retention)	15.528	1	15.528	.077	.782
Method And Gender	Post-Test (Retention)	390.731	2	195.365	.966	.382
Error	Post-Test (Retention)	48110.28	160	202.144	-	-
Total	Post-Test (Retention)	133458.7	164	-	-	-
Corrected Total	Post-Test (Retention)	65507.48	163	-	-	-

Table 6 revealed a significant main effect for teaching methods concerning post-knowledge retention,  $f(1,160) = 29.98, p \leq .000$ . Therefore, the null hypothesis was rejected. This means that a significant ( $P \leq .000$ ) difference exists between the experimental groups and control groups. Thus, using the discovery method to teach Chemistry was effective. Ho 4 shows



no significant difference in the mean knowledge retention scores of male and female students taught Chemistry using Discovery method. From table 6,  $f(1,100) = .077$ ,  $P \leq .782$ . A significant impact was not observed for knowledge retention and gender. Therefore, the null hypothesis was accepted.

## Discussion

As shown in Table 1, there is a difference between the mean achievement scores of students taught with discovery method and the lecture method. This indicates that teaching methods, especially the discovery method, have an impact on achievement in Chemistry. This is inline with Orakwue and Okigbo (2023), who mentioned that students understand better using activity-based learning. From Table 5, a significant impact was observed for the teaching method with respect to post-achievement scores between the experimental and control groups. Therefore, the null hypotheses were rejected. Thus, using the Discovery method of teaching to teach Chemistry was effective on achievement.

The study in Table 2 shows that male students taught Chemistry with the discovery method had a better score than their female counterparts. Table 5 revealed that gender is a significant factor in students' overall achievement scores. Thus, agreeing to some extent with some research findings of Ajayi and Ogbaba (2017), whose findings from the experimental group revealed that the male subjects achieved significantly better than their female counterparts. Therefore, the null hypotheses were also rejected.

In Table 3, for the post-CRT, the experimental group, that is, students taught using the discovery method, obtains a higher mean retention score while the control group taught using the lecture method has a lower mean retention score. Table 6 revealed a significant main impact for teaching methods with respect to post-knowledge retention. This result also agrees with Naiman and Ezeibe (2020), whose study also revealed that students taught with G.D.M. retain better than those taught with the lecture method. Therefore, the null hypothesis was rejected. Thus, using the discovery method to teach Chemistry was effective in retention.

Table 4 showed that male students taught with the discovery method had a better mean retention score than their female counterparts. Table 6 revealed a significant main impact for teaching methods with respect to post-knowledge retention. Therefore, the null hypothesis was accepted. It also agrees with the results of Ayodele (2018), whose findings revealed that the male students benefited more than their female colleagues in retention. Thus, agreeing to some extent with Oguezie and Osuafor (2021), whose findings from the experimental group revealed that there was no significant difference between boys and girls in their retention test.



Thus, gender has an impact on the mean retention scores of students taught with the Discovery method. This means that a significant difference exists between the experimental group. Thus, using the discovery method to teach Chemistry was effective in male retention.

### **Conclusion**

The findings of this study underscore the significant impact that the discovery method of teaching can have on enhancing students' academic achievement and knowledge retention in chemistry education. The effective integration of discovery method into the educational process is essential for making abstract concepts more tangible, fostering creativity, and promoting a deeper understanding of scientific principles. Chemistry education is not merely a transmission of knowledge, but a catalyst for critical thinking, creativity and innovation. However, to fully realize these benefits, it is crucial to address the challenges associated with their use, such as securing necessary resources to boost our technology for sustainability. Nevertheless, the impact of the economic meltdown bite on education as most companies producing educational materials have folded up and the existing companies under producing these materials, leading to scarcity and high cost. The fate of scientific instructions for technological advancement should be re-imagined or re-created by encouraging a discovery teaching strategy. Also, economic meltdown calls for rethinking of approaches to challenging assumptions and to harness the transformative power of chemistry education. Hence, by implementing the recommendations provided, educational institutions can improve the quality of chemistry education, ultimately leading to better academic and retention outcomes in the sciences among students.

### **Recommendations**

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

1. In the period of economic meltdown, there is a need for the government to re-imagine or re-create our economy through technological advancement. The workplace and workforce need to cut out measured patterns, plot points, trace patterns and encourage more discoveries.
2. Re-imagine science teaching as a tool for survival, innovation and societal renewal while also embracing transformation in science teaching via leveraging on local and global partnership.
3. Teachers Training institutions, such as Colleges of Education and Universities that offer vocational courses, should adopt the discovery method or career-specific skills for



- teaching their students. This should be enhanced to generate interest and retention of knowledge in generic skills that are broadly transferable to almost any career.
4. Students should always be allowed to participate actively and interact freely with the teachers, and relate learning to practical experiences.
  5. Discovery approach should be integrated into the curriculum of Chemistry as one of the effective teaching approaches to use.
  6. Teachers of Chemistry should always adopt discovery approach for teaching their students. This will enable the students to cater for themselves in their classrooms and hence improve their learning outcomes.
  7. In-service training, workshops and seminars should be organized by ministries of education and related government agencies for the training of teachers on how to make use of the discovery method for teaching science subjects generally and chemistry in particular.
  8. The policy makers and curriculum planners should not only spell out those effective teaching methods or approaches to be used, but they should monitor their implementation as well.

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