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Examining the Impact of the 7E Learning Cycle on Secondary School Students' Academic Achievement in Chemistry in Lagos State

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Abstract

This study aims to explore the influence of the 7E Learning cycle model on secondary school *students' academic performance in chemistry in Lagos state. The study employs a quasi-experimental design. The study was conducted across twelve secondary schools in Lagos State, with a total sample size of 410 students from SS2 classes. Intact classes were randomly assigned to either the experimental group, which utilized the 7E Learning Cycle model (LCM), or the control group, which followed conventional teaching methods. Four instructional tools (7E LCM teachers' guide, instructional guide for conventional approach, and instructional manuals for both approaches) were used to guide the teaching process. Data collected were analyzed using mean, standard deviation and, ANOVA statistical tool for the research hypotheses. The findings indicated a significance difference in the performance of chemistry students exposed to* the *7E Learning Cycle model, with a (t Stat = 21.15; t Critical = 2.02) demonstrating the effectiveness of the model. The results also showed that the 7E Learning Cycle model had a more positive impact on students' academic achievement in chemistry than the conventional lecture method. However, the analysis revealed no significant gender-based differences in the impact of the 7E Learning Cycle model on students' academic performance. The t-statistic for this comparison was 2.18, which was below the critical value of 2.37, suggesting that both male and female students benefitted equally from the 7E instructional approach. It is recommended that Chemistry educators adopt innovative teaching methods, to foster greater student engagement and interest in the subject.*

Keywords: 7E Learning Cycle Model, Quasi-Experimental, conventional Method, Chemistry students

Introduction

Chemistry is a foundational science discipline that underpins technological advancements and serves as a cornerstone of scientific progress. It is the study of matter, its properties, and the processes through which substances combine or separate to form new compounds, as well as the interactions between substances and energy. According to Akinnodi (2020), it is the science that examines the properties of different atoms, the ways in which they bond to form molecules, the interactions between various types of molecules, and the associated energy changes that occur during these processes. Chemistry plays a crucial role in various fields, including medicine, agriculture, transportation, housing, and industry (Gongden & Lohdip, 2011). Dania (2014), further emphasized that chemistry is a fundational subject for many core courses. Given its importance, there is a pressing need to adopt effective teaching and learning strategies that not only improve student achievement but also enhance the retention of chemistry concepts.

The 7E learning Cycle Model (LCM), an instructional strategy designed to enhance conceptual understanding, includes seven phases: Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend (Cherono, Samiko, & Kabesa, 2021). Balta and Sarac (2016), suggested that science teachers should adopt the 7E Learning Cycle Model (LCM) in their teaching, as it has been shown to enhance students' academic performance. As Eisenkraft (2003) posits, once new knowledge is generated, existing learning models should be modified to ensure their continued relevance and effectiveness. The stages of the 7E LCM are designed to be interconnected, allowing students to engage in scientific inquiry by exploring instructional materials and applying learned concepts or principles to new situations. This approach fosters deeper understanding and promotes active learning, which is critical for academic success.

Many students in African secondary schools, particularly in Nigeria, face significant challenges in learning the sciences, with chemistry being one of the most problematic subjects. Umoh (2003) highlighted that candidates' performance in the Senior School Certificate Examination (SSCE), administered by the West African Examination Council (WAEC), has consistently yielding some of the lowest results. Several studies (Sharma, 2018; Nja et al., 2020) have identified a range of factors contributing to this ongoing trend of poor achievement in chemistry. Key factors include students' attitudes towards the subject, insufficient resources such as textbooks, a shortage of qualified teachers,

irregular school attendance, strained student-teacher relationships, inadequate learning environments, and the geographical location of schools. Additionally, perceived difficulties in conducting chemistry practical further exacerbate students' struggles and contribute to their overall poor performance in the subject.

Although numerous studies have been conducted to identify the challenges and opportunities within chemistry education in Nigeria, few have specifically examined the impact of the 7E Learning Cycle Model. This study seeks to address this gap in the literature by exploring the effect of the 7E Learning Cycle Model on students' performance in chemistry, with a focus on Lagos State, Nigeria, and potentially extending its relevance to the broader African context.

Purpose of the Study

The aim of this study is to examine the impact of the 7E Learning Cycle Model on students' performance in chemistry, with a focus on schools in Lagos State, Nigeria, and a broader consideration of its applicability within the African context.

The specific objectives of the study are to:

Assess the impact of the 7E Learning Cycle Model on students' academic achievement in chemistry in secondary schools within Lagos State.

Compare the academic performance of students taught chemistry using the 7E LCM with those taught through conventional instructional methods.

Investigate potential gender-based differences in the effectiveness of the 7E LCM on male and female students' achievement in chemistry in Lagos State secondary schools.

Research Questions

The following research questions were formulated:

1. What is the effect of the 7E LCM on students' academic achievement in chemistry in secondary schools in Lagos State?
2. How does the academic achievement of students taught chemistry using the model differ from those taught through conventional instructional methods?
3. Are there any gender-based differences in the impact of the model on male and female students' academic achievement in chemistry in Lagos State secondary schools?

Research Hypotheses

To guide the study, the following hypotheses were proposed at a significance level of $p>0.05$:

H_{o1}: There is no significant effect of the 7E LCM on students' academic achievement in chemistry in secondary schools in Lagos State.

H_{o2}: There is no significant difference in the effect of the model on the academic achievement of male and female students in chemistry in secondary schools in Lagos State.

Methodology

This study employed a pretest-posttest control group quasi-experimental design. This design was selected due to the nature of the student population, as participants were from intact classes, making random assignment unfeasible. The target population for the study consisted of senior secondary school two (SS2) students in Alimosho Local Government Area, Lagos State, Nigeria. A total of 410 chemistry students in SS2 constituted the sample size and consequently intact classes were randomly assigned to control and experimental group. A total of twelve senior secondary schools were purposively selected for the study: three schools were assigned to the experimental group, where the 7E Learning Cycle Model (LCM) would be implemented, and three schools were assigned to the control group, where conventional instructional methods would be used.

The following research instruments were utilized:

Student Chemistry Achievement Test (SCAT) - to assess students' academic performance in chemistry.

7E Learning Cycle Model on Electrolysis (Experimental Group) - a tailored manual designed to guide the implementation of the 7E LCM in the teaching of electrolysis.

Conventional Instructional Manual on Electrolysis (Control Group) - a manual for conventional teaching methods on electrolysis.

Instructional Guide on the 7E Learning Cycle Model (Control Group) - a guide to ensure uniformity in the delivery of instruction for the control group.

The content and face validity of the instruments were ensured through expert review by a chemistry educator and a specialist in measurement and evaluation. To assess the reliability of the Chemistry Achievement Test (SCAT), a Cronbach's alpha coefficient of 0.81 was obtained, indicating satisfactory internal consistency. Data collection involved assigning students to two treatment groups: the

experimental group and the control group. A pretest was first administered to all students to assess their baseline cognitive levels in chemistry. Following the pretest, the experimental group received instruction using the 7E Learning Cycle Model (LCM), while the control group was taught using the conventional instructional model (CIM). The posttest was then administered to both groups to evaluate the impact of the respective instructional methods on students' academic achievement in chemistry.

The 7E Learning Cycle Model (LCM) instructional manual, developed by the researchers, was used as a guide for the experimental group during the instructional process. The lesson activities were structured around the seven stages of the 7E LCM, including Elicit, Engage, Explore, Explain, Elaborate, and Extend. At the conclusion of the instructional period, a posttest was administered to both the experimental and control groups. The data collected from both groups were analyzed using both descriptive and inferential statistics. Descriptive statistics, including mean and standard deviation, were used to address the research questions. Inferential analysis was conducted using Analysis of Variance (ANOVA) to assess the difference between the groups. The research hypotheses were tested at the 0.05 level of significance using t-test statistics to determine the effectiveness of the 7E LCM in comparison to the conventional instructional method.

Results

Research Question One:

What is the effect of the 7E Learning Cycle Model on students' academic achievement in chemistry in secondary schools in Lagos State?

The result presented in Table 1 shows a comparison of students' chemistry achievement between two groups: the control group (taught using conventional methods) and the experimental group (taught using 7E Learning Cycle Model). Here's an interpretation of the data:

Table 1: Descriptive Statistics of Effect of Treatment on Students' Chemistry Achievement

		Pre-test		Post-test	
	N	Mean	Std Deviation	Mean	Std Deviation
Control	207	50.0	2.15	51.90	6.29
Experimental	203	50.80	4.33	68.10	7.11

From the experiment conducted, as shown in Table 1 above, the mean pre-test score for the experimental group was 50.80 while that of the control group was 50.20. In the post-test, there was a mean increase for the two groups, the experimental group had a gain score and the mean post test score of 68.10 while the control group had a mean post- test score of 51.90 which shows that there was gain score for the control group also. This substantial increase (17.3 points) suggests that the 7E LCM had a positive impact on students' performance in chemistry. The results suggest that the 7E Learning Cycle Model had a positive effect on students' academic achievement in chemistry, with the experimental group demonstrating a significantly higher posttest score than the control group, suggesting that 7E LCM could be an effective instructional strategy for improving students' academic performance.

Research Question two: How does the academic achievement of students taught chemistry using the 7E Learning Cycle Model differ from those taught through conventional instructional methods?

Table 2: Descriptive Statistics of Effect of Treatment on Students' Chemistry Achievement

		Pre-test		Post-test		
	N	Mean	Std Deviation	Mean	Std Deviation	Mean Diff.
Control	207	50.20	2.15	51.90	6.29	1,70
Experimental	203	50.80	4.33	68.10	7.44	17.30

From the experiment conducted, as shown on Table 2 above, the control group shows a slight increase in mean scores from the pretest (50.20) to the posttest (51.90), but the improvement is small. The standard deviation also increases significantly from 2.15 to 6.29, indicating that there is more variability in the students' performance after the intervention. The experimental group showed a more substantial improvement from pretest (50.80) to the posttest (68.10) with a mean difference of 17.30. the standard deviation also increases (from 4.33 to 7.44), but the overall higher mean suggests that, on average, students in the experimental group showed significant improvement in chemistry achievement compared to the control group.

Research Question Three: Are there any gender-based differences in the impact of the 7E Learning Cycle Model on male and female students' academic achievement in chemistry in Lagos State secondary schools?

Table 3: Descriptive Statistics of Effect of Treatment and Gender on Students' Chemistry Achievement

			Pre-test		Post- test		
		N	Mean	Std. Deviation	Mean	Std. Deviation	Mean Diff.
Experimental	Male	180	48.92	4.30	53.85	10.64	4.93
	Female	230	50.00	10.00	57.08	8.65	7.08

The table above shows the scores of male and female students from the experimental group. As shown on table 3 above, the mean pre-test score for the male students was 48.92 while that of the female students was 50.00. In the post test, there was a mean increase for the male and female students, the male students had a gain score of 4.93 while the female students had gain score of 7.08. This indicates that 7E Learning Cycle Model has a positive impact on male and female students, however, the female students exhibit a higher increase in academic achievement in Chemistry as a result of 7E Learning Cycle Model than male students.

Research Hypothesis One

H_{01}: There is no significant effect of the 7E Learning Cycle Model on students' academic achievement in chemistry in secondary schools in Lagos State.

Table 4: t-Test Paired Sample for Mean

Statistics	Pre-test	post-test
Mean	50.80	68.10
Variance	9.33	11.64
Observations	207	207
Pearson Correlation	-0.04	
Hypothesized Mean Difference	0	
Df	414	
T Stat	21.15	
P (T≤ t) one-tail	5.48E-25	
t Critical one-tail	1.68	
P (T≤ t) two-tail	1.1E-24	
t Critical two-tail	2.02	

Table 4 above shows the t-test analysis of the mean scores of the experimental students for the pre-test and post-test, the t-value or t Stat (21.15) is greater than the critical t-value (2.02), indicating that the observed difference between pretest and posttest scores is statistically significant. Also, there is an increase in the mean scores from pretest (50.80) to posttest (68.10), suggesting that students' academic achievement in chemistry improved after the treatment with the 7E LCM. The pearson correlation (-0.004) indicates a weal negative relationship between the pretest and posttest, suggesting that the changes in individual students' scores are not strongly related to their initial scores, implying the intervention had a broad impact across the sample. The p-values for both one tail and two-tail were extremely small, supporting the rejection of the null hypothesis. The results show a statistically significant increase in students' academic achievement in chemistry after using the 7E LCM. Since the p-value is very small (far below 0.05) and the t-statistics is much larger than the critical value, we reject the null hypothesis that "there is no significant effect of the 7E LCM on the students' academic achievement in chemistry".

Research Hypothesis Two

H_{02}: There is no significant difference in the effect of the 7E Learning Cycle Model on the academic achievement of male and female students in chemistry in secondary schools in Lagos State.

Table 5: t-Test: Paired Two Sample for Mean

Statistics	Male	Female
Mean	4.93	7.08
Variance	10.64	8.65
Observations	180	230
Pearson Correlation	-0.65	
Hypothesized Mean Difference	0	
Df	460	
T Stat	2.18	
P (T≤ t) one-tail	0.002	
t Critical one-tail	1.90	
P (T≤ t) two-tail	0.004	
t Critical two-tail	2.37	

Table 5 above revealed that the T Stat (2.18) is less than the t Critical (Two-tail = 2.37), meaning that the difference between the groups (male and female) in terms of posttest scores is not statistically significant at the 0.005 level for a two-tailed test. However, the p value (0.004) is very small and suggests that there is a statistically significant difference between pretest and posttest scores within each gender group. For the one-tailed test, the T Stat (2.18) is greater than the t Critical (One-Tail =1.90), and the P value (0.002) is very small. This indicates that the treatment had a statistically significant effect on students' academic achievement in chemistry. While the t-stat for the difference between genders is not significant at the 0.05 level (for the two-tailed test), there is significant evidence that both groups improved from pretest to posttest, as indicated by the very low p-values for the one-tailed test. This suggest that the 7E LCM had a positive effect on both male and female students, but there is no clear evidence from this data that gender played a significant role in how much improvement each group made. Although females showed a slightly higher posttest score, the statistical tests do not

support a strong claim that gender-based differences in the treatment's effect are significant. Therefore, gender does not significantly influences the impact of the 7E LCM on academic achievement. The differences in improvement between male and female students are small and not statistically significant.

Discussion of Findings

The data findings from this study indicated that the mean scores of students in the 7E Learning Cycle Model group at the posttest level were higher than their scores at the pretest level, while the mean scores of students in the lecture group at the posttest level were just slightly different from their pretest mean scores. The result suggest that the students in the experimental group performed better than those in the control group. The experimental group had a notable increase in their posttest scores (mean = 68.10) compared to the control group's posttest scores (mean = 51.90),

which indicates that the 7E Learning Cycle Model was more effective in enhancing students' chemistry achievement. However, the increased standard deviation in both groups suggests that there was greater variability in individual performance particularly in the experimental group. Therefore, the 7E LCM seems to be a more effective instructional method for improving academic achievement in chemistry compared to conventional teaching methods. The findings of this study are in an agreement with the findings of Cherono, Samiko, and Kabesa (2021). The findings of Alexander, Benjamin, George, Kofi, and Amoako (2020) also agreed with this present study as the findings showed that there is a significant difference in achievement levels between students who received instructions with the 7E Learning Cycle Model and traditional teaching methods.

Conclusion

This study investigated the impact of the 7E Learning Cycle Model on students' academic achievement in Chemistry. Using a quasi-experimental design, the research involved two groups: an experimental group taught using the 7E Learning Cycle and a control group receiving instruction through conventional pedagogical approaches. Based on the findings, the following conclusion were drawn:

Female students were more prevalent than male students in senior secondary school science classes.

The 7E Learning Cycle Model had a significantly greater positive effect on students' academic achievement in Chemistry compared to conventional teaching methods.

No significant difference was observed in the mean chemistry achievement scores between male and female students taught using the 7E Learning Cycle Model, suggesting that gender does not significantly influence the effectiveness of the model.

These results highlight the potential of the 7E Learning Cycle Model to enhance student achievement in chemistry, regardless of gender.

Recommendations

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

1. It is recommended that educators integrate the 7E Learning Cycle Model more frequently into their classroom instruction.
2. The exclusive reliance on conventional teaching methods should be minimized, particularly at the primary and secondary education levels.
3. More instructional materials should be provided to educators to facilitate the use of the combination of 7E Learning Cycle Model and other methods.

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