

Comparative Study of Adaptive Teaching and Lecture Methods on Secondary School Students' Achievement in Chemistry in Delta State

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Abstract

The objective of this study was to compare the efficacy of adaptive teaching and lecture methods in enhancing the achievement of secondary school students in Chemistry in Delta State. The study was directed by two hypotheses. The study employed a 2x2 pretest, posttest, planned variation quasi-experimental factorial design. The study sample comprised 39,904 students Public Senior schools in Delta State. The study utilised the simple random sampling technique to choose a sample of 311 Chemistry students from six schools. The researcher developed Chemistry Achievement Test (CAT) for data collection, which was then validated by three experts. The CAT's validity was also evaluated based on its content and construct. The reliability coefficient of CAT was calculated to be 0.78, using the Kuder-Richardson 21 method. The CAT was conducted as a pretest prior to the treatment and as a posttest afterwards. The acquired scores were examined via Analysis of Covariance (ANCOVA). The findings indicated a notable disparity in the average achievement scores among students who were instructed in chemistry using adaptive teaching versus lecture methods, with the former yielding superior results. Furthermore, there was no significant interaction detected among adaptive teaching method, lecture method and sex in relation to the average achievement scores of chemistry students. The study's results demonstrated that the adaptive teaching strategy is more effective in improving students' achievement in Chemistry, regardless of their sex, as compared to the lecture method. Therefore, integration of adaptive teaching method into chemistry curriculum by schools and teachers, among others was recommended. This may encompass tailored guidance, customized learning strategies, and the utilization of technology-driven materials to accommodate the varied educational requirements of students.

Keywords: Adaptive Teaching Method, Lecture Method, Chemistry, Chemistry Achievement

Introduction

Chemistry is the scientific discipline that investigates the characteristics and behaviour of matter in its various forms, including the compounds that compose our surroundings and the transformations that these substances undergo under different circumstances. The significance of Chemistry in the establishment of a country's scientific foundation cannot be overstated and Nigeria is no exception. It has a crucial impact on altering the environment and enhancing the overall quality of life. A nation's technical growth is fundamentally necessary. Being a fundamental scientific study, it is typically a requirement for students to be enrolled in several professional fields such as Nursing, Medicine, Pharmacy, Agriculture, Engineering and Geology, among others. Giginna and Nweze (2014) assert that the study of chemistry is of utmost significance to humanity due to its principles that have facilitated contemporary progress. Chemistry is essential for the advancement of a rising nation like Nigeria by fostering the growth of scientifically literate individuals, so facilitating its transition to the status of a developed country. The country need the expertise of competent chemists to instruct the subject in order to fulfil its objective of being one of the world's top 20 economies by 2040.

The primary objective of teaching is to facilitate students in acquiring knowledge and skills. In order to facilitate successful instruction and acquisition of knowledge, the instructor must employ suitable pedagogical method. Based on personal experience, the lecture method is the prevailing instructional approach employed in senior secondary schools in Nigeria. According to Okpala and Okigbo (2021), the conventional lecture method is a form of instruction where the teacher communicates information to the students in a one-way manner. The lecture method involves the teacher delivering knowledge or content verbally to a group of students or learners in a formal manner. The lecture method is primarily employed in situations where there are big groups or limited time available. The lecture method is thought to encourage students' passive engagement, limited contact among students and a lack of teamwork during the teaching and learning process. The lecture method fails to accommodate the academic requirements of individual students in the classroom. Students in a given classroom varies with respect to ability level, learning styles and aptitude among others. Thus, there is need to try alternative teaching method such as adaptive teaching method that put the academic need of individual students into consideration during instruction.

The adaptive teaching method is an educational approach that aims to accomplish a common instructional goal with learners that have diverse individual characteristics, such as prior achievements, aptitude or learning preferences (Ikwumelu, Oyibe & Oketa, 2015). Adaptive teaching, as per Borich's (2011) definition, is adjusting instructional approaches to ensure that all learners are given the opportunity to attain the required standards. Adaptive teaching refers to the practice of modifying instructional methods in order to effectively address the specific requirements and preferences of individual learners. The process involves modifying, accommodating and evaluating within the educational setting. This is a pedagogical method that prioritises the whole class while also addressing the specific needs of individual students. It entails understanding the previous degree of achievement of your learners and offering specific assistance. This statement emphasises the need of comprehensive pre-class preparation and the following adjustments made to the teaching and learning process throughout the lesson. Implementing

adaptive teaching methods is crucial for optimising the academic performance of all students. Adaptive teaching offers students a customised and tailored learning experience, which can enhance both student pleasure and the effectiveness of the learning process. Adaptive teaching method involves remedial and compensatory approach (Adeyemi, 2017). Therefore, adaptive teaching method is conceived in the present study as an instructional method in which purposeful effort is made by the teacher to accommodate individual differences in learners' characteristics for designing effective instruction.

Adeyemi (2017) identifies two primary approaches utilised in adaptive teaching: the remedial approach and the compensating approach. The remedial approach focuses on addressing the fundamental abilities that a learner must acquire in order to effectively understand and grasp new concepts. The remedial approach involves the process of re-teaching skills and concepts that students have not successfully mastered in earlier educational attempts. The remedial approach emphasises repetitive practice to cultivate certain skills in learners, hence facilitating their ability to easily comprehend new material. The remedial approach is characterised by its proactive nature, since it prioritises equipping learners with essential basic information or abilities prior to participating in structured education, such as student-centered debates and question-and-answer sessions. In contrast, the compensatory approach is characterised by a responsive nature, as it chooses teaching techniques based on their efficacy in offsetting the learners' deficiencies in fundamental knowledge or abilities. This may entail the delivery of the material through additional educational tools and interactive exercises. This study focused on adaptive teaching using the remedial approach. In this study, students were exposed to the basic knowledge or skill necessary for easy comprehension of each content area in chemistry before instruction in the form of question-and-answer session. On evaluation and analysis of students' performance in this session, instructions were given to students to remedy their knowledge deficiencies and preparations were made using any suitable instructional plans to teach students who manifested similar needs. The teacher employed varied instruction throughout the instructional process to cater to the diverse academic demands of several student groups, with the aim of enhancing their academic performance.

The promotion of adaptive teaching method has been present since ancient times, as educators have recognised that personalised education, tailored to individual learning styles, enhances the learning process (Alonso, Guzman & Amescua, 2013). Customising instruction to suit the individual needs of students effectively tackles academic challenges in a way that is highly tailored to each student. The implementation of an adaptive teaching method may be more effective in enhancing students' achievement in Chemistry, in contrast to the conventional lecture method. Therefore, the main aim of this study was to compare the effects of adaptive teaching and lecture methods on students' achievement in Chemistry, to ascertain the most optimal methodology for Chemistry instruction, regardless of the sex of students.

Sex pertains to the anatomical and physiological attributes that differentiate males from females, while considering social and cultural diversities. Sex refers to the societal implications associated with an individual's biological categorization as either male or female. This encompasses the development of individual and collective identities, anticipated outcomes, actions and the distribution of authority that emerge from interpersonal exchanges (Ambe-Uva, Iwachukwu & Jubrin, 2008). The influence of sex and its interaction with instructional methods

have remained inconclusive. Studies had shown that certain instructional methods favour males more than females and others reported otherwise. Some teaching methods tend to be sex sensitive (Izuegbunam, 2018), while others are not (Nwanze, 2016). Effective instructional method, however, must have the potency to positively enhance achievement and attitude of students, irrespective of students' sex. Thus, this study, further, ascertained if adaptive teaching and lecture methods interact with students' sex to influence their achievement and attitude towards Chemistry. It is against this background that this study sought to investigate the effects of adaptive teaching and lecture methods on Senior Secondary School students' academic achievement in Chemistry in Delta State in order to identify and recommend the most effective teaching method for Chemistry instruction between them. In addition, the study further sought to explore if adaptive teaching and lecture methods can combine with sex to influence the achievement of students in Chemistry.

Statement of the Problem

The primary goal of teaching Chemistry at the secondary school level is to impart fundamental understanding of chemical ideas and principles to students by carefully selecting and organising content. In order to accomplish this goal, it is necessary to utilise suitable pedagogical methods in the instruction and acquisition of chemical knowledge, given the significant impact that chemical has on the economic advancement of any nation. Chemistry, despite its significance, has shown a consistent decline in students' performance in the Senior School Certificate Examination (SSCE) based on the available information from the West African Examination Council (WAEC) between 2015 and 2020. The underperformance of students can be attributed to various factors, such as the utilisation of inadequate teaching methods. The conventional lecture method which is predominately used by Chemistry teachers in Nigerian schools does not seem to cater for students' individual differences with respect to ability level, learning style and aptitude. This suggests that the lecture method does not take into consideration all the academic needs of individual students during instruction. Thus, there is the need to try an alternative teaching method such as adaptive teaching method. This method make provision for individual students' academic needs during instruction. Therefore, the problem of the study is; will the use of adaptive teaching method enhance Chemistry students' achievement than the conventional lecture method?

Purpose of the Study

The primary purpose of this study is to assess and compare the effect of the adaptive teaching and lecture methods on the academic achievement of secondary school students in chemistry in Delta State. The study is explicitly tailored to:

1. compare the difference in the mean achievement scores between students taught chemistry using adaptive teaching and lecture methods;
2. determine the interaction effect between adaptive teaching method, lecture method and sex on the mean achievement scores of chemistry students.

Hypotheses

The study was guided by two hypotheses:

- HO₁: There is no significant difference in the mean achievement scores between students taught chemistry using adaptive teaching and lecture methods.
- HO₂: There is no significant interaction effect between adaptive teaching, lecture method and sex on the mean achievement scores of chemistry students.

Methods

The study employed a 2x2 pretest, posttest, planned variation quasi-experimental factorial design. The selected design was considered appropriate for the study because subject randomization was not implemented. Instead, complete classrooms were employed to minimise any interference with existing school operations. The study encompassed a grand total of 39,904 students enrolled in public Senior School two (SS11) offering Chemistry in Delta State. The selection of SSII Chemistry students was contingent upon the preceding selection of SS11 students into certain fields, namely Sciences, Social Sciences and Arts. This enabled the researcher to focus exclusively on the science category. The study comprised 311 chemistry students. The schools were chosen using the simple random sampling technique. The implementation of simple random sampling was utilised to guarantee that all schools in Delta State had an equal chance of being selected for this study. The Chemistry Achievement Test (CAT) was used for data collection. CAT comprised 50 multiple choice questions derived from past WASSCE questions on hydrocarbons, alkanes, alkenes, alkynes, benzene and alkanols. The data gathering encompassed the use of six distinct categories of compounds. The researcher verified the validity of CAT by evaluating its facial, content and construct validity. The reliability of the CAT was assessed using the Kuder-Richardson 21. The rationale for utilising this method is based on its appropriateness for multiple-choice objective test items. The CAT was administered to 30 Chemistry students in a Senior School in the Etsako West Local Government district of Edo State. These students live outside the specified study area. The responses provided by the students were assessed and the resulting scores were examined using Kuder-Richardson 21, yielding a reliability coefficient of 0.78. The intervention involved providing students with Chemistry instruction in distinct cohorts using an adaptive teaching method and lecture method. Preliminary assessments were carried out before the intervention, and follow-up assessments were undertaken afterwards with the aid of CAT. The obtained scores were evaluated using ANCOVA.

Results

HO₁: There is no significant difference in the mean achievement scores between students taught chemistry using adaptive teaching and lecture methods.

Table 1

Summary of ANCOVA Comparison of Achievement Scores of Students Taught Chemistry Using Adaptive Teaching and Lecture Methods

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	16235.230 ^a	2	8117.615	97.034	.000
Intercept	83410.772	1	83410.772	997.048	.000
Pretest	6535.741	1	6535.741	78.125	.000
Method	8412.932	1	8412.932	100.564	.000
Error	25766.577	308	83.658		
Total	1045726.000	311			
Corrected Total	42001.807	310			

The statistical analysis reveals a substantial disparity in the average scores of students who received instruction using adaptive teaching compared to those who were taught utilising lecture method. The presence of statistical significance is demonstrated by the F statistic of 100.564 and a p-value below 0.05, as presented in Table 1. Thus, the first null hypothesis is refuted. Hence, there exists a significant difference in the mean achievement scores between students who received instruction in chemistry through adaptive teaching method as opposed to lecture method, with a distinct advantage shown for those who were taught utilising the adaptive teaching method.

HO₂: There is no significant interaction effect between adaptive teaching, lecture method and sex on the mean achievement scores of chemistry students.

Table 2

Summary of ANCOVA on Interaction Between Adaptive Teaching, Lecture Methods and Sex on Students' Mean Achievement Scores in Chemistry

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	16395.935 ^a	4	4098.984	48.984	.000
Intercept	77691.697	1	77691.697	928.446	.000
Pretest	5472.730	1	5472.730	65.401	.000
Method	8156.621	1	8156.621	97.475	.000
Sex	88.842	1	88.842	1.062	.304
Method * Sex	54.364	1	54.364	.650	.421
Error	25605.872	306	83.679		
Total	1045726.000	311			
Corrected Total	42001.807	310			

The obtained F(1, 306) value of 0.650, with a P-value of 0.05, as reported in Table 2, indicates no statistically significant interaction between the adaptive teaching method, lecture method and sex on the average achievement scores of Chemistry students. Therefore, the null hypothesis remains unquestioned. Therefore, no significant interaction is seen between the adaptive teaching method, lecture method and sex on the mean achievement scores of Chemistry students.

Discussion

The study found a significant difference in the mean achievement scores of students who were taught chemistry using adaptive teaching vs lecture methods, with the adaptive teaching method yielding better results. Therefore, students who received instruction in Chemistry through the adaptive teaching achieved superior average scores in achievement compared to their peers who were taught Chemistry using the lecture method. This observation could be hinged on active learning, immediate feedback and differentiated instruction among others offered by adaptive teaching method. Adaptive teaching method incorporated active learning strategies, such as interactive exercises, simulations and problem-solving tasks. These activities required students to actively engage with the subject matter, apply their knowledge and think critically, leading to better understanding and performance. Adaptive teaching method, also, typically provided immediate

feedback to students on their learning progress and performance. This feedback allowed students to identify their strengths and weaknesses and make necessary adjustments in real-time. The active engagement of students in their own learning, facilitated by this approach, likely played a role in the observed increase in achievement scores. In addition, adaptive teaching method provided differentiated instruction based on individual student needs. Students with different prior knowledge, learning styles and abilities received targeted instruction and resources that match their specific requirements. This personalized approach helped to address gaps in understanding and facilitate more effective learning, which may have contributed to higher achievement scores than the lecture method. This finding supports the findings of Clair (2015), who observed that students instructed in Mathematics using an adaptive learning system achieved superior final grades compared to students taught through the standard lecture method. In contrast to the assertions made by Murray and Perez (2015), this study discovered no substantial disparity in students' achievement in a digital literacy course when comparing those instructed through an adaptive teaching with those instructed through a conventional lecture method.

The study also did not find any significant interaction effect between the adaptive teaching method, lecture method and sex on the average achievement scores of chemistry students. This indicates that the integration of adaptive teaching and lecture methods did not combine with students' sex to influence students' achievement in Chemistry. The impact of adaptive teaching and lecturing method on students' achievement in Chemistry remains consistent regardless of the students' sex. This finding aligns with the study conducted by Murray and Perez (2015), which concluded that there is no notable correlation between adaptive teaching, traditional teaching, gender and students' performance in a digital literacy course.

Conclusion

Based on the findings of the study, it was concluded that adaptive teaching and lecture method have the potency to improve students' achievement and attitude towards chemistry. Additionally, adaptive teaching method is more effective in improving students' achievement in Chemistry compared to lecture method, regardless of students' sex.

Recommendations

- The study's findings and conclusion lead to the following recommendations:
1. Schools and teachers should incorporate adaptive teaching method into their chemistry curriculum. This could include personalized instruction, individualized learning plans and the use of technology-based resources to cater to the diverse learning needs of students.
 2. Teachers need to be trained in using adaptive teaching method effectively. Professional development programmes should be organized to equip Chemistry teachers with the necessary knowledge and skills to implement adaptive teaching method in the classroom.
 3. Additional research should be conducted to explore the specific aspects of adaptive teaching method that made them more effective than the lecture method. Understanding the individual components and strategies that contribute to improved achievement and attitude towards chemistry can help in refining instructional practices.

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