

Effects of Autonomous Method of Teaching on Students' Academic Performance in Chemistry in Uyo Local Government of Akwa Ibom State

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Abstract

This study examined the effects of the autonomous teaching method on students' academic performance in Chemistry in Uyo Local Government Area of Akwa Ibom State. Two research questions and two null hypotheses guided the study. The quasi-experimental design with non-equivalent control groups, pre-test, and post-test was adopted. The study involved 80 senior secondary one (SS I) students drawn from two randomly selected intact classes in two purposively selected secondary schools. Chemistry Achievement Test (CAT) was used for data collection. The instrument was validated by three experts. The instrument had a reliability index of .78 determined by using Kuder Richardson formula (K-R-20) Data were analyzed using mean, standard deviation, and ANCOVA. The null hypotheses were tested at 0.05 level of significance. Findings revealed that there is a significant effect in the mean achievement scores of students taught Chemistry using the autonomous method. Additionally, no significant difference was found in the academic performance of male and female students in Chemistry. Based on the findings, it was recommended that autonomous learning strategies be incorporated into the Chemistry curriculum to foster independent learning and improve students' Academic performance.

Keywords: Autonomous Teaching Method, Chemistry Achievement, Academic Performance, Gender, Quasi-Experimental Design.

Introduction

Chemistry is a foundational branch of science that deals with the study of the structure, composition, properties, and reactions of matter in various forms. It plays a vital role in the technological and industrial development of any nation. According to Udo and Akpan (2023), Chemistry has significantly contributed to the advancement of modern technologies through its principles applied in innovations across industries. Chemistry remains an essential science subject in the senior secondary school curriculum globally. It serves as a prerequisite for fields such as medicine, pharmacy, agricultural sciences, textile technology, chemical engineering, printing, and synthetic industries.

Despite the high enrolment of students in Chemistry in external examinations like those conducted by the West African Examinations Council (WAEC) and the National Examinations Council (NECO), recent studies (Etuk & Essien, 2021; Ekong, 2022) indicate that students' performance in Chemistry remains consistently poor. This trend has been largely attributed to the persistent use of traditional teaching methods such as the lecture or expository method, which dominates Chemistry classrooms in secondary schools. These conventional methods,

according to Ekanem and Udo (2020), often prioritize rote memorization over conceptual understanding and practical application, which leads to low engagement and limited retention among learners.

In response to the shortcomings of traditional pedagogy, researchers and educators have advocated for the adoption of more innovative and student-centered teaching approaches. Methods such as inquiry-based learning, concept mapping, simulations and games, constructivist strategies, and problem-based learning have been suggested to enhance students' achievement and interest in science subjects (Effiong & Johnson, 2019; Bassey & Abia, 2021). Among these modern strategies, the autonomous method of teaching has gained increasing attention for its ability to foster independent learning and critical thinking. This method redefines the roles of both teachers and students. No longer are students passive recipients of knowledge; they are now active participants who take responsibility for their own learning. Similarly, teachers are transitioning from knowledge dispensers to facilitators of learning, guiding and supporting students rather than directing all classroom activity.

The concept of learner autonomy has been greatly affected by technological advancements, enabling new modes of education such as distance learning, homeschooling, and computer-assisted instruction. These formats empower students to take control of their learning experiences, thereby promoting self-direction, flexibility, and engagement. As noted by Lamb and Reinders (2018), this paradigm shift from teacher-centered to learner-centered education is driven by a redefinition of teaching priorities—from instruction to facilitation, and from dependency to independence in learning. According to Williams & Thompson (2021), the ability to take charge of one's own learning encompasses a range of competencies that enable an individual to control various aspects of the learning process. These include setting personal learning goals, selecting appropriate learning materials, determining study strategies, and evaluating one's progress. This conceptualization implies that full autonomy is closely tied to the learner's capacity and responsibility to self-direct their education. Similarly, Morris (2020) affirms that this capacity involves developing a metacognitive awareness of oneself as a learner, an understanding of the learning environment, the subject matter, and the cognitive processes involved in learning.

Hughes (2019) supports this notion by emphasizing that autonomous learners utilize metacognitive strategies such as critical reflection, independent decision-making, and the ability to transfer acquired knowledge across different learning contexts. Recognizing the value of individual learning autonomy to societal advancement, the National Policy on Education (FRN, 2013) highlights the need to design instructional systems that promote self-directed learning. In this context, autonomous learning is understood as learning initiated and directed by individuals through real-life experiences, reading materials, digital tools, group activities, and learning clubs. This becomes especially relevant for senior secondary students who, according to Piaget's theory (in Adetunji and Nwankwo, 2018), are typically in the formal operational stage of cognitive development. At this stage, they are capable of abstract reasoning, hypothesis formulation and testing, and independent problem-solving.

Global education reforms increasingly advocate for a shift from traditional teaching approaches to more discursive classroom practices that foster students' active participation in problem-solving and reasoning (Oluwaseun, 2022). In support of this shift, educational technologists have developed digital tools and online learning platforms that encourage student-centered learning. For instance, e-learning and computer-based instruction are increasingly being utilized to facilitate learning beyond the physical classroom and to enhance the development of autonomous learners (Nwachukwu, 2021). As Nwachukwu (2021) argues, autonomous learning is a process where learners take control of their educational experiences, indicating that students, rather than teachers, play the central role in directing the learning process. However, autonomous learning does not imply complete learner isolation. It involves creating opportunities for students to seek clarifications, collaborate with peers and instructors, and progress at their own pace—factors essential in mitigating issues such as mathematics anxiety (Okon, Musa, Ekpo, and Adebayo, 2022). Essentially, autonomous learning entails empowering students to develop learning strategies, make academic choices, explore content, and demonstrate understanding independently (Okon *et al.*, 2022).

As noted by Littlewood (2020), autonomy in learning does not exclude the teacher's role entirely. Although learners are ultimately responsible for their progress, the teacher continues to play a crucial facilitative and supportive role. This shared responsibility ensures that learners are effectively prepared for independent learning (Littlewood, 2020). In a study on learner autonomy in Malaysian tertiary institutions, Ahmad and Noor (2020) compared students in public universities to those in private universities concerning their preferences for autonomous versus teacher-centered learning. Their findings showed that while public university students favored traditional approaches, private university students demonstrated a gradual shift toward greater autonomy. Further, Ahmad and Idris (2021) explored the link between autonomy and motivational attributions among undergraduates and found that autonomous learners were more balanced in attributing academic outcomes to both internal and external factors.

In a related study, Kaur (2023) investigated the role of learner autonomy in vocabulary acquisition among Malaysian ESL learners. She identified learner-specific variables as crucial determinants in mastering the four core language skills—listening, speaking, reading, and writing. The study revealed that limited lexical competence often leads to reduced proficiency and a diminished ability to integrate across the four language domains. According to Kaur, one of the ultimate goals of language instruction is to develop lifelong learners who are capable of engaging in independent, self-directed learning. This underscores the relevance of exploring autonomous learning methods in other subject areas, including Chemistry, where self-regulation may enhance students' academic outcomes.

Academic achievement, widely recognized as a key educational outcome, has consistently been linked to the effectiveness of instructional methods. Achievement, defined as the successful attainment of a goal (Anderson & Malik, 2018), in the academic context refers to the extent to which learners meet specified educational objectives. Therefore, this study seeks to examine the impact of autonomous learning strategies on students' academic

performance in Chemistry, with a particular focus on measurable outcomes such as test scores and concept mastery.

Gender is another critical variable considered in this study. According to Okeke (2017, as cited in Aniaku, 2022), gender is a socio-cultural construct that assigns specific roles, expectations, and behavioral patterns to individuals based on their biological sex. Oludipe (2022) further observed that gender-based stereotypes continue to influence career aspirations and academic preferences in Nigeria. Professions such as Medicine, Engineering, and Architecture are often perceived as male-dominated, while fields like Nursing, Typing, and Catering are typically associated with females. In light of these societal perceptions, this study not only investigates the efficacy of autonomous learning in enhancing academic performance in Chemistry but also contributes to ongoing scholarly debates concerning the role of gender in shaping students' academic outcomes.

Given the increasing need to foster independent thinking and problem-solving abilities in students, especially in science subjects like Chemistry, autonomous learning emerges as a promising pedagogical approach. It empowers learners to take ownership of their educational journey, enhances motivation, and supports the development of higher-order cognitive skills essential for academic success. Despite the emphasis on teacher-centered methods in many classrooms, there is growing evidence that students benefit more when they actively participate in their learning process through self-directed strategies. Furthermore, the potential of autonomous learning to bridge gender gaps and foster equitable achievement among male and female students makes it a vital area for exploration. This study is therefore positioned to examine the effect of autonomous learning strategies on students' academic performance in Chemistry, with particular attention to the effect of gender.

Statement of the Problem

In the contemporary educational landscape, there is a growing emphasis on learner-centered approaches that foster autonomy, critical thinking, and lifelong learning skills. Autonomous learning, which encourages students to take responsibility for their own learning process, has been widely acknowledged as a means of improving academic performance and cultivating independent learners. However, despite global advocacy for the adoption of autonomous learning strategies, the Nigerian secondary school system still heavily relies on conventional, teacher-centered methods, particularly in science subjects like Chemistry. Chemistry, being a core science subject, is vital to technological advancement and scientific literacy. Yet, students' performance in the subject remains unsatisfactory at both internal and external examinations. This persistent underachievement raises concerns about the effectiveness of current instructional approaches in engaging learners meaningfully. There is a need to explore alternative teaching strategies that can better enhance students' understanding and performance in Chemistry.

Moreover, learner variables such as gender have been shown to influence students' engagement, interest, and achievement in science subjects. In Nigeria, gender stereotypes continue to shape students' perception of science-related fields, with males often perceived as more capable in scientific and technical disciplines than their female counterparts. This societal

bias may affect how students, particularly females, respond to autonomy in learning and perform in Chemistry. Despite the potential of autonomous learning to transform science education, limited empirical studies have been conducted in the Nigerian context to examine its efficacy on students' academic performance in Chemistry. Even fewer studies have explored the influence of gender on the effectiveness of autonomous learning methods. Therefore, it becomes imperative to investigate how autonomous learning strategies affect students' academic achievement in Chemistry and whether gender plays a moderating role in this relationship.

Objective of the Study

The main purpose of this study was to determine the effects of autonomous method of teaching on students' academic performance in Chemistry in Uyo Local Government Area. Specifically, the study sought to:

1. To determine the relative effect of autonomous method of teaching on students' academic performance in Chemistry in Uyo Local Government Area
2. To determine the effect of gender on the students' academic performance in Chemistry taught using autonomous method of teaching.

Research Questions

The research was guided by the following questions:

1. What are the relative effects of autonomous method of teaching on students' achievement in Chemistry?
2. What is the effect of gender on the mean achievement scores of students taught Chemistry using autonomous methods of teaching?

Research Hypotheses

The following null hypotheses were formulated and tested at .05 level of significance.

H₀₁. There was no significant effect in the mean achievement scores of students taught Chemistry using autonomous method.

H₀₂. There was no significant effect in the mean achievement scores of male and female students taught Chemistry using autonomous method.

Methodology

This research adopted the quasi-experimental design. Specifically, the study applied pre-test, post-test Non-equivalent control group design. Quasi-experimental design is considered appropriate for the study because intact classes were used to avoid disruption of normal class lessons. The pre-test was used to partial out initial difference in the two groups and also to control selection bias which is a threat to internal validity.

This study was conducted in Uyo Local Government Area of Akwa Ibom State. It is the state capital and it shares the common boundaries with Abak, Etinan, Ibestikpo Asutan, Ibiono, Ikono, Itu and Uruan L.G.A. Uyo Local Government Area as a people speaks "Ibibio" language. This is the local dialect in Ibibio land and entire Akwa Ibom State. Uyo people are of the Ibibio stock and speak Ibibio language. There are 15 public Secondary schools in Uyo Local Government Area and also the University of Uyo resides in this town.

Population for the study included all senior secondary one (SSI) Chemistry students in Uyo Local Government Area of Akwa Ibom State. However, a sample population of eighty (80) Senior Secondary one (SSI) Chemistry students from two secondary schools purposely selected in Uyo from two intact classes of 37 and 43 students were used for the study. Out of the two intact classes of 80 students one of the intact classes consisting of 37 students from one of the sampled schools was assigned to group I and was treated using autonomous teaching method while the other intact class (43 students) from a different sampled school was assigned to group II and was treated using normal teaching method respectively.

Chemistry Achievement Test (CAT) was developed by the researcher and was used to collect data for the study. The Chemistry Achievement Test CAT consisted of 20 multiple choice objective questions developed by the researcher. The research instrument (Chemistry Achievement Test) was face validated by three experts. These experts validated the items in terms of clarity of instrument, clarity of language and appropriateness and adequacy of the items in measuring what they supposed to measure. Scores of the Chemistry Achievement test that were obtained from trial testing was used to estimate the reliability co-efficient of the instruments using Kuder Richardson formula (k-R-20) and yielded a reliability index of 0.78. Kuder Richardson (K-R-20) was used because the test items consisted of multiple choice objective questions that were dichotomously scored.

Data for the study was collected through pre and post tests using the CAT. The pre-test was administered to the subjects before the treatment to measure the students' group equivalence and to provide the researcher with baseline data about the subjects while post-test was administered to the students one week after the treatment. Data collected from the two tests (pre and post) after treatment was used for data analysis. The scores obtained from the pre and post-test was analyzed using mean and standard deviation and Analysis of Covariance (ANCOVA). Mean and standard deviation was used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.5 % level of significance.

Data Analysis and Discussion of Findings

Research Question 1: What are the relative effects of autonomous method of teaching on students' achievement in Chemistry?

Table 1: Mean Achievement Scores of Experimental Groups I and II

Group	Method	Pre-test			Post-test		Gain Score
		N	Mean	S.D	Mean	S.D	
I	Autonomous	37	7.75	2.24	17.20	2.61	9.42
II	Autonomous	43	7.15	2.33	12.40	3.14	5.25
Mean difference			0.62		4.80		

Result in Table 1 indicated that the pre-test mean achievement scores for experimental groups I and II were 7.75 and 7.15 with standard deviation of 2.24 and 2.33 respectively and mean difference of 0.62 at pre-test. This indicated that both Experimental groups I and II were relatively at the same cognitive level before treatment. However, the post-test achievement

mean scores for Experimental groups I and II were 17.20 and 12.40 respectively with standard deviation of 2.61 for Experimental groups I and 3.14 for experimental group II and mean difference of 4.80. The achievement gain score for Experimental group I was (9.42) over that of experimental group II (5.25). The higher achievement gain score of experimental group I (9.42) over experimental group I (5.25) indicated that autonomous method has relative effect on students' academic performance in Chemistry.

Research Question 2: What is the effect of gender on the mean achievement scores of students taught Chemistry using autonomous method?

Table 2: Mean Achievement Scores of Male and Female Student in Experimental Groups I and II.

Group	Method			Pre-test		Post-test		Gain Score
		Sex	N	$\bar{X}$	S.D	$\bar{X}$	S.D	
I	Autonomous Method	M	15	8.38	2.22	16.61	2.37	8.22
		F	22	7.27	2.18	17.68	2.74	10.40
II	Autonomous Method	M	23	7.70	1.78	11.90	2.22	4.20
		F	20	6.60	2.72	12.90	3.85	6.30

Table 2 shows that the pre-test achievement mean scores for Experimental group I male and female were 8.38 and 7.27 with standard deviation of 2.22 and 2.18 respectively; indicating that both male and female students in the Experimental group I were at the same cognitive level before treatment. On the other hand the post-test achievement mean scores for Experiment I group male was 16.61 and females 17.68 with standard deviation of 2.37 and 2.74 respectively with gain score of 8.22 for male and 10.40 for female students respectively indicating that autonomous method enhances female students' achievement in Chemistry more than the male students. On the other hand, in the experimental group II the male and female students' pre-test mean scores were 7.70 and 6.60 respectively with standard of 1.78 for males and 2.72 for females, indicating that male students performed better than the female students before treatment. However, the post-test scores for the experimental group II male and females were 11.90 and 12.90 with standard deviation of 2.22 and 3.85 respectively and achievement gain score of 4.20 for male and 6.30 for females indicating also that autonomous methods has relative effect on female students' achievement more than male students in Chemistry.

Testing of Hypotheses

Null Hypothesis 1: There is no significant effect in the mean achievement scores of students taught Chemistry with autonomous methods.

Table 3: Analysis of Covariance (ANCOVA) for the Effects of Autonomous Methods on Students' Mean Achievement Scores in Chemistry.

Sources of Variance	SS	df	MS	F-ratio	Sig.
Corrected Model	4.72.726	2	236.136	28.38	.00
Intercept	1736.664	1	1736.664	208.771	.00
Pre-test	11.476	1	11.676	1.380	.24
Method	472.099	1	472.099	56.75	.00
Error	640.524	77	8.318		
Total	18636.000	80			
Corrected Total	1112.800	79			

Result of data analysis in table 3 shows that the probability value associated with the calculated value of F (56.75) for the effect of method on the achievement of students is 0.00. Since this value (0.00) is less than the 0.05 level of significance, the null hypothesis is rejected. Hence there is a significant effect in the mean achievement scores of students taught Chemistry using autonomous method.

Null Hypothesis 2: There was no significant effect in the mean achievement scores of male and female students taught Chemistry using autonomous method.

Table 4: Analysis of Covariance (ANCOVA) for the Effect of Gender on Student Mean Achievement Scores in Chemistry Taught Using Autonomous Method

Sources of Variance	SS	df	MS	F-ratio	Sig.
Corrected Model	487.581	4	121.895	14.622	.00
Intercept	1552.061	1	1552.061	186.182	.00
Pre-test	5.432	1	5.432	.652	.42
Group	452.876	1	452.876	54.326	.00
Gender	15.288	1	15.288	1.834	.18
Group* Gender	.024	1	.024	.003	.095
Error	625.219	75	8.336		
Total	18636.000	80			
Corrected Total	1112.800	79			

The analysis in Table 4 was done to test hypothesis 2. The analysis shows that the probability value associated with the calculated value of F (1.834) for the effect of gender on students' achievement is 0.18. Since this value is greater than 0.05 level of significance, the null hypothesis is accepted. Thus, gender has no significant effect on the students' academic performance when taught chemistry using autonomous method.

Discussion of Findings

The significant effect observed in the mean achievement scores of students taught Chemistry using the autonomous learning method can be attributed to the unique features of this approach, which actively engages students in their learning. Autonomous learning empowers students to take control of their learning process, promoting independent inquiry, critical thinking, and problem-solving abilities. This learner-centered method allows students

to explore Chemistry concepts at their own pace, utilize digital tools, and engage in hands-on activities, making abstract ideas more tangible and relevant. As a result, students become more motivated, develop stronger metacognitive skills, and ultimately achieve higher academic performance compared to those taught using conventional methods that often limit student engagement and creativity. This finding agrees with those of Costner (2012) and Yaushua (2021) although they used different approaches as explained above. This is because autonomous learning strategies has the potential of creating in students the power of enquiry, interaction with a variety of models of Chemistry concepts as well as improve their heuristic problem-solving skills. It could have the power of encouraging investigative skills and thereby paving the way for mathematical activities that could lead to a higher cognitive level of achievement.

Furthermore, the finding that gender has no significant effect on students' academic performance when taught Chemistry using the autonomous learning method highlights the inclusive nature of this approach. Autonomous learning minimizes gender-based effects by providing equal opportunities for both male and female students to participate in problem-solving tasks, practical experiments, and collaborative learning activities. The result also aligns with the findings of Yaushua (2021), who observed no significant effect in the achievement of students by gender when exposed to similar strategies. However, this outcome contrasts with the findings of Lauchance and Mazzocco (2016), Blossfield et al. (2019), as cited in Clement and Anyor (2021), who found that male students outperformed female students in some learning contexts. Despite these differences, it is evident that the autonomous learning strategy, particularly when supported by technology such as computers, is gender-friendly and fosters equal engagement. It emphasizes hands-on and minds-on learning, allowing students to actively explore, experiment, and interact with Chemistry concepts, which in turn can lead to improved achievement and understanding of the subject.

Conclusion

This study examined the effect of autonomous learning strategies on students' academic performance in Chemistry, with a focus on the effect of gender on the students' performance. The findings demonstrated that students who learned through autonomous methods performed significantly better in their academics in chemistry. This suggests that autonomous learning fosters deeper understanding, encourages active engagement, and enhances critical thinking and problem-solving abilities among students. Additionally, the results showed no significant effect in achievement between male and female students when exposed to autonomous learning strategies. This indicates that autonomous learning is an inclusive approach that benefits all students equally, regardless of gender. It provides opportunities for hands-on and minds-on learning, which supports improved comprehension and retention of Chemistry concepts. Overall, autonomous learning proves to be a more effective and equitable instructional approach compared to traditional methods. It empowers students to take charge of their own learning, promotes self-regulation, and prepares them for lifelong learning. These findings

highlight the importance of integrating student-centered teaching methods into Chemistry education to enhance achievement and close gender gaps in science learning.

Recommendations

On the basis of the research findings, the following recommendations have been developed:

- i. Autonomous learning strategies be incorporated into the Chemistry curriculum to foster independent learning and improve students' academic performance.
- ii. Schools should invest in and provide access to technological tools and digital resources to support autonomous learning, ensuring all students can benefit regardless of background.

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