



**EFFECTS OF GAGNE'S INSTRUCTIONAL STRATEGY ON SENIOR SECONDARY
SCHOOLS CHEMISTRY STUDENTS' ACADEMIC ACHIEVEMENT AND
ATTITUDES IN HADEJIA EDUCATION ZONE JIGAWA**

Ummi Abubakar

Department of Physical Science Education,
ADUSTECH Wudil, Kano, Nigeria
abubakarummi04@gmail.com

And

Dr. Isyaku, Zarewa Bala

balalaisyakuzarewa@gmail.com

And

Prof. J.S. Mari

Department of Science Education
Ahmadu Bello University, Zaria

And

Muhammad Aminu Abubakar

Department of Economics
Federal University Dutse Jigawa Nigeria
State, Nigeria.
mabubakar@fud.edu.ng

And

Dr. Yusuf Adamu, Bello Shuaibu, Hassana Abullahi Wakil & Gambomi Abdulkadir

Department of Physical Science Education,
ADUSTECH Wudil, Kano, Nigeria

Abstract

This study investigated the effect of Gagne's instructional strategy on students' achievement and attitude toward balancing chemical equations in chemistry. Specifically, the study sought to determine the difference in achievement and attitude of students taught using Gagne's instructional strategy and those taught using the conventional lecture method, as well as examined the effects of gender on students' achievement and attitude when exposed to the Gagne's instructional strategy. A quasi-experimental research design was adopted for the study. The population comprised of 12,361 senior secondary school students, from which a sample of 127 students were selected using stratified random sampling technique and assigned to experimental and control groups. Two instruments were used for data collection: the Balancing Chemical Equation Achievement Test (BCEAT) and the Students' Attitude toward Chemistry Questionnaire (SASQ). The data collected were analyzed using descriptive statistics of mean and standard deviation to answer the research questions. Inferential statistics including the independent samples t-test and Mann-Whitney U test were employed to test the null hypotheses at 0.05 level of significance. The findings of the study revealed that students taught using Gagne's instructional strategy performed significantly better in achievement than those taught using the lecture method. Furthermore, students in the experimental group developed a significantly more positive attitude toward chemistry compared to those in the control group. The study concluded that Gagne's instructional strategy is effective in enhancing students' academic achievement and attitude toward chemistry



and is equally beneficial to both male and female students. The study has the following recommendations: that chemistry teachers should adopt Gagne's instructional strategy; educational authorities should organized seminar and workshops; leaner centred methods should promoted; and gender inclusiveness to reduced gender bias.

Keywords: Gagne's Instructional Strategy, Students' Academic Achievement, Attitudes.

Introduction

Science and technology are crucial drivers of sustainable development and socioeconomic growth globally, empowering individuals and fostering societal progress. They enable people to adapt to new challenges, contribute actively to their communities, and unlock their full potential, as highlighted by Ibrahim, Adamu and Ibrahim (2018). Effective science instruction in schools is vital for transferring knowledge to real-world problems, helping students develop a deep understanding of scientific principles. Science itself is a universal discipline involving observations and experiments to comprehend the physical and natural world, ranging from the air we breathe to the food we eat. Science education, therefore, delves into how scientific knowledge is taught, learned, and understood, aiming to equip students to interpret scientific explanations, evaluate evidence, understand the nature of scientific knowledge, and engage productively in scientific practices, with chemistry being a significant component (Zarewa, 2023; Windschitl, 2016).

Chemistry, as a fundamental branch of science, focuses on the study of chemicals, elements, and the properties and composition of matter (Zarewa, 2023). It plays a critical role in addressing contemporary sustainability challenges such as environmental pollution, climate change, energy production, and waste management, necessitating its teaching within a relevant context (Jegstad & Sinnes, 2015). Despite its importance as a core science subject required for admission into various science-based tertiary programs (Adejuyigbe, 2016),

students' academic performance in chemistry has been consistently poor in external examinations like WAEC and NECO, as reported by (Nagari, Kankia, Yusuf, & Shuaibu, 2024). This decline is often attributed to the prevalent use of traditional lecture methods by teachers, which fail to promote meaningful learning and often lead to misconceptions and low achievement (Dwyer & Childs, 2017; Adu-Gyamfi et al., 2020; Ajayi, 2017; Ejidike & Oyelana, 2015; Graulich, 2015; Hanson, 2017; O'Dwyer & Childs, 2015). These findings underscore the critical need to investigate and implement more effective instructional strategies, such as Gagne's instructional strategy, which can significantly influence learners' academic achievement and attitude by employing necessary conditions for learning.

Gagne's instructional strategy, comprising nine events, is an instructional design aimed at facilitating effective learning by guiding students from concrete to abstract concepts, which is vital for subjects like chemistry (Sabiru, 2013). These events include gaining attention, informing objectives, stimulating recall, presenting stimuli, providing guidance, eliciting performance, giving feedback, assessing performance, and enhancing retention and transfer (Sabiru, 2013; Ngussa, 2014). This hierarchical learning theory posits that mastering prerequisite concepts is essential for acquiring new, more complex tasks, promoting meaningful learning and improved academic performance (Wang, 2015; Ugwu, 2015). Therefore, this study aims to investigate the impact of Gagne's instructional strategy on students'

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achievement, attitude, and gender in chemistry within the Hadejia Education Zone of Jigawa State, Nigeria (Harefa, Hulu, & Siswanti, 2024).

Statement of Research Problem

Stakeholders in science education have raised concerns about students' underperformance in Chemistry in SSCE and WASSCE

examinations. Despite Chemistry's importance, literature reveals a consistent trend of poor performance in the subject at the senior secondary level (Ogundele, Olanipekun, & Aina, 2014). The table below presents an analysis of NECO results over a three-year period. NECO examination results were used in this study because they were more accessible than WAEC results.

Table 1 NECO Analysis for Chemistry in Hadejia Zone

Year	Number Registered	Number of Credit Score	Percentage of credit score
2016	1797	1581	87.97%
2017	1889	1601	84.75%
2018	1956	1308	66.87%
2019	2010	1640	81.59%
2022	2908	2124	66%
2023	3547	2784	78.48%

Source: Jigawa Education Resource Department (JERD) Report, (2024).

Table 1 above, present NECO analysis for Chemistry in Hadejia Education Zone for the period of 2016, 2017, 2018, 2019, 2022, and 2023 with the credit passed of 87.97%, 84.75%, 66.87%, 66.87%, 81.59%, 66% and 78.48% respectively. The decline in students' performance can be seen between 2019 and 2022 of 15.59%. This ugly outcome is not far from the poor and inappropriate instructional strategies adopted by chemistry teachers, which are the major challenges facing the effective implementation of chemistry curriculum (Esogwa, 2015).

These calls for the adoption of alternative teaching strategies that involves students' active participation, interaction and collaboration which can motivate and encourage problem solving skills in the students. Gagne's learning hierarchy is among the alternative strategies, since it gives students the opportunity to participate, interact and collaborate among themselves in a knowledge acquisition activity, thereby improving their difficulty resolution abilities and enhancing their achievement. However, this study investigated the effect Gagne's

instructional strategy on senior secondary school Chemistry students' academic students and attitudes. Consequently, this research work developed methods of delivery of instruction in Chemistry by exposing SS II students to innovative instructional method which is Gagne's instructional strategy, with the view of students' performance and attitudes in learning chemistry.

Objectives of the study

The objectives of the study were specifically to:

1. determined the effect of Gagne instructional strategy on students' academic achievement in chemistry among science senior secondary schools in Hadejia Educational Zone.
2. examined whether Gagne's instructional strategy significantly influences the attitudes of chemistry students exposed to compared and those taught using the lecture method?

Research Questions



The following research questions were raised for the study:

1. What is the effect of Gagne instructional strategy on students' mean academic achievement scores in chemistry among science senior secondary schools in Hadejia Educational Zone?
2. What is difference in the mean mean attitude scores of chemistry students taught chemistry using Gagne instructional strategy and those taught using lecture method?

Research Hypotheses

The following research hypotheses (H_0) were formulated and were tested at 0.05 level of significance:

H_{01} There is no significant difference in the mean academic achievement scores of students taught chemistry using Gagne instructional strategy and students taught using lecture method.

H_{03} There is no significant difference in the mean academic achievement scores between male and female students taught chemistry using Gagne instructional strategy.

Methodology

The study employed a quasi-experimental control group design, which involved pre-test and post-test assessments (Stratton, 2019). The control and experimental, consisting of both male and female students were employed. A pretest was administered to the two groups, before the treatment to determine the comparability of experimental and control groups' ability level. The experimental group was taught the concept of balancing chemical equation using Gagne's instructional strategy, while the control group was taught the same concept using conventional method of teaching. At the end of the treatment period, a post-test was administered to both groups of students in order to determine the effectiveness of the

treatment on balancing chemical equation. The treatment was carried out for the period of six weeks.

The research design of the study was presented in figure 3.1 below:

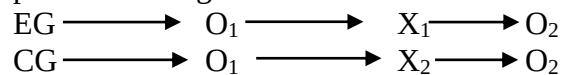


Figure 3.1 Research Design

Note:

EG = Experimental Group

CG = Control Group

O_1 = Pre-Test (Test given before the treatment)

O_2 = Post-Test (Test given after the treatment)

X_1 = Gagne Instructional Strategy

X_2 = Lecture method

The population for this study covered the entire senior secondary two (SS II) chemistry students in Hadejia Education Zone, Jigawa State. According to the Jigawa Education Resource Agency's 2024 report, the Hadejia Education Zone has 21 government-owned science secondary schools, which include five (5) male schools with 2,740 students, 3 female schools with 886 students, and thirteen (13) mixed-gender schools with total of 8,735 students with a total number of 12,361 students.

If the sample drawn from each unit is random one, the procedure is then termed as random sampling (Singh & Mangat, 1996). Two single sex and two mixed sex schools were drawn from 21 secondary schools' population. The unit of sampling was in secondary schools rather than in individual learners, because secondary schools operate as intact classes (Benjamin, 2024). Two single sex and two mix sex schools are sampled for the study, (see table 3.2). To ensure the schools selected are far apart from each other, two experimental and two control schools were randomly selected from each sub-counties using random sampling were



the selection of numbers at random used by using table of random numbers. This is to ensure that each school has an equal chance to be selected. In like manner 31, 44, 25 and 27 students in each category and one hundred and twenty-seven (127) students in all are selected, these figures are in line with Tuckman (1975), Sambo (2008) and Fraenkel and Wallen (2000) who recommend that a minimum sample size of 30% is reasonable figure in arriving at the total number of the subjects to participate in a research study. Hence, the 127 students and 4

schools drawn from the population of 12,361 and 21 schools respectively is in agreement with schools of thought. The average age of student was found to be 16 years. For the purpose of this study and intact classes was used comprising of a total number of 127 number of SS2 chemistry students to ensure that regular class period is not altered. Two schools were assigned as experimental groups and the other two schools served as controlled group as shown in the table 2 below:

Table 2: Sampled Schools

S/N	Names of Schools	Males	Females	Total
1.	GDSS Shagari	16	15	31
2.	GDSS Gawuna	15	10	25
3	GGSS Famfo Goma	-	44	44
4	GSTC Hadejia	27	-	27
	Total	58	69	127

Source: Jigawa State Education Resource Agency report, (2024).

Therefore, the sample size in the research were 127 SS2 students from two (2) single sex and two (2) mixed secondary schools. Nkapa (1997), argued that there is no strict rule for obtaining sample size but Frankel and Wallen (2000), recommended minimum 30 sample size. Hence, this number was adequate for the study. A pretest was administered on the subject in the four schools to determine the equivalence of the subject in the sampled schools. The scores obtained from the schools were subjected to analysis using t-test to determine the equivalence in the ability for the study sample.

Two instruments were developed and adopted by the researcher: Balancing Chemical Equation Achievement Test (BCEAT) and Students Attitude Scale Questionnaire (SASQ), the two instruments were adopted from Sabiru (2013). The questionnaire was divided into two sections:

section A which comprises of students personal data response while in section B, BCEAT was adapted from past questions papers of West African Examinations Council (WAEC), National Examinations Council (NECO) and chemistry textbooks, while SASQ consist of a 5-point Likert scale responses (i.e Strongly agree, Agree, Undecided, Disagree, Strongly disagree) and is on the students attitude level. Balancing Chemical Equation Achievement Test (BCEAT) which were used for pretest and posttest in order to measure the level of performance among SS II students.

The instrument Balancing Chemical Equation Achievement Test (BCEAT) was Pilot tested to assess its reliability and feasibility before being used in the main study. The pilot study was conducted at Government Day Secondary School Wunti (GDSS Wunti) using 30 SS2 students, which was selected from the overall population but



not included in the study sample, this involved test and retest method of Balancing Chemical Equation Achievement Test (BCEAT), the interval between test and retest was 14 days as recommended by Sambo (2008).

Instruments are validated by experts, senior lecturers from both Chemistry and Science Education Departments of Aliko Dangote University of Science and Technology, Wudil. Also two chemistry teachers on the rank of vice principals of a senior secondary school in Hadejia Education Zone. They were requested to do face and content validity. Based on their comments, the content validity of the test was found to be within the ability level of students, free from ambiguities and has covered the study area. It also means that the instruments was able to measure up the intended area of the study.

Reliability is the consistency or stability with which an instrument measures what it claims to measure at any given time. An index of reliability measure is the reliability coefficient (Segal & Coolidge, 2018). In this study, test retest method was used to determine reliability of BCEAT, using Pearson product moment correlation coefficient (PPMC) statistical tool and the test retest reliability of the instrument were 0.85 and 0.75 respectively.

The instrument used for data collections was the Balancing Chemical Equation Achievement Test (BCEAT), used as pretest and posttest. Pre BCEAT test was administered to ascertain their group equivalence on the level of understanding of the research topic at the start of the study,

which test the students prior knowledge on the topic and at the same time, was used as a benchmark to monitor students' progress in the classroom, posttest mark of both the subjects in the experimental and control group were compared to determine their achievement and attitude of the students.

Both the experimental and control groups were taught the same topic but different lesson plan/note was used in teaching the two groups. The treatment lasted for a period of six weeks, after which the post BCEAT was administered to both the experimental and the control group to compare their performance. Student's attitude scale questionnaire (SASQ) was also administered to both experimental and control group, before and after the treatment. After the students have completed their responses, the questionnaire was collected and subjected to the data analysis.

The data generated from the balancing chemical equation achievement test (BCEAT) were analyzed using mean and standard deviation for research questions, while the hypotheses stated in chapter one using analysis of t-test and non-parametric U-test.

The analysis was done with help of Statistical Package for Social Sciences (SPSS) version 23 to make reliable inference from the data, all statistical tests will be tested for significance at alpha (α) level of 0.05.

Results

Research Question One: What is the effect of Gagne instructional strategy on students mean academic achievement scores in chemistry among science senior secondary schools in Hadejia Education Zone?

Table 3: Mean and Standard Deviation of Pretest Scores for Experimental and Control Groups

Group	N	Mean	SD
Experimental	75	2.21	1.74
Control	52	2.48	1.97



Table 3 showed the experimental group had a mean pretest score of 2.21 with a standard deviation of 1.74, while the control group recorded a mean of 2.48 with a standard deviation of 1.97. The closeness of the mean scores indicates that both groups possessed nearly the same level of prior knowledge

before the commencement of the treatment, suggesting initial equivalence of the groups. Research Question Two: What is the mean attitude scores of students in chemistry when taught using Gagne instructional strategy and those taught using Lecture method?

Table 4: Mean and Standard Deviation of Posttest Achievement Scores for Experimental and Control Groups

Group	N	Mean	SD
Experimental	75	22.12	2.39
Control	52	8.88	2.99

Table 4 indicated that, students in the experimental group obtained a higher mean achievement score (22.12) compared to those in the control group (8.88). This indicates that students exposed to Gagne's instructional strategy performed better academically than those taught using the lecture method.

H₀₁: There is significant difference in the mean academic achievement scores of students taught chemistry using Gagne's instructional strategy and students taught using lecture method. This null hypothesis was tested using inferential statistics of independent t-test. The result of the analysis is presented in Table 6.

Null Hypothesis One

Table 6: Independent Samples t-Test of Posttest Achievement Scores for Experimental and Control Groups

Variable	Group	N	Mean	SD	T	df	P-Value	Decision
Posttest	Experimental	75	22.12	2.39	27.66	125	0.000	Reject H ₀
	Control	52	8.88	2.99				
	Total	127						

Table 6 above, shows the independent samples t-test comparison of posttest achievement scores of students in the experimental and control groups. The result indicates that students in the experimental group obtained a higher mean score ($M = 22.12$, $SD = 2.39$) than students in the control group ($M = 8.88$, $SD = 2.99$). The t-test analysis revealed a statistically significant difference between the two groups, $t_{(125)} = 27.66$, $p < 0.05$. Based on this result, the null hypothesis which stated that there is no significant difference in the mean

achievement scores of students taught using Gagne's instructional strategy and those taught using lecture method was rejected. This implies that Gagne's instructional strategy significantly improved students' achievement in balancing chemical equations.

Null Hypothesis Two

H₀₂: There is no significant difference in the mean attitude scores of students taught chemistry using Gagne's instructional strategy and students taught using lecture



method. This null hypothesis was tested using non-parametric statistics of Mann-

Whitney U test. The result of the analysis is presented in Table 7.

Table 7: Summary of Mann-Whitney U Test of Attitude for Chemistry Students in Experimental and Control Groups

Variable	Group	N	Mean Rank	U	Z	P-Value	Decision
Attitude Score	Experimental	75	90.00	0.00	-9.58	0.000	Reject H_0
	Control	52	26.50				
	Total	127					

Table 7 above, presents the Mann-Whitney U test comparison of students' attitude scores between the experimental and control groups. The result shows that students in the experimental group obtained a higher mean rank (MR = 90.00) than students in the control group (MR = 26.50). The Mann-Whitney U analysis further revealed a statistically significant difference between the two groups, $U = 0.00$, $Z = -9.58$, $p < 0.05$. Based on this result, the null hypothesis which stated that there is no significant difference in students' attitude toward chemistry between the experimental and control groups was rejected. This implies that students exposed to Gagne's instructional strategy developed a significantly more positive attitude toward chemistry than those taught using the lecture method.

Discussion of the Findings

The findings are interpreted in relation to instructional effectiveness, learner engagement, and gender equity in science education.

The first finding of the study revealed a clear difference in the mean achievement scores of students taught using Gagne's instructional strategy and those taught using the lecture method. Students in the experimental group recorded a substantially higher mean score than students in the control group. The corresponding hypothesis test further showed that this difference was statistically

significant. This implies that the instructional strategy had a strong positive effect on students' academic achievement in balancing chemical equations. The effectiveness of Gagne's instructional strategy can be attributed to its structured sequence of instructional events, which systematically guide learners from attention and motivation to practice, feedback, and retention. Such a learner-centred approach enhances comprehension, reduces cognitive overload, and promotes active participation, thereby improving academic outcomes. This finding supports the general educational principle that structured and interactive teaching strategies tend to yield better learning results than the lecture methods. This is in agreement with the findings of Sabiru (2013), Abadi & Ghotbaddini (2023) and Musa (2024).

The second finding of the study showed a significant difference in students' attitude toward chemistry between the experimental and control groups. Students who were taught using Gagne's instructional strategy demonstrated more positive attitude compared to those taught through the lecture method. The hypothesis test confirmed that this difference was statistically significant. This result indicates that beyond improving cognitive performance, the instructional strategy also enhanced the affective domain of learning. The interactive and motivational elements embedded in Gagne's instructional



events such as gaining attention, providing guidance, and offering immediate feedback likely increased students' interest, confidence, and enjoyment of the subject. Positive attitude is a critical factor in science learning because it influences persistence, curiosity, and willingness to engage with complex concepts. Therefore, the improvement in attitude observed in this study reinforces the value of learner-centred instructional strategies in fostering both intellectual and emotional engagement in chemistry. This in line with Sabiru (2013) and Yusuf (2013).

The results underscore the importance of structured, learner-centred instructional approaches in secondary school chemistry classrooms. By improving both cognitive and affective learning outcomes without gender bias, such instructional strategies contribute significantly to inclusive and effective science education.

Conclusion

Based on the findings of this study, it can be concluded that Gagne's instructional strategy is an effective teaching approach for improving students' academic achievement in balancing chemical equations. The strategy not only enhances students' cognitive understanding of chemistry concepts but also promotes a positive attitude toward the subject.

This indicates that the strategy is inclusive and suitable for diverse classroom settings. Overall, structured and learner-centred instructional approaches such as Gagne's model play a significant role in improving both academic performance and students' attitude towards chemistry.

Recommendations

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

1. **Adoption of Gagne's Instructional Strategy:** Chemistry teachers should adopt Gagne's instructional strategy in teaching balancing chemical equations and other chemistry topics, as it has been shown to significantly improve students' academic achievement.
2. **Chemistry Teacher Training and Workshops:** Educational authorities and school administrators should organize seminars, workshops, and professional development programmes to train chemistry teachers on the effective implementation of structured instructional strategies such as Gagne's model.
3. **Attitude Development in Science Classrooms:** Teachers should deliberately employ motivational and feedback-oriented teaching techniques to foster positive attitudes toward chemistry and other science subjects among students.

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