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Effect of Conceptual-Change Instruction on Performance in Chemical Equations among Secondary School Students in Giwa Education Zone, Kaduna State, Nigeria

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Abstract

This study investigated the effects of Conceptual-Change Instructional Strategy on Performance in Chemical Equations among secondary school students in Giwa Education Zone, Kaduna State, Nigeria. The population comprised of 4,401 SS II Chemistry students, and sample of 98 students from two public coeducation senior secondary schools were selected from the 18 senior secondary schools in Giwa Education Zone. The study adopted the pre-test, post-test quasi experimental and control group design. The students in Experimental group were taught the concept of Writing and Balancing Chemical Equations using Conceptual-Change Instructional Strategy while those in Control group were taught the same concept using Conventional method for the period of six weeks. The Instrument used for data collection was Chemical Equations Performance Test (CEPT) with reliability coefficients of 0.81 and 0.75 respectively. Two Objectives, two research questions and two null hypotheses were formulated and tested to guide the study. Independent t-test and Mann-Whitney (U-test) statistical tools were used to test the null hypotheses at $p \leq 0.05$ level of significance. The findings revealed among others that there was statistically significant difference between the mean performance scores of students in experimental and control groups in favour of the experimental group; the findings also revealed that there is no statistically significant difference between the male students and the female students in the experimental group. It was therefore recommended among others, that senior secondary school Chemistry teachers should endeavour to use the Conceptual-Change Instructional Strategy while teaching Writing and Balancing Chemical Equations (WBCE), in order to improve students' Academic Performance in the Concept.

Keywords: Conceptual-Change, Instructional Strategy, Performance, and Chemical Equations

Introduction

Chemistry plays a pivotal role in engineering sustainable economic development and growth in any nation. Kenni (2020) described chemistry as the catalyst of sustainable national growth and development. It is recognized as the gateway to future professions in various fields of studies like Agricultural Science, Biochemistry, Engineering, Medicine, Pharmaceutical Science, among others. According to Jimson (2018), Chemistry should be studied in schools so as to increase man's knowledge and further improve the quality of understanding the environment for survival. Chemistry education has been seen as one of the major bedrock, for the transformation of national economy; and therefore, must be adequately attended to, due to the gains of learning and advancement of science education. Despite the key role of chemistry as the central science that forms the basic foundation to many disciplines and in improving the quality of life, the performance of Nigeria secondary school students in the subject remained a matter of serious concern for many years (Jegede, 2018). This means that the massive failures in Chemistry subject still persist. Some of the attributed reasons to this problem are inability of teachers to pass chemistry ideas across to students which may be due to the teaching methods used, instructional materials, and students' wrong perceptions that chemistry is difficult, to mention but few (Oladejo, Ademola, Ayanwale & Tobih, 2023). Among the reasons for students' perceptions on chemistry as being difficult subject, according to Thangavel (2019) in accordance with Njoku & Attah (2018), are the theoretical nature of the subject and its' abstractness; in which Writing and Balancing Chemical Equations is one of them. Chemical Equations are the symbolic and quantitative representations of the changes that occur in the process of chemical reactions, based on the principle that matter is neither created nor destroyed during chemical reactions (Dula, 2018; Baah & Ampiah, 2022). Chemical Equation shows the chemical formulas of substances that are reacting and the substances that are produced. This means that the number of the atoms of the reactants and products need to be balanced.

For example, the chemical equation: $x A + y B \longrightarrow p C + q D$ shows that A and B are the reactants while C and D are the products. The subscripts x, y, p and q are the stoichiometric coefficients which represent the relative amount of



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substance of the reactants and products. The single-headed arrow indicates the direction of the reaction and shows that the reaction is an irreversible one. The arrow means “gives”, “yields”, “produces” or “forms” and the plus (+) sign means “and”. However, studies have shown that the ability to write chemical equations correctly is not a simple one Dula (2018). It is one that requires a functional understanding of the requisite subordinate concepts of atoms and atomicity, molecules and molecular formula, atomic structure and bonding, valency, use of brackets, radicals, subscripts and coefficient and molar ratio (Baah & Ampiah, 2022). Therefore, this study investigated the effects of Conceptual-Change Instructional Strategy on Academic Performance in Writing and Balancing Chemical Equations among Secondary School Students in Giwa Education Zone, Kaduna State, Nigeria. Writing and Balancing of Chemical Equations is so fundamental that without mastery in it, students find every other aspect of chemistry difficult (Ekere, 2014). Poor foundation in the teaching and learning of Writing and Balancing Chemical Equations makes the learning of chemistry not effective. The ability to correctly balance chemical equations is a fundamental requirement of any chemistry curriculum; however, the process of balancing and interpreting chemical equations appear to cause much difficulty to many students (Grimes, 2022). Thangavel (2019) observed that when a student cannot write and balance chemical equations correctly, he cannot communicate effectively within the chemistry community. This is because the medium of expression in chemistry is the chemical equation, which means that formulae show chemistry at a standstill while equations show chemistry in action. One of the learners’ factors that generally affect meaningful learning in chemistry especially chemical equations, according to Baba (2018), is the misconceptions held by students on chemistry concepts. Concepts are cognitive and abstraction that represents classes of things, events or ideas (Chavan & Patankar, 2025). They are generally seen as natural semantic categories which help to unite things, qualities and occurrence on the basis of similarity of characteristic. Concepts are kinds of mental glue that tie our experiences to our present interactions with the world, and because the concept themselves are connected to our larger knowledge structure. And when a learner makes wrong perception on a particular concept, especially in chemistry, it becomes misconception.

Misconceptions in Writing and Balancing Chemical Equations cannot be overlooked, as it is the expression medium or mirror image of chemistry. While reviewing some studies in science education literature, especially in chemistry, such as those of Kalpana (2024), Baba (2018) and others, it has been observed that students enter the learning environment with many misconceptions about topics like stoichiometry, mole concept, volumetric analysis, Faraday’s law of electrolysis, chemical equilibrium and others; all mainly in their equation aspects. Therefore, concept of chemical equation is also one that encompasses both invisible and abstract conceptions; and about what students have misconceptions. Among other misconceptions in Writing and Balancing Chemical Equations is that students confused subscripts in chemical formulas with stoichiometric coefficients in chemical equations. Yusuf (2023) found that students commonly harbour misunderstandings while Writing and Balancing Chemical Equations which hinder stoichiometry problem-solving. Also, Dula (2018) stated that lack of knowledge of valence numbers and failure to understand Concepts like atomicity, uses of brackets, the significance of subscripts and coefficients, contribute to students’ difficulties. Misconceptions are found highly resistant and cannot be easily removed by traditional methods, which are more or less like rote-learning, since students often fail to construct consistent relations between concepts; thus, Onder (2026) revealed that they also fail to integrate their ideas into appropriate conceptual frameworks after traditional instruction. In order to remove or remediate misconceptions, alternative instructional approaches need to be used so as to overcome misconceptions and then facilitate learning. Also, Onder (2026) suggested that these instructional approaches or strategies ought to be consistent with constructivist view of learning where each learner is actively engaged in constructing knowledge, where the links between the new information and the prior knowledge is constructed actively. This is in conjunction with Ausubel’s theories of learning, including Xu, Villafane and Lewis (2023) as pointed out that the effect of prior knowledge depends on the type of instructional method used. Moreover, these approaches stress the importance of conceptual change. Conceptual-change is the process whereby concepts and relationships change over the course of an individual lifetime or over the course of history. It is generally defined as learning that changes an existing conception like belief, idea or way of thinking (Wikipedia, 2018). According to Campbell, Cook, Kusch and Moulton (2009), there are five (5) specific strategies, in the 1992 version of the stages of change model, to promote an individual behaviour to the next stage and prevent a relapse to a previous stage; and these are: (i) Precontemplation [this means not to think about change of a situation]; (ii) Contemplation [this is to think about change by weighing its’ pros and cons]; (iii) Preparation [this is intending to take



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action on changing within next month]; (iv) Action [this is to actively involved in the changing process]; (v) Maintenance [this is to have maintained the change for at least six months, and working to prevent relapse]. Performance is stimulated by interest, and lack of interest may be caused by uninteresting teaching methods (Chukwu, 2021). Academic performance, as observed by Shuaibu (2017), is the exhibition of knowledge attained or skills developed by learners in a course of study including the test scores administered by teachers. It is the overall measure of academic performance of students in a given test after a period of instruction and teaching, usually weighed as a score (Lawal, 2020). Vonstumni, Sophie, Hell, Benedict, Chamoro and Thomas (2021) lamented that academic performance of students are being embedded by some several factors, which may include the family background of the students, types of school and its' location, truancy, educational background of the parents, influence of peer group, qualification and quality of the teacher, and many more. Also, Salisu (2026) ascertained that academic performance is influenced by a number of factors such as instructional materials available, class size, qualification and experience of science teachers, teaching strategies employed among others. Studies on academic performance like that of Canpolat, Pinarbasi, Bayrakoecken and Gebar (2026) founded that Conceptual-Change Approach enhances students' understanding of Chemical Equilibrium Concepts. Therefore, the learners who performed academically well have more advantages over their counterparts; since Nuthanap (2017) and Daulta (2018) said, in their researches, that academic achievement is the main criterion to judge students' potentials and capabilities. It is on this base that this study aims to investigate if Conceptual-Change Instructional Strategy can enhance the Academic Performance based on Gender, i.e. both male and female learners. The importance of gender to science learning cannot be over-emphasized. One of the major goals of reforming science education is to ensure science-oriented program for every child to partake actively and maximally learn; irrespective of sex, social background or ability levels (Gadzama, 2022). Gender is the biological and sexual characteristics by which an individual is identified with as being male or female. It is one of the factors that interacts with students' academic performance in teaching and learning of science (Olorukooba, Lawal & Jiya; 2012). Issues of gender in relation to enrolment, participation and academic performance have raised a lot of concern in science education. Okoye (2023) saw gender as a range of physical, mental and behavioural characteristics pertaining to and differentiating the masculinity and femininity of an individual. A number of studies have shown that gender affects students' performance in science education; however, the extent to which that assertion is true still remains an issue to be backed up by empirical evidence. Duniya (2019) opined that gender issues in science education as it affects performance remain unsolved. Ihuarulam (2022) observed that the influence of gender on students' performance and misconceptions in Nigeria has for a long been a concern to educational researchers; and there are different views on the influence of gender on students' performance and misconceptions in science. While some reported that gender had no effect on performance and misconceptions in science (Usman & Lawal, 2017), others observed that female students were significantly better than the male students (Bunkure, 2012; Yusuf, 2013). Contrary to the view expressed above, some other researchers explained that male students were superior over their female counterparts in science achievement and also possessed fewer misconceptions (Kauru, 2024). Thus, the effect of gender on learning outcomes in sciences still remain an issue of debate among educators because of conflicting results from studies that focus on gender and performance. It also means that performance differ individually, and also among gender. Therefore, this study investigated the effects of Conceptual-Change Instructional Strategy on Academic Performance in Writing and Balancing Chemical Equations among Secondary School Students in Giwa Education-Zone, Kaduna State, Nigeria.

Statement of the Problem

With global Scientific and Technological growth so occurring rapidly, according to Onwuegbuzie (2020), the declining Students' interest in science courses and career (especially Chemistry) is a worldwide concern that has prompted reform efforts in science education on an international scale. The belief by some students that chemistry is a difficult subject has adversely affected their interest and performance in both internal and external examinations. Chemistry educators, as reported by Muhammad (2024^a), are continuously researching for better approach in teaching and learning chemistry so as to bring about meaningful learning; and also identify the factors that are responsible for the persistence poor performance in chemistry subject. Science educators (Baba, 2018) have reported the poor performance in science subjects, especially chemistry, in both Senior Secondary Certificate Examination (SSCE) and West African Senior School Certificate Examination (WASSCE) which are organised and conducted by National Examination Council (NECO) and West African Examination Council (WAEC) respectively. A critical look at the data from public examination body of WAEC (2018-2025) and NECO (2018-2025) indicates that the academic performance of Nigerian Chemistry Students over years is not



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encouraging as the enrolment increases. WAEC Chief Examiners' Reports (2018-2025) also lamented that the percentage of students that pass chemistry at credit level was very low compared to the total entry, and this could be attributed to numerous factors such as lack of students' Conceptual knowledge (especially in the aspect of Writing and Balancing Chemical Equations), lack of understandable teaching method, lack of integrating teaching method with instructional materials, predominant use of lecture method, among others. This incidence of poor performance is attributed to many factors like improper use of instructional materials (Enohuean, 2018), constant use of lecture method (Efe, 2017), students' misconception in Science (Amadi and Uzoma, 2018), to mention but few. It is on these premises that this study seeks to use Conceptual Change as an instructional strategy to assess its effects on Academic Performance in Writing and Balancing Chemical Equations among Secondary School Students in Giwa Education-Zone, Kaduna State, Nigeria.

Objectives of the Study

The objectives of this study were to:

1. find out the difference between the mean academic performance of Secondary School Chemistry Students taught Writing and Balancing Chemical Equations using Conceptual-Change Instructional Strategy and those taught the same concept using Conventional Teaching Method.
2. ascertain the difference between the mean Academic Performance of male and female Secondary School Chemistry Students in Writing and Balancing Chemical Equations when exposed to Conceptual-Change Instructional Strategy.

Research Questions

The study sought to provide answers to the following research questions:

1. What is the difference between the Academic Performance mean scores of Secondary School Chemistry students taught concept of Writing and Balancing Chemical Equations using Conceptual-Change Instructional Strategy and those taught the same concept using Conventional Teaching Method?
2. What is the difference between the Academic Performance mean scores of male and female Secondary School Chemistry Students in Writing and Balancing Chemical Equations when exposed to Conceptual-Change Instructional Strategy?

Null Hypotheses

The following null hypotheses were formulated to test the above-mentioned research questions at $p \leq 0.05$ level of significance:

- H₀₁:** There is no significant difference between the Academic Performance mean scores of Secondary School Chemistry students taught the concept of Writing and Balancing Chemical Equations using Conceptual-Change Instructional Strategy and those taught the same concept using Conventional Teaching Method.
- H₀₂:** There is no significant difference between the Academic Performance mean scores of male and female Secondary School Chemistry Students in Writing and Balancing Chemical Equations when exposed to Conceptual-Change Instructional Strategy.

Research Design

This study is non-randomized Quasi-Experimental employing Pre-test Post-test Control Group Design, as suggested by Kerlinger (1973). Intact classes of SS II Chemistry Students were selected randomly in order to avoid disruption of normal class lessons, and they were divided into two major groups. One group was assigned as experimental group (EG) while the other was control group (CG). Before the treatment, the two groups were pre-tested (O_1) on performance (CEPT), in order to get the differences in terms of ability between the experimental and the control groups. Then the experimental group was exposed to Concept of Writing and Balancing Chemical Equations using Conceptual Change Instructional Strategy (X_1) while the Control Group was exposed to the same Concept using the conventional Lecture Method (X_0). After six (6) weeks of treatment, both groups were subjected to post-test (O_2) using the performance test (CEPT), so as to determine the effectiveness of Conceptual Change Instructional Strategy (CCIS) on the Students' Academic Performance in Writing and Balancing Chemical Equations. The population of the study consist of all the second-year students in public Senior Secondary Schools (SS II) offering Chemistry in Giwa Education-Zone, Kaduna State, Nigeria. There were total numbers of eighteen (18) Public Senior Secondary Schools found in the Zone, and the schools are both co-educational and single-sexed comprising 2,133 male students and 2,268 female students; and they were located within three (3) Local Government Areas which are Sabon-gari, Kudan and Giwa in Kaduna State. These eighteen (18) schools comprise of sixteen (16) co-



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educational and two (2) single-sexed schools being purely female schools. The choice of SS II was considered appropriate because the students have been more exposed to some basic Chemistry concepts than SS I who have not yet gained more academic experience, and also SS III who were busy preparing for their SSCE examinations. Purposive and simple random sampling techniques were used in selecting the sample of the study. Co-educational schools were purposively selected, while the simple random sampling technique was used to select four schools. The selected schools were subjected to general chemistry performance test, and the result obtained were subjected to analysis of variance (ANOVA) and Scheffe's test; in order to test the ability level of the students (Equivalence test), to know which schools are significantly difference or not. Two schools that were found to have similar ability level became the experimental and control group. This was done using simple random sampling through hat and drop method. The sample size for this study was started with a total number of one hundred (100) but ended with a total of ninety-eight (98) SS II Chemistry Students in which forty-seven (47) of them were male while the female were fifty-one (51). This is in consensus with the Central Limit Theory (CLT) who recommends $N \geq 30$ sample size in any population, as in compliance with Guilford & Frucher (1973), Tuckman (1975), Gay (1996), Sambo (2008) and Usman (2010).

Sample for the Study

S/N	School	Group	No of SS II Sampled Male Female		Total
1.	School A	Experimental	23	28	51
2.	School B	Control	25	22	47
	Total		48	50	98

The decision as to which of the two schools was to be used as the experimental or control group was made by using simple random sampling technique through hat and drop. This was done by writing the names of the remaining two schools each on a separate small piece of paper and folded, then asked a child to pick one paper. The first paper picked was assigned as group A (Experimental) while the second one is automatically group B (Control). An instrument Chemical Equation Performance Test (CEPT) was used for the study and it was adapted by the researcher in order to test the students' knowledge in Writing and Balancing Chemical Equations as contained in the senior secondary schools' syllabus. The CEPT instrument was adapted from Chemistry West African Examination Council (WAEC) past questions papers ((2018-2025)). Validity of a test item concerns what a test measures and how it does it. So; for error reduction, the instrument: CEPT were subjected to face and content validation by the panel of science educators who are experts in the subject area and in test construction. Also, the content validity of CEPT was validated by three experts comprising Professors and Doctors: two from Science Education Department (ABU, Zaria), one from Chemistry Department (ABU, Zaria). The instrument CEPT was pilot tested in order to clarify or to further determine the reliability coefficient and feasibility of these developed instruments, such as their facility and discrimination indices. The target participants for this pilot testing were 30 SS II Chemistry students in DSS, Samaru who are parts of the population but not in the sample of the study. Test-retest method was used for the reliability of CEPT. The first test was given to the participants, and the second test was administered after two weeks interval. This was in line with the recommendations of Tuckman (1975) and Sambo (2008); which proposed that at a minimum of two weeks interval for test-retest procedure, students might have forgotten the contents of the first test given. Pearson Product-Moment Correlation Coefficient (PPMCC) statistic was used by the application of SPSS in analysing the reliability coefficient (r) on the instrument. Based on the data obtained from pilot testing of the CEPT, the reliability coefficient (r) of the instrument used for this study was estimated to be $r = 0.75$. This indicated that the instrument is reliable, and was used for the study. The study involved Writing and Balancing Chemical Equations using Conceptual Change Instructional Strategy. The lesson plan for experimental group was designed based on Conceptual Change Instructional Strategy while the control group was taught Writing and Balancing Chemical Equations using the conventional method lesson plan. In other to have an effective data collection, familiarization visits were made to selected schools with a formal introductory of letters and also to seek permission from the appropriate authorities to carry out the research in the schools. Based on these permissions, the Chemistry teacher of each selected schools introduced the researcher to the students selected as study subject before the actual teaching. The instruments developed by the researcher were administered both at the beginning as pre-test and after the treatment as post-test, and the students responded to the test items in the presence of the researcher. The instrument Chemical Equations Performance Test (CEPT), were administered by the researcher for a period of 60 minutes as pre-test to both the experimental and control groups in

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order to test their academic performance level before treatment. The pre-test scores of the experimental group was obtained prior to the administration of treatment to serve as data for determining the equivalence of the experimental and control groups. After the administrations of pre-test, the experimental group was taught by the researcher on how to balance Chemical Equations using Conceptual-Change Instructional Strategy, while the control group was also taught the same concepts of balancing Chemical Equations by the researcher using Conventional Method. Six weeks of instruction were spent with both experimental and control groups, using a total of 60 minutes per week. Immediately after the six weeks of treatment, post-test was administered to both groups. The instruments were retrieved immediately on completion by the respondents while scores were then collated based on the groups' performance, and subjected to data analysis based on research questions and hypotheses formulated. The post-test scores obtained after the treatment administration served as data to measure any significant changes in students' academic performance. The responses of the Chemical Equations Performance Test (CEPT) were scored using the marking scheme. Each correct response was scored two marks with a maximum score of 100 marks. Probability level of $p \leq 0.05$ was used for retaining or rejecting the stated null hypotheses (H_0). The data collected were analysed with Statistical Package for the Social Science (SPSS). Mean and standard deviation were used to answer the research questions while the scores obtained from CEPT provided the data for testing the stated hypotheses 1-2.

Presentation of Results

Research Question One:

What is the difference between the Academic Performance mean scores of Secondary School Chemistry students taught concept of Writing and Balancing Chemical Equations using Conceptual-Change Instructional Strategy and those taught the same concept using Conventional Teaching Method?

Table 2 Mean and Standard Deviation on Academic Performance Scores of Students in the Experimental and Control Groups.

Groups	N	Mean	Std. D	M. df
Experimental	51	47.08	7.74	10.95
Control	47	36.13	11.49	

The result of the descriptive statistic in Table 2 showed the mean academic performance scores for students in the experimental group to be 47.08 with a standard deviation of 7.74, while the mean academic performance scores for their counterparts in the control group was 36.13 and a standard deviation of 11.49; Thus, having a significant mean difference of 10.95. This indicated that there was difference between the mean academic performance scores of experimental group and the control group, when taught Writing and Balancing Chemical Equations using Conceptual-Change Instructional Strategy and those taught the same concept using Conventional Teaching Method in favour of the experimental group. To test whether the mean different was significant or not, null hypothesis One was tested.

Null Hypothesis One: There is no significant difference between the Academic Performance mean scores of Secondary School Chemistry students taught the concept of Writing and Balancing Chemical Equations using Conceptual-Change Instructional Strategy and those taught the same concept using Conventional Teaching Method.

Table 3: t-test Analysis on the difference between the Mean Performance Scores for Experimental and Control Groups

Groups	n	Mean	Std. D	df	t-cal.	P	Remark	Decision
Experimental	51	47.08	7.74	301	5.57	0.00	Sig.	Reject
Control	47	36.13	11.49					

Sig. at $p \leq 0.05$ level

Results of the independent t-test analysis in Table 3 showed that the calculated p-value of 0.00 is less than the adopted 0.05 alpha level of significance at degree of freedom (d.f) 301; also, the calculated t-value of 5.57 is greater than the standard t-

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critical of 1.98 (i.e. $p\text{-value } 0.00 \leq 0.05$, $t\text{-cal. } 5.57 > t\text{-cri } 1.98$ at d.f 301). This confirmed that the significance difference is in favour of the experimental group. This is as a result of Conceptual-Change as Instructional Strategy that the students in the experimental group were exposed to. Therefore, the null hypothesis which stated that there is no significant difference between the Academic Performance mean scores of Secondary School Chemistry students taught the concept of Writing and Balancing Chemical Equations using Conceptual-Change Instructional Strategy and those taught the same concept using Conventional Teaching Method, is hereby rejected. This implies that there is significant difference between the mean academic performance scores of experimental and control group in favour of the experimental group.

Research Question Two:

What is the difference between the mean academic performance scores of male and female Secondary School Chemistry Students in Writing and Balancing Chemical Equations when exposed to Conceptual-Change Instructional Strategy?

Table 4: Mean and Standard Deviation on Academic Performance Scores of Male and Female Students in the Experimental Group

Gender	N	Mean	Std. D	M. df
Male	23	48.43	8.35	2.47
Female	28	45.96	7.17	

From the descriptive statistic in Table 4, the mean performance scores for male students in the experimental group was 48.43 and a standard deviation of 8.35; while the mean performance score for their counterpart female students in the same group was 45.96 and a standard deviation of 7.17, with the mean difference of 2.47 respectively. This indicated that there is difference in the mean performance scores of male and female students in the experimental group when taught writing and balancing chemical equation concepts in the experimental group. To test whether the difference in the mean performance scores was significant or not, null hypothesis three was tested.

Null Hypothesis Two: There is no significant difference between the Academic Performance mean scores of male and female Secondary School Chemistry Students in Writing and Balancing Chemical Equations when taught using Conceptual-Change Instructional Strategy.

Table 5: t-test Analysis on the difference between the Performance Scores for Male and Female Students in the Experimental Group.

Gender	N	Mean	Std. D	df	t-cal	P	Remark	Decision
Male	23	48.43	8.35	49	1.14	0.21	N.S	Retain Ho
Female	28	45.96	7.17					

No Sig. at $p > 0.05$ level

Results of the independent t-test analysis in Table 5 showed that the calculated p-value of 0.21 is greater than the adopted 0.05 alpha level of significance at degree of freedom (df) 49, also that the calculated t-value of 1.14 is less than the standard t-critical 2.01 (i.e. $p\text{ value } 0.21 > 0.05$, $t\text{-cal} > t\text{-cri } 2.01$ at df 49). This implied that there is no significance difference in the academic performance of male and female students in the experimental group. This was as a result of exposing both male and female students to Conceptual-Change Instructional Strategy in the experimental group. Therefore, the null hypothesis which stated that there is no significant difference between the Academic Performance mean scores of male and female Secondary School Chemistry Students in Writing and Balancing Chemical Equations when exposed to Conceptual-Change Instructional Strategy, was hereby retained.

Discussion of Findings

The major aim of this study was to investigate the effects of Conceptual-Change Instructional Strategy on Interest and Academic Performance in Writing and Balancing Chemical Equations among Secondary School Chemistry Students in



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Giwa Education-Zone, Kaduna State, Nigeria. For this purpose, Chemical Equation Performance Test (CEPT) were used to collect data on students' performance. The data collected were analyzed at $P \leq 0.05$ level of significance. The results in

Table 2 showed that statistically significant difference exist between the academic performance of students in the experimental and control group in favour of the experimental group; hence, null hypothesis 1 was rejected. The rejection of the null hypothesis indicated that significant difference exist between the academic performance of chemistry students taught the concept of writing and balancing chemical equation using Conceptual-Change Instructional Strategy and those taught the same concepts using conventional method. This is due to the fact that conceptual-change demands a teaching strategy where students are given time to: identify and clear their preconceptions; examine the capability and usefulness of their own ideas and those of others, including scientists; then reflect on and reconcile differences in those ideas. Unlike the conventional method which is teachers-centered. This finding is in conformity with the findings of: Syuhendri (2017), Ashiru (2022), Abakpa and Iji (2022), Muhammad (2024^b), Agiande et al (2025), and Aminu (2025) among others who concluded from their findings that conceptual-change instructional strategy improved the academic performance of students significantly when compared to conventional method of teaching.

Table 3 showed that there is no statistically significant difference between the academic performance of male and female chemistry students in the experimental group; hence, null hypothesis 3 was retained. The retaining of the null hypothesis indicated that significant difference does not exist in the academic performance of male and female chemistry students' that are taught the concepts of writing and balancing chemical equations using Conceptual-Change Instructional Strategy. This is due to the fact that conceptual-change demands a teaching strategy where students are given time to: identify and clear their preconceptions; examine the capability and usefulness of their own ideas and those of others, including scientists; then reflect on and reconcile differences in those ideas. This finding is in line with the earlier findings of: Olorukooba, Lawal and Jiya (2012), Chow and Yong (2023), Fatoba and Aladejana (2024), Olasheinde and Olatoye (2024), and Usman and Lawal (2017), who concluded from their findings that conceptual-change instructional strategy improved the academic performance of both male and female students significantly equally. And this finding is in disconformity with the findings of; Yusuf (2023) who explained that female students significantly enhanced their performance in science concepts more than male students. In the same vein, this finding is also contrary to the findings of Kweileh and Zaza (2021), Theraza (2023), Tim (2024) and Muhammad (2024^b), who observed that male students were superior in science performance having fewer misconceptions compared to their female counterparts.

Conclusions

Based on the findings from this study, the following conclusions were drawn:

1. Conceptual-Change Instructional Strategy was effective in enhancing the academic performance of senior secondary school Chemistry students. Thus, Conceptual-Change Instructional Strategy is viable and has ability of improving senior secondary school Chemistry students' academic performance in Writing and Balancing Chemical Equations.
2. Teaching the concept of Writing and Balancing Chemical Equations using Conceptual-Change Instructional Strategy was found to be gender- friendly. This means that when SSS male and female Chemistry students were taught using Conceptual-Change Instructional Strategy, the result obtained indicates no significant difference in the academic performance mean scores between male and female Chemistry students.

Recommendations

On the basis of the findings of this research work and the conclusions reached, the following recommendations were proffered:

1. Conceptual-Change Instructional Strategy should be encouraged in the science classrooms because of its efficiency in enhancing the Interest levels of the students.
2. It is also recommended that Conceptual-Change Instructional Strategy be used by science teachers (especially in Chemistry), as it aids meaningful understanding of what was taught.
3. Since the Conceptual-Change Instructional Strategy is not gender-bias, it could serve as an Effective Instructional Strategy in both single-sexed and co-educational schools.
4. School administrators, professional associations and research centers like Science Teachers Association of Nigeria (STAN), Mathematics Associations of Nigeria (MAN) and the Nigeria Educational and Research Development Council



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(NERDC) among others; should incorporate the Conceptual-Change Instructional Strategy in their seminars, workshops and conferences.

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