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Effect of deductive and inductive teaching methods on senior secondary school students' achievement in chemistry in Obio/Akpor local government area of Rivers State, Nigeria

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Abstract
The study examined the effect of deductive and inductive teaching methods on senior secondary school students' achievement in Chemistry in Obio/Akpor Local Government Area of Rivers State Nigeria. Three research questions and three hypotheses guided the study. Quasi-experiment of the non-equivalent, control group design was used. The sample consisted of 140 senior secondary II (SS 2) Chemistry students selected by multistage sampling technique. Two intact classes were assigned to experimental group (deductive and inductive methods) and one intact class to control group (lecture method). The research instrument was Chemistry Achievement Test (CAT) with reliability coefficient of 0.80. The data collected were analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA). The result among others revealed that students exposed to inductive teaching method significantly performed better than the students exposed to deductive and conventional teaching methods. The study therefore recommends that, inductive teaching method should be fully incorporated into the teaching of Chemistry topics at the senior secondary schools levels in Rivers State and other state in Nigeria. In addition, government should sponsor teachers to attend workshops and seminars for appropriate and efficient use of inductive teaching method.

Keywords: deductive method, inductive method, lecture method, academic achievement, chemistry, Obio-Akpor, Rivers State

Introduction
Chemistry is one of the core science subject taught at the senior secondary school levels in Nigeria in view of the fact that its knowledge and practice cannot be over emphasized in this present world of science and technology. Chemistry is a science that studies the properties, composition and structure of chemical substances and the change they undergo (Loh & Tan, 2006) [13]. It is a field of study that encompasses physical occurrences and learners are constantly required to discovery concealed ideas, describe acceptable capacities and relate fundamental laws and theories using high level rational ability (Nurrnbern & Pickering, 1987) [18]. Chemistry is a very important science subject as it is a pre-requisite for studying science based professional courses in higher institutions of learning such as medicine, engineering, pharmacy, nursing, agriculture, and food science and the host of others. It is therefore, reasonable to say that Chemistry is the bedrock of scientific and technological development of any country and by implication, the socio-economic development of the country. The growth of any country today hinges on its technological and scientific development. Teachers are required to find means of arousing their learners to develop confidence in science and science linked discipline (Sola & Ojo, 2007) [23]. Chemistry, in particular is central to many of the scientific fields of human endeavours; therefore, the teaching Chemistry should be given serious attention.

Science teaching is not just handling of concepts and materials around science. It also includes arousing and giving ideas in a thought-provoking method by the teacher. The teacher need be able to construct appropriate learning experiences which reveal an atmosphere for learners' self-exploration, problem solving, inductive reasoning, etc. To realize this, there are varieties of teaching methods handy and the teacher has to choice from the methods, which are appropriate for the specified groups of learners and concepts in a given setting (Gilbert, 2011) [7]. Educationist opined that teaching-learning practice is the vital influence for understanding the idea of Chemistry. To adjust with the fast explosion of knowledge of Chemistry, the students must be ready to process material appropriately. Hence, two approaches (Deductive and Inductive methods) have been identified as methods of reasoning that promotes ones' understanding of concepts, especially scientific ideas and knowledge. No wonder, the combination of the two methods of reasoning lead to the development of scientific methods of approaching phenomenon observed in the world.

Origins and Definitions of Deductive and Inductive Instruction
Deductive teaching method was predominant until the inductive method was formerly accepted in scientific experimental learning and mathematics, in the 20th century (Yuen & Teresa, 2009) [25]. Deductive teaching is commonly seen as the conventional teaching method, in which the teacher is the specialist in the source of facts whereas the learners are passive receivers of facts.

Inductive method on the other hand, began from inductive thinking, mental development and constructivist epistemology that were initially adopted by Jean Piaget in 1976 (Yuen & Teresa, 2009) [25]. It was usually explained in difference with conventional lecture-based, deductive teaching. Prince and Felder (2006) [21], presented inductive technique as a better alternate which begins with a set of observation or experimental data to deduce, a case study to investigated or difficult real-world problem to unravel.

In inductive technique, learners are led to evaluate the data or situation and unravel the problem, generating the needed facts, rules and principles at which point they are given the needed information or assisted to discern it for themselves (Prince & Felder, 2006) [21]. Nevertheless, inductive method does not remove the dormant for frontal teaching of

concepts. The teacher assesses the students' Knowledge, lead them to question and explain it and allow the production of new knowledge (Bransford, Brown & Cocking, 1992). Figure 1 below diagrammatically illustrates how deductive and inductive approaches are carried out.

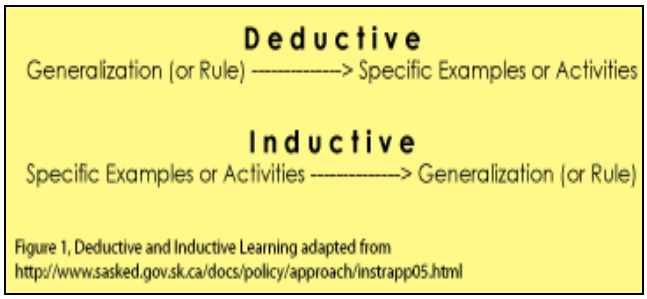

Fig 1

A deductive approach to instruction is a more teacher-centered approach. This means that the teacher gives the students a new concept, explains it, and then has the students practice using the concept. For example, when teaching a new Chemistry concept, the teacher will introduce the concept, explain the rules related to its use, and finally the students will practice using the concept in a variety of different ways. However, deductive method is often criticized because: a) it teaches concepts in an isolated way; b) little attention is paid to meaning; c) practice is often mechanical.

This method can, however, be a viable option in certain situations; for example, when dealing with highly motivated students, teaching a particularly difficult concept, or for preparing students to write exams. In contrast with the deductive method, inductive instruction makes use of student "noticing". Instead of explaining a given concept and following this explanation with examples, the teacher presents students with many examples showing how the concept is used. The intent is for students to "notice", by way of the examples, how the concept works. Using the concept of matter situation, the teacher would present the students with a variety of examples for a given concept without giving any preamble about how the concept is used. As students see how the concept is used, it is hoped that they will notice how the concept is to be used and determine what matter is. As a conclusion to the activity, the teacher can ask the students to explain the concept of matter with examples as a final check that they understand the concept.

Stages of Deductive and Inductive Teaching Methods

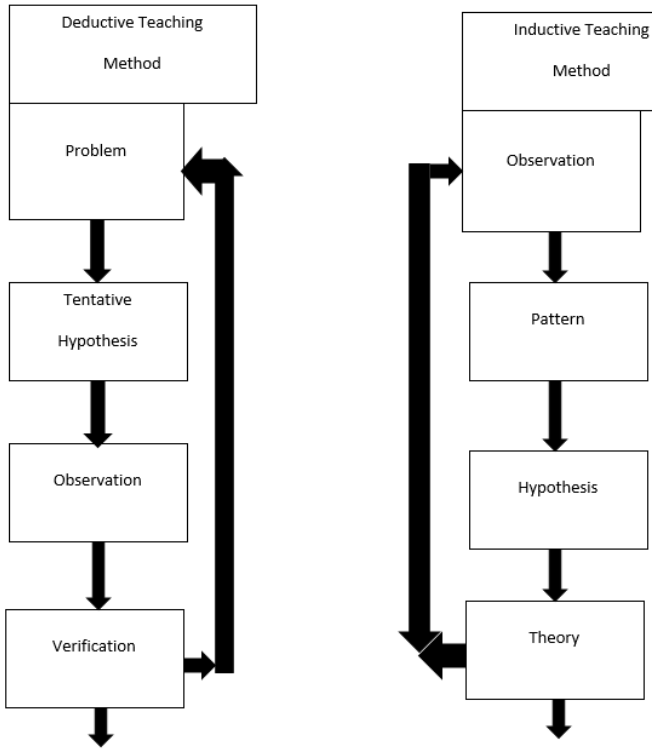

Fig 2: Stages of deductive and inductive teaching method

Deductive method for educating depends on an allowance; it continues from general to specific and from dynamic and cement. In this technique for instructing the teacher tells the standard, head or law to the learner and afterwards, the average is introduced, authority or regulation with the assistance of explicit models. Above all else, the standards are given, and after that, learners are approached to apply these guidelines to tackle more issues. This strategy is utilized for showing fundamental science in junior auxiliary, higher optional or higher classes. The deductive methodology continues from the general (rules, laws, administrators or recipe) to explicit (models), obscure to know, unique direction to solid model and from complex to basic. A deductive technique for instructing includes away from the issue, looking for a provisional theory, planning a speculative idea, and checking (See figure 2) for compelling acknowledgement of the case. Deductive thinking or sensible derivation or "top-down" rationale, is the way toward thinking from at least one proclamation to arrive at a consistently certain resolution. The deductive technique for teaching is very surprising from an inductive strategy. A deductive method is more teacher focused methodology which implies that the teacher gives the learner another idea, clarifies it, and afterwards has the learner utilize the concept.

The inductive strategy depends on the rule of acceptance. Enlistment intends to set up a generally accepted fact by indicating that on the off chance that it is valid for a specific

case and is further validation for a sensibly sufficient number of instances then it is useful for all such claims. Consequently, in this strategy, from the outset stage, an issue is tackled based on past information, thinking, thinking and knowledge of the student. At this stage, learner doesn't think about any equation, standard or technique for tackling the given issue. When a satisfactory number of comparable models, realities or items are introduced to the students, they attempt to come to a result for each one of those (See figure 2). The inductive teaching technique is profoundly dug in science training, utilizing the inductive technique. The teacher gives the students or learner a particular test or issue, for example, an investigation that should be deciphered or a certifiable issue should be tackled. The learners should then utilize their base-information to research, test, investigate and reach their own decision or arrangement. The inductive strategy, which is usually deciphered in schools as the logical technique is generally utilized as a guide for perception, request based learning and fills in as a rule for student examination concerning next to zero consideration is at first paid to the subject of why any of that is being done, what true wonders can the models clarify, what viable issues would they be able to be utilized to address, and why the learners should often think about any of it. The lone inspiration to discover that learners get on the off chance that they get any whatsoever is a proposal that the material will be significant later in the educational program or vocations (Prince & Felder, 2006) [21]. In inductive teaching, just different realities and models are introduced to the students and from where they need to discover or set up an overall equation. Along these lines, it is a strategy for developing a recipe with the assistance of a sufficient number of solid models. Hence, an inductive method for showing leads from known to obscure, specific to general or guide to available standard and cement to extract. At the point when various solid cases have been perceived, the student himself can endeavour for speculation.

Literatures reviewed on the application of inductive and deductive methods for teaching, demonstrates that both teaching methods are unique; however, very successful. There have been a number of such investigations on using inductive and deductive instructing methods to a few subjects. For instance; Obeidat and Alomari (2020) [19] investigated the impact of using inductive and deductive teaching upon EFL undergraduate students' achievement at the Hashemite University. More specifically, the study explored the effect of using inductive and deductive approach on students' achievement in some grammatical issues included a book adopted for teaching Grammar in the Department of English Language and Literature. The research instrument used was a pre-post-test developed by the researchers. Two groups of students are chosen for the purpose of the study. Whereas the experimental group was taught through inductive approach, the controlled group was taught through the deductive approach. Results show significant differences between the means of students' scores in the two groups on the post-test, in favour of the experimental group. Results also reveal no significant differences according to study-year, the type of school they graduated from, and gender. In the light of these results, the researchers suggest some recommendations for TEFL researchers and EFL instructors.

In a similar study conducted by Gorat and Prijambodo (2013) [8], who investigated the effect of using deductive and inductive approach in teaching English to 64 students (32 in each section) on their conditional sentence mastery, it was found that inductive teaching approach was more effective than deductive teaching approach. Also in a study carried out by Eriksson (2014) [6], who examined the effectiveness of modified inductive learning of English grammar among foreign language students, it was also found that the inductive method was more effective than the deductive.

Berendse (2012) [2] examined the efficiency of deductive and inductive method in Uteract University, Netherland, and the participants were 54 secondary school students. Pretest and post-test design was used in the study but the pretest differed from the post-test. The data collected were analyzed using t-test to ascertain whether there is significant difference between deductive and inductive method of teaching of past simple and present perfect tense in English Language. The finding of the study shows that deductive method was more efficient in teaching English tenses and it had an influence in long term memory.

Emre (2015) [5] explored the effects of inductive grammar instruction and deductive grammar instruction on the acquisition of conditionals and relative clauses in three aspects: written production, i. e. grammar accuracy in writing tasks, grammar test scores and students' and the instructor's perspectives. The study was carried out with 38 intermediate level EFL (English as a Foreign Language) students. During a four-week period, one instructor taught grammar to two groups. In the inductive group, the students worked on consciousness-raising tasks to discover the meanings and rules of the target grammatical structures. Later, they received feedback from the instructor. In the deductive group, the instructor explained the meanings and the rules of the target grammatical structures directly.

The grammar pre and post-test scores did not reveal a statistically significant difference between the scores of the two groups. Furthermore, there was not a statistically significant difference between the writing tasks of the two groups in terms of grammar accuracy. The questionnaire administered in the inductive group implied that the learners generally had positive perspectives on inductive learning. The interview conducted with the instructor revealed that she regarded inductive approach as a more interactive but less practical way of teaching. Nevertheless, she preferred inductive teaching on condition that the students were motivated and the target structures were new to them. In the light of these findings, teachers and material developers might consider involving both approaches in their practices and work in order to ensure variety the paper concluded.

Adams, Onwadi and Idika (2021) [1] investigated the impacts of Inductive Teaching Method (ITM) and Deductive Teaching Method (DTM) on the performance of Junior Secondary School three (JSS III) students in Basic science. The study applied a pretest-posttest quasi-experimental design. Six (6) junior secondary schools three (JSS III) were purposively chosen inside Abuja Municipal Area Council (AMAC), of the Federal Capital Territory (FCT), Nigeria. A total of six hundred and twenty (620) participants comprising of three hundred and fifty-five (355) male students and two hundred and sixty-five (265) were involved in the study. The intact class was used in each of the selected schools, and the instruments for data collection was the Basic Science

Performance Test (BSPT). The arithmetic means standard

variation and One-way Analysis of Covariance (ANCOVA) were applied using Statistical Package for Social Sciences (SPSS) version 26 to test two hypotheses at the 0.05 level of significance.

The preliminary test result revealed that the data collected met the normality assumption, few outliers and homogeneity of variance. The main result showed that the most effective and preferred teaching method is the inductive teaching method. There was a significant difference in the male student's mean performance [F (2,351) = 25.911, p=0.000] between the three groups. The study also discovered no significant difference in the female student's mean performance [F (2,260) = 0.154, p=0.857] between the three groups while adjusting for the pretest score. Given the discoveries, it is suggested that the utilization of inductive teaching method should be encouraged and the necessary facilities and equipment needed for proper implementation should be provided by the school authorities.

Other studies include those of Dameus, Tilley and Brant, (2004) [4] in Agricultural Economics; Narendra and Yadav (2017) [16] for Mathematics; Rodex reaction in Chemistry by Jong, Acampo and Verdonk (1995) [12]; Nejla (2000) [17] in Chemistry; Silas and Bright (2012) [22] in Circle Geometry and Trigonometry; Hafsah, (2014) [9] in Electrochemistry. Numerous studies have been directed to research the effectiveness of deductive and inductive methods of teaching various subjects; the summary of the comparative studies by scholar reviewed above shows that studies in the area of effect of deductive and inductive methods of teaching Chemistry among senior secondary schools' students in Obio-Akpor local government area of Rivers state have not been investigated so far. This study shall therefore fill the research gaps and provide a solution with the established problems.

Statement of the Problem

Student's persistent poor performance in Chemistry has been partially attributed to poor teaching and instructional methods used by teachers. The gravity of the awful performance of secondary school students in Chemistry and continuous use of conventional methods of teaching is considered as one of the main deficiency influencing the learning and high accomplishment in Chemistry. Several learners find Chemistry as limitation in achieving their goals and purposes.

Learners desiring to study medicine, engineering, pharmacy and other science related courses cannot do so except they credit Chemistry. Consequently, it is essential to prepare the learner beginning from the secondary level to assist them increase their academic feat in Chemistry. Underachievement of learners in science subjects, mostly Chemistry, has taken a stern height as stated by West African Examination Council. Based on this science teachers are required to find appropriate methods to deal with the existing colossal failure in Chemistry if they are to stop the exodus of science learner's to art and social science subjects.

Therefore, there is the need to improved consciousness of teaching method to be applied by the teacher while teaching Chemistry and increased confidence on the part of deductive and inductive teaching method on senior secondary school students' achievement in Chemistry must be examined. Thus, the aim of this study was to examine the effect of deductive and inductive teaching methods on senior school students' achievement in Chemistry in Obio-Akpor Local Government Area of Rivers State.

Research Questions

1. What is the effect of deductive teaching method on the achievement of students in Chemistry?
2. What is the effect of inductive teaching method on the achievement of students in Chemistry?
3. To what extent do deductive and inductive methods of teaching differ on students' achievement in Chemistry?

Hypothesis

1. There is no significant difference in students' achievement between those taught with deductive and those taught with lecture method.
2. There is no significant difference in students' achievement between those taught with inductive method and those taught with lecture method.
3. There is no significant difference in students' achievement between those taught with deductive method and inductive method.

Methodology

Research Design

The study adopted quasi-experimental design specifically pretest, post-test, non-equivalent and control group form. The purpose of using this form agrees with Kolo (2003), who says that, experiments are to investigate possible causal and effects correlation among two or more variables by the application of treatment which cannot be resolved by observation or description.

Population of Study

The population of this study comprises of all learners in Government Senior Secondary Schools in Obio-Akpor Local Government Area of Rivers State. There are 14 (fourteen) government senior secondary schools with an overall number of 3,698 Chemistry students.

Sample and Sampling Techniques

The sample for the study was 140 senior secondary II (SS2) Chemistry students selected via multistage sampling technique. Two intact classes were assigned to experimental group (deductive and inductive method) and one intact to control group (lecture method). The number of Chemistry students in these (3) schools were four hundred and thirty nine (439) students. The distribution of the samples drawn from the population is as presented in Table 1 below.

Table 1: Sample distribution by schools and group

S. N.	Names of school	Population of chemistry study	Group	Number sampled
1	Community secondary school (CSS) Rumuolumeni	154	Experimental	48
2	Community secondary school (CSS) Rumuapara	148	Control	45
3	Community secondary school (CSS) Ogbogoro	137	Experimental	47
	Total	439		140

The choice of the three (3) schools above is because they share common characteristics like student's type, academic objectives, educational facilities and educational policies.

Research Instrument

The instrument for data collection was researchers constructed Chemistry Achievement Test (CAT). The Chemistry achievement test had two parts, the first part sought answers on students' personal data such as school, sex and class while part two (2) was based on questions covering concepts such as, concept of periodicity of element and carbon and its compounds. The test consisted of 30 multiple choice items with five options A to E. The students were expected to put a tick (√) on the correct option of their choice. The maximum and minimum points obtainable in the test included 30 and 0 points respectively because each correct answer attracted 1 mark and wrong one attracted no mark.

Validity of the Instrument

The instrument used for this study was developed by the researchers. After drafting the thirty (30) test items for the achievement test, they were given to the Chemistry Education experts, one secondary school Chemistry teacher and one Educational Measurement and Evaluation lecturer in Ignatius Ajuru University of Education, Rumuolumeni. Furthermore, the experts were given the objectives, research questions and hypotheses of the study to aid their task. Observations, remarks and submissions by the experts were used to adjust the instrument were necessary before the instrument was used for field work. The table of specification is as given in Table 2.

Table 2: Table of Specification for 30 multiple choice items in Chemistry

Topic	No. of Questions	Question Distribution	% of Questions	Questions Distribution Based on Bloom Education Taxonomy		
				R	U	T
Periodicity of element	15	3,5,6,8,9,11,15,16,17,18,19,22;23,24,27	50	8	3	4
Carbon and its compound	15	1,2,4,7,10,12,13,14,20,21,25,26,28,29,30	50	7	5	3
Total	30		100	15	8	7

Key: R= Remembering, U= Understanding, T= Thinking

Reliability of the instrument

Reliability of the instrument was ascertained by administering the instrument to 30 students in Obio-Akpor local government area of Rivers State who were not part of the sampled schools. The student's responses were subjected to Kuder-Richardson 20 formula (KR-20) to determine the internal consistency. The reliability co-efficient of 0.80 was obtained for the instrument. The value is considered high enough to guarantee the use of the instrument.

Method of Data Collection

The method of data collection was in three stages:

Stage one: permission was obtained from the authorities of the schools that were involved for the use of their students and lesson period, which lasted for two weeks each to both experimental and control schools.

Stage two: the students (Experimental and control groups) of the study were subjected to pretest under the same condition to determine the level of their performance with the assistance of research assistant (students' classroom teacher).

Stage three: after treatment, which lasted for two weeks, the same instrument was administered to the students as post-test and the score obtained recorded as post-test scores.

Method of Data Analysis

The relevant data collected were subjected to mean and standard deviation statistics in order to obtain and provide answers to the research questions. Analysis of co-variance (ANCOVA) was used to test the hypotheses formulated for the study at 0.05 level of significance. ANCOVA was used in order to take care of the errors of initial differences in the ability level of the students. The pretest scores were used as covariate while post-test score was the dependent variable.

Results

Research Questions 1: What is the effect of deductive teaching method on the achievement of students in Chemistry?

To answer the above question, data gathered on students' achievements after treatment were subjected to mean and standard deviation statistics. The result is as presented in Table 3.

Table 3: Mean and standard deviation of students' achievement between deductive and lecture methods

Method	n	$\bar{x}$	*Sd*
Deductive	48	12.60	3.96
Lecture	45	12.60	3.66

Table 3 shows the mean and standard deviation values for the deductive and lecture methods. The mean and standard deviation for deductive group was 12.60 and 3.96 respectively, while that of the lecture method, and were 12.60 and 3.66 respectively. A closer examination of the two mean values revealed that there is no difference in the means score for the two groups. This showed that the achievement of the student exposed to deductive method and lecture method did not differ.

Research Question 2: What is the effect of inductive teaching method on the achievement of students in Chemistry?

To answer the above question, data gathered on students' achievement after treatments were subjected to mean and standard deviation statistics. The result is presented in Table 4.

Table 4: Mean and Standard deviation of students' achievement between inductive and lecture methods

Method	*n*	$\bar{x}$	*Sd*
Inductive	47	18.57	3.59
Lecture	45	12.60	3.66

Table 4 shows the mean and standard deviation values for inductive method (Experimental group) and lecture method (control group). The mean and standard deviation for inductive method was 18.57 and 3.59 respectively, while that of the control group (lecture method), mean and standard deviation value was 12.60 and 3.66 respectively.
This showed that student taught using inductive method had higher academic achievement than those taught using lecture method.

Research Question 3: what is the effect of deductive and inductive teaching method on the performance of students in chemistry?
To answer the above question, data gathered on students' achievement after treatments were subjected to mean and standard deviation statistics. The result is presented in Table 5.

Table 5: Mean and standard deviation of students' achievement between deductive and inductive teaching methods

Method	*n*	$\bar{x}$	*Sd*
Inductive	47	18.57	3.59
Deductive	48	12.60	3.96

Table 5 shows the means and standard deviation values for the deductive and inductive group. The mean and standard deviation for deductive methods was 12.60 and 3.96 respectively while those of inductive method were 18.57 and 3.59 respectively.
This implies that students taught using inductive teaching method had higher academic achievement than those taught using deductive method.

Hypothesis 1: There is no significant difference in students' achievement between those taught with deductive method and those taught with lecture method.
To test this hypothesis, the pretest and post-test scores of the Chemistry Achievement Test of the experimental group and control group were analyzed using ANCOVA. The result is as shown in Table 6.

Table 6: Summary of ANCOVA analysis on the difference in students' achievement between deductive and lecture methods

Source	Type III sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11.363	2	5.681	.389	.679
Intercept	947.434	1	947.434	647.434	.060
Pretest	11.362	1	11.362	.778	.380
Group	.362	1	.312	.021	.884
Error	1314.917	90	14.610		
Total	16096.00	93			
Corrected total	1326.280	92			

NS= Not significant, p (.884)> 0.0.5 level of significance

Table 6 shows that the calculated F (1, 90) = .021 which is not significant at 0.05 level of significance. Hence, the stated null hypothesis is therefore accepted. The result was that there is no significant difference in students' achievement between those taught with deductive method and those taught with lecture method in Chemistry.

Hypothesis 2: There is no significant difference in students' achievement between those taught with inductive method and those taught with lecture method.
To test the hypothesis, the pretest and post-test scores of the Chemistry Achievement Test of the experimental group and control group were analyzed using ANCOVA. The result is as shown in Table 7.

Table 7: Summary of ANCOVA analysis on the difference in students' achievement between inductive and lecture methods

Source	Type III sum of Squares	df	Mean Square	F	Sig.
Corrected Model	855.514	2	427.757	33.181	.000
Intercept	1446.725	1	1446.725	112.222	.000
Pretest	34.932	1	34.934	2.710	.103
Group	529.814	1	539.814	41.097*	.000
Error	1147.355	89	12.892		
Total	24542.000	92			
Corrected total	2002.870	91			

*Significant, p (.000) < 0.05 level of significance.

Table 7 reveals that the calculated F (1, 89) = 41.097 is significant at 0.05 level of significance. Hence, the stated null hypothesis is rejected. The result was that there is significant difference in students' achievement between those taught with inductive method and these taught with lecture method in Chemistry.

Hypothesis 3: There is no significant difference in students' achievement between those taught with deductive method and those taught with inductive method.
To test this hypothesis, the pretest and post-test scores of the Chemistry Achievement Test of the students in deductive method and those in inductive method were analyzed using ANCOVA. The result is as shown in Table 8.

Table 8: Summary of ANCOVA analysis on the difference in students' achievement when taught with deductive method and inductive method

Source	Type III sum of Squares	df	Mean Square	F	Sig.
Corrected Model	896.340	2	448.170	32.185	.000
Intercept	1375.797	1	1375.797	98.801	.000
Pretest	49.877	1	49.877	3.582	.062
Group	418.277	1	418.277	30.038*	.000
Error	1281.092	92	13.925		
Total	25172.000	95			
Corrected total	2177.432	94			

*Significant, p (.000) < 0.05 level of significance.

Table 8 indicates that the calculated F (1, 92) = 30.038 was found to be significant at 0.05 level of significance. Therefore, the null hypothesis is hereby rejected. The result is that there is significant difference in students' achievement between those taught with deductive method and those taught with inductive method in Chemistry.

Discussion

Effect of deductive method and lecture method on student's achievement in chemistry

From the findings, it was discovered that students taught using deductive and lecture method had no significant difference in achievement. This was confirmed by their calculated mean academic achievement in Chemistry which were 12.60 and 12.60 for experimental and control group students respectively. The result here reveals that there is no difference in students' achievement when taught with deductive method and lecture method. This is because they are both teacher centered in which communication is one way because the teacher is the only one speaking. The result disagrees with Hmeden and Naji (2016) [11] who found that deductive teaching method (experimental group) achieved better than the control group (conventional lecture method). The deductive teaching method is strong instructional devices that can broaden the students' scope of chemical contents.

Effect of inductive method and lecture method on student's achievement in chemistry

From the findings it was discovered that students taught using inductive method had significantly better academic achievement than their counterparts taught with lecture method. This result is not entirely surprising, as in fact, confirms the assumption of Martins (2000) [14] that the students taught using inductive method (experimental) performed significantly better than those taught using traditional lecture method. This was confirmed by their calculated mean achievement in Chemistry which was 18.57 and 12.60 respectively.

Chemistry which is a core science subject demands critical thinking. The finding is in agreement with Muhammad (2007) [15] that inductive teaching method has been described as problem solving, critical thinking, reflective investigation, deductive reasoning and not ordinary individual assumption.

On the other hands, the result of this study disagrees with Omokaadejo (2015) [20] who published that there was no significance difference in students' performance between those taught with inductive method and those taught with lecture method.

Effect of deductive method and inductive method on students' achievement in chemistry

The result her reveals that there is difference in students' achievement between students taught with deductive method and those taught with inductive method, in favour of inductive method. The finding was also statistically found to be significantly different. The finding is consistent with Kuder's findings in 2009 in Spain. Kuder's study showed that there was a little higher level of performance as well as higher level of satisfaction in the group exposed to the inductive lesson. The next finding which supports this study was that by Haight (2007) [10]. The result showed a significant difference among students mean immediate test scores favouring inductive approach.

Similarly the result agrees with Berendse (2012) [2], Wang (2012) [24] that there was significant difference in students' performance between those that taught with deductive method and those that taught with inductive method, who found that inductive approach is more efficient than deductive approach.

Conclusion

Based on the findings of the study, it was concluded that inductive teaching method is effective for teaching concepts in Chemistry at secondary school level as the method enhanced academic achievement in Chemistry.

Recommendations

The following recommendations are made:

1. Teachers should be encouraged to teach Chemistry using inductive teaching method and discourage the use of lecture method alone as the former technique enhances better academic achievement.
2. Government should support teachers to participate in workshops and seminars on the appropriate and effective use of inductive instructional method, so as to equip them with the relevant skills for inductive teaching.
3. The Ministry of Education should provide all the needed teaching aids and facilities for the efficient use of inductive teaching technique in Chemistry.

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