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Effect of Constructivist-based Instructional Strategy on Senior Secondary School Students' Achievement in Chemistry

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Abstract
The study investigated the Effect Constructivist Based Instructional Strategy on Senior Secondary Students' Achievement in Chemistry. The high rate of failure in Senior Secondary School Chemistry necessitated the study. The study employed a quasi-experimental design specifically, the pretest posttest non-equivalent control group design. The study was carried out in Abakaliki Education Zone of Ebonyi State. The population of the study is three thousand, two hundred and forty two (3,242) Senior Secondary School two (SS 2) students who were selected from the seventy eight (78) coeducational secondary schools in Abakaliki Education Zone. The sample consisted of one hundred and seventy four (174) senior secondary school two (SS 2) science students who were sampled from four coeducational senior secondary schools randomly selected from the four Local Government Areas that make up Abakaliki Education Zone. Two of the schools were assigned to treatment group while two were assigned to control group. Intact classes were used throughout the study. The treatment group was taught using constructivist based instructional strategy while the control group was taught using conventional method. Three research questions and three null hypotheses guided the study. A Chemistry Achievement Test (CAT) which is made up of thirty (30) items was used to collect data for the study. The data collected for the research questions were analyzed using mean and standard deviations while the hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. The result of the study showed that Constructivist Based Instructional Strategy is superior to Conventional Method in facilitating students' achievement in Chemistry. It also revealed that gender does not have an effect on the achievement of students when taught with Constructivist Based Instructional Strategy. It was also found that there is no interaction between method and gender on students' achievement in Chemistry. This implies that the use of conventional method in teaching might have been partly responsible for the students' poor performance in Chemistry. Based on the findings of the study, it was recommended that Constructivist Based Instructional Strategy should be used by Chemistry teachers in teaching both male and female students because it facilitates teaching and learning and does not discriminate across gender. It was also recommended that government should organize seminars, workshop and conferences with the aim of training Chemistry teachers on the effective use of Constructivist Based Instructional Strategy in teaching.

Keywords: Constructivism, Instructional Strategy, Senior Secondary School, Achievement, Chemistry.

Introduction

Science is a knowledge attained through the study of the operation of general laws on nature especially the knowledge which is obtained, tested, approved and accepted through a scientific method (Igwe, 2018). This implies that science is made up of not all the isolated bits of knowledge but that knowledge which has been systematically assembled and put together in some sort of organized manner. Knowledge generally, implies all the truths, facts, information and principles learned throughout time (Eze &Agbomma, 2018). Science is a special type of discipline with peculiar characteristics, the prominent among them is the approach through which knowledge is pursued (Kosobameji, 2022). This approach is commonly called scientific method. It is a logical, rational and systematic process by which knowledge in the discipline is pursued and conclusion about nature around them is drawn. In general, science involves a pursuit of knowledge covering general truths or the operations of fundamental laws (Adak, 2016). Science plays a vital role in the society because it relates to

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everything about man's daily life and to every career. Man's daily life activities and career are the products of scientific knowledge and thinking. Science helps to construct further knowledge and understand phenomena, which are the results of the tremendous development of technology.

As a result of the numerous benefits of science, Nigeria government through the Federal Ministry of Education recommended the teaching of science subjects in secondary schools. Science is studied as Basic Science and Technology in Junior Secondary Schools. The purpose is to build basic foundation in students at the lower levels and to prepare them for the study of core science subjects at the post basic levels of education (FME, 2016). The core science subjects taught in Senior Secondary Schools are Chemistry, Biology and Physics (WAEC, 2018). Chemistry is a physical science that studies the chemical substances of which matter is composed, their properties and reactions, and the use of such reactions to form new substances. It is an experimental science that systematically studies the composition, properties and activities of organic and inorganic substances and various elementary forms of matter (Adegoke, 2018). Chemistry is very important because it helps in meeting man's basic needs of foods, clothing, shelter, energy and clean air, water and soil. Products of chemical technologies such as drugs, help to improve the quality of our life in numerous ways by promoting new solutions to problems in health, materials and energy usage. It is also important owing to the fact that everything we do is Chemistry. Our body is made of chemicals and all these chemicals undergo chemical reactions. Chemistry is central to our existence and provides insight into how we interact with the world around us. It plays important role in the growth and development of chemical industries around the world. The inclusion of Chemistry in the school curriculum is predicted by the emphasis placed on the teaching of science subjects as instrument per excellence for nation building (Eze &Agbomma, 2018). It is indeed related to everything on earth as aptly said in the slogan: What on earth is not Chemistry? Chemistry plays important role at engineering sustainable economic development and growth of any nation (Johnstone, 2017). The importance of Chemistry in the development of any nation cannot be underestimated, especially in Nigeria where the national income rests mainly on petroleum and petrochemical industries. As a branch of science, Chemistry is highly important in modern societies because of its requirement as a pre-requisite to the study of many other science oriented courses in tertiary institutions. It is therefore very important that for a nation to develop in science and technology, the teaching and learning of Chemistry need to be improved. The achievement in Chemistry and in science generally also needs to be of high level. It is in consideration of the great importance of Chemistry in our national development that the government, researchers, Chemistry teachers, Science Teachers Association of Nigeria (STAN) and other agencies are making frantic efforts to promote achievement in Chemistry. In spite of these efforts, the achievement of students in Chemistry at Senior Secondary School has been poor and deplorable over the years (Njoku, 2017; WAEC, 2020). Some researchers noted that the methods of teaching employed by teachers are responsible for the poor achievement in Senior Secondary School science subjects (Njoku, 2019). Adesoji and Babatunde (2018) are of the opinion that students hold misconception about Chemistry concepts which leads to the students' poor performance in Chemistry. These misconceptions may be due to the instructional approaches employed by the teachers in teaching the subject. Therefore, there is need for adopting proper teaching strategy in Chemistry at secondary school level.

The way students are taught in Senior Secondary schools often affects learning of Chemistry. To this effect, Ogwa (2020) emphasized that learners need to be stimulated by using appropriate teaching strategies. Ifeakor (2016) observed that most of the time, Chemistry is taught using ineffective methods instead of hands on approach. Appropriate teaching methods therefore lead the students to acquire appropriate scientific skills, which may likely enhance students' achievements in science. However, most Chemistry teachers do not use appropriate teaching method rather they resort to the conventional methods which may not enhance students' achievement. Conventional method is concerned with the teacher being the controller of the learning environment. There are many conventional methods adopted by teachers in teaching Chemistry in Senior Secondary Schools these days. Lecture method is the commonest conventional method of teaching in Nigerian schools. This method of teaching involves verbal presentation of ideas, concepts, generalizations and facts. In lecture classroom, most of the teaching activities are done by the teacher in form of talking while the students are either passive listeners or slightly involved. It is a teacher-centred approach involving largely the one way didactic approach because most of the talking is carried out by the teacher while students remain as passive listeners, taking down notes (Kosobameji, 2022). In this method of teaching, the students get the impression that they can only learn when their teacher is present, teaching. Learning here is chiefly associated within the classroom and is often competitive. The lesson's content and delivery are considered to be the most important

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and students master knowledge through drill and practice (such as rote learning). In spite of these arguments, most science teachers still use lecture method because of its advantages, which include the fact that it can be used to cover a large content area at a time. This method can also be used to teach a large class, which is a common feature in Nigerian secondary schools. Hence, lecture (chak-talk) method was used to teach the controgroupl in this study.

The major responsibility of the classroom teacher is to help students attain maximum achievement in their learning tasks. As the processes of all learning and teaching revolve around the students, it is important that the method used in teaching Chemistry in secondary schools recognizes the central position of the students and due attention paid to them. In teaching Chemistry, teachers are expected to have good knowledge of the subject before introducing it in the classroom. This will enhance effective teaching of the subject in the secondary schools. There is need that teachers develop the interest and attitude of the students with regard to the subject through their methods of teaching. Teachers who have good exposure and experience in Chemistry can easily foster the adjustment of students, matching curricular offerings to levels of mental development; understand students' basic cognitive and social problems, making curricular specifications relevant. This can motivate the students to learn the subjects better. The main objective of teaching Chemistry in secondary schools are to help the students develop their knowledge and skills in chemical science and project their efforts in education so as to be useful to themselves and the society in general. For this reason, students have to appreciate the subject and pay special attention to its teaching. Giving student's opportunities for developing manipulative skills that will enable them to function effectively in the society within the limits of their capacity through the different methods of teaching based on the teaching competence will encourage them to make learning process effective and rewarding. There is no doubt that effective teaching usually facilitates learning and makes it more meaningful. In line with this, Sander (2017) stated that effective teaching helps the learner to learn better while poor teaching would naturally lead to poor learning and consequently poor achievement. Based on the ongoing discussion, it could be observed that failure to use appropriate teaching methods would lead to a decline in students achievement in chemistry. Several researchers investigated the causes of students' poor achievement in Senior Secondary School Certificate Examination (SSCE) Chemistry concepts and the most recurring factor is inefficient teaching methods employed by the school Chemistry teachers.

There has been a wide cry each year when West African Examination Council (WAEC) or National Examination Council (NECO) releases its annual results as a result of students' poor performances especially in science subjects. Candidates' performances in the Senior School Certificate Examination (SSCE) conducted by WAEC have consistently remained poor with Chemistry recording one of the poorest and worst results over the years. For instance, from the data collected from the statistics unit of the WAEC office, Yaba Lagos (2017), as shown in the table in appendix 1, it is evident that there has been a persistent increase in the poor performance of candidates in the WAEC Chemistry. This ugly trend has continued and seems getting worse every year. Despite government's effort towards sustainable teaching and learning of science among Nigerian students right from the junior secondary school level, the enrollment of students in core science subjects and science oriented courses at the senior secondary school level and tertiary institutions respectively is still very poor. Oludipe and Oludipe (2016) attributed the poor trend in science enrollment to the existing curriculum and teaching methods in science. A particular concern of the critics has been the apparent inability of many students to engage in complex solving activities and to apply school knowledge and skills to do real life problems in work place settings. The above concern necessitated the urge for some other instructional strategies that appeal to the learners in such a way that would fully realize the objective of science education. Curriculum activities depends so much on textbooks and students are therefore, regarded as passive element into which information is poured by the teacher. In this approach, many students struggle to understand concepts in isolation, to learn parts without seeing whole and make connections where they see disparity and to accept as reality what their conceptions question (Ogbonna, 2019).

The effect of learning efficiency of male and female students may not be the same, hence the issue of gender in Chemistry achievement. Gender is a set of characteristics distinguishing between male and female, particularly in the cases of men and women. Gender can influence the way students learn in secondary schools. An issue of contention in Nigeria today is the issue of gender in our society which includes the educational system. Gender roles may be difficult to change but as they are sociological label, they are subject to change. Although gender roles are internalized very early in life, they vary across social, political, educational and economic dimensions. Considering the analytic and tasking nature of science, females are socialized early in life to believe that Science, Technology and Mathematics (STM) are meant for males.

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In the recent times, educators have expressed diverse views about gender and achievement especially in sciences. While some are of the view that males do better than females, others do not agree with this view. The later argue that achievement is a factor dependent on several factors such as socio-economic background, teaching method, among others (Igwe, 2016). In report by West African Examination Council in Senior School Certificate Examination (2015) statistics of result in Nigeria by subjects, grades and sex, it was revealed that there was an insignificant difference between male and female achievement in science. Eze and Agbomma (2018) stated that, if education is to be seen as the right of every child everywhere, every girl therefore, should be given the opportunity of transforming her life and that of her community. In Nigeria today, gender bias is still prevalent. It has persisted even within the science classroom. Igwe (2016) stated that gender issue is an important factor in educational setting and could be a militating factor to high achievement of learners in sciences.

Achievement in chemistry can be enhanced through a paradigm shift from the use of ineffective method of teaching to an approach that would enhance the development of science process skills, which will lead to the development of scientific attitude and enable the students to construct knowledge on their own. This is what constructivism is all about. From the current studies on how students learn science, new ideas and innovative instructional approaches which are proved to be more effective have been revealed. Such instructional approaches include; the use of inquiring, cooperative learning, problem solving and constructivist approach. Constructivism is an action-oriented approach to learning where students are required to build upon already existing knowledge in order to understand better and apply new concepts. Teachers are there to guide students through their cognitive processing and devise classroom activities to help students learn. Constructivism is one of the many educational approaches which teachers can leverage to enhance learning outcomes. It focuses mainly on building upon students' existing knowledge base and helping them connect what they already know and the new concepts. Teachers who employ constructivism in classroom can help foster greater students engagement and create useful dialogues which can help the students understand better new ideas. Constructivism is relatively new with deep historical roots and is derived mainly from the work of Piaget, Brunner, Papert, Vygotsky and Bandura. It is a kind of learning strategy that lays emphasis on active role of learners in the process of constructing their own knowledge. Thus, constructivism is a learning approach where students learn by interpreting a message with the immediate environment as the determinant. The pioneers of constructivism in education are of the view that constructivism promotes higher order thinking skill as well as critical thinking. The fundamental issue about constructivist learning is that individuals in a given environment construct their own concept of the universe. Constructivist studies lay more emphasis on how learners develop their own concepts. Constructivist teaching is assumed to foster critical thinking and creates active and motivation in learners.

Based on the captivating attributes of constructivist approach to learning, many researchers in the field of science have advocated for the application of the constructivist approaches in science classrooms especially for the beginners in science education. Though current researches on constructivist strategy to science instruction tend to reveal an improvement in concept formation, research efforts did not focus much on Chemistry within our educational context. As a result of this, the actual impacts of constructivist based teaching strategy in classrooms are still doubtful and need empirical verification. This therefore makes it difficult for researchers in education to explore and certify the actual effects of the constructivist based teaching strategy on students' achievement in Chemistry. Constructivism is a theory that explains how knowledge is constructed in human being when information encounters existing knowledge which had been developed by experiences. It also means an approach to teaching and learning which lays emphasis on the ways knowledge is acquired in order to adapt to the world. Constructivism is an active, contextualized process of constructing knowledge rather than acquiring it (Agulanna& Nwachukwu, 2016). According to the authors, knowledge is constructed based on personal experiences and hypotheses of the environment. Learners continuously test these hypotheses through social negotiation. Each individual has a different interpretation and construction of knowledge. The learner cannot be a blank state (tabula rasa) but can bring past experience and cultural factors to a situation. Constructivism is an approach to education that is based on the premise that learning is the result of "mental construction. In order words, students learn by fitting new information together with what they already knew. Constructivists believe that learning is affected by context in which an idea is taught as well as by students' beliefs and attitudes. Constructivism is basically a theory based on observation and scientific study about how people learn. It states that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. When learners encounter something new, they have to

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reconcile it with their previous ideas and experience, may be by changing what they believe or may be by discarding the new information as irrelevant. In any case, learners are the active creators of their own knowledge. To do this, they ask questions, explore and access what they know. In classroom, the constructivist view of learning can point towards a number of different teaching practices. In general sense, it usually means encouraging students to be active in classroom and also to use these active strategies (experiments, real-life problem-solving skill to create more knowledge and then reflect on and talk about what they are doing and how their understanding is changing. The teacher ensures he or she understands the students' pre-existing conceptions, and gives the activity to address them and then builds on them. Constructivist instructional strategy according to Agulanna and Nwachukwu (2016) focuses on making meaning and knowledge construction and not memorization. In this approach, the learner learns by personally and uniquely developing an understanding and making sense of information. The constructivist instructional strategy is considered a veritable tool for shifting science teaching from the conventional (lecture) method, which is teacher-centred, to the hands-on method, which is learner-centred. It therefore focuses on problem-solving, constructing and reconstructing ideas and methods. A teacher using the constructivist approach poses a problem and monitors student's exploration, guides students' inquiries, and promotes a new pattern of thinking. Constructivist instructional approaches can be applied across learners of ages, including adults. Constructivist view of learning recognizes the fact that students need time to express their current thinking, interact with objects, organisms, substances and equipment to develop a wide range of experiences on which to base their thinking. A constructivist instructional approach provides a built-in structure for creating a constructivist classroom.

There are different models of constructivist instructional approach. These models range from 5Es, 6Es and 7Es. Sometimes, a current model has to be amended to maintain its value after new information, insights and knowledge have been gathered. Such is now the case with the highly successful 5E learning cycle and instructional model. Research on how people learn and the incorporation of that research into lesson plans and curriculum development demands that the 5E model must be expanded to a 7E model. The 7Es of the learning cycle was developed by Arthur Eisenkraft in (2015). The 7Es allows students and teachers to experience common activities to use and build on prior knowledge and experience to construct meaning and to continually access their understanding as a concept. The 7Es describe a phase of learning that leads students through seven phases of learning that are easily described using words that begin with letter "E". These words are elicit, engage, explore, explain, elaborate, extend and evaluate.

Although, recent studies on constructivist based instructional strategies to science instruction tends to reveal an improvement in students' achievement, research efforts did not focus on Chemistry within our education context. As a result of this, the actual effects of constructivist based instructional strategy in chemistry classrooms are still in doubt and need empirical verification. Researchers in Chemistry education are therefore faced with the challenge of exploring and verifying the actual effects of constructivist based instructional strategy on students' achievement in Chemistry. It is in response to this challenge that the researcher deems it necessary to verify empirically, the Effect of Constructivist Based Instructional Strategy on Senior Secondary School Students' Achievement in Chemistry.

Statement of the Problem

Studies have shown that there is poor enrollment of students in core science subjects and poor performances of students in chemistry especially in Senior Secondary School Certificate Examinations. This may be attributed to some factors, one of which is the use of ineffective instructional approaches in teaching the subjects. In teaching and learning, instructional methods play a very vital role towards concertizing learning as they make learning meaningful and help to improve students' academic achievement. The commonest method of teaching in most of Nigerian Secondary Schools today is the conventional (lecture) method. Teachers seem to adopt verbalistic and theoretical method as a way of teaching and learning the subject rather than using instructional materials.

This may be responsible for the poor academic achievement in Chemistry. Teaching and learning of Chemistry in Nigeria are largely unsatisfactory as earlier discussed in the background of this work. These issues have been a great concern to the researcher because if they are not checked and corrected, scientific literacy and skill development will be jeopardized. This led to the search for the methods and procedures for effective teaching and learning. The search for the effective method of teaching and learning gave birth to many instructional strategies which include constructivist based instructional strategy. Thus, the need to ascertain the effect of constructivist based instructional strategy on Ebonyi State senior secondary school students' achievement in Chemistry.

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Aim and Objectives of the Study

The aim of this study was to determine the effect of constructivist based instructional strategy on senior secondary school students' achievement in Chemistry. Specifically, the study sought to ascertain:

1. effect of constructivist based strategy on academic achievement of students in Chemistry.
2. effect of constructivist based strategy on the me an achievement scores of male and female students in Chemistry
3. interaction effect of methods and gender on students' mean achievement scores in Chemistry.

Research Questions

The following research questions guided the study:

1. What is the effect of constructivist based teaching strategy on students' mean achievement in Chemistry?
2. What is the mean achievement score of male and female students taught Chemistry using constructivist based teaching strategy?
3. What is the interaction effect of teaching method and gender on students' mean achievements in Chemistry?

Hypotheses

The following null hypotheses were tested at 0.05 alpha level:

Ho_1: There is no significant difference in the mean achievement scores of students taught chemistry using constructivist based instructional strategy and those taught using conventional teaching method.

Ho_2: There is no significant difference in the mean achievement scores of male and female students taught Chemistry using constructivist based instructional strategy.

Ho_3: There is no significant interaction effect of teaching methods and gender on students' mean achievement in Chemistry.

Materials and Methods

Design of the Study

The design of the study is quasi-experimental design. The specific design used in the study is a pretest posttest non-equivalent control group design. In a quasi-experimental study, there is no random assignment of subjects (Hong, 2015). Intact classes were used for the study to avoid disruption of normal class lessons. There were a treatment and a control groups.

The study design is illustrated as shown below:

O_1 X_1 O_2

O_1 X_1 O_2

Where:

O_1 = Measurement taken before treatment (Pretest)

X_1 = Treatment for experimental group (Constructivist based instruction)

O_2 = Measurement taken after treatment (Post test)

X_1 = Treatment for control group (Conventional strategy)

Area of the Study

The study was carried out in Abakaliki Educational Zone of Ebonyi State. The zone comprises of four local government areas namely; Abakaliki, Ebonyi, Izzi and Ohaukwu. It shares geographical boundaries with Benue State by East, Ikwo and Ezza by West, Ishielu and Ezza North by North and Cross River State by South. AbakalikiEducation Zone is made up of many secondary schools, both public and private. Some of the schools are coeducational schools while some are single-sex schools. The people of the zone are mainly farmers. There are good number of traders and civil servants in the zone. The people of the zone are Igbos by their cultural background and Christians by religion.This area was chosen for the study because of the prevalent poor performances recorded by science candidates in Senior Secondary School Certificate Examination (SSCE) in the Zone every year.

Population of the Study

The population of the study comprised of 3,242 senior secondary school two (SS 2) students in 78 public co-educational secondary schools in Abakaliki Education Zone of Ebonyi State (SEB, 2024). Students of senior

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secondary school two (SS2) of four purposively selected secondary schools in Abakaliki Educational Zone were used for the study.

Sample and Sampling Technique

Intact classes were used for this study. A sample of 174 students (86 males and 88 females) was drawn from the four secondary schools selected from the 78 public co-educational secondary schools in Abakaliki Education Zone of Ebonyi State using simple random sampling. One school was chosen from each of the four Local Government Areas that make up Abakaliki Education Zone. Two of the four schools were assigned to treatment group while the other two schools were assigned to control group through tosses of a coin. Schools A and C were used for control group while schools B and D were used for experimental group.

Instrument for data Collection

The instrument the researcher used for data collection is a Chemistry Achievement Test (CAT). The instrument consisted of thirty multiple choice items with options A, B, C, and D. The items in the CAT were developed by the researcher based on the content to be taught in the lesson during the experiment. The topics are Rate of Chemical reaction, Energy and Chemical Reactions and Chemical Equilibrium.

Validation of Instrument

The content validity of the Chemistry Achievement Test (CAT) was done by three specialists. Two specialists in Chemistry Education and one in Educational Measurement and Evaluation. A CAT of forty (40) items was generated in line with the content scope and sent to the specialists. Each of them examined the test items in terms of clarity, relevance and format, and made some modifications on them as were deemed appropriate. Ten(10) out of the forty(40) items generated were dropped, and thirty(30) items were finally recommended.

Reliability of the Instrument

The instrument was subjected to trial testing in two co-educational secondary schools each in Onueke and Afikpo Educational Zones. This was carried out by administering some copies of the CAT to the SS2 science students and the data obtained from their responses in the trial testing was used to estimate th e reliability of the instrument. The trial testing was used to determine the reliability of the test items. The reliability of the CAT was determined using Kudder-Richardson procedure which gave a reliability index of 0.75. The CAT was also tested for internal consistency.

Experimental Procedure

At the beginning of the study, pretest consisting of thirty (30) Chemistry Achievement Test (CAT) items from the topics taught during the experiment was administered to the Chemistry students in treatment and control groups in the four schools used for the study. Their scripts were marked by the researcher and the raw scores were kept and used with the posttest scores after the experiment.

The Chemistry teachers in the sampled schools were used as research assistants during the study. The researcher organized a workshop where the Chemistry teachers were trained on how to use the instructional strategies while teaching the students. Constructivist based instructional strategy (guided discovery method) was used to teach the treatment group while conventional method (chalk-talk) was used to teach the control group. The Chemistry teachers in the four selected schools conducted the teachings in their respective classes using the instructional package and lesson notes prepared by the researcher. The teachers for the treatment group used real word experiences like burning, fading of colours of clothes and rusting of materials to explain the concepts in the topics. The students were encouraged to actively construct their own knowledge on the Chemistry concepts. Hands-on activities like experiments, simulations and investigations were also used to help the students explore and discover new concepts in the topics. The students were also guided to ask questions, investigate and find answers through inquiry. The experiment was carried out during the school hours using the school timetable and it lasted for six weeks. At the end of the experiment, the researcher with the help of the Chemistry teachers, administered the posttest to the students in both the treatment and control groups. The scores collected from both the pretest and the posttest were used in answering the research questions and testing the hypotheses.

Method of Data Collection

The researcher went to the selected schools and met with the school authorities. He explained to them that he was carrying out a research on the "Effect of Constructivist Based Instructional Strategy on Senior Secondary

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School Students' Achievement In Chemistry. He told the school authorities that he had chosen their schools to use and conduct the research and would use their SS2 science students.

Two of the four schools selected were used for the experimental group and the other two for the control group. The researcher conducted a pre-test on the students both the experimental group and control group. At the end of the experiment, the researcher conducted a post test on the two groups. Their scripts were marked by the researcher and the scores were kept separately and used for data analysis.

Method of Data Analysis

The researcher answered the research questions using mean and standard deviation. The hypotheses were tested at 0.05 level of significance using the Analysis of covariance (ANCOVA). ANCOVA is the most suitable because it takes care of lack of initial equivalence in the groups since intact classes were used for the study.

Control of Extraneous Variables

The researcher adopted the following procedures to ensure that extraneous variables were properly controlled in the study.

a. Instructional situation variable: In order to ensure that the instructional situation is the same for all the schools used in the study, the researcher will prepare instructional manuals for the teachers in both treatment and control groups. The teachings will be conducted in all classes of senior secondary school two (SS11) in the different secondary schools to be used for the study.

b. Teacher variable: The researcher will organize separate pretreatment conferences for the teachers in the treatment and control groups. This will help to establish a common instructional standard among the teachers. The researcher will monitor the teachers to ensure that they adhere strictly to the specifications of the manuals.

c. Subject interaction: The researcher will use separate schools for the treatment and control groups. This will ensure that the students in the two groups do not mix up and exchange ideas with regards to the experiment.

d. Testing effect: Since it is the same tests will be used for both pretest and posttest, the researcher will reshuffle the items he used in the pretest before using them in the posttest. This will make it difficult for the students to recognize that it is thesame test that they took in the pretest would be given to them in the posttest. They would not be able to recall the answers easily.

Results

Research Question 1: What is the effect of constructivist based instructional strategy on students mean achievement scores in Chemistry?

Table 1: Mean achievement scores of students taught Chemistry using constructivist based instructional strategy and those taught using conventional method.

Groups	Adjusted mean	Std Deviation	Number
Constructivist based strategy (Experimental group)	19. 42	2. 48	78
Conventional method (Control group)	17.71	2.76	96

Summary of the data analysis in Table 1 shows that the adjusted mean for the students taught with constructivist based instructional strategy (experimental group) is 19.42 while the adjusted mean for those taught with conventional method (control group) is 17.71. This implies that those taught with constructivist based instructional strategy performed better than those taught with conventional method. Constructivist based instructional strategy therefore is better than conventional method in facilitating students' achievement in Chemistry.

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Research Question 2: What is the mean achievement scores of male and female students taught Chemistry using constructivist based instructional strategy?

Table 2: Mean achievement scores of male and female students taught Chemistry using constructivist based instructional strategy.

Gender	Adjusted mean	Std Deviation	Number
Male	19.28	2.58	40
Female	19.58	2.40	38

Summary of the data analysis in Table 2 shows that the mean score of male students is 19.28 while that of the female students is 19.58 for the group taught Chemistry using constructivist based instructional strategy. This means that there is a very small gain difference (infavour of female students) between the mean achievement scores of male and female students taught Chemistry using constructivist based instructional strategy.

Research Question 3: What is the interaction effect of teaching method and gender on students' mean achievement in Chemistry?

Table 3: Interaction effect of methods and gender on students' mean achievement in Chemistry?

Gender category	Method	
	Constructivist based	Conventional
Male	19.28	17. 54
Female	19.58	17.86

Summary of the result in Table 3 indicates that constructivist based instructional strategy is better than conventional method at the two levels of gender. It is also revealed from the Table that there is no significant interaction between method and gender on students' achievement in Chemistry at each level of gender category.

Testing of Hypotheses

$H0_1$: There is no significant difference in the mean achievement scores of students taught Chemistry using constructivist based instructional strategy and those taught using conventional teaching method.

Table 4: ANCOVA test of significant difference for methods on students' achievement in Chemistry.

Source of variation	Type 111 Sum of squares	Df	Mean square	F	Sig.
Corrected model	133.950	4	33.487	4.750	.001
Intercept	2130.820	1	2139.820	303.518	.000
Pretest	3.213	1	3.213	.456	.501
Method	125.891	1	125.891	17.857	.000
Gender	3.921	1	3.921	.556	.457
Gender * method	.000	1	.000	.000	.994
Error	1191.459	169	7.050		
Total	60729.000	174			
Corrected total	1325.408	173			

a. Rsquared= .101 (Adjusted Rsquared = .080

b. Computed using alpha =.05

For hypothesis 1, the alpha level (0.05) is greater than the significance of F (0.000). The researcher therefore rejects the null hypothesis and concludes that there is a significant difference in the mean achievement scores of students taught Chemistry using constructivist based instructional strategy and those taught using conventional teaching method.

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$H0_2$: There is no significant difference in the mean achievement scores of male and female students taught Chemistry using constructivist based instructional strategy.

Table 5: ANCOVA test of significant difference for method by gender for experimental group only.

Source	Type 111 sum of squares	Df	Mean squares	F	Sig
Corrected model	1.807	2	.903	.143	.867
Intercept	1238.519	1	1238.519	196.286	.000
Pretest	.006	1	.006	.001	.975
Gender	1.803	1	1.803	.286	.594
Error	473.232	75	6.310		
Total	29901.000	78			
Corrected Total	475.038	77			

a. Rsquared = .004 (AdjustedRsquared = -.023)
b. Computed using alpha = .05

Summary of the result in Table 5 indicates that the F.value is 0.29 and the significance of F is 0.59. Since the alpha level (0.05) is less than the significance of F (0.59), the researcher therefore upholds the null hypothesis and concludes that there is no significant difference in the mean achievement scores of male and female students taught Chemistry using constructivist based instructional strategy.

$H0_3$: There is no significant interaction effect of teaching methods and gender on students' mean achievement in Chemistry

Table 6: ANCOVA test of significance for interaction between methods and gender on achievement students in Chemistry.

Source of Variation	Type 111 Sum of Squares	Df	Mean Square	F	Sig
Corrected Model	133.950	4	33.487	4.750	.001
Intercept	2139.820	1	2139.820	303.518	.000
Pretest	3.213	1	3.213	.456	.501
Method	125.891	1	125.891	17.857	.000
Gender	3.921	1	3.921	.556	.457
Method * Gender	.000	1	.000	.000	.994
Error	1191.459	169	7.050		
Total	60729.000	174			
Corrected Total	1325.408	173			

a. Rsquared = .101 (AdjustedRsquared = .080
b. Computed using alpha = .05

Summary of the data analysis shown in Table 4 shows that the significance of F at alpha level of 0.05 is 0.994. Since the value of significance of F (0.994) is greater than the alpha level (0.05), the null hypothesis which states that there is no significant interaction effect of teaching methods and gender on students' mean achievement in Chemistry, is not rejected. This indicates that there was no interaction effect between methods and gender on students' mean achievement in Chemistry.

Discussion

Effect of Constructivist Based Instructional Strategy on Students' Academic Achievement in Chemistry.

From the results of the data analysis presented in Table 1 of chapter four, it was found that there exists a significant difference between the academic achievement of students taught with constructivist based instructtional strategy and those taught with conventional method. The result showed that those taught with constructivist based instructional strategy (experimental group) had a higher adjusted mean than those taught with conventional method (control group). The result of the ANCOVA test of the null hypothesis in Table 4, also revealed that there is a significant difference in the mean achievement scores of students who were taught Chemistry using constructivit based instructional strategy and those taught using conventional teaching method. The finding is in line with the works of Madu (2016). The finding is also in support of the work of the Sridevi (2019) who reported that constructivist teaching is more effective than conventional teaching in terms of perception of nature of science amongst standard students

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Effect of Constructivist Based Instructional Strategy on Academic Achievement of Male and Female Students in Chemistry.

The result of the data analysis shown in Table 2 of Chapter four indicates that the mean scores of female students is a bit higher than those of male students for the group taught with constructivist based instructional strategy. However, the difference in mean scores of the female students and the male students is not much. This implies that there is no significant difference in the mean achievement scores of male and female students taught Chemistry using constructivist based instructional strategy. This finding is in line with the study of Oludipe and Oludipe(2020) whose finding also revealed that there is no significant difference in academic achievement of male and female students at the pretest, posttest and delayed posttest levels. This present study is also in support of the work of Sridevi (2019) which revealed that constructivist approach is effective for both boys and girls in improving academic achievement in science.

Interaction Effect of Method and Gender on Students' Academic Achievement in Chemistry.

The finding from the result analysis presented in Table 3 reveals that constructivist based instructional strategy is better than conventional teaching method at the two levels of gender. This is in support of the study of Oludipe and Oludipe (2020) whose work revealed that constructivist instructional technique is better than conventional approach in facilitating students' academic achievement. The present study also revealed that there is no interaction between method and gender on students' mean achievement in Chemistry. This finding is in line with that of Etuk (2017) whose work on the Efficacy of Constructivist Instructional Strategy on Students' achievement in Basic Science showed no significant interaction between teaching method and gender. It is also in agreement with the work of Ukwungwu (2016) who carried a meta-analysis of gender differences in students in Physics and found out that gender difference is not significant. This is however in contrast with the findings of Oludipe and Oludipe(2020) who found out that there were significant interaction effect of treatment and anxiety on academic achievement of students.

Conclusion

Based on the findings of this study, the researcher concluded that constructivist based instructional strategy is better than conventional teaching method. The students taught with constructivist based instructional strategy achieved higher than those taught with conventional method. The study revealed that the mean score of female students is slightly higher than those of male students for the group taught with constructivist based instructional strategy. This means that the use of constructivist based instructional strategy improved both male and the female students' academic achievement in Chemistry with an insignificant gain difference in favour of female students. The constructivist based instructional strategy is better than conventional method at the two levels of gender with no interaction effect between method and gender. Thus, for a better achievement in Chemistry, the teachers should be encouraged to use a constructivist-based instructional strategy with other appropriate teaching methods in teaching. The use of this variety of teaching methods will improve the understanding of the subject leading to students' higher academic achievement.

Recommendations

The following recommendations are made based on the results of the study:

1. Constructivist based instructional strategy should be used by Chemistry teachers because it facilitates effective teaching and learning.
2. Constructivist based instructional strategy should be used for both male and female students since it does not discriminate across gender.
3. Seminars, conferences and workshops should be organized for Science teachers on the use of constructivist based instructional strategy.

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