CHAPTER ONE

INTRODUCTION

Background to the Study

Knowledge of science and technology is pivotal to sustainable development in any national economy. Developed nations such as United State of America boast of so many scientific inventions, hence, it is among the nations rated as world super powers. They forged ahead because they recognized the importance of science. Science and technology is a vehicle which a nation can use to accelerate economic growth, increased productivity, competitiveness, job creation, development for self-reliance and overall development. Every branch of science such as chemistry has important contribution to make in a nation's technological advancement.

The contributions of chemistry to the scientific and technological development in many countries cannot be over-emphasized. Knowledge of chemistry plays a vital role in the quality of life of different nations. In Nigeria, chemistry has provided the theoretical base for the synthesis of medicines, soap, paints, shoes, textiles, detergents and cosmetics, fertilizers, cement, ceramics, margarine, plastics, glass. Jegede (2007) affirmed that chemistry occupies a central position among the science because of its remarkable contributions in areas such as petroleum, engineering, medicine, textile industry, agriculture, pharmacy etc. Knowledge of chemistry helps to position students in undertaking numerous career opportunities such as chemists, pharmacists, doctors, chemical engineers, biochemists, agricultural scientists, geologists among others.

Despite the increasing importance and usefulness of chemistry to the world at large, and Nigeria in particular, the secondary school students' performance in the subject remain discouraging. Serious concern has been expressed by parents and the society in relation to the poor performance of students in chemistry in the senior school certificate examinations.

According to Oli (2013), West African Examination Council (WAEC) reported a summary of 37.87 pass of students in chemistry in the year 2011. Okoli(2011) also reported a summary of 33.4 pass of students in chemistry in the year 2010.There is rather a fluctuating poor performance of students in chemistry in WASSCE, (See Appendix A, p. 108for details), WAEC published results from 2009 to 2015 showed that performance of chemistry students is not encouraging. Table 1 shows performance of 50.7%, 42.8%, 48.6%, 41.0% and 38.3% for 2011 to 2015 respectively. The result for the last five years shows fluctuating poor performance and the credit passes are mostly on the C grade (borderline). The reasons adduced for the poor performances of students by chemistry Chief Examiners include: Students' non adherence to instructions, poor knowledge of most chemistry concepts, lack of skills on the usage of technical terms where required, poor knowledge of laboratory set-up and names of laboratory apparatus, poor mathematical skills, among others.

Similarly, researchers have advanced reasons for poor performance of students,in relation to the unsatisfactory performance, Njoku (2004) and Jegede (2007) reported factors such as poor instructional strategies, societal influence, teacher factor, infrastructural problems, lack of interest as well as poor study habit on the part of chemistry students as factors affecting students' performance.Poor method of instruction was equally reported by Njelita (2005) as a factor affecting performance of students. Njelita was of the view that most 1
educators employ teacher-centered instruction in delivering their lessons. In consonant with this view, Jegede, (2007) pointed out that the type of instructional plan used by teachers determine how effective learning could be, hence good teaching makes learning more meaningful. Jegede is of the view that poor teaching would lead to poor learning and poor performance while effective teaching will enable students to gain mastery of the subject matter, which leads to excellent performance.

In the past years, many instructional strategies such as concept mapping, mastery learning, advance organizers, scaffolding, and inquiry-based learning have been employed by Nigerian educators to promote students learning in chemistry. Yet, there seem not to be much improvement in students' performance in chemistry over the years.This demands a re-examination of the instructional strategies used in teaching chemistry.

There is need for educators to shift from teacher-directed instruction such as lecture method (chalk and talk method) to a more participatory active learning environment where students participate actively and make use of their creative minds. Poor method of instruction can be supplemented with enhanced activity-based and participatory method of instruction. For example, the direct method of instruction most often used by teachers can be supplemented with flipped classroom instruction (FCI). The direct instruction (DI) which is sometimes referred to as chalk and talk or lecture method is widely used in secondary schools, it is a teacher-centred approach. According to Joyce, Weil and Calhoun(2000) it is a teaching strategy, which reliesstrictly on lesson plans and lectures with little or no room for variation. It sparingly include activities such as discussion. Allan, (2013) is of the opinion that DI is a method of imparting basic knowledge or developing skills in a teacher-centred learning environment (using lecture method or demonstration of material to students). DI encourages students to be listeners and keen observers in contrast to exploratory instruction which focuses on inquiry, discovery and active learning.The term direct instruction is in line with an instructional strategy developed by Siegfried Englemann and Carl Bereiter in the late 1960s (Allan, 2013). According to Nelson and Johnson (2005), DI has its root in behaviourism. Behavioral theorists emphasize breaking behaviour and skills into component tasks and mastering each subcomponent. They emphasize the importance of modelling desired behaviour and using feedback and reinforcement to guide students towards desired goals.

Generally, a direct instruction proceeds through five phases. Joyce, Weil and Calhoun (2000) described the five phases as orientation, presentation, structured practice, guided practice and independent practice. In the first phase, the teacher clarifies the goal of the lesson, explains why the lesson is important, ties the lesson to previous lessons and students' prior knowledge, and motivates the students. These ensure the students' mental set and prepare them for the lesson. This is followed by the second phase which involves presentation or demonstration of new materials to the students. In this phase teachers using direct instruction give multiple examples and provide accurate illustrations. The third phase is guided practice where the teacher structures the initial practice by leading the students through step-by-step and giving feedback on correct and incorrect responses. This is followed by phase 4 which check for understanding and provides feedback verbally or in writing.The final phase (phase 5) of a direct instruction lesson is independentpractice, which is meant to reinforce the knowledge or skill acquired. This can be accomplished through homework. According to Allan, DI is highly teacher-centred. Thislargely promotes passive listening and not active participation by students in learning. This may lead to loss of interest and frustration on the part of students. DI does not furnish students with processing skills required in the 21st century; hence, more activity based instruction such as flipped classroom instruction (FCI) is advocated.

FCI is not entirely a new instructional approach but an older approach to teaching that has become more organized. Strayer(2012) used the phrase-invertedclassroom, which is an earlier version of the flipped classroom where the initial learning is done outside the classroom. Constructivist psychologist such as Bruner (1966) sees the flipped classroom as instructional strategy where students construct their own learning by doing the assigned learning activities with a minimal initial help from the teacher. The FCI employs group-based interactive learning activities inside the classroom (student-centred learning) which is based primarily on the theories of Bruner and Vygotsky (1978).

Flipped classroom instruction is an educational method of instruction that consists of internet-based instruction outside the classroom and interactive group learning activities inside the classroom. It can simply be described as schoolwork at home and homework at school (Willis, 2014). In FCI, students work on assigned activities outside the classroom (having prior knowledge) and inside the classroom they discuss and interact on the same materials. In this instance, the use of educational technology and activity learning are the two major components of the flipped classroom instruction, whichblends online and in-class learning based on activities. Flipped classroom presents study guides to students through bulk SMS, which are practiced by the students as homework before the topic is treated in the class. This is a contrast with the traditional teaching method, which involves teaching the topic in the class before homework is given.

Bergman and Sams (2012) view flipped classroom as a teaching strategy whereby students work on assigned activities outside the classroom and the class time is devoted to building their knowledge base. In this type of instruction, students are empowered to take charge of their own learning, at their own pace. Educators who use FCI no longer bear the sole responsibility of imparting knowledge, rather students' active participation in the learning process and the classroom session becomes centre for effective interaction between teachers and students. The FCI is one of the approaches through which teachers introduce technology to students in a learning environment thereby encouraging self-directed learning.The Federal Republic of Nigeria (FRN) 2008 in the National Policy on Education (NPE) agreed that teaching has to be practical, activity-based, experimental and ICT supportive. Students may be instructed to study some new materials in the internet for the next class instruction, review teacher-created video content outside the classroom or read a section of a textbook. The class time is used for more engaging, interactive activities facilitated by the teacher. In this instance, students are encouraged to take charge of their own learning. The FCI changes the environment of initial introduction of new topic to an interactive class where every student is capable of contributing to the topic. It incorporates formative and diagnostic evaluations, as well as promotes meaningful face-to-face learning activities (Natalie 2015).The FRN also emphasized that teaching has to be participatory, exploratory, and child-centred. In relation to this view Ausubel (1968) pointed out that learning occurs best when students interact in the classroom. This promotes interest, retention and participation in the subject studied. The flipped classroom instruction provides the teacher with a means of achieving the desired student-centred learning environment where students participate actively and not passive listeners.

Student participation in teaching and learning process is an essential quality in any educational experience. Most researchers are of the view that students' participation increases their critical thinking ability, enhances their intellectual development and improves their academic achievement (Abdullah, Bakar & Mahbob, 2015; Siti Maziha, 2010). Student’s participation in classroom activities implies involvement in the classroom processes and procedures. This involvement may be described as active or passive. While active participation includes asking questions, voicing opinion or involving in class discussion in the class; passive participation involves taking notes, sitting quietly and listening (Abdullah, Bakar and Mahbob, 2015). However, Steel, Laurens and Huggins (2013) provided a broader perspective of classroom participation when they described it as "a range of student activities undertaken before, during and after class." This suggests that class participation can be categorized as in-class participation and out-of-class participation. While the former deals with student activities undertaken inside the classroom, the later includes those undertaken outside the classroom. Whether activities are outside or inside the classroom, it is important that students engage actively. In this study, students' participation in chemistry implies students' involvement in both in-class and out-of-class activities associated with the learning of the subject. Participation of students in and outside chemistry classroom may enhance their interest in learning the subject.

Interest is a very essential factor in students' learning. Hidi and Reminge (2006) view interest as the predisposition to re-engage with particular class of objects, events or ideas, while Okoro (2012) defines it as an individual's behavioural tendency to be attracted towards a certain class or classes of activities.Hidi and Reminge's view of interest integrated some level of consistency in the object of attraction over time. In agreement with Hidi and Reinge, the researcher sees students' interest in chemistry as recurrent positive disposition to activities associated with the teaching and learning of chemistry. Many educators that carried out research on students' interest towards the learning of science revealed that students show poor interest to science. However, use of activity-based instructional strategy could arouse and sustain students' interest in learning. Narmadha and Chamundeswari (2013) observed that students' interest towards chemistry has a direct effect on their academic achievement. Okoye, Okongwu and Nweke (2015) affirmed that increase in students' interest leads to increase in their achievement in chemistry and vice versa.

Academic achievement of students implies learning outcomes of students in terms of level of skills, knowledge and ideas, which they acquire. It connotes performance in school subject. In this study, academic achievement refers to the quality of academic skills and knowledge acquired by students in chemistry. Poor instruction by teachers and non or low participation by students could lead to low interest and poor achievement by students. Jessy(2010) pointed out that learning occurs when students put more effort, attention and are more active in the learning process. Students do not learn effectively when they do not participate actively in learning. Non-participation could lead to lack of interest and poor achievement in any subject (Sargant, 1993). Activity-based learning encourages learners to work cooperatively in groups and individually, which leads to high academic achievement (Elechi 2013).

Gender is a term, which describes behaviour, and attributes expected of individuals based on being either a male or female in a given society (Esan,2002). Students' gender may have an influence on the interest, participation and academic achievement in chemistry. As a chemistry teacher, the researcher observed that male and female students face different challenges in chemistry. Such challenges call for instructional approach, which will enhance student's interest, participation and academic performance irrespective of gender or any other intervening factor. It is therefore imperative to find out appropriate instructional approach, which will enhance students' performance in chemistry.

Research evidence from international context shows that flipped classroom instruction has been effective in improving students' academic achievement in most science subjects including chemistry (Wiginton, 2013).However, there is dearth of research on its effect on students' interest, and participation but given the activity-based nature of flipped classroom instruction (FCI), it might enhance students' participation and interest which could culminate in high academic achievement. For this reason, therefore, there is the need to ascertain its effects on students' interest, participation and academic achievement in chemistry in Nigerian context.

Statement of the Problem

The problem of poor achievement of students in chemistry in Senior School Certificate Examination (SSCE) (See Appendix A, p. 108Tables 1 & 2 for details on students' achievement) is of great concern to both parents and the society. Researchers have advanced reasons for the poor achievement, which include poor instructional approach, lack of interest, poor study habit.

The present instructional approach used by most chemistry teachers seems to be teacher-centred type of instruction. The direct method of instruction mainly used in secondary schools seems not to give students enough opportunity to actively participate in classroom activities. This may affect their ability to gain processing and reasoning skills in chemistry, which are necessary for application in the world of work.

Based on the above view, it becomes pertinent that a study on an innovative, collaborative and participative approach, which can help students become more active, is carried out. Flipped classroom instruction (FCI) is one of such innovative and collaborative type of instruction.

The problem of the study put in a question form therefore is; will flipped classroom instruction affect student's interest, participation and academic achievement in chemistry when compared to the use of direct instruction in secondary schools in Anambra State?

Purpose of the Study

The purpose of this study is to investigate the effect of flipped classroom instruction (FCI) on students' interest, participation and academic achievement in chemistry. Specifically, the studydetermined the:

1. Effect of FCI on students' interest in chemistry when compared to those taught using DI.
2. Effect due to gender on students' interest in chemistry.
3. Interaction effect of instructional approaches (FCI & DI) and gender on students' interest in chemistry.
4. Effect of FCI on students' participation in chemistry when compared to those taught using DI.
5. Effect due to gender on students' participation in chemistry.

6. Interaction effect of gender and instructional approach (FCI & DI) on students' participation in chemistry.
7. Effect of FCI on students' academic achievement in chemistry when compared to those taught using DI.
8. Effect due to gender on students' academic achievement in chemistry.
9. Interaction effect of gender and instructional approach (FCI & DI) on students' academic achievement in chemistry.

Significance of the Study

The findings of the study will be of importance to chemistry teachers, students, parents, curriculum planners and future researchers.

The findings will be beneficial to chemistry teachers because it will provide them with effective method of teaching which they will incorporate in their day to day classroom instruction in order to promote learning. The findings will offer teachers ample time for classroom activities. The problem of time constraint, rushing to cover syllabuses, not conducting science practicals will be drastically reduced because much is covered outside the classroom. The result of the study is expected to help chemistry teachers in the proper implementation of the curriculum; active learning and participation of students is equally encouraged.

The findings will enable Post-Primary School Service Commission (PPSSC) to organize workshops and seminars for teachers on flipped classroom instruction in order to promote the implementation of student-centred learning technique.

The finding of this study will be beneficial to students because it will expose them to flipped classroom instruction which will enable them develop skills in oral communication, self-efficacy, social and group skills necessary for success outside the classroom, increase in their retention ability, a good study habit and enhance creativity. The findings of the study will help to activate students' interest in the learning of chemistry as well as make them have supportive and committed relationships. It will enable students appreciate the need for their involvement in collaborative learning activities within and outside the classroom which will improve their performance and enable them to make better grades in chemistry at a sitting. This will equally remove financial burdens on parents.

The findings of this study will equally be beneficial to curriculum planners and administrators. It will enable them include in their list of activity-based instructions and recommend such teaching method to chemistry teachers and plan in-service training regarding the use of such method. In the reform for a successful shift from teacher-centred teaching approach to student centred approach, the flipped instruction can be popularized and included as one of the recommended approaches to teaching science.

Parents' assistance to their children in carrying out the assigned work at home will save them the trouble of their children engaging in irrelevances outside the classroom/school environment. Students crediting chemistry at a sitting as a result of effect of FCI will make parents happy, proud and at the same time remove the burden of paying school fees a second time.

It is equally hoped that the result from this research would contribute to knowledge by adding information to the search for solutions to problems militating against the effective teaching and learning of chemistry in secondary schools.

Scope of the Study

The study was delimited to finding out the interest, participation, and academicachievementof senior secondary two(SS2) students in chemistry using FCI in single sex public secondary schools in Awka Education zone ofAnambra State. The content coverage of this study focuses on two major areas namely periodic table (PT) and chemical reactions (CR) selected from first term, scheme of work in chemistry for SS2 students. The two areas fall within the scheduled weeks and times for this study.Scheme was based on new national curriculum for senior secondary schools prepared by Association of Nigerian Conference of Principals of Secondary Schools (ANCOPSS, 2013). The two areas consist of the following topics as indicated in the scheme of work (See Appendix B, p. 109).

(i) Periodic table-groups, periods, metals, non-metals.

(ii) Families: (a) Electronic configuration S.P.D.F according to groups 1-8/0 that is Alkali metals, Alkali-earth metals and other family names (halogens, rare gases). (b) Properties

(iii) Change in size (atomic radii/ionic radii) (a) Changes down the groups and across the periods (b) Ionization energy, electron affinity and electronegativity changes down the groups and across the periods

(vi) Chemical reactions: (a) Basic concepts: reactants, products, reaction rate (b) Introduction to collision theory (c) Factors affecting rate of chemical reactions (d) Types of chemical reactions.

These areas were selected because of their significance in laying good foundation for the study of chemistry as well as because they enable students be adequately prepared for further studies in chemistry and other areas. It is essential in the development and understanding of other areas in senior secondary school chemistry. Specifically, these areas were selected because they fall within the schedule weeks and times for the study.

Research Questions

The study was guided by the following research questions:

1. What is the mean interest scores ofstudents taught chemistry using FCIand those taught using DI?

2. What is the mean interest scores of male and female students in chemistry?

3. What is the mean participation score of students taught chemistry using FCI and those taught using DI?
4. What is the mean participation score of male and female students in chemistry?
5. What is the mean achievement score of students taught chemistry using FCI and those taught using DI?
6. What is the mean achievement score of male and female students in chemistry?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

1. There is no significant difference in the mean interest scores of students taught chemistry using FCI and those taught using DI.
2. There is no significant difference in the mean interest scores of male and female students.
3. There is no significant interaction effect of teaching methods and gender on the interest of the students in chemistry
4. There is no significant difference in the mean participation scores of students taught chemistry using FCI and those taught using DI.
5. There is no significant difference in the mean participation scores of male and female students.
6. There is no significant interaction effect of teaching methods and gender on the participation of the students in chemistry.
7. There is no significant difference in the mean achievement scores of students taught chemistry using FCI and those taught using DI.
8. There is no significant difference in the mean achievement scores of male and female students.

9. There is no significant interaction effect of teaching methods and gender on the achievement of the students in chemistry.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter reviewed literature related to the study. The review was organised under the following subheadings:

Conceptual Framework

- Flipped classroom instruction
- Interest
- Participation
- Academic achievement

Theoretical Framework

- Social Development Theory by Lev Vygotsky
- Jerome Bruner's Theory of Learning

Theoretical Studies

- Importance of teaching chemistry in secondary schools
- Chemistry education in Nigeria secondary schools
- Instructional approaches to the teaching of science (chemistry) in secondary schools
- Theoretical perspectives on flipped classroom instruction
- Influence of gender on students' interest and participation
- Theoretical studies on the effect of flipped classroom instruction on students' interest and participation
- Gender issues in science education

Empirical Studies

- Effect of flipped classroom on student's academic achievement
- Effect of flipped classroom instruction on students' interest and participation in learning
- Gender and achievement of students taught with flipped classroom instruction.
- Gender issues in science education

Summary of the Review of Related Literature

Conceptual Framework

Flipped Classroom Instruction

Flipped classroom is a type of instruction that consists of internet-based individualized instruction outside the classroom and interactive group learning activities inside the classroom. It can simply be described as school work at home and home work at school. In other words, the flipped classroom instruction moves what is traditionally done in the classroom to be done at home and the work done at home moves into the classroom. Flipped classroom is an instructional design that replaces the traditional lecture-in-class with assigned learning activities outside the class and back into the class for interactive learning where the teacher guides the students as they apply concepts and engage creatively in the subject (Willis,2014).

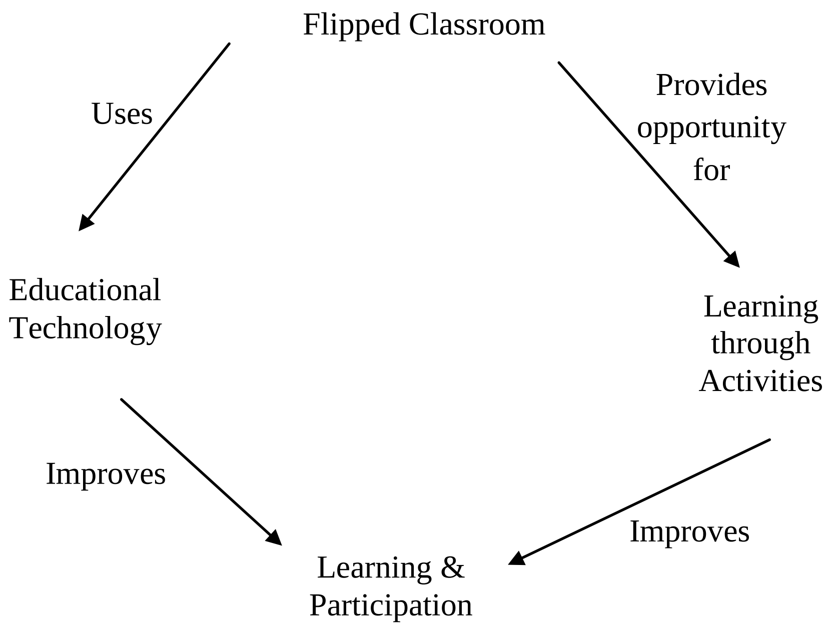

Figure 1: An illustration of how Flipped Instruction Works

Flipped classroom is not a new instructional approach, but an older approach that has become more organized. The phrase "inverted classroom" was used by Strayer (2012) in his study of differences between classroom environments. The inverted classroom method of instruction is an earlier version of the flipped classroom. In flipped classroom, sequence of instruction is reversed in such a way that students learn by making better use of class time for active engagement and mastery learning.

The flipped instruction involves helping students to use the class time to enhance what they had studied initially at home by participating in group discussions, engaging in laboratory activities, and projects that involve higher level thinking (McKnight, 2013). In flipped classroom students take ownership of their own learning and teachers talk with students and not talking to student. The entire paradigm of teaching moves from a traditional model of teachers as imparters of knowledge towards a model of teachers as facilitators and coaches who carefully observe students, identify their learning needs and guide them to higher levels of learning (Goodwin & Miller, 2013).

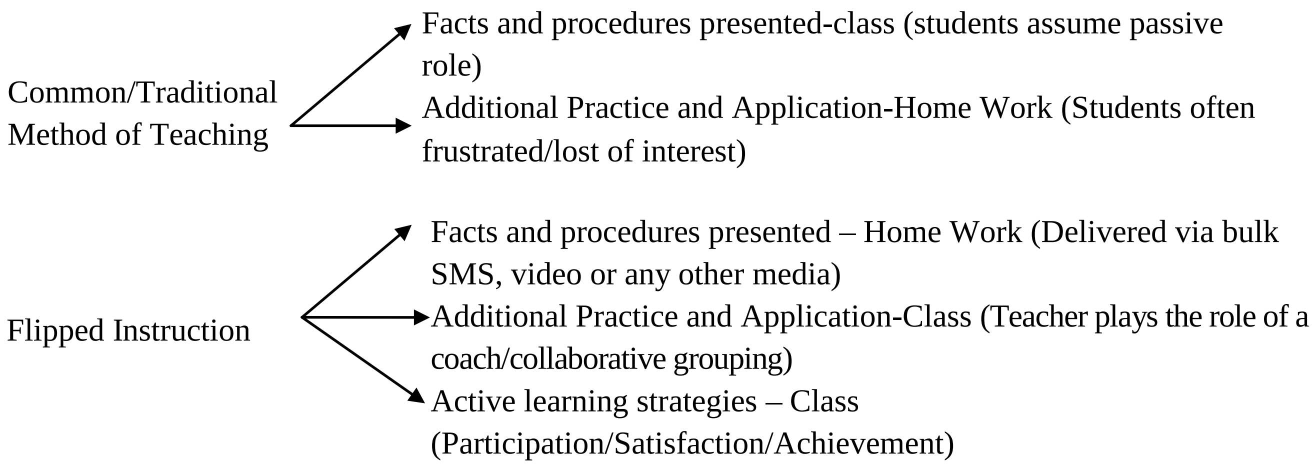

Figure 2: Flipped Instruction compared with Common/Traditional Method of Teaching –homework

It is on this regard that this study sets out to find out the effect of flipped classroom instruction on students' interest, participation and academic achievement in chemistry.

Interest

Interest is a desire or positive feeling an individual has for something.It is an individual's behavioural tendency which can be attracted towards a certain class or classes of activities. In a classroom setting, interest is required to meet students' intellectual as well as emotional needs. Interest can never be imposed on an individual by external force, but a teacher can help increase the learner's interest (Li, 1981). Interest is source of motivation which drives people to do what they want to do when they are free to choose (Okoro, 2012). The strength of a person's attitude is his interest hence interest is a power or the force an individual has towards manifestation in a person's behavior. Interest is a feeling somebody has for something he or she feels is valuable and beneficial. Moreso, interest is a state of curiosity about something. It is an influence due to personal importance or capability. Interest refers to the psychological state of engaging or predisposition to re-engage with particular classes of objects, events or ideas overtime (Hidi & Reminge, 2006). Interest promotes intrinsic motivation which has been shown to drive and sustain student's engagement in a particular task. This study therefore intends to find out how flipped classroom instruction will affect students' interest in chemistry.

Participation

Participation is an act of involvement/engagement in a given situation. Student's participation in teaching and learning process is an essential quality in any educational experience. Students' participation increases their critical thinking ability, enhances their intellectual development and improves their academic achievement (Abdullah, Bakar & Mahbob, 2015; Murray & Lang, 1997; Siti Maziha, 2010; Tatar, 2005). Student participation in classroom is the act of involvement in the class activities. This involvement may be described as active or passive. While active participation includes asking questions, giving opinion or involvement in discussing a topic, passive involvement includes taking notes, sitting quietly, and listening, However, Steel, Laurens and Huggins (2013,p.32) provided a broader perspective of Class participation when they described it as "a range of student activities undertaken before, during and after class." This suggests that class participation can be categorized as in-class participation and out-of-class participation. While the former deals with student activities undertaken inside the classroom, the later includes those undertaken outside the classroom. Whether activities are outside or inside the classroom, the most desirable is that there is an active engagement. In-class, participation involves playing an active role in all in-class activities. This study views students' participation in chemistry as involvement of students’ actively in both in-class and out-of-class activities associated with the flipped classroom instruction.

Academic Achievement

Achievement is an act of accomplishment. Achievement involves completing, attaining or accomplishment to successful performances. It is successful execution of an action.Academic achievement of students implies learning outcomes of students in terms of level of skills, knowledge, ideas they acquired. Academic achievement is a measure of students’ cognitive abilities. Santrock (2004) opined that academic achievement is the measurement of what the learner has learned or what skill the learner has mastered. This ability of the learner to learn is measured by results that show the extent of his performance. According to Nworgu (2003) measurement of achievement involves the determination of the degree of attainment of individuals in tasks, courses or programmes to which the individuals were sufficiently exposed. This takes cognizance of all possible learning outcomes and categories of instructional objectives. Therefore, this study aims at finding out the effect of flipped classroom on students’ academic achievement.

Theoretical Framework

Learning theories describes the ways information is absorbed, processed and retained in course of learning. There are many theories that have been propounded by different educators concerning teaching and learning. These theories have inspired a lot of approaches to teaching and learning of science. It is therefore necessary to discuss some of the theories on which this study is achieved as well as their relevance to the study. Two theories were reviewed, namely:

Lev Vygotsky’s Social Development theory and

Jerome Bruner's cognitive theory of learning

Social Development Theory

Lev Vygotsky propounded the social development theory of learning in 1978. He proposed that social interaction influences cognitive development. Vygotsky believed that process of life development depends on social interaction and that social learning actually leads to cognitive development.

Vygotsky believes that culture has made two contributions to the intellectual development of a child namely: acquisition of the content of their thinking (their knowledge) and the providing means of their thinking which is the tools of intellectual adaptation. These tools include speech and writing to mediate their social environments. Initially children develop these tools in order to communicate their needs. Vygotsky explained that when these tools are internalized, higher thinking skills will be accomplished. He stressed the importance of social interaction in the development of cognition.

This theory implies that Cognitive development involves a dialectic process whereby a student learns through problem-solving experiences guided by a more capable hand. Schools should therefore promote classroom environment where students would play active role in their own learning. Vygotsky's theory challenges the teacher and students to play a role of collaboration with each other rather than the teacher dictating the materials to the students for future recitation. A teacher should collaborate and interact with students in order to create meaning in such a way that students can make their meanings. Based on the Vygotsky's theory, the classroom learning environment should embrace interactions, discussions, collaborations, cooperation, small group instruction where students will be actively involved, thus making the classroom a community of learning.

This is in line with the flipped classroom instruction whereby the class time is solely devoted for active student-centred learning. It involves active learning environment where students are encouraged to use their creative minds and collaborative efforts. In the Flipped Classroom students make use of the class-time to enhance what they had studied initially at home by participating in group discussion and laboratory activities which involves higher level thinking. Vygotsky's theory challenges the direct approach of instruction whereby the teacher disseminates knowledge to be memorized by the students. In this study the researcher sought to find out how flipped classroom instruction affect the interest, participation and academic achievement of students in chemistry.

Jerome Bruner's Theory of Learning

Jerome Bruner, an American cognitive psychologist and educational psychologist, propounded his theory in the year 1964. The major theme in the Brunner's theory is that learning is an active process in which learners construct new ideas or concepts based on existing knowledge. Bruner stressed that teachers should make concerted effort to encourage students discover principles by themselves and engage in an active dialogue. Bruner encouraged activity-oriented and student-centred approaches to learning which is the back bone of flipped instruction.

Like Piaget, Bruner developed three stages of instruction based on development. The three stages are enactive (birth to three years), iconic (3years to 8years) and symbolic(8years and above). Each of the stages is dominant at different phases of development but all are present and accessible always. The first stage he termed enactive implies that an object or event is understood, known or represented by the actions that have been performed with it. In other words, when a person learns about the world through actions on physical objects and the outcome of these actions. The second stage according to Bruner is iconic representation which is the assessment of a mental representation in the form of images. In this stage, learning can be obtained through the use of models and pictures. Symbolic representation is the highest level which represents the ability of the learner to develop the capacity to think in abstract terms. Based on these three stages, Bruner recommended using a combination of concrete, pictorial and symbolic activities that lead to more effective learning.

Bruner maintained that learning is an active process where the learner is encouraged to participate actively in the learning process. He described discovery learning in terms of inquiry-based instruction where a learner constructs his or her own knowledge for himself or herself as opposed to being told about something. By engaging in flipped classroom learning there is a deliberate shift from a teacher-centred classroom to a student-centred approach, where in-class time is meant for exploring topics in greater depth and creating richer learning opportunities. Students move from being the product of teaching to the centre of learning, where they are actively involved in knowledge formation through opportunities to participate in their learning in a meaningful way (Noora Hamdan& McKnight, 2013). The flipped classroom instruction advocates that teachers should facilitate learning process by developing lessons that involve active learning where learners take charge of their own learning and construct their own knowledge.

The provision of prior knowledge of content material through teacher-created videos, sending bulk short message services(sms) containing study guide, or other media to students before class-time, places students in a better position to participate effectively when the same material is being treated during class time. This might help to sharpen student's thinking ability, develop problem-solving skills and enhance creativity. Bruner describes discovery learning in terms of inquiry-based instruction where the teacher guides and facilitates learning. The teacher is no longer seen as a 'sage on the stage' but a 'guide by the side'.

This is in line with flipped classroom instruction (FCI) whereby students are given opportunities to make inquiries / discoveries during the outside class activities. In the inside class (lesson time) activities, the teacher guides, coaches and talks with the students during the learning process. Therefore, the FCI presents the teacher as a facilitator who allows the students to make discoveries on the content through inquiries.

Theoretical Studies

This section is discussed under the following subheadings; chemistry education in Nigeria secondary schools, traditional and student-centred approach to the teaching of science, importance of teaching chemistry in secondary schools, theoretical perspective on flipped classroom, studies on interest participation and academic achievement, impact of technology on learning.

Importance of Teaching Chemistry in Secondary Schools

Teaching of chemistry in Nigerian secondary school system starts in senior secondary school class 1(SS1), and ends in senior secondary three(SS3). Science teachers are the key factors in the actualization of the goals of teaching science in secondary schools as stipulated in the National policy on Education(2004). These goals include the follows:

- To produce scientists for National development
- To cultivate inquiry and rational mind for the conduct of a good life and democracy
- To provide studies in technology
- To provide knowledge and understanding of the complexity of the physical word, the forms and conduct of life

Chemistry teachers require specialized competence in their field of study to enable them plan and select appropriate teaching methods in order to ensure effectiveness. A competent chemistry teacher should be able to do his/her job well, facilitate students' emotional, social, intellectual interest and attitude towards the subject.

The major aim of teaching chemistry in secondary schools is to enable the students to develop knowledge and skills in chemical science and project their efforts in education in order to be useful to themselves and the society in general. This provides the students opportunities to develop manipulative skills that will enable them to function effectively in the society.

There is need for chemistry teachers to use appropriate methods of teaching in order to stimulate students' interests towards learning of chemistry. This will help to realize the goals in the curriculum as well as the national policy on education.

Teaching chemistry in secondary schools will enable students

- Acquire basic theoretical and practical knowledge and skills;
- Apply skills to meet social needs of creating employment and wealth;
- Be positioned to take advantage of the numerous career opportunities offered by chemistry.
- Develop interest in the subject chemistry
- Develop reasonable level of competence in ICT application that will engender entrepreneurial skills
- Acquire basic STM knowledge and skills;
- Be adequately prepared for further studies in chemistry
- Develop the spirit of problem solving in science related issues (FME, 2007).

These will help in laying sound basis for scientific and reflective thinking, developing in the students the ability to adapt to his/her changing environment, equip students to live effectively in the modern age of science and technology and giving the students opportunity for developing manipulative skills to enable them function effectively in the society. Knowledge of chemistry is pivotal to the development of the scientific base of most countries.

In so many ways, chemistry has contributed towards providing our basic needs as well as improving the quality of human life. Its contributions towards medicine, food, clothing, transportation, explosives, housing are summarized as follows.

Medicine: Many of us enjoy healthy life due to the variety of medicines available as a result of chemical research and technology. Big pharmaceutical firms finance the research to find new and better drugs which is going on all the time.

Food: preservation and food storage for long periods are made possible due to the especially designed chemical process. Thus such foods are made available to more people and can equally be exported to distant countries. Fertilizers and insecticides have greatly aided the increase of food production.

Clothing: Due to intensive chemical research, man-made textile fibres are produced and made available in wide range of clothing materials that can be bought cheaply.

Transportation: Chemists produce suitable fuel and structural materials like alloys which are light, strong and heat resistant. Morden transportation which is an essential feature of today's world is made possible by chemists.

Explosives: Chemistry contributes to the discovery and description of the theoretical bases for the behaviour of chemical substances such as explosives used in the military. It is the duty of the military to defend the territory of a nation or a state.

Housing: Chemical industries produce building materials like cement, steel, concrete, bricks, tiles, etc. These materials are used in the construction of houses to overcome the present increasing need for houses especially in cities.

Chemistry Education in Nigeria Secondary Schools

Chemistry is one of the science subjects offered in Nigerian senior secondary schools. Various curriculum development bodies in Nigeria have played different roles in developing various science curricula. The Nigeria Secondary Schools Science Project (NSSSP) was developed by the Comparative Education Study and Adaptation Centre and aimed at developing students' conceptual thinking, manipulative skills and scientific attitudes, Ayodele (1999). Various challenges that faced the implementation of the NSSSP as listed by Ayodele (1999) were as follows:

- Inadequate funding by the government.
- Lack of infrastructure such as equipment, space, personnel.
- Lack of effectiveness in teaching.
- Implementation problems.
- Lack of materials
- Inability of the science curriculum to meet the needs of the society which the school served.
- The contents were designed to satisfy requirements for further studies.
- Learning was accomplished by recitation of facts all the time.

Reforms in secondary school chemistry curriculum as documented in the FME (1985) was aimed to

(a) Facilitate a transition in the use of scientific concepts and techniques acquired in integrated science with chemistry;

(b) Provide the students with basic knowledge in chemical concepts and principles through efficient selection of content and sequencing;

(c) Show chemistry in its inter-relationship with other subjects;

(d) Show chemistry and its link with industry, everyday life, benefits and hazards;

(e) Provide a course which is complete for pupils not proceeding to higher education while it is at the same time a reasonably adequate foundation for a post-secondary chemistry course.

The curriculum planners recommended guided discovery as the approach for the teaching of the chemistry topics and it is to ensure that learners are provided with continuous experiences in the skills of defining problems, recognizing assumption, critical thinking, hypothesizing, collection and recording data, manipulating variables and applying generalizations. However, Okon (2007) noted that chemistry curriculum is faced with a number of challenges such as lack of effective teaching, in-sufficient time for carrying out activity teaching, implementation problems, among others.

In line with the Federal Government reform in education and the need to attain the Millennium Development Goals (MDGs) and the critical target of the National Economic Empowerment and Development Strategies (NEEDS), emerging issues like peace and dialogue, value orientation, human rights education, family life, HIV and AIDS education, entrepreneurial skills were also incorporated into the relevant contents of the new senior secondary school curriculum (FME, 2007).

The objectives of the revised senior secondary school chemistry as stated in FME 2007 are to enable students:

- develop interest in the subject chemistry;
- acquire basic theoretical and practical knowledge and skills;
- develop interest in science, technology and mathematics (STM)
- acquire basic STM knowledge and skills;
- develop reasonable level of competence in ICT application that will engender entrepreneurial skill;
- apply skills to meet social needs of creating employment and wealth;
- be positioned to take advantage of the numerous career opportunities offered by chemistry;
- be adequately prepared for further studies in chemistry.

The teacher is the major implementer of the reformed curriculum. He is expected to concretizes the curriculum in the classroom by engaging in relevant activities that will ensure the achievement of the curriculum objectives but the reverse is the case as chemistry students still perform poorly in senior school certificate examination, Ogun (2007).

Implementation of the reformed curriculum calls for teacher effectiveness in all ramifications, in order to ensure that the learning environment is student-centred. An effective teacher would interact skilfully with the students so that learning becomes meaningful. Teaching task requires careful planning and appropriate use of teaching strategies by the teacher.

Flipped classroom instruction may promote effective teaching and learning as it is purely a student-centred instruction whereby the students take charge of their learning under the guidance of the teacher. The in-class portion of the flipped classroom instruction provides students enough time to practice and integrate the skills within a given task with the teacher as a guide.

Instructional Approaches to the Teaching of Science in Secondary Schools

Teaching is as old as man and polymorphous in nature which literately takes many different forms ranging from direction of the deployment of resources in definite strategies to achieve objectives. It is an interactive process that attempts to assist students in acquiring skills, knowledge, ideals, attitude and so on. Teaching does not only involve the teacher, learner, infrastructure but also the style of teaching and its outcome. Teaching strategy according to Smith (2011) refers to a pattern of teaching acts that serves to attain certain outcomes. It is purposefully conceived and determined plan of action which is a generalized plan for a lesson. Students taught with effective teaching strategy will acquire skills and scientific attitudes needed for future challenges.

Teaching strategy ensures that students are engaged in exchange of ideas as well as attainment of content objectives. There are quite a number of teaching strategies that instructors employ in teaching and learning of chemistry. Some of the teaching strategies for chemistry are discussed below:

Direct Instruction:

Direct Instruction (DI) is a very common teaching strategy, relying strictly on lesson plans and lectures with little or no room for variation. It does not include activities such as discussion (Joyce, Weil and Calhoun, 2000). It is a method of imparting basic knowledge or developing skills in a teacher-controlled learning environment (using lecture or demonstration method). DI teaches by passive learning in contrast to exploratory instruction such as inquiry-based learning, discovery learning or active learning, (Allan 2013).

The term direct instruction is affiliated with an instructional strategy developed by Siegfried Englemann and Carl Bereiter in the late 1960s (Allan 2013). DI has its root in behaviourism. Behavioral theorists emphasize breaking behaviour and skills into component task and mastering each subcomponent. They emphasize the importance of modelling desired behaviour and using feedback and reinforcement to guide students towards desired goals.

Generally, a direct instruction proceeds through five phases. Joyce, Weil and Calhoun (2000) described the five phases under orientation, presentation, structured practice, guided practice and independent practice. In the first phase, the teacher begins the lesson with an orientation. Clarifies the goal of the lesson, explain why the lesson is important, relate the lesson to previous lessons and students' prior knowledge, and motivate the students. These ensure the students' mental set and prepare them for the lesson. This is followed by the second phase which involves presentation or demonstration of new materials to the students. In this phase an effective teacher gives multiple examples, provide accurate illustrations. The third phase is guided practice where the teacher structures the initial practice by leading the students through step-by-step and giving feedback on correct and incorrect responses. This is followed by phase 4 which check for understanding and provides feedback verbally or in writing.

The final phase (phase 5) of a direct instruction lesson is extended practice which is meant to reinforce the knowledge or skill acquired. This can be accomplished through homework.

Lecture Method:

Many years ago, lecture style of instruction was the most widely adopted technique in classrooms. It involves oral presentation of facts with little or no participation by the learner. It is a process of teaching by giving spoken explanations of facts to the learned. The lecture method is usually descriptive whereby the teacher does all the talking, thus no room is given for exchange of ideas. In this situation, the learners listen and remain passive to the lesson which encourages rote-learning and memorization of facts. According to Njelita (2005), the teaching of chemistry in most secondary school are mainly theoretical and teacher dominated which does not allow students to be actively engaged in the lesson, hence no meaningful learning is achieved. There is an emphasis on learner-centred approach of teaching which allows the learner to interact with resources while the science teacher guides the lesson for the attainment of the stated objectives.

In lecture method, teachers dictate information to students with little or no opportunity of providing their own input or protest the information being given to them. According to Pari (2014), lecture method of teaching involves having an authoritative figure at the front of a class room, delivering a speech/information to the students. He stated further that the teaching method is quite one-sided as well as full passive experience for students. When students are not actively engaged in a discussion concerning a topic/material, such material will seem worthless to the students. Generally, education involves critically analysing the provided information and learning how to apply such information in another context. If the students had no opportunity of interacting/discussing with the teacher/instructor delivering the material, they will only receive a shallow understanding of the material being delivered. The students might as well be bored with the delivered material as they will have no room to learn how the material applies to them on a personal level. Long-term retention of content by the learners will not be achieved as the learners are placed in a passive model rather than active role.

Lecture method of instruction is therefore teacher-centred and lacked active involvement hence its usefulness as a method of instruction is limited, especially in teaching science-oriented courses. The flipped instruction seems more of student-centred which encourages active involvement of students in order to promote higher level thinking, problem solving, group processes (meaningful learning).

Laboratory Method:

Laboratory is a place equipped for experimental study, and it is synonymous with scientific investigation. Laboratory activities are mainly used in the teaching of science for the purpose of verifying science principle, laws or theories taught to the students. It is the focal point for the study of science and provides the learner the opportunity to gather experiences in the field of science. With laboratory experience, students are able to interact directly with the material world. Through laboratory activities, a deeper understanding of the science processes can be achieved, which include participation and help to develop critical thinking Omosu (2006) in Okoli (2011). It provides concrete experiences that are used to substantiate the theoretical aspect of science.

The use of laboratory based method requires science teachers to organize and structure instructional materials so as to stimulate the learners and contribute towards meaningful understanding of the scientific knowledge. The laboratory activities also provide exercises like observing, manipulating of materials, classifying, measuring, operating and interpreting data, thus lead to acquisition of suitable scientific skills and attitudes, Adeyomo (2005). The effectiveness of laboratory based instructional strategy depends so much on the position assumed by the science teacher in the teaching and learning of science. When the science teacher assumes the position of a dispenser of knowledge the laboratory becomes a centre for verification of knowledge. The science teacher could as well act as a guide to learning and the laboratory becomes a place where knowledge is discovered. Laboratory activities help to awaken and sustain different ability levels of students' interests, participation, reasoning ability and investigational talents in science through direct-hands/mind-on-activities, Obiekwe (2010). Experimentation underlines scientific knowledge and understanding. Laboratories are good settings for teachers.

However, some problems are being encountered by the science teachers in their attempt of using the laboratory based teaching strategy, these problems include poor equipment of laboratories, large class size Agwu (2005) among others. All the same, there is a shift towards project-based learning as recommended in the educational/curriculum reforms, NRC (2005).

Project-Based Learning Method:

This is a teaching method that invests responsibility on student or group of student to carry out learning activities with the teacher playing the role of a supervisor. It is a practical method of instruction that requires creative and innovative minds on the part of the learner. Project-based method of instruction presents students with real life problems which they solve by thinking and working together. While working on the project, students develop further skills and new knowledge. Project method of instruction can be carried out as:

Individual Project: This is carried out by an individual learner, who does all the activities concerning the project, but receives help and guidance from the teacher.

Group Project: This involves a group or the whole class, in which group effort is needed to accomplish the assigned project.

Management Project: In this case, students are responsible for managing/taking care of a project.

Project teaching method can be applied in all subject area but might not be applicable in all the contents of the subject Akubuilo (2004). Project based learning strategy can be termed a special form of take home examination that aid students development in creativity. It requires students', explore of important and meaningful questions through a process of investigation and collaboration on a daily basis, Zee and Robert, (2001). It engages learners in seeking background information, asking questions, designing investigations, making predictions, data collection, analysing and interpreting data, making explanations and making products to share ideas Okoli (2011).

Project-based learning strategy is equally seen as an activity by which students develop an understanding of a topic through involvement in a real life problem and also have some degree of responsibility in designing. It is an out-of-school exercise organized by the teacher involving the use of defined procedure for solving the problem, Okafor (2008). Anyanwu (1993) in Okoli (2011) reported that project-based instruction produced significant improvements in students'achievement in chemistry.

Project-based method is a special instructional activity built into a lesson to create more independent interaction between the chemistry teacher and the students so that meaningful learning is actualized. It is the believe of most science educators that a child should be allowed to make discoveries in science. Project-based instruction is used in teaching chemistry hence it is applicable to this study.

Discovery Method of Instruction:

This is a constructivist based approach to education as well as technique of inquiry-based instruction, that takes place in problem solving situations where the learner finds things out for himself by the use of his mental processes. Bruner Jerome is given the credit of originating discovery learning in the 1960s. Bruner (1961) is of the view that practice in discovering for oneself teaches the learner to acquire information in such a manner that makes that information more readily viable in problem solving.

Discovery learning takes place only when the students are not provided with the exact answer but rather the materials in order to find the answers on their own. Thus, the learner draws on his/her own experience as well as prior knowledge to interact with the environment by exploring and manipulating objects, battling with questions and performing experiments. Discovery learning has two essential processes namely: assimilation and accommodation. Assimilation is a process whereby the learner has the ability of integrating new information with the existing cognitive structure. In this case, the learner reconciles the incoming information with old information. Accommodation process involves the learner restructuring his cognitive structure in order to fit in the new incoming information. In this process, the teacher presents a conflict/problem situation and the learner tries to resolve the problems.

The following are three types of discovery learning: Guided discovery learning pure discovery learning and effective surprise. In guided discovery, the teacher is a facilitator and guides the learning situation. The teacher should not dictate or dominate learning rather he provides the materials, set goals and evaluate the learning outcome. Pure discovery learning is an activity that involves fact finding whereby the students are left on their own to find solution to scientific problems. All the materials and facilitates associated with the exercise are provided and the learner is given absolute freedom to carry out the findings to the problem. Effective surprise as a discovery learning method involves using any activity that may capture learner's interest and promotes learning.

In discovery learning process, learners are allowed to exercise their initiative with the teacher as a facilitator, mentor, coach or consultant of the learning process. The teacher makes adequate use of questioning, coaching and create a classroom environment that will not be authoritative but that which will enable learners to progress in their search for the solution of the given task. In other words, the learners are provided with both direction and freedom in the classroom.

Discovery learning according to Castronova (2005) increases learner achievement when the learner is learning skills rather than facts. The use of discovery-based instruction promotes information retention, motivation and interest. However, most educators have the fear that using discovery method of instruction will affect covering of the course content considering the available time for teaching. Okolo (2010) points out that discovery learning will require too much preparation, time (time consuming) and class sizes. The science teachers' target is to complete the syllabus and end of year examination. The in-class activities in flipped class is mainly for interaction and solidification of knowledge/facts acquired in the outside-class activities of the flipped classroom. Thus there is enough time for the in-class activities.

Cooperative Learning Strategy:

Cooperative learning strategy is an instructional strategy in which students work in small groups in order to accomplish a common learning goal under the guidance of a teacher. The students in small groups are of different levels of ability that uses a variety of learning activities to improve their understanding of a topic. Cooperative learning is a type of collaborative learning that attains higher level thinking and preserves information for a long time than students working individually. This kind of learning supports the adage that says "two heads are better than one." It fosters interaction and cooperation among students. Cooperative learning strategy is designed to eliminate winner or loser competition found in the traditional learning environment. Davidson (1990) sees cooperative learning strategy as a task for group discussion involving face-to-face interaction, mutual helpfulness, an atmosphere of cooperation and individual accountability. Richard (2001) views cooperative learning as that instructional strategy that promotes teaching of academic and collaborative skills to small heterogeneous groups of students.

The learning strategy is found on the principles of constructivist psychology. It is an instructional strategy that consist of heterogeneous grouping of students in order to work together to help one another accomplish an assigned task. Each member of a group is responsible not only for learning what is taught but also for helping team mates learn, thus creating an atmosphere of achievement. Positive interdependence is one of the elements governing cooperative learning, whereby students are made to understand that they are linked with each other in such a manner that one cannot succeed unless every member in the group succeeds (sink or swim together) (Johnson and Johnson, 1988 in Enechi 2013).

Other elements of cooperative learning strategy include group processing, interpersonal and small groups skills, team contract, a clear set of specific objectives, social skills, individual accountability, face-to-face interaction and a host of other. The cooperative learning group makes each member a stronger individual and as such students learn together to achieve greater individual competency.

The use of cooperative learning requires training, experience and perseverance. A call for radical shift was made at the 1998 world conference on science held in Romania on the ways science is taught in all the countries UNESCO, (2004). Okebukola (2002) is of the opinion that innovative approaches to teaching science is a way forward.

There are new strategies that can respond to the challenges on the use of introductory materials in teaching. These introductory materials are called advance organizers.

Advance Organizer:

This refers to a relatively short arrangement of material introduced to learners before the lesson. It is information presented prior to learning, which can be used by the learner to organize and interpret new incoming information, Anne (2011). Advance organizer is a kind of cognitive bridge which teachers use to help students make a link between what they know and what is to be learnt. Nwankpa (1991) in Enechi (2013) sees advance organizer as introductory material presented to the students at the beginning of a lesson and it facilitates learning of the details of the topic. Advance organizer derived from Ausubel model of meaningful learning, simply serves as appetizers, openers, introductory behaviour to a lesson as well as a mechanism to help to link new learning material with existing related ideas. It is not a summary of a previous lesson rather it provides a structure for student's thinking. Therefore, advance organizers are frameworks that enable students learn new ideas/materials and meaningfully link these ideas to the existing cognitive structure. They can be in form of short stories, demonstrations, questioning, reading materials etc.

Advance organizers fall into two major categories, namely comparative and expository organizers. Comparative organizers are used when the material to be learnt is not entirely new. They are intended to point out ways in which that material resembles and differs from that which is already known. Expository organizers are used when the new learning material is unfamiliar to the learner. Expository organizers emphasis context and link the essence of the new material with some relevant previously acquired concepts, Shihusa (2009).

Advance organizer enhances assimilation of concepts and act as anchor for the reception of new material. Ausubel (1960), points out that cognitive restructuring process that is as a result of advance organizers leads to some learning outcome. Many science educators believe that learners should be helped to build links to previous experiences and facilitate in knowledge construction by engaging them actively in the learning process. This method is applicable to this study as a method used in teaching chemistry.

Generative Learning Strategy:

This is a learner-centred instructional activity that makes the learner active in the learning process. It enables the learner to construct meaningful understanding of materials/ information found in the environment. The concept of generative learning shows that the mind is not a passive recipient of information but actively constructs its own interpretations of information and draws inferences from the information. Through the learner's self-generation of relationship and understanding the knowledge can be generated meaningfully. Generative learning is achieved the moment students are able to ask meaningful questions, draw graphs, state objectives, prepare table of values, demonstrate experiments, solve problems, draw inference from observation, compose titles among others. Science educators have stressed the need to enhance students' meta-cognition in order to improve their scientific achievement. The use of concept mapping strategy is advantageous in order to achieve this.

Concept Mapping Strategy:

This is a visual representation of key elements/concepts/idea and to illustrate their relationships. It is a diagram of nodes, each containing concept labels, that are linked together with directional lines that are also labelled Zeilik (2003). Concept mapping is a diagrammatic visualization of relationships between different concepts enclosed in a box or ones which are linked with arrows. It is a two-dimensional, hierarchical mode-link diagram that shows the structure of knowledge within a scientific discipline.

Concept maps were developed on the basis of Ausubel's theory of meaningful learning. According to Ausubel learning will only be meaningful when the learner is able to comprehend the relationship of what is being learned to other knowledge. Concept map is a graphic tool that organizes, connect and synthesize information Mustafa (2013).

Concept maps can be used as a graphic organizer during lessons and after lessons to assess development of students' understanding, especially in terms of inter-relationship between concepts. The concept map shows at a glance specific performance areas, their interrelationship and their strategic priority. However, the strategy does not easily allow for the inclusion of detailed information and may require an experienced facilitator. Concept mapping is quite related to learning cycle model.

Learning Cycle Strategy:

This is a planning strategy that has a number of stages or phases and is consistent with contemporary theories about how people learn. Chinapah's learning model in Okoli (2011) points out five stages – engage, explore, explain, extend and evaluate.

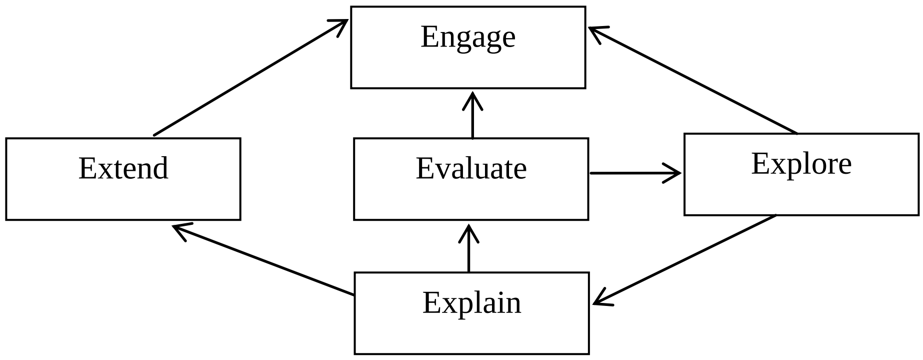

Figure 3: Chinapah's Learning Model (1983)

Engage: This involves introducing a lesson in such a manner that students are engaged on the topic. This will generate curiosity and interest on the topic of study, raise certain questions and responses from the students.

Explore: In this case the students are required to examine the predictions or may form new ones. The students may use alternatives and discuss such with each other.

Explain: Students provide their own explanations.

Extend: This calls for concepts and skills applications in new but similar situations.

The learners are in position to propose solutions, ask questions, experiment and record observations.

Evaluation: This is carried out through the learning process. The instructor observes the students' skill change in thinking and test their knowledge on how the new concepts are applied.

Science instructional processes are being structured as a result of innovative learning strategies in such a manner that the learner is the central point of the interaction. The learner is actively engaged in the learning process through discussion, demonstration, asking question peer-tutoring, debates. These help to establish a healthy inter-personal relationship among learners. The innovative approach that encourages higher order thinking skills like synthesis and analysis is known as active learning process.

Active Learning Process:

This involves any instructional method that engages learners in the learning process. According to Bonwell (1991), active learning is any instructional activity involving students doing something and thinking about what they are doing. It is mainly a participatory approach whereby learners are actively engaged in the learning process. Active learning involves the use of different learning strategies as show in Figure 5.

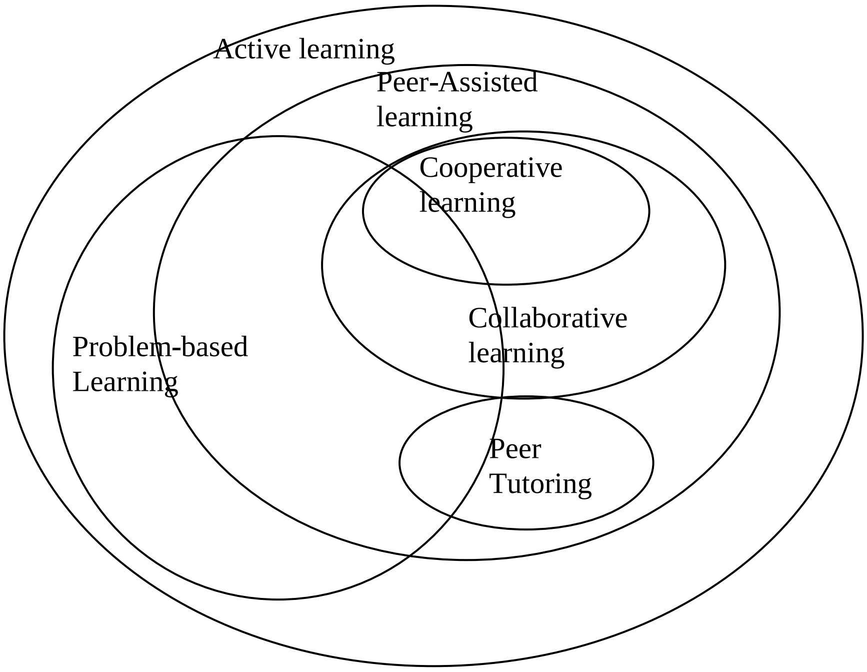

Figure 4: Jacob Lowellis Venn Diagram of several Student-Centered Learning Methods (2013)

Peer assisted learning involves the acquisition of knowledge and skill through active help and support among equals. Collaborative learning explains virtually all the current techniques in educational practice.

Cooperative learning represents the most carefully structured end of the collaborative learning. It involves learners working in groups and each member takes responsibility for a different sub-goal. Members' contributions are pooled together to ensure that the goal is reached.

Problem-based learning is learner-centred that occurs in small student groups with the teacher as a facilitator. In this type of active learning, problems form the organizing focus and stimulus for learning, Lowell (2013). Problem-based learning strategy uses problems to develop problem-solving skills in the learner.

Recent advancements in technology and ideology have opened up new directions for researches in education. The flipped classroom instruction (a new pedagogical method) is one of such openings that embarrass student-centeredness in learning.

Theoretical Perspectives on Flipped Classroom

Flipped classroom is a teaching strategy whereby students watch instructional videos, read content material with guided questions and answers as homework and class time is used for discussions, projects, experiments and to provide personalized coaching to individual students.

The flipped classroom utilizes group-based interactive learning activities inside the classroom, thus embracing student-centred learning theories based on the work of Piaget 1964 and Vygotsky, 1978. The student-centred learning which is the focus of flipped classroom embraces peer-assisted learning, cooperative learning, constructivism and collaborative learning, problem-based learning, peer-tutoring, laboratory activities/experimental learning.

Flipped instruction is regarded as a blended instruction due to the fact that a portion of the instruction is done at home and another portion delivered in a face-to-face learning environment. Alvarez 2011, Bergmann &Sams, 2012 consider flipped instruction as a form of blended learning. Alvarez (2011) further described flipped classroom instructional learning as a shift from traditional lecture method (teacher-centered) to student-centered instruction where the students have the privilege of being actively engaged, and by so doing embrace meaningful learning.

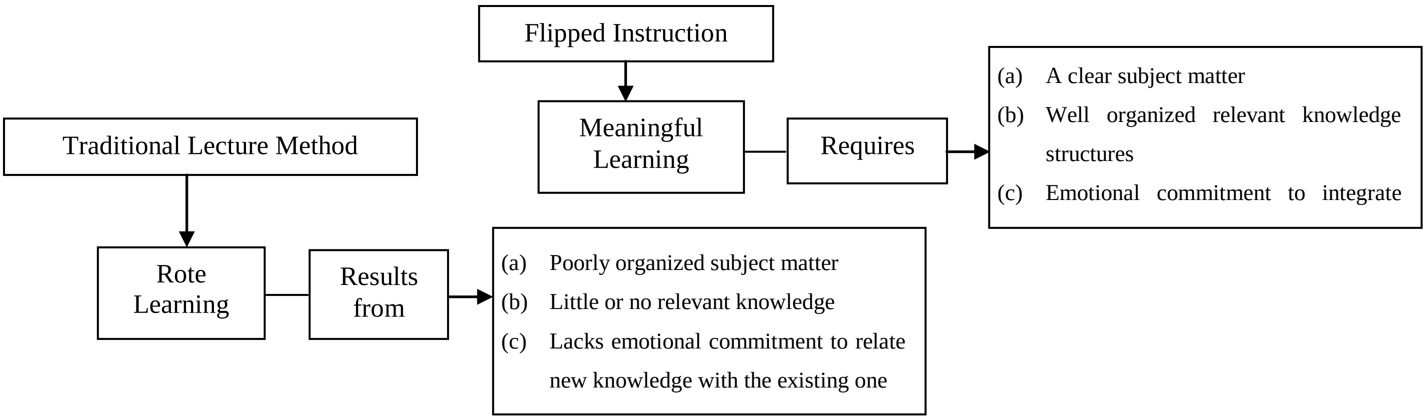

Figure 5: Meaningful Learning Compared with Rote Learning

Flipped instruction provide students the prior knowledge of the content materials outside of class through teacher-created video, guiding questions to the material from internet or textbooks, practice problems as homework et cetera. As a result of this, students become prepared for classes and the classroom encounter focuses on exercises, asking and answering questions, discussions, problem-solving among other things (Kurtz, 2014).

Technologies are becoming more widely available and the focus on integrating technology into learning is increasing on daily bases, interest in flipped learning is equally growing in that direction. Educational technology and activity learning are the two major components of the flipped classroom instruction. Flipped classroom is described as a learning strategy that blends online and in-class learning.

The origin of flipped classroom instructional approach is associated with some educators and researcher like Bergam and Sams who employed the flipped classroom instruction in his write up about flipped classroom describes the teacher as the guide on the side and not 'sage on the stage'.

Flipped classroom instructional strategy has seen marked growth over the year as a result of been brought into the lime light by Bergam and Sams in 2012. Other scholars like Mangan (2013) in Willis (2014), has expended the practice of flipped instruction to include recorded materials which are used by the students at home and worked on in class. Proponents of the flipped classroom have provided evidence that show a high level of success in the strategy. Students are more engaged, have better ability to address questions that require application of content knowledge and are generally more satisfied with the classroom experience (Flipped Learning Network, 2012). Combination of these factors make the flipped classroom very attractive to teachers, schools, faculties and universities in general that are itching to initiate changes that increase student learning in their classrooms.

Alvarez (2011) explained that with the flipped classroom students are less frustrated and disruptive in class because there is someone on hand to help one-on-one, that a much larger percentage of assignments are completed and to a much higher quality and that notes/reading guides are now available at home for students to prepare for in-class activities.

By providing an opportunity for students to use their new factual knowledge and also have access to immediate feedback from peers and the teacher, the flipped classroom help students learn to correct misconceptions and organize their new knowledge such that it is more accessible for future use.

According to Brame (2013) in Willis (2014), there are four main elements indicative of the flipped classroom. These are:

- An opportunity for students to gain first exposure prior to class
- An incentive for students to prepare for class
- A mechanism to assess students understanding
- In – class activities that focus on higher level cognitive activities

The backbone of flipped classroom lies on these four elements. Each of these elements is tied to research-based learning principles that make the flipped classroom a potential teaching method that can improve students' learning.

The elements and their connections to research-based learning principles are described as follows:

Element 1: An opportunity for students to gain first exposure prior to class. Students are not introduced to material/content through a whole class lecture, rather, the teacher in a flipped classroom provides an opportunity for students to gain first exposure prior to class. Initial exposure of content to students outside class helps to free up class time for activities that bring about higher levels of learning. It equally gives the teacher opportunity to help students retrieve and build upon prior knowledge. In the traditional method of teaching, students' prior knowledge is prompted through warm-up activities like reminding students of previously learned content or a review of home work. A reasonable part of class time is utilized in doing these introductory activities in class, but in flipped instruction the prompting of prior knowledge takes place outside the class time. The first learning principles by Ambrose, Bridges, Dipietra, Lovett and Norman in Willis, (2014) suggest that students' prior knowledge can help or hinder learning. Learning occurs when the learner is able to make a connection to what he or she already know and interpret the new knowledge through a lens created by prior knowledge (Vygotsky, 1978). Making students look at content material through reading a text or watching a video outside the class time and space in classroom will provide the students reasonable time to think about what they already know. This will enable the students to start the process of assimilating the new content. Learning can as well be hindered if students have inaccurate knowledge; hence, it is very necessary that teachers assess what the students know before designing learning activities.

Allowing students to learn and practice some basic concepts before coming to class help students retrieve prior knowledge or create knowledge and as such become prepared to learn at a deeper level. Cognitive Load Theory was used by some researchers (Paas, 1998; Sweller in Willis, (2014) to show that learning is a process of creating kinds of stored knowledge known as Schema. The schemas are developed and connected together then stored and retrieved from long-term memory when needed. Simple schemas that are related can combine to form more complex schemas, and the connections become more automated within the schemas, thus freeing up the working memory for more processing. The freeing up of the working memory is described as decreasing the cognitive load. The moment learners are filled with a lot of new materials with limited connection, their cognitive load become high due to the fact that their minds will be busy creating scheme and connecting them to other schemas. Paas, in Willis (2014) pointed out that if a student's cognitive load is either too low or too high his/ her learning will be degraded. Students will be bored when they are not well challenged but they will withdraw when the challenge is too much. Therefore, learning activities need to be tailored in such a manner that students are challenged without overloading them cognitively.

The flipped classroom instruction provides teachers the way of helping their students to create and strengthen schema outside of class, and as such reducing the cognitive load needed for deeper learning inside the class. When students are well directed on the ways to think about prior knowledge outside of class, the cognitive load will reduce and learning becomes better managed as students are in class.

Students will need access to resources outside of class for them to succeed in a flipped learning environment. Wireless internet access has made it possible for students to have access to materials, that will enable them to create prior knowledge on the material outside of class, then in class time, students will work interactively and cooperatively under the guidance of the teacher. Students need to be helped or directed by the teacher to organize their prior knowledge and make connections between prior knowledge and new material. Note-taking strategy which involves key words or questions, examples and a small summary on the material to be learned can be given to the students in order to help them organize their thoughts and make connections. Students who have not learned the art of note-taking will gain the skills to organize the material they are exposed to outside of class and identify gaps in their learning.

Internets, teacher – created content video and note taking strategy are learning tools teachers can use in a flipped classroom to provide students with an opportunity to gain first exposure of material outside-of-class. The challenge is to ensure that students do the outside-of-class work, which leads to element 2 of the flipped classroom.

Element 2: Provide an incentive for students to prepare for class.

Brame, (2013) pointed out that students must be motivated in order to carry out the required work to prepare for class. Motivation is a drive that makes students wants to learn. It increases the effort of students' behaviour in a positive manner. Akinboye (1996) viewed motivation as incitement of students' desire of knowledge, need for achievement or interest in a particular subject matter.

Yoloye (1993) in Okoli (2012) classified motivation into two types, viz: intrinsic and extrinsic motivation. Intrinsic motivation is the drive or desire to learn solely for improving ones knowledge disregarding any kind of reward. It is drive to succeed within the student. It involves the development of an internal drive in the student which helps him/her study efficiently and attain self-actualization rather than to please any particular audience. Extrinsic motivation is just the opposite.

In terms of learning, motivation is important and very necessary. The learning principles of Ambrose as indicated in Willas (2014) explained that student's motivation determines, directs and sustains what they do to learn. Motivation to achieve a goal depends a lot on the subjective value of the goal as well as the expectancies that surround the successful attainment of the goal, Bundura (1978) in Wiginton (2013). Goals are set based on the values placed on such goals and the expectancies regarding the goals.

It is worthy of note that students set different kinds of goals for themselves. Such goals include learning goals which are concerned with increasing competence, for example (a) truly wanting to know how to balance a chemical equation (b) performance goals deals with judgment about competence, such as the goals of getting a good grade. Other types of goals that are equally motivating are affective goals for example wanting to engage in a stimulating activity and social goals, Ford (1992). From the on-going, students come to classes with different types of learning goals, and a one-fit-all approach cannot really motivate all the students equally.

The motivation to work in order to achieve a goal comes from the value placed on the goal. Yoloye (1993) in Okoli (2012) explain three sources of value: attainment value which is the satisfaction of completing a given task, intrinsic value or the satisfaction of performing the actions of the task and thirdly, the instrumental value which is the satisfaction of achieving a short-term goal in order to work towards a longer-term goal. These three source of values can work individually as well as in concert with one another. The value placed on a goal by a student may change as knowledge is gained. Interest can be developed in four phases, namely triggered situational interest, maintained situational interest, emerging individual interest and well-developed individual interest, Hidi and Renninger (2006). Interest builds from first exposure and grows if value is placed on what is being learned.

Flipped classroom advocates are of the view that prior learning activities which take place outside the class will contribute to triggered situational interest. These calls for design of in-class activities that will enable the students attach value to the activities which in turn move them further along the well-developed individual interest.

The flipped classroom instruction provides opportunities that will enable the teacher create different activities that can address students' individual differences and to motivate them in such a manner that typical lecture method alone cannot do. The moment motivation is sustained in the students, the teacher ensures that the students are learning what they are supposed to learn and that brings in the third element of the flipped classroom.

Element 3: Provide a mechanism to assess student understanding. In his description of flipped classroom, Brame (2013) in Willis (2014) used these terms to describe the third component. The flipped classroom instruction has enough time that allows the teacher to make use of different forms of feedback.

Feedback is not only correctness of a problem on an assignment, that is, having red x on student's work in chemistry but a comment that guides the student in identifying his error is more informative. Feedback, according to Winne and Butler (1994) is an information that enable a student to confirm, add to, or restructure information in memory. Feedback has effect on many aspects of learning and can be utilized to provide students with life-long learning strategies. In flipped classroom instruction, appropriate setting of goals and providing adequate feedback help students learn content as well as develop skills that will enable them become self-directed learners. Feedback is really necessary for students' outside-of-class work to ensure proper foundational knowledge and at the same time enhance in-class activities.

Element 4: Provide in-class activities that focus on higher level cognitive activities.

The provision of in-class activities that encourage higher level of cognitive activities is the fourth and last element that completes the flipped classroom instruction, in Willis (2014). Shifting initial exposure of content outside of class creates an additional in-class time that allow students to work on activities that are at a high cognitive level. Cognitive level is organized in various ways and contains a hierarchical list of terms used in categorizing the cognitive domain ranging from concrete to abstract. Knowledge, comprehension, application, analysis synthesis and evaluation are the six levels that are ranked from simplest to the most complex and are used to categorize the cognitive demands of learning objectives and goals. However, as a result of research on learning and cognition the taxonomy was revised into remember, understand, apply, analyze, evaluate and create (Krathwohl 2002). This has not changed the original idea.

Developing mastery, acquisition of component skills, integrating them and students knowing when to apply what they have learnt is the fourth learning principles proposed by Ambrose *et al* (2010) in Willis (2014) which guide the fourth element of the flipped classroom instruction. The teacher as an expert provides and organizes in-class activities that will address the different levels of the domain.

In designing instruction, the teacher has to take note of the differences among students so that students are helped to master a domain. In order to achieve this, effort is made to provide practice that will enable student to make connections between component skills and applications, as well as knowing when and why such skills should be applied.

This type of learning requires enough time, and the in-class portion of the flipped classroom instruction provides students enough time to practice and integrate the skills within a given task under the guidance of the teacher.

Flipped Learning Network (2012) commended that after the use of the flipped instruction, students are

- more likely to engage in collaborative decision making
- more likely to engage in critical thinking and problem solving
- the teacher is more likely to take into account students' interest, strengths and weaknesses
- more likely to have a choice in what learning tasks they engage in
- view learning as a more active process
- have more constant and positive interactions

On the other hand, teachers, educators' administrators are provided with the following indicators to use when guiding the integration and implementation of flipped instruction in their schools:

- Provide the students with different ways to learn content and demonstrate mastery
- Give students opportunities to engage in meaningful activities with the teacher being a guide
- Make content accessible and relevant to all students

- Conduct on-going formative assessments during class time through observations and by recording data to inform future instruction (Flipped Learning Network (FLN), 2014).

Flipped classroom instruction incorporates quite a number of approaches that are student-centred in one single exercise which is not common with the traditional method of instruction in Nigeria.

Influence of Gender on Students' Interest and Participation

Studies on Interest in Science: Many educators that carried out surveys of students' attitude towards the learning of science revealed that students display poor attitude to science and they came up with the following stand points that students show:

1. Poor disposition towards studying science
2. Undesirable attitudes of scientists such as dishonesty, perseverance, critical mindedness, willingness to change opinions and objectivity. Aminu (1989) discovered that infrastructure facilities are poor and suggested for improvement. Okoye, Okongwu and Nweke (2015) reported that increase in students' interest leads to the increase in their achievement in chemistry whereas decrease in students' interest brings about decrease in achievement in chemistry. Narmadha and Chamundeswari (2013) observed that students interest towards chemistry has a direct effect on their achievement in the subject they found out that male students have higher interest in chemistry than female counterparts. Enechi (2013) reported a contrary view that female students have higher interest in chemistry than male students.

The Nigeria education system is not left out in the search for strategies that will encourage student-centred learning activities which is the backbone of our curriculum implementation (active learning). Flipped classroom has started working in some parts of the world, hence this study wishes to find out its effect on secondary school students' learning of chemistry in Anambra state, Nigeria.

Participation/Chain of Response Model: This begins with the individuals and ends with external factors. It is called chain of response model because each of the stages is seen as links in a chain. Each stage influences another. The more positive the learner's experience at each stage the more likely he or she is to reach the last stage – the decision to participate (McGivney, 1993). Participation in a learning activity whether in organized or self-directed is not a single act but the result of a chain of responses, each based on an evaluation of the position of the individual in his or her environment (Cross, 1981). The main elements in the chain are

(a) Self-evaluation

(b) Attitudes about education

(c) The importance of goals and the expectations that these will be met

(d) Life transitions

(e) Opportunities and barriers

(f) Information on educational opportunities

(g) The decision to participate. This model emphasizes the interaction between various elements and in so doing moves away from simplistic explanations. This is culturally bound and allows for zig-zagging movements, and for interaction and accumulation (Smith 1977). According to McGiveny (1993:17) non-participants have little or no knowledge of the educational opportunities available but majority of the participants are hindered to some of the hindrances or barriers are discussed as follows:

(a) Situational barriers: These are the ones that can arise from ones' situation at a given time. They include lack of money – the cost of studying;

(b) Institutional barriers: These include practices and procedures that exclude or discourage learners from participating in the learning activities;

Dispositional barriers: These are related to attitude and self-perceptions about oneself as a learner, like lack of confidence because of previous educational achievements.

Sargant (1991) found out that there is a strong skewing of educational participation to certain age ranges. The majority of student participated fully in learning at the younger age range of 45 years and above. Sargant (1991) further found out that there is a division in subject interest between male and females; differential rates of participation between different ethnic groups and sticking differences along class and age lines particularly in relation to organized education provision.

Wong (1998) in his research on ways to improve students' achievement found out that the only way or factor that increased students' achievement was the significance of a teacher which include the teachers' preparation which is the strongest predictor of students' achievement. Other teachers' factors include that of teacher expertise.

The bottom line is that there is no way to create good schools without good teachers. It is the administrator who creates a good school. And it is the teacher who creates a good classroom (Wong, 1998).

Eggleston and Newbould (1968:18) in Wiginton (2013) discovered that sex, environment effectiveness of the teachers, reaction of individual towards examination, psychological frame of the testers at the time of the test are major factors that affect students' achievement in science.

Studies on Gender

Research has shown that there is conflict between cultural beliefs and school. Fathers prefer investing in boys' education to investing on girls. If education is to be given to girls at all it would be in the area of arts and humanities and such professions like housekeeping

(Ivowi, 1992 in Okoli 2012). In the Northern part, it is believed that sending girls to schools is against culture as the girl child would be exposed to moral decadence and the likelihood of losing respect for elders. Girls are married out at a tender age to avoid this. The born of a female child is seen as a disappointment in many Nigerian cultures and as such girl-child is treated as a second class citizen. Culturally their roles are defined as domestic as girl child is expected to keep the houses, wash dishes cook and carry the young ones. This gives them very slim chance to study both at home and in school.

Culturally, highly educated women are not regarded as good wives and their possibilities for marriage becomes limited. This is instilled into the mind of a growing female early in life. This caused them to be myopic in their life aspiration. The dominance of male culture over female is a tradition which has socialized females into believing that it is a taboo to venture into an occupation for males. Females are culturally assigned duties of catering for family, fetching water for cooking, cleaning houses etc. This is true as well as in Nigeria (Okoli, 2011, UNESCO, 2004) and in the so-called western or developed nations (Dines, 1993 and Featherman, 1993). This hampers the females' involvement in science. The belief that males excel in science has been handed down from generation to generation by teachers, parents, peers and others through subtle and unintended messages to females.

Despite all the above cultures and actions, efforts towards promoting the status of female worldwide are advocated. Science is a means of equipping an individual with the necessary knowledge and skills such as intellectual, social technological and political needs needed for all round development and positive contribution to the society (Okoli, 2011).

Theoretical Studies on the Effect of Flipped Classroom on Students' Interest and Participation

Scholars are of the view that flipped classroom has positive effect on students' learning behaviour one of which is their interest in learning. Fulton (2012) noted that teachers' use of flipped classroom can increase students' levels of interest and engagement.

Furthermore, Ruddick, K. (2012) cited in Freeman &Schiller, 2013, p.63) on their part reported of Student comment on Assessment of their Learning Gains(SALG) survey shows thatt "the RI (flipped)students became more interested in andfelt less intimidated by chemistry…"

Flipped classroom has also been perceived as a strategy that enhances students' engagement. Student engagement refers to students' desire to actively participate in routine class activity such as submitting homework, listening to the topic, working on what the instructor asks them to do and actively attending the class (Ma, Han, Yangand Cheng,2014). Obviously, student engagement is viewed as being synonymous with student participation. In this light, Kim, Kim, Khera, & Getman (2014) are of the view that the use of flipped classroom instructional strategy increases students' participation in out-of-class work and are also motivated to engage in these activities independently. Citing McLaughlin and the colleagues, Zainuddin and Halili (2016) noted that flipped classroom tend to increase students participation in discussions and classroom activities as well as enhance their interaction with their peers.

Empirical Studies

This part of the literature review deals with related empirical studies. Many educators have carried out different studies on varying instructional approaches but few empirical research was found on the effect of flipped classroom instruction on students' achievement.

Effect of Flipped ClassroomInstructionon Students' Academic Performance

Wiginton (2013) carried out a study titled effects of flipped instruction on students' learning style, self-efficacy and academic achievement in algebra. The main purpose of the study was to determine whether participation in flipped instructional classroom had any effect on students learning style, self-efficacy and academic achievement in mathematics (algebra 1). The researcher used an explanatory mixed-methods research design. The population consisted of 776 students of high school located in the south eastern United States. The sample for the study was 66 students that enrolled in Algebra at the high school of the University of Alabama. Three classes were used, namely: A Class had 20 students, Class B had 24 students, Class C had 22 students participated in the study.

The instruments used for data collection were:

a) Quality Core End-of-Course Assessment (Quality Core EOC)

b) Mathematics self-efficacy scale-revised (MSES-R).

c) Structured interviews and direct observation of students and teachers in their respective learning environment.

d) Soloman and Felder Index of learning styles questionnaire (ILSQ).

The researcher administered and collected the pre-test directly at the beginning of the research period. Post-test was administered to the participants at the end of the treatment and collected immediately by the researcher.

Means and standard deviations were used to answer research questions. The hypotheses were analysed using multivariate analysis of covariance (MANCOVA). The findings indicated that the performance of students in the FCI was more positive than those in traditional instructional class. It was also found out that there was no significant difference between the achievements of male and female students taught using FCI. Wiginton recommended that classroom teachers should use FCI in order to create more time during class for active learning which include discussions. The study was carried out using FCI in a high school outside Nigeria using algebra. The present study on the effect of FCI was carried out in secondary schools in Anambra state of Nigeria using SS2 chemistry students.

Willis (2014) carried out a study on the effect of flipped classroom instruction on an undergraduate pre-calculus class on four-year University in the South Eastern United States. The purpose of the study was to determine the effect of FCI on students' achievement in pre-calculus. The research design used was quasi-experimental non-equivalent group design.The control group was composed of 22 students who were taught using traditional lecture-based method. The experimental group consisted of 22 student taught using flipped classroom instruction in the same institution but nobody was told about a class being taught with experimental method. The instruments used for data collection was mathematics achievement test. Statistical analysis was done using test. The findings of the study indicated that FCI was more effective in enhancing students' academic achievement in pre-calculus than the use of lecture method of instruction.

Willis recommended that since FCI has been found to be effective in enhancing students' performance in pre-calculus, it should also be extended in teaching other disciplines.The reported research was carried out using FCI in a university setting outside Nigeria using mathematics undergraduate students. The current study on the effect of FCI was carried out in secondary schools in Anambra state of Nigeria using SS2 chemistry students.

Kenna (2014) examined the effect of flipped classroom instruction on student's self-efficacy and gender difference towards physics in North Dakota state university of agriculture and applied science using 22 high school students that enrolled in a private school. The main purpose of the study was to determine the effect of FCI on students' performance. The students were splited into two classes taught by the same teacher who was also the researcher. The sample consist of nine females (41%) and 13 male (59%) students from the school population of 306 students with 48.4% female and 51.6% male. Self-efficacy scale (Miller et al 2004) was used for this study.

A quasi-experimental non-equivalent control group design was adopted for the study, and the instrument used for data collection was self-efficacy scaler. The researcher used a coin throw to determine the class to be used as the experimental group (intervention group), from the result, the afternoon class became the intervention group and the morning class became the control (comparison group). The comparison group made up of eleven students (64% male and 36% female) were taught in the morning hours using traditional lecture-based instruction while the intervention group made up of eleven students (55% male and 45% female) were taught in the afternoon hours using flipped instruction. In-class time was used for laboratory activities, discussions, answering questions.

Data was analysed using descriptive statistics.

The results indicated an increase in their average self-efficacy score with the flipped classroom and a decrease with traditional classroom. When analyzed separately, the females showed an increase in self-efficacy while the males showed a decrease using the flipped classroom. Kenna recommended among others that educators in different disciplines should make use of FCI in their day to day teaching. The reported study was carried out on the effect of FCI on physics students outside Nigeria. The current study intends to ascertain the effect of flipped instruction on students' interest, participation and achievement in chemistry in Anambra State, Nigeria.

Effect of Flipped Classroom Instruction on Students' Interest and Participation in Learning

In United States of America, Szparagowsk (2014) carried out an experimental study on effects of FCI on students' academic achievements in mathematics using a sample of 66 students in the flipped classroom and non-flipped classroom in an intact class in high school with a population of 382 students. The aim of the study was to find out the effect of FCI on students' mathematics learning. Quasi-experimental design was used for the study. Students' interest was measured using student interest questionnaire. The data collected was analyzed using mean, standard deviation and t-test. The findings of the study showed that students taught using FCI performed higher than the students taught using traditional method of instruction. Szparagowsk recommended that awareness of the benefits of FCI should be given to serving teachers to enable them make use of it in their teaching.

In China, Yujing (2015) examined the influence of flipped classroom on learners' empowerment in English writing course. The researcher used a comparative quasi-experimental design. He used a population of 418 students and a sample of 70 first year students in a Chinese university among whom 36 were assigned to flipped classroom group and 34 assigned to traditional classroom group. An 18-item Learner Empowerment Scale was used to collect data for the study. Where empowered learners tend to have positive attitudes toward the course content and the instructor, and participatedin more activities. The collected data was analyzed with mean, standard deviation and t-test. It was found that students exposed to English writing using flipped classroom strategy were more empowered than their counterparts. The researcher concluded that flipped classroom can have a vital influence on studentperception of empowerment, which indicates that learners in flipped classroom are more interested in Englishwriting courses than learners in traditional classroom.

Boeve, Meijer, Bosker, Vugteveen, Hoeskstra and Albers (2016) carried out a study to ascertain the influence of flipped classroom and lecture instructional strategies on students' study behaviour and the relationship between students' study behaviour and their academic achievement. The sample of the study was 500 students enrolled in introductory statistics course. Two hundred and five (205)who were pedagogical science major were taught using flipped classroom while 295 students in psychological major were taught using lecture method. Diary was used to collect information from students on their study behaviour such as their participation in various activities in the class and attendance to lecture while their performance was measured using multiple choice questions. Data was analysed using percentages, mean, standard deviation, t-test and multiple regression. The study found that there was no significant difference in the study behaviour of students under flipped classroom and those under lecture method. It also found no significant relationship between study behaviour and the academic performance of the students.

In Spain, Oscar, F., Isabela, D. and Patricia S. (2016) carried out an evaluative investigation to ascertain the efficacy of the flipped classroom instruction. It used mixed method approach with sample of 26 students for the quantitative and 8 students and their professors for the quality aspect. The data was analyzed used frequencies and percentages. Students' comments of the survey confirmed an increase ofinterest in the course, which also indicates that students were motivated to attendclass. Most of the students also agreed that the flipped classroom instruction enhanced their participation in the classroom activities and increased their communication with fellow students and their professors.

Another study was carried out in Taiwan by Shih and Tsai (2017) titled students perception of FCI in a marketing course. The purpose of the study was to find out students' perception of the FCI after being exposed to the strategy. The instrument for data collected was interviews and questionnaires. An experimental design was adopted using a sample of 72 students taking marketing course in a technical university in Southern Taiwan. Mean and standard deviation were used to analyze the quantitative data collected. It was found that students perceive flipped classroom instruction as effective in improving their subject interest, interest in the topic, interest in knowledge construction as well as their interest in class. Shih and Tsai recommended that FCI should be extended in teaching other disciplines at different levels. The reported research was carried out using FCI in a marketing course in a university outside Nigeria. The current study is on effect of FCI on chemistry students' interest, participation and academic achievement in Nigeria.

In China, Rui, Lian-rui, Rong-zheng, Jing, Xue-hongand Chuan (2017) carried out an experimental intervention to ascertain the effect of flipped classroom instruction on medical students' interpreting an electrocardiogram (ECG) and their attitude to learning compared with lecture-based learning. It used a sample of 181 junior-year medical. Ninety students were assigned to experimental group while 91 were assigned to control group. A test on ECG and self-administered questionnaire were used to measure students' ability to interpret ECG and to evaluate the students' attitudes respectively. The data was analyzed using ANCOVA. The study found students in the experimental group scored significantly higher than the control group on ECG interpretation. It was also found that greater proportion of the students in the flipped classroomgroup held positive attitudes toward the flipped classroom method. Furthermore students in flipped classroom participated more than those in lecture-based classroom as they devoted significantly more time than those in the control group. It was concluded, among other things, that flipped classroom teaching can improve medical students' interest in learning. The reported study is related to this present study in the aspect of using FCI to determine student interest in learning and academic achievement but in chemistry not in medicals.

In Georgia, another recent study titled effects of FCI on students' motivation in anatomy and physiology was carried out by Dixon (2017). The research design was a quasi-experimental, pretest-posttest non-equivalent group design using a sample of 128 high school students enrolled in anatomy and physiology. This sample consisted of 64 students in experimental and 64 in control groups. Those in the experimental group engagedin the treatment, the flipped classroom, using instructional materials on the educational website, applied content material taught using hands-on activities and assignedlaboratory experiments. Sixty-four participants in the control group received instruction using traditionalface-to-face lecture-homework format and also engaged in assigned laboratory experiments. Data was collected usingScience Motivation Questionnaire II (SMQ-II) andthe Human Anatomy and Physiology Unit Test. The data was analyzed using ANOVA and ANCOVA. The findings shows that students taught using FCI had greater motivation than those taught with traditional classroom. Therefore, it was recommended that teachers in various disciplines should incorporate FCI in their teaching in order to improve student learning-out-come. Dixons study is related to the current study in the aspect of using FCI but the present study is carried out in Nigeria at senior secondary school level.

Gender and Achievement of Students taught with Flipped Classroom Instruction

Overmyer (2014) carried out a research to ascertain the effect of flipped classroom on students' performance in Algebra as well as to ascertain the main and interaction effect of gender and treatment on students' academic performance. The researcher adopted a quasi-experimental design. The sample was composed of students' 70 students taking from college Algebra in Columbus university. Thirty-five students were in flipped classroom and lecture-based classroom each. Mathematics achievement test was used to collect data on students' performance in Algebra. Data analysis was done with mean, standard deviation and multiple regression analysis. The study reported that there was significant effect of flipped classroom on students' academic achievement. Therewas nostatistically significant difference between the common final exam scores of males and females.Likewise there is not a statistically significant interaction between thetreatment and gender on final exam scores which means that students did notrespond differently to the flipped classroombased on their gender. Overmger recommended that educators should make use of FCI in other disciplines. The reported study is related to the present study in the aspect of FCI on students learning-out-come but this study was carried out in Nigeria and at senior secondary school level.

Gross, Pietri, Anderson, Moyano-Camihort and Graham (2015) carried out a study to ascertain the influence of flipped classroom and traditional instructional strategies on students' engagement and performance as well as the influence of gender. The study used a sample of 133 students enrolled in biochemistry, molecular biology and chemistry drawn columbus university in the US. Data was collected using test and questionnaire. The data collected was analyzed with mean, standard deviation and ANCOVA. They found out that students in flipped classrooms participate more in course activities than those in the traditional classroom. They interact with the online components of the course and prepare for class than those in the traditional class. It was further found that there is no significant interaction between gender, teaching method and students' performance in examination. However, upon disaggregation of analysis based on each teaching strategy, there was a significant difference between male students outperformed the female students in traditional classroom but no significant difference was found between males and females in FCI. The reported study is related to this study in the aspect of determining the effect of FCI on students' performance but the present study was carried out in Nigeria at senior secondary school level of education using SS2 chemistry students.

Gender Issues in Science Education

Globally, gender issues have become critical and of great concern, especially to educators and researchers over the world. Educational researchers have been making serious efforts to bridge the gap, yet no consistent result has been established. There are different findings/opinions on the influence of gender on students' academic achievements in various disciplines at the secondary school level. In a study of gender difference in a mathematical problem – solving amongst Nigerian students. Esan (2002) revealed that boys' level of participation in science, technology and mathematics activities is higher than that of girls. Similarly, Veloo, Hong and Lee (2015) carried out a study on Gender and Ethnicity Differences Manifested in Chemistry Achievement and Self-Regulated Learning. The study was a survey design, and random sampling method was used to select 358 students of matriculation science one-year programme. The results of gender differences showed that male students obtained significantly higher academic achievement in chemistry than their female counterparts. However, there was no significant gender difference in self-regulated learning.

Also, a study on the effect of gender and location on students' academic achievement in chemistry in secondary schools was carried out by Ezenda and Obi (2013). The study was quasi-experimental, pretest and post-test non-equivalent control group design. The sample consisted of 125 senior secondary (SS) 2 chemistry students. Three research questions and three null hypotheses guided the study. The result of the study showed that there is a significant difference between male and female students' academic achievement in chemistry. The male students performed better in chemistry than their female counterparts. In another study carried out by Omwirhiren and Anderson (2016) on Effect of Class Size and Students' Attitude on Academic Achievement in Chemistry at Demonstration Secondary School Ahmadu Bello University Zaria, Nigeria. Three research questions and three hypotheses guided the study. The sample was made up of 50 students and 5 teachers. The research instrument was structured questionnaire consisting of 20 questions to determine students' attitude towards chemistry and 10 questions designed for teachers to determine the effect of class size in teaching chemistry. Data collected was analyzed using percentages, mean and standard deviations for research questions and t-test statistics to analyze the hypotheses at 0.05 level of significance. The result revealed that boys performed better than the girls. In addition, Adepoju (2011) equally observed that there is gender inequality in science, technology and mathematics in favour of males. Also Okereke and Onwukwe (2011) in their study on influence of gender, school location and the use of play-stimulation on school achievement in chemistry revealed a significant gender difference in achievement in favour of males.

There are other contrary views which include: a study on Age and Gender as Predictors of Academic Achievements of College Mathematics and Science Students. The study was carried out by Abubakar and Oguguo (2011). The study adopted an expo-factor design, and used three hundred and thirty-two (332) students consisting of two hundred and twenty-three (223) females and one hundred and nine (109) males. Three research questions and one hypothesis guided the study. Mean, standard deviation, analysis of variance and Z-test which tested the formulated null hypothesis at 0.05 level of significant were used for the study. The result showed no significant gender difference in academic achievement of the students. Similarly, Fatokun, Egya and Uzoechi carried out a study on Effect of Game Instructional Approach on Chemistry Students' Achievement and Retention in Periodicity. It was a quasi-experimental study, specifically adopted pretest-posttest non-equivalent control group design. Four research questions and five hypotheses tested at 0.05 level of significance study. Multi-stage random sampling technique was used to select 96 senior secondary two (SS2) students who participated in the study. Mean and standard deviations were used to answer the research questions while one-way ANCOVA was used to analyze the hypotheses. The result revealed that gender has no influence on both achievements and retention of the students.

Olatunji and Olusola (2016) conducted a survey research in Ikere Local Government Area of Ekiti State, Nigeria on Students' Attitude and Gender as Correlates of Students' Academic Performance in Biology in Senior Secondary Schools. One hundred and eighty (180) SS2 biology students were randomly drawn from six secondary schools in Ikere L.G.A of Ekiti State. Instruments for data collection were Biology Attitudinal Scale (BAS), Gender and Academic Performance in Biology (GAPB) and terminal continuous assessment results. These instruments were subjected to validity and reliability mechanism and were found suitable for the study. The findings revealed that there was no statistical significant difference in the students' gender and academic performance in biology.

Summary of Review ofRelated Literature

The review of related literature to this study was organized under the following subheadings: conceptual framework, theoretical framework, theoretical and empirical studies.The conceptual framework related to the study such as flipped classroom instruction, interest, participation and academic achievement were briefly explained.

The study reviewed the theories of Vygotsky and Brunner and revealed that classroom learning environment should embrace interactions, discussions, collaboration, cooperation among others where students will be actively involved. This calls for active involvement of the students in their learning. Reviewed literature further examined different theoretical and empirical studies related to this study and discovered that active learning (student-centered approach) have not yet been fully embraced by chemistry teachers in Nigeria secondary schools.

The flipped classroom instruction seems to have all the characteristics necessary to fill the gaps in other instructional strategies commonly adopted by chemistry teachers in Nigeria and Anambra State in particular. The review indicated that some studies have been conducted both locally and internationally on the effect of FCI in teaching science subject but no study known to the researcher has been conducted on the effect of FCI on students' interest, participation and academic achievement in chemistry in Anambra state. Consequently, there is need to ascertain the effects of FCI on students' interest, participation and academic achievement in chemistry in Nigeria context and particularly in Anambra State.

CHAPTER THREE

METHOD

This chapter presents and describes the procedures that were adopted in conducting the study. It was discussed under the following subheadings: Research design, area of the study, population of the study, sample and sampling techniques, instruments for data collection, validation of the instruments, reliability of the instruments, experimental procedure, control of extraneous variablesand method of data analysis.

Research Design

The study adoptedquasi-experimental research design to determine the effect of flipped classroom instruction on students' interest, participation and academic achievement in chemistry. Quasi-experimental research design is an experiment whereby participants cannot be randomly assigned to experimental and control groups. Specifically, the study used non-equivalent control group design. This design was employed because it was not possible to randomly assign participants to experimental and control groups. Classes that were already established (intact classes) were used for the study because randomization will disrupt the school activities.

Symbolically, the design is represented as follows:

$$\frac{O_1 \quad X \quad O_2}{O_1 \quad X_2 \quad O_2}$$

Figure 6: Diagrammatic Representation of the Design of the Study

X represents treatment to experimental variable

X_2 represents no treatment

O_1 refers to pre-test

O_2 refers to post-test

------- Dashed lines separating two rows show two groups not equated by random assignment (Nworgu, 2015).

Area of the Study

The study was carried out in Awka Education Zone of Anambra State, Nigeria. Anambra state is part of the old Eastern Region of Nigeria (surrounded by Enugu and Abia in the East, Delta on the West, Kogi in the North, Imo and Rivers in the South). The state has six Education Zones namely: Aguata, Awka, Nnewi, Ogidi, Onitsha and Otuocha. Awka Education Zone consists of five local government areas(LGA) namely Aniocha, Awka North, Awka South, Dunukofia and Njikoka.

In the state capital(Awka) some institutions of higher learning and Post-Primary Schools Services Commission (PPSSC) that coordinate the activities of all the six zones are located in Awka Education Zone. Thus majority of the inhabitants in Awka Education Zone are literate in various fields of academics while others are business men and women, farmers and artisans.The decision to use Awka Zone was because the zone has the highest number (61) of public secondary schools, highest number of LGA and highest population of SS2 chemistry students,(See Appendix C and D, pp. 110 and 111 for details). The zone is therefore, considered a good representative of the state population of the study area.

Population of the Study

The population of this study consisted of1821 senior secondary year two (SS2) students offering chemistry in all the 61 public secondary schools in Awka Education Zone of Anambra state for the 2016/2017 academic session. The population was made up of 766 male and 1055 female SS2 chemistry students (PPSSC, Awka, 2016),(See Appendix D, p. 111 for the population distribution).The SS2 class is a second year class in senior secondary education in Nigeria which is not approaching external examination like SS3 class. In addition, they are not affected by new environment into the new level of education like the SS1 class. Based on this consideration, the SS2 chemistry students were considered more appropriate for the study.

Sample and Sampling Techniques

The sample for the study consisted of 124 SS2 chemistry students (76 males and 48 females). The sample was drawn from the population of 1821 SS2 chemistry students in Awka Education Zone of Anambra State. A multistage sampling procedure was used to draw the sample. Purposive sampling technique was used to select two single sex (male) senior secondary school out of seven boys public secondary schools in Awka Education Zone (See Appendix E, page 113). In the same way, two single sex (female) schools in Awka Education Zone were selected. (See Appendix F, p. 114). Purposive sampling technique involves selection of sample that possesses some specific characteristics which are relevant in achieving the purpose of a study (Nworgu, 2015). The purposive sampling technique was used because the four single sex public secondary schools (See Appendix G, p.115 for sample distribution according to gender) are close to Awka capital tertiary. This will equally promote good network services and effective monitoring. The four schools also have other common characteristic like qualified and experienced chemistry teachers, standard and equipped chemistry laboratories, have written WAEC and NECO for at least ten years.

In the second stage, experimental and control groups were assigned to the two boys schools and two girls schools by simple random sampling technique toss of coin / hat-draw method (throwing of coin). The two schools (males and females) that choose head were assigned to experimental groups while the schools (males and females) that choose tail were assigned control groups. Finally, one intact class in each of the four schools was used for the study. Three schools out of the four schools have three streams/classes of SS2 students offering chemistry. One intact class was selected by simple random sampling technique which involved writing, one yes and two no on three different pieces of papers and fold (use of ships of paper or lucky dip). The researcher puts the folded papers in a small bag and three students from the different streams were asked to pick one each from the small bag. The class that picked yes was used for the study. This is to ensure that all the three classes had equal chances to participate in the study and to avoid biased assessment of the students.

Instruments for Data Collection

Three instruments were used for data collection, namely; Chemistry Personal Interest Questionnaire (CPIQ).Learner'sParticipation Questionnaire (LPQ) and Chemistry Achievement Test (CAT).

The Chemistry Personal Interest Questionnaire (CPIQ) was developed by the researcherbased on students' experiences in the course of learning chemistry in secondary school. It was developed to enable the researcher assess students' interest in chemistry. It is made up of 11 items (See AppendixH, P.116 for details) on a four-point scale developed by the researcherwhich has the following response options: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). These options were scored 4,3, 2 and 1 respectively.

The Learner's Participation Questionnaire (LPQ) was alsodeveloped by the researcher in order to assess students' involvement in the learning of chemistry. It comprised of 11 items based on students' experiences in learning chemistry in secondary school, (See Appendix I, p. 107 for details). A 4-point scale developed by the researcher with response options of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) was used to collect the data.The response options were scored 4, 3, 2 and 1 respectively. (See Appendix I, p.117 for details).

The third instrument used for the study was Chemistry Achievement Test (CAT). CAT was developed to enable the researcher evaluate the students' academic achievement in chemistry. It consisted of 32 multiple choice questions with four options selected from past questions of West African Senior School Certificate Examination (WASSCE), National Examination Council (NECO) past questions and standard chemistry text books. The items were based on the two major areas contained in the four weeks topics in SS2 chemistry scheme of work (See Appendix J, Page 118for details). These 32 items were developed using a table of specification (See Appendix K, Page 120 for details).

Scoring procedure for CAT: The CAT is made up of 32 multiple choice objective tests with four option per item (A,B,C and D). Each correct answer is 1 mark while each incorrect answer is zero mark. Therefore, the maximum/highest score is 32 while the minimum/lowest score is 0. Respondents that score below 16marks (half of the total mark) have poor achievement while those that scored 16 and above to have high achievement.

Validation of the Instruments

The instruments (CPIQ, LPQ & CAT), answers to CAT, SS2 chemistry scheme of work, lesson plans and table of specification were given to three experts, two in the Department of science Education and one in the Department of Education Foundations (Measurement $ Evaluation) all from Nnamdi Azikiwe University, Awka. The instruments were subjected to face and content validity.The validation was mainly based on clarity of expressions, none ambiguity, relevance andability of the instruments to measure what they are expected to measure. The validators' corrections and comments (see Appendix T, pp. 154-156) were incorporated into the instruments before the instruments were given to the supervisor who made the final corrections.All suggestions, comments and corrections were considered by the researcher before the final copy of the instruments were produced.

Reliability of the Instruments

Test items of the instruments (CPIQ, LPQ and CAT) were first administered to 20 chemistry students of two single sex (male and female) Secondary Schools that were not involved in the sample for the study but have similar academic environment and background with the schools used for the study. The reliability of CPIQ and LPQ were established using Cronbach alpha. This yielded 0.91 and 0.90 alpha coefficients respectively. The reliability of the CAT was ascertained using Pearson Correlation Coefficient. Split-half method was used to obtain two sets of scores that were correlated using the Pearson Correlation coefficient. This yielded a coefficient value of 0.89 (See Appendix U, pp. 157 for details).

Experimental Procedure

(a) Training of Research Assistants

The researcher visited the four selected schools for an official permission from the school authority.The research assistants used for this study were SS2 chemistry teachers with B.Sc in chemistry education and more than five years of teaching experience. They were the current chemistry teachers in the sampled schools used for the study. The researcher then organized a training programmefor research assistants (chemistry teachers) in their various schools in order not to interfere with the school activities. The teachers that taught the control groups had a discussion with the researcher individually on how to use the lesson plan prepared by the researcher.

The training for the experimental group was mainly an interactive session with the individual teachers in order to get them acquainted with the flipped classroom instructional procedure. The meeting for the training lasted for two weeks (twice a week) for forty minutes each. The following were highlighted during the training programme:-

Week One

- Introduction of the research assistants
- The purpose of the training programme
- Discussion on chemistry teaching in secondary schools
- Interactions on the likely factors that affects poor performance of students in chemistry
- Discussion on common strategies used in the teaching of chemistry in secondary schools

- Discussion on various instructional strategies that involve student-centeredness
- Flipped classroom instruction and how it will be carried out in chemistry class
- Discussion on mobile phones and internet in Nigeria and secondary schools in particular
- Role of internet and mobile phones in flipped instruction
- Research assistants to collect students' contact phone numbers

Week Two

- Discussion on topics to be covered within the four weeks of teaching
- The researcher demonstrates how the flipped classroom instruction could be implemented
- Discussions on the instruments for data collection
- Extensive discussion on the lesson plan and experimental conditions
- Research assistants demonstrate how the flipped classroom instruction could be implemented in a chemistry classroom
- Corrections as well as reactions by the research assistants

(b) Administration ofthe Instruments (pre-test)

Pre-test of the three instruments (CPIS, LPQ & CAT) was administered to both experimental and control groups in their various classrooms before the commencement of the treatment. The instruments were administered to the students by their chemistry teachers (research assistants) under the supervision of the researcher. The students responses were marked and kept by the researcher.

The experimental groups were then taught using flipped classroom instructionfor four weeks (4 weeks of teaching and assessment) while the control groups were taught using direct instruction.

(c) Teaching of the Participants/Students

The study was carried out in the first term of 2016/2017 academic session for a period of six weeks (two weeks for introduction/training of research assistants, four weeks of teaching and assessment). The teachings were conducted in the intact classes of the various selected four schools using their chemistry time table (one double period of 80 minutes and a single period of 40 minutes). Throughout the period of the experiment the control groups (one boy's school and one girl's school) were taught using direct instructionwhere the students listen, ask questions, observe and write down notes. For the double period, the teacher employedlecture method, direct instruction,demonstration and problem solving in delivering the lesson.The experimental groups were taught using flipped classroom instructionwhich involves the following stages:

Week Three: The researcher sends study guide lines/hints concerning the topic to be treated and a short video teaching to the students through their contact phone numbers. The research assistants equally gave the study guide directly to the students especially for those living in the dormitory who may not have access to phones. These study guides were provided to the students three or moredays before the class time/day of the lesson

The study guideline on periodic table (PT) sent to the experimental group were; look at the PT chart carefully,What is it made up of? Name the first 30 elements of the PT. PT has 8 vertical column known as groups and horizontal rows known as periods, name two elements from each group, PT contains metals, metalloids, non-metals and transition elements etc. The students must have prepared themselves for the lesson using the above study guidelines (outside class activities). The inside class activities which was the real teaching of the topic, the students were engaged in activities such as group discussions, class discussions, mapping out block of elements from the periodic table chart etc.

(i) Group Discussions: The teacher placed the students in groups of 5 members and asked them to discuss the periodic table using the study guideline given/sent to them previously. During the group discussion, the teacher goes round the different groups to ensure that order is maintained and that the materials are being discussed. Every student is expected to write down points from the discussion.

(ii) Class Discussion and Interaction: The teacher calls the different groups together for a general discussions/interaction on the topic (period table) using the same study guide lines. The students were asked to map out blocks of elements from the displayed PT chart.The teacher moderates/directs the discussion; using the PT chart and the study guide lines, the teacher ensures that every aspect is well discussed. The teacher encourages the students to ask questions concerning the topic, as well as stating the challenges they encountered during the outside class activities (on the study guide).

Week Four: Outside class activities- The students in the experimental group received study guideline from the researcher and the research assistants. The study guidelines were drawn from the topic to be treated which include: the different families of the periodic table: alkali metals(group 1 Element), the halogens (group 7 elements), the noble/rare gases (group O elements) e t c. write down the outermost electronic configuration of atoms in groups 1 to 7. Find out the group that belong to S-block, P-block, D-block and F-block elements. A video that discussed the above study guideline was equally sent to the students by the researcher. This enables the students to be fully ready for the lesson/inside class activities. The teacher allows the students to introduce the topic for the lesson and ask them to bring out their findings concerning the topic.

The following activities were used by the teacher; Group discussion, draw electronic configuration of different elements, mapping out blocks from the periodic table chart.The teacher moderates/directs every aspect of the activities during the lesson and encourages the students to ask question when need arises.

Week Five: Outside class activities- The researcher/research assistantssends study guideline.

Inside class activities- The teacher introduced the lesson by asking the students to name the materials/items sent to them for the outside class activities. Group discussions and interactions were used by the research assistants.

Week Six: Outside class activities: Students in the experimental groups received study guideline on chemical reaction to be treated. The study guide contains the following; what is reactant and products? What is rate of chemical reaction? Name the factors affecting rates of chemical reaction. Differentiate between exothermic and endothermic reactions e t c. this enable the students to be prepared for the lesson.

Inside class activities: The teacher placed the students in groups of five for discussion on the topic using the study guideline. The teacher goes round the different groups, monitor and direct the discussions. Class interaction was used to summarize the inside class activities.

Generally the treatment involved:

a. Outside-class activities

b. Inside-class activities (class time/lesson period)

a) Outside class activities

   i. The students were exposed to material/topic before the day of the lesson

   ii. The students were exposed to the materials/topic using quiz/simple questions that guided them in exploring the material/topic.

   iii. The materials/topics were accessed through textbooks, more capable peers, internet, mobile phones, (mobile video format) etc.

   iv. Materials were given to the students at least 3-days before the lesson.

b) Inside-class activities/class time: This section involve the following:

   i. Question and answer: Questions were posed by the teacher or the students and were mainly based on the material the students were exposed to.

ii. Co-operative method: The students were placed in small groups to interact on their findings concerning the material/topic given to them previously. The group activity was allowed for about twenty-five minutes, after which the whole class came together, for a general interaction with the teacher as a facilitator.

iii. Class discussion: The teacher guided and directed the students on a discussion of the material previously given to them.

iv. Demonstration,experiments, guided discovery collaborations, and other strategies that involves active participation of the students were also used, as the class time is enough to engage the students.

In the in-class part of the flipped classroom the students were actively engaged in the learning process. Their critical thinking, interest and attitude towards learning were well challenged. The in-class activities involved the teacher sharing ideas with the students and not the teacher talking to the students.

In the use of the flipped classroom instruction (FCI) the students were engaged in active construction of knowledge, build mental models of what is learnt, integrate and apply the content of study.The class time was quite enough to accommodate the use of various active learning approaches, as the students were privileged of having prior knowledge of the material before coming to class.

(d) Administration of the instruments (post-test): The pre-test items were rearranged and administered to both experimental and control groups in their various classrooms after the treatments. The items were collected, scored andanalysed.

Control of Extraneous Variables

The following steps were put in place to control extraneous variables that might be a threat to the validity of the findings.

a. **Hawthorne effect**: Students' awareness of being studied can affect their performance. This can be minimized by using the regular chemistry teachers for the study as well as using the normal time assigned for chemistry in the school time table. In addition, the pre-test and post-test will be administered to the students as part of their normal continuous assessments for chemistry.

b. **Effect of pre-test and post-test:** The pre-test items were rearranged before administering them for post-test. A period of six weeks will be allowed for the experiment which is long enough to cancel the effect of pretest on the post-test scores. In addition, the pretest and post-test will be administered as normal continuous assessment for chemistry.

c. **The teacher variable:** The researcher prepared lesson plans for the experimental groups and the control groups.This will help to ensure uniformity to the experimental procedure as well as the lesson plan with the facilitators. The teachers would not be allowed access to the test instruments beforehand. The four research assistants are B.Sc chemistry education holders and have more than six years teaching experience.

d. **Experimenter bias:** This will be controlled by not allowing anybody outside the class teachers for treatment group to know about any experimental groups going on anywhere.

e. **Initial group difference:** The research design for the study is pre-test post-test non-equivalent group design, hence intact classes were used in order not to disrupt the administrative set-up in the schools. However, to control the initial group difference in terms of learning environment, cognitive ability, achievement ability, the pre-test scores were used as covariate to post-test scores using Analysis of Covariance (ANCOVA).

Method of Data Analysis

The research questions were answered using mean. The hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. ANCOVA was used to take care of the initial differences among the groups. In that case pretest scores were used as covariate measures. The decision for the hypotheses was that whenever the Pvalue was less than 0.05, the null hypothesis was rejected; otherwise, the null hypothesis was not rejected.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

This chapter treats the presentation, interpretation and analysis of data. The data are presented in tables based on the six research questions and nine hypotheses that guided the study. The tables provided answers to the research questions as well as for testing the hypotheses. The table were derived from a statistical package (See Appendix Y, p. 158 for details) via a raw data (See Appendix X, pp. 156-157 for details). The major findings of the study were equally summarized.

Research Question 1: What is the mean interest scores of students taught chemistry using FCI and those taught using DI?

Table 1: Mean Interest Scores of Students in Chemistry

Method	N	Pretest mean	Posttest Mean	Gain in Mean
FCI	62	36.15	40.86	4.71
DI	38	34.26	36.05	1.79

Table 1 reveals that the mean post-test score and gain in mean score of students taught chemistry using FCI were higher than that of students taught using DI. This suggests that FCI was effective in enhancing students' interest in chemistry.

Research Question 2: What is the mean interest scores of male and female students taught chemistry using FCI?

Table 2: Mean Interest Scores of Male and Female Students in Chemistry

Gender	N	Pretest Mean	Posttest Mean	Gain in mean
Male	32	36.66	41.41	4.75
Female	30	35.60	40.27	4.67

Table 2 indicates that FCI is effective in enhancing both male and female students' interest in chemistry.

Research Question 3: What is the mean participation score of students taught chemistry using FCI and those taught using DI?

80

Table 3: Mean Participation Scores of Stude Chemistry

Method	N	Pretest Mean	Posttest Mean	Gain in mean
FCI	62	36.27	41.15	4.88

DI	38	31.16	33.84	2.68

Table 3 reveals that the students taught chemistry using FCI had higher pretest mean participation score, posttest mean score and gain in mean score in chemistry, than those in the control group taught using DI. This suggests that FCI is effective in enhancing students' participation in chemistry.

Research Question 4: What is the mean participation score of male and female students in chemistry?

Table 4: Mean Participation Scores of Students in Chemistry

Gender	N	Pre-test Mean	Posttest Mean	Gain in mean
Male	32	36.19	41.25	5.06
Female	30	36.37	41.03	4.66

Table 4 indicates that FCI is effective in enhancing both male and female students' participation in chemistry.

Research Question 5: What is the mean achievement score of students taught chemistry using FCI and those taught using DI?

Table 5: Mean Achievement Scores of Students in Chemistry

Method	N	Pretest Mean	Posttest Mean	Gain in Mean
FCI	62	9.45	20.34	10.89
DI	38	7.74	11.37	3.63

Table 5 reveals that the students taught chemistry using FCI had pretest mean achievement score of 9.45 and posttest mean score of 20.34 with gained mean 10.89 in chemistry, while those in the control group taught using DI had pretest mean score of 7.74 and posttest mean score of 11.37 with gained mean 3.63. With posttest mean score of 20.34, FCI is effective in enhancing students' achievement in chemistry.

Research Question 6: What is the mean achievement score of male and female students in chemistry?

Table 6: Mean Achievement Scores of Male and Female Students in Chemistry

Gender	N	Pretest Mean	Posttest Mean	Gain in mean
Male	32	11.03	20.69	9.66
Female	30	7.77	17.13	9.36

Table 6 indicates that FCI is effective in enhancing both male and female students' achievement in chemistry.

Testing the Null Hypotheses

Table 7: ANCOVA on the Effects of FCI on students Interest in Chemistry and those taught using DI

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	903.083[a]	4	225.771	49.440	.000	
Intercept	237.591	1	237.591	52.028	.000	
Pretest	278.310	1	278.310	60.945	.000	
Gender	6.315	1	6.315	1.383	.243	NS
Method	197.637	1	197.637	43.279	.000	S
Method*Gender	22.441	1	22.441	4.914	.029	S
Error	433.827	95	4.567			
Total	153671.000	100				
Corrected Total	1336.910	99				

Hypotheses 1: There is no significant difference in the mean interest scores of students taught chemistry using FCI and those taught using DI.

Data relating to hypotheses one is contained in table 7.

Table 7 shows that there was a significant main effect of the treatment on the interest of students in chemistry $F(1, 99) = 43.278$, $P<0.05$. Therefore, null hypothesis one was rejected. Thus, effect of FCI on the interest of students in chemistry is significant when compared to that of those taught using DI.

Hypotheses 2: There is no significant difference in the mean interest scores of male and female students.

Data relating to hypotheses two is contained in table 7.

Table 7 also shows that there was no significant main influence of gender on the interest of students in chemistry F (1, 99) = 1.383, P>0.05. Therefore, null hypothesis two was not rejected. Thus, there is no significant difference in the interest of male and female students.

Hypotheses 3: There is no significant interaction effect of teaching methods and gender on the interest of the students in chemistry.

Data relating to hypotheses three is contained in table 7.

Table 7 further shows that there was significant interaction of teaching methods and gender on interest of students in chemistry F (4, 99) = 4.914, P<0.05. Therefore, null hypothesis there was rejected. Thus, there is significant interaction effect of teaching methods and gender on the interest of the students in chemistry.

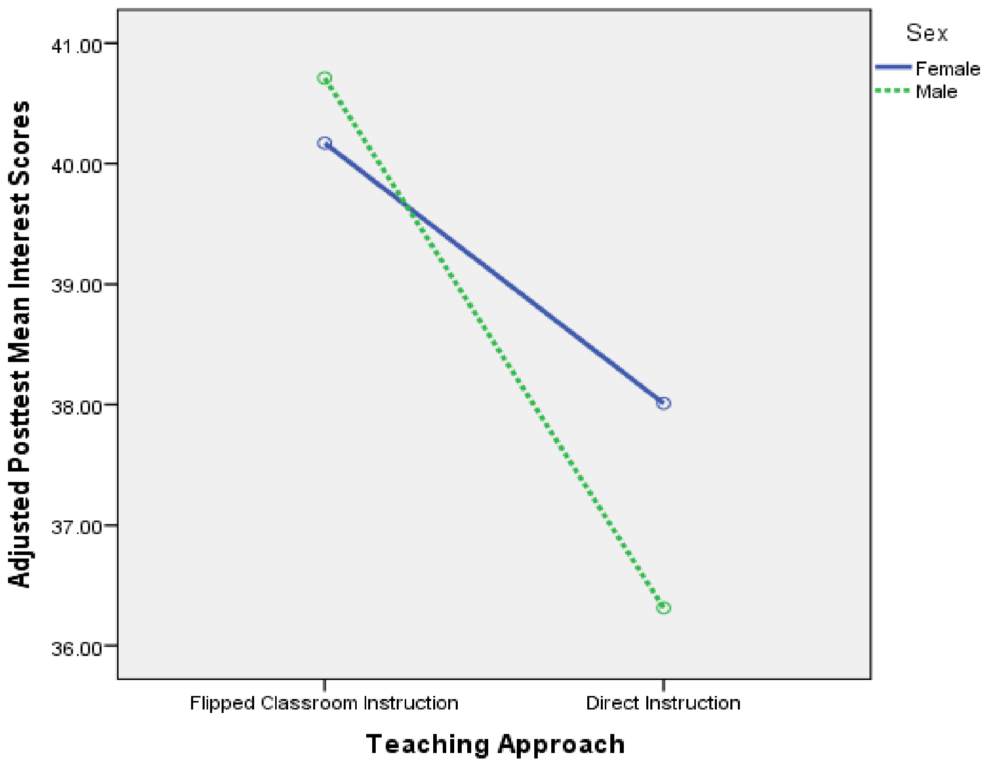

Figure 7: Plot of Interaction effect of Instructional Approach and Gender on interest scores

Figure 7 shows that the interaction of instructional approaches and gender is significant and disordinal. Thus, male students' interest improved more than females in the experimental group while female students' interest improved more than males in the control group.

Table 8: ANCOVA on Interaction Effect of Instructional Approaches and Gender on Students' Participation in Chemistry

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	1882.334[a]	4	470.583	91.802	.000	
Intercept	122.046	1	122.046	23.809	.000	
Pretest	499.017	1	499.017	97.349	.000	
Gender	5.990	1	5.990	1.169	.282	NS
Method	134.088	1	134.088	26.158	.000	S
Method*Gender	15.536	1	15.536	3.031	.085	NS
Error	486.976	95	5.126			
Total	149595.000	100				
Corrected Total	2369.310	99				

Hypotheses 4: There is no significant difference in the mean participation scores of students taught chemistry using FCI and those taught using DI.

Data relating to hypotheses four is contained in Table 8.

Table 8 shows that there was a significant main effect of the treatment on the participation of students in chemistry $F(1, 99) = 26.158$, $P<0.05$. Therefore, null hypothesis four was rejected. Thus, effect of FCI on the participation of students in chemistry is significant when compared to that of those taught using DI.

Hypotheses 5: There is no significant difference in the mean participation scores of male and female students.

Data relating to hypotheses five is contained in Table 8.

Table 8 also shows that there was no significant main influence of gender on the participation of students in chemistry $F(1, 99) = 1.169$, $P>0.05$. Therefore, null hypothesis five was not rejected. Thus, there is no significant difference in the participation of male and female students.

Hypotheses 6: There is no significant interaction effect of teaching methods and gender on the participation of the students in chemistry.

Data relating to hypotheses six is contained in Table 8.

Table 8 further shows that there was no significant interaction of teaching method and gender on participation of students in chemistry F (4, 99) = 0.085, P>0.05. Therefore, null hypothesis six was not rejected. Thus, there is no significant interaction effect of teaching methods and gender on students' participation in chemistry.

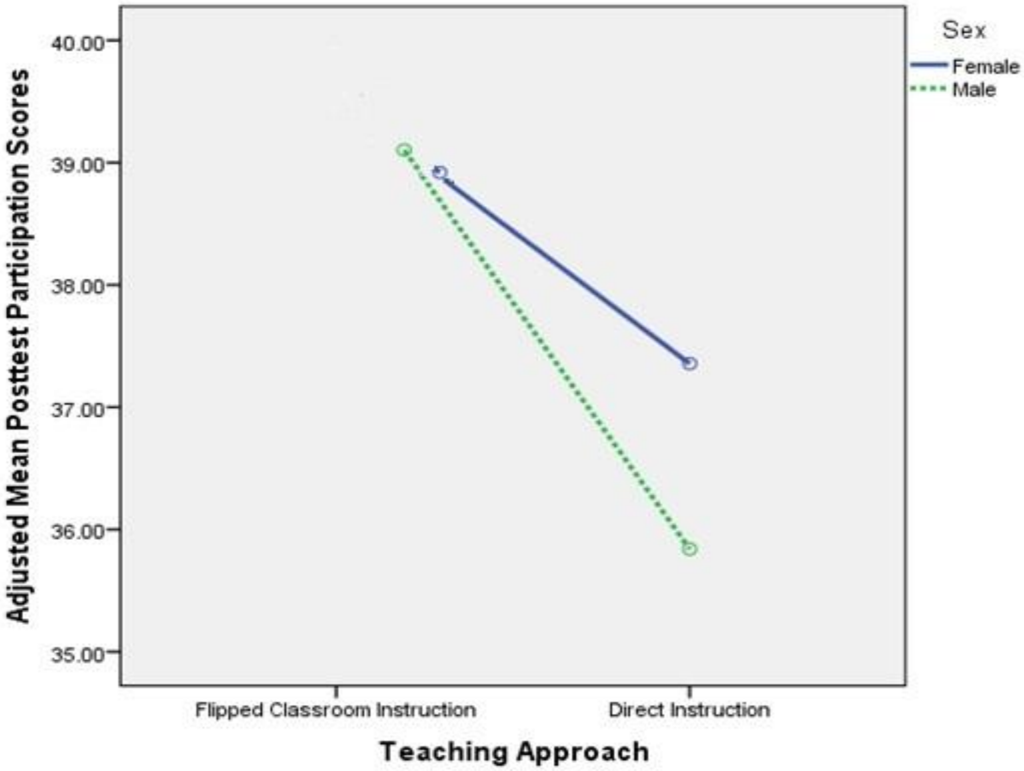

Figure 8: Plot of Interaction of Instructional Approach and gender on participation

The plot of the interaction effect of teaching methods and gender is not significant.

Table 9: ANCOVA on Interaction Effect of Instructional Approaches and Gender on Students' Achievement in Chemistry

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	1661.537[a]	4	415.384	49.711	.000	
Intercept	716.285	1	716.285	85.721	.000	
Pretest	105.292	1	105.292	12.601	.001	

Gender	25.075	1	25.075	3.001	.086	NS
Method	826.797	1	826.797	98.946	.000	S
Method*Gender	11.511	1	11.511	1.378	.243	NS
Error	793.823	95	8.356			
Total	28312.000	100				
Corrected Total	2455.360	99				

Hypotheses 7: There is no significant difference in the mean achievement scores of students taught chemistry using FCI and those taught using DI.

Data relating to hypotheses 7 is contained in Table 9.

Table 9 shows that there was a significant main effect of the treatment on the achievement of students in chemistry F (1, 99) = 98.946, P<0.05. Therefore, null hypothesis 7 was rejected. Thus, effect of FCI on the achievement of students in chemistry is significant when compared to that of those taught using DI.

Hypotheses 8: There is no significant difference in the mean achievement scores of male and female students.

Data relating to hypotheses eight is contained in Table 9.

Table 9 also shows that there was no significant main influence of gender on the achievement of students in chemistry F (1, 99) = 3.001, P>0.05. Therefore, null hypothesis eight was not rejected. Thus, there is no significant difference in the achievement of male and female students.

Hypotheses 9: There is no significant interaction effect of teaching methods and gender on the achievement of the students in chemistry.

Data relating to hypotheses nine is contained in Table 9.

Table 9 further shows that there was no significant interaction of teaching method and gender on achievement of students in chemistry F (4, 99) = 0.085, P>0.05. Therefore, null hypothesis nine was not rejected. Thus, there is no significant interaction effect of teaching methods and gender on students' achievement in chemistry.

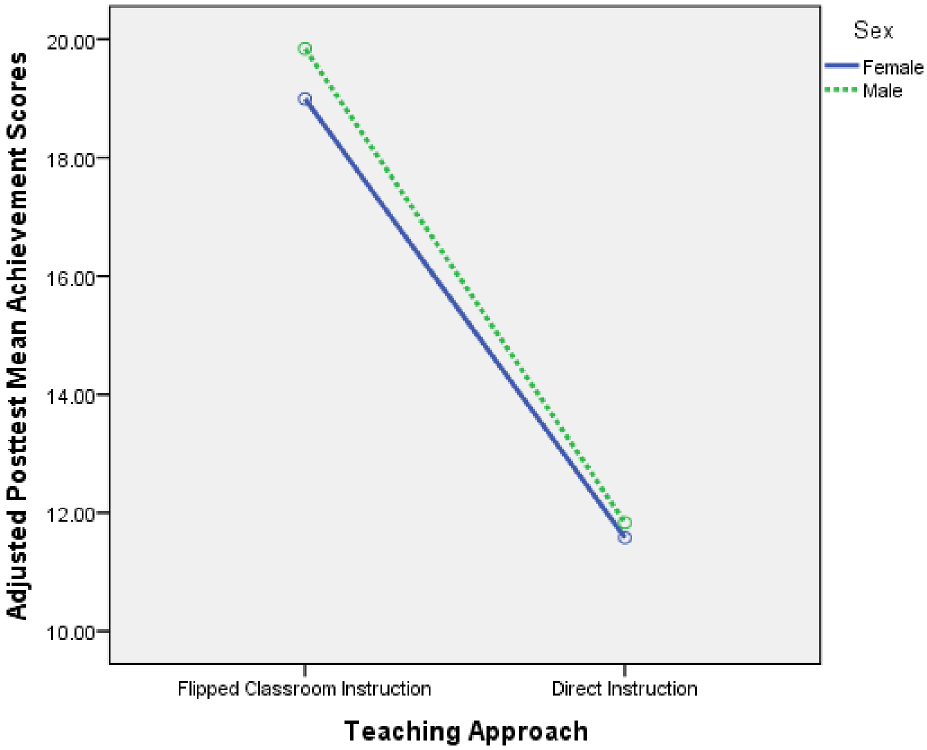

Figure 9: Plot of interaction effect of instructional Approach and Gender on Achievements scores

Figure 9 shows that the interaction of instructional approaches and gender is not significant and ordinal. This shows that the effect of the instructional approaches on students' achievement is more in one category of variables. Thus, the instructional approach affected the males more.

Summary of Findings

The major findings in the study are as follows:

1. FCI is effective in enhancing students' interest in chemistry.
2. FCI is effective in enhancing students' participation in chemistry.
3. FCI is effective in enhancing students' achievement in chemistry.

4. There is no significant difference in the interest, participation and achievement of male and female students in chemistry.
5. There is significant interaction effect of Instructional Approaches (FCI & DI) and gender on students' interest in chemistry.
6. There is no significant interaction effect of Instructional Approaches (FCI & DI) and gender on students' participation in chemistry.
7. There is no significant interaction effect of Instructional Approaches (FCI & DI) and gender on students' achievement in chemistry.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

This chapter presents a discussion of the results of the data analyzed, conclusion, implication of the study, recommendations, limitations of the study and suggestions for further studies.

The results of this study were discussed in line with the research questions and hypotheses as well as relevant literature. The findings were discussed under the following sub-headings:

- Effect of FCI on students' interest scores in chemistry
- Effect of FCI on students' participation scores in chemistry
- Effects of FCI on students' achievement scores in chemistry
- Effects of FCI on the interest, participation and achievement relative to gender
- Interaction effect of instructional method and gender on students' interest, participation and achievement in chemistry

Effect of FCI on students' interest in chemistry

One of the major purposes of this study was to find out whether FCI improved students' interest in chemistry than the DI. The result of the effect of FCI on student's mean interest scores in chemistry when compared to those taught using DI as shown in Tables 1,2 and 7 revealed that FCI is effective in improving students' interest in chemistry and was significant over DI. This result, therefore confirms that the experimental group acquired a higher interest in chemistry than the control group. The FCI is activity based and as such gave the students the opportunity to be engaged in activities that aroused their interest with the teachers as facilitators. The direct instruction does not involve activities like cooperative learning and discussion but embraces teacher-centred teaching approach which encourages passive listening as well as teacher-controlled learning environment, (Joyce, Weil & Calhoun, 2000). This suggest that the features of the direct instruction must have contributed to the poor interest of the chemistry students taught p table and chemical reactions using direct instruction.

This finding agrees with the findings reported by Yujing (2015) who found that the use of flipped classroom teaching strategy increased students' interest in English Language. The findings agree with the findings of Obiekwe (2010) who found that active learning environment (student-centered approach) engages learners' interest and enable them develop better understanding of the subject matter than teacher-controlled learning environment. However, Boevé, Meijer, Bosker, Vugteveen, Hoekstra and Albers (2016) reported a contrary finding which suggested that the study behaviour which indicated interest of students taught statistics using flipped classroom strategy and lecture method do not differ. The reported difference in effectiveness of flipped classroom could be due to the difference in the group of students used for the study and the class size. Boevé et al used 205 students in pedagogical science as experimental group and 209 in psychology as control group while the two groups used by Yujing and the current researcher were homogeneous and a relatively smaller groups.

Effect of FCI on students' participation scores in chemistry

A second major finding of this study is that FCI effectively increased the participation of students and was significant when compared to that of those taught using DI. The result of the finding suggests that FCI has many learning activities that students can participate in than the DI. This is in line with Kurtz (2014) who reported that FCI provides opportunities that will enable the teacher create different learning activities that can address students' differences in such a manner that typical lecture method alone cannot do. FCI, being a novel strategy may have contributed to the higher mean participation scores of the chemistry students.

This agrees with the view of Willis (2014) that flipped instruction consists of activities that students can participate effectively in the learning process. Murray and Lang (1997) also pointed out that students who participate actively in a learning process will learn the subject matter more effectively than students taught in the traditional lecture approach. This agrees with Ikonta and Maduekwe (2005) who reported that students taught with new strategy other than what was conventional, recorded a significantly better performance.

Effects of FCI and DI on students' achievement scores in chemistry

The result of the study also revealed that FCI was effective in improving the academic achievement of chemistry students when compared to that of those taught using DI. The effect of FCI on achievement was also significant. The academic achievement of the chemistry students taught with FCI was better than that of those taught with DI. FCI promotes the development of critical thinking through discussion/cooperative learning and clarification of ideas which gives students a greater liberty to advance their own ideas and at the same time benefit from the ideas of other. Kurtz's emphasis the use of innovative approaches and methods other than what is in the traditional/conventional classrooms. This is to ensure that learning is relevant and make students functional in the ever growing world/society.

This result is in line with the findings of Kenna (2014) who reported that FCI had a significant positive effect in promoting students' academic achievement when compared to traditional classroom. The finding also agrees with Wiginton (2013) who reported that students in the flipped learning environment scored significantly higher on mathematics achievement than those in the traditional learning environment (lecture-homework strategies). In line with the finding, Kurtz (2014) pointed out that educators should be encouraged in the use of innovative teaching methods like flipped classroom instruction (FCI). In support of the above, Nwatamalu (2005) emphasized that educators/teachers should make use of the technologies/innovation in computers, satellite operations (mobile phones), internets, new different strategies and approaches in classroom instructions in order to help learners acquire skills and knowledge that will make them effective in the society.

Still in support of the result, Enechi (2013) reported a significant difference in achievement of chemistry students taught hydrocarbons using cooperative learning approach (experimental group) and those taught with lecture method (control group). This was in favour of those taught with cooperative learning approach. However, Willis (2014) reported a contrary view in his own investigation on the effect of flipped classroom on students' academic achievement. He reported that there was no significant difference in the examination scores for the experimental group and the control group. The researcher attributed this to the technological problems (poor network services) that look place during the treatment period which frustrated the students. Hence, the FCI had no obvious effect on the scores of the experimental group.

Effects of FCI on the interest, participation and achievement relative to gender

Another major finding of this study is that the effect of FCI on male and female students' interest, participation, and academic achievement in chemistry is not significant. This suggests that both male and female chemistry students benefited equally. Therefore, gender is not a significant factor in students' interest in chemistry (periodic table and chemical reactions) when taught using FCI. This agrees with the finding of Okafor (2008) who reported no gender difference in students' interest in chemistry. Hidi and Reminger (2006) also support the finding that gender is not a significant factor in students' interest. However, Okoli (2011) reported a contrary view that there is gender difference in students' interest in chemistry in favour of females.

Also,gender is not a significant factor in students' participation in learning periodic table and chemical reactions when taught using FCI. Although, no known study has explicitly undertaken gender dimension in students' participation, Abdullah, Bakar and Mahbob (2012) showed that in two out of the three classes observed, female students had greater participation scores than the male counterparts.

This is supported by Ojo (2004) who found out that male students performed significantly better than females in mathematics. The data from the results revealed a no gender difference in chemistry students' mean achievement scores when taught periodic table and chemical reactions using FCI. This indicated that no significant difference existed between the mean achievement scores of the male and female students in experimental group. The finding contrast that of Enechi (2013) who reported that male students achieved higher in chemistry than their female counterparts. Jegede 2007, also pointed out that gender has impact on students' achievement in chemistry and other science related subjects. However, a supporting finding was reported by Ezeuka (2013) in his study on effect of cooperative teaching approach on students' achievement and retention in some difficult concepts in chemistry.

Interaction effect of instructional approaches and gender on students' interest, participation and academic achievement in chemistry

Interaction effect of teaching approaches (FCI and DI) and gender on students' interest in chemistry is yet another major propose of the study. The results indicated that there was a significant interaction effect of teaching approaches (FCI and DI) and gender on students' interest in chemistry. The interaction plot is disordinal showing that the effects of the teaching approaches in interest was gender sensitive. This implies that teaching approach (FCI and DI) and gender had some form of interaction and their combined effort on students' interest in chemistry was significant. This may be attributed to the learning activities involved in FCI that must have aroused and increased the students' interest. On the other hand, the female students were more effective and had higher interest when exposed to DI. This finding is in line with Okoli (2011) who reported that there is interaction effect between teaching approach and gender. Okafor (2008) had a contrary finding.

The result showed no significant interaction effect between teaching approach and gender on chemistry students' participation and achievement. Thus, the null hypothesis was not rejected. The plot of interaction here was ordinal for both participation and achievement. This implies that both male and female students participated and achieved actively but not equally, hence there was no statistically interaction of teaching approach and gender on students' mean participation in chemistry. Gender dimension in students' participation is not very common in research community. All the same, Abdullah, Bakar and Mohbob (2012) reported that in two out of the three classes observed, female students had a higher participation score than their male counterparts. This result agreed with Ojo (2004) and Enechi (2013) who reported in their independent studies that teaching approach and gender had no interaction on students' achievement. In the contrary, Okoli, (2011) reported the existence of interaction effect between teaching approach and gender on students' achievement.

Conclusion

This study investigated the effect of flipped classroom instruction on students' interest, participation and academic achievement in chemistry. The findings revealed that FCI is effective in enhancing students' interest, participation and academic achievement in chemistry. The study reveals that the effect of FCI on male and female students' interest, participation and academic achievement in chemistry was not significant. However, no significant interaction was observed between instructional approaches and gender on chemistry students' participation and achievement, but there is significant interaction effect on that of students' interest.

Implication of the Study

The result of this study has a reasonable educational implication for chemistry teaching and learning in Nigeria especially for secondary school teachers and students. From the study it was found that flipped classroom instruction has the capability of enhancing students' interest, participation and academic achievement in chemistry. This implies that teachers, educators and facilitators of learning in all contexts and at all levels should adopt flipped classroom instructional approach and other relevant participatory and innovative teaching approaches to enhance performance of learners.

Flipped classroom instruction, being a learner-centered teaching approach where students take charge of their own learning and participate actively in the learning process will enhance quality of passes in WAEC and NECO examinations and eligibility for admission into tertiary institutions. It will equally guarantee self-actualization and self-reliance needed in the present day Nigeria.

Furthermore, it was found that FCI favoured both male and female students. This implies that, FCI is not gender specific. It had a positive impact on both male and female students. Teacher and facilitators should therefore use FCI approach on their male and female students without discrimination. This will go a long way to improve the interest, participation and academic performance of both gender.

Recommendations

Based on the result of the study, the researcher recommends the following:

1. Since flipped classroom instruction has been found to be effective in enhancing students' interest, participation and academic achievement in chemistry, it should also be extended in teaching other disciplines.
2. Since serving teachers are not very familiar with flipped classroom instruction and its benefits, seminars, workshops and conferences should be organized by relevant professional bodies and Government to educate them on FCI.
3. Government should help in terms of providing adequate fund to ensure the success of the seminars, workshops and conferences.

4. Curriculum planners should incorporate FCI in the curriculum for pre-service teachers in order to popularize the approach among trainee teachers

Limitations of the Study

The generalizations made in this study are subject to the following limitations

a. Pre-test post-test non-equivalent group research design (quasi-experiment) was adopted for the study. The design naturally uses intact classes as groups. Random assignment of samples to FCI and DI was not applied. Therefore, the equivalence of the groups was unlikely.

b. Some of the participants were not included in the statistical data analysis due to non-completion of the treatment and attrition.

c. The use of two concepts in chemistry and only SS2 chemistry students of the public single sex secondary schools as the sample for the study (public co-educational secondary schools and private owned school not included) made the generalization of the findings difficult.

d. The length of time for the treatment was not quite sufficient to show maximum proficiency gains. Thus, the findings might differ in a longer treatment.

Suggestions for further studies

Further research could be undertaken by future researchers in the following areas:

1. A study could be carried out on the effect of FCI using coeducational and private schools in Awka capital city.
2. Replication of the present study in other states of the nation and in other subject areas.
3. A study could be carried out in other education zones of Anambra state.
4. A study on the effect of FCI on students' academic achievement in other areas in chemistry.

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APPENDIX A

Table 1: Distribution of Grades Awarded over the last seven years in Ordinary Level Chemistry, 2009-2015

Year	A	B	C	A, B, C	D	E	F	NG	E, F, NG
2009	9.2	22.5	28.4	63.1	21.5	8.7	5.6	1.0	15.4
2010	7.6	22.2	26.3	56.1	25.4	10.1	6.8	1.6	18.5
2011	4.4	23.7	22.6	50.7	23.7	10.8	11.8	3.2	25.8
2012	6.2	20.9	15.7	42.8	29.1	8.3	10.4	9.4	28.1
2013	4.4	14.1	30.1	48.6	25.8	11.5	8.6	5.4	25.8
2014	1.9	12.4	26.7	41.0	25.7	10.5	15.2	7.6	33.3
2015	1.7	13.1	23.3	38.3	25.2	13.0	14.8	8.7	36.5

Percentage of candidates awarded each lettered grade in Ordinary Level Chemistry, 2009-2015

Table 2

Year	**A1**	**A2**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	**D1**	**D2**	**D3**	**E**	**F**	**NG**
2009	3.0	6.2	5.9	8.6	11.0	10.7	8.6	9.1	5.3	6.8	9.4	8.7	5.6	1.0
2010	2.2	5.4	4.9	8.6	8.7	9.1	9.1	8.1	7.9	7.7	9.8	10.1	6.8	1.6
2011	2.2	2.2	2.2	4.3	17.2	7.5	4.3	10.8	6.5	4.3	12.9	10.8	11.8	3.2
2012	1.0	5.2	4.2	7.3	9.4	2.1	6.3	7.3	13.5	5.2	10.4	8.3	10.4	9.4
2013	2.2	2.2	2.2	2.2	9.7	7.5	8.6	14.0	5.4	3.2	17.2	11.8	8.6	5.4
2014	0.0	1.9	0.0	5.7	6.7	6.7	9.5	10.5	7.6	8.6	9.5	10.5	15.2	7.6
2015	0.0	1.7	0.9	2.6	9.6	7.0	6.1	10.4	7.0	5.2	13.0	13.0	14.8	8.7

Percentage of candidates awarded each lettered grade in Ordinary Level Chemistry, 2009-2015

Source: *2015 WAEC Chief Examiner's Report. Retrieved from http://www.waecnigeria.org.html*

APPEDNDIX B

First Term Chemistry Scheme of Work for SS2 Class

1. Periodic table. A, periodic laws (statement/explanation). B, groups and periods of common elements. C, blocks of element metals, non-metals, metalloids and transition metals and their distinguishing characteristics.
2. Families. A, electronic configuration spelt according to groups (I-VII) i.e group 1A-Alkaline metals, group 2- alkaline earth metals and other family names. B, properties of elements in the periodic table.
3. Change in size (atomic radii/ionic radii). A, changes down the group and across the period and accompanying changes in properties. B, ionization energy, electron affinity and electronegativity changes down the group and across the periods.

4. Chemical reactions. A, basic concepts, reactants, products, reaction time, reaction rate. B, introduction to collision theory. C, factors affecting rate of chemical reaction, Name of substance, concentration/pressure,temperature, catalyst. D, types of chemical reactions endothermic and exothermic.
5. Chemical equilibrium. A, introduction using simple equations. B, concept of systems at dynamic equilibrium and their properties. C, principals, factors affecting equilibrium of chemical reactions, concentration, temperature and pressure.
6. Mass volume relationship. A, basic concepts, mole, molar quantities, molarity, standard temperature and pressure (S.T.P) relative density and relative molar mass. B, calculations involving mass and vol. S.I.units of quantities i.e length, mass, volume e.t.c.
7. Acid- base. A, simple acid- base titration. B, common indicators and the PH range. C, heat of neutralization (introduction), construction of wooden retort stand.
8. Water. A, structure of water. B, solubility (basic concepts; solute, solvent, solution) solubility of different substances. C, factors that affects solubility. Uses of solubility curves.
9. Hardness of water. A, Meaning, causes and types. B, Methods of removal of hardness, advantages and disadvantages of handwater. C, purification of water. D, production of distilled water.
10. Air. A, Constituents, percentage composition. B, properties of air. C, Flame drawing, labelling and explanation of different parts/ zones of flame.
11. Hydrogen. A, configuration and possible oxidation ions. B, isotopes of hydrogen and unique position of hydrogen in the periodic table. C, laboratory preparation and industrial preparation of hydrogen. D, physical and chemical properties and uses.
12. Revision and examination.

APPENDIX C
Education Zones in Anambra State

Zones	LGA	No. of Snr. Sec. Schools	Total No. of Schools
Aguata	Aguata	21	
	Orumba North	13	47
	Orumba South	13	
Awka	Aniocha	16	
	Awka North	8	
	Awka South	18	61

	Dunukofia Njikoka	8 11	
Nnewi	Ekwusigo Ihiala Nnewi South Nnewi North	8 17 17 8	50
Ogidi	Idemili North Idemili South Oyi	16 13 11	40
Onitsha	Ogbaru Onitsha North Onitsha South	11 16 6	33
Otuocha	Anambra East Anambra West Ayamelum	10 7 9	26
Total	**21**	**256**	**256**

Source:*Post Primary School Service Commission (PPSSC), Awka 2015*

APPENDIX D
POPULATION DISTRIBUTION OF PUBLIC SECONDARY SCHOOLS WHICH OFFER CHEMISTRY IN AWKA EDUCATION ZONE
AWKA SOUTH LGA

S/N	NAME OF SCHOOLS	MALE	FEMALE	TOTAL
1	ST. John secondary school Awka	O	100	100
2	Igwebuike Grammer school Awka	117	0	117
3	Girls secondary school Awka	0	92	92
4	Community secondary school umuokpu	34	40	74
5	Capital city secondary school Awka	29	36	65

6	Kenneth Dike memorial secondary school Awka	-	-	-
7	Ezi-Awka community school Awka	12	17	29
8	Community secondary school Okpuno	28	34	62
9	Nneoma Community secondary school Nibo	3	3	6
10	Community secondry school Mbaukwu	10	10	20
11	Emeka Aghasili High school Nise	-	-	-
12	Community secondary school Agulu-Awka	35	64	99
13	Community Secondary School Amawbia	12	11	23
14	Union secondary school Umuawulu	-	-	-
15	Union secondary school Amawbia	4	2	6
16	Ezeike High school Nibo	1	23	24
17	Holy cross High school Umuawulu/Mbaukwu	6	6	12
18	Community Secondary School Isiagu	2	2	4
	TOTAL	293	440	733

NJIKOKA LOCAL GOVERNMENT AREA

S/N	NAME OF SCHOOLS	MALE	FEMALE	TOTAL
1	Comprehensive secondary school Nawfia	90	0	90
2	Girls secondary school Abagana	0	20	20
3	Nnamdi Azikwe secondary school Abagana	40	0	40
4	Ide secondary school Enugwu-Ukwu	17	20	37
5	ST. Michael model Comprehensive secondary school Nimo	16	0	16
6	Girls Secondary School Nimo	0	23	23
7	Community secondary school Abba	-	-	-
8	Government Technical collage Enugwu-Agidi	-	-	-
9	Girls secondary school Enugwu-Agidi	0	9	9
10	Nawfia Community secondary school Nawfia	2	5	13
11	Okutalukwe Community secondary school Enugwu/ukwu	7	6	13
		172	83	255

DUNUKOFIA LOCAL GOVERNMENT AREA

S/N	NAME OF SCHOOL	MALE	FEMALE	TOTAL
1	ST. Mary's High school Ifitedunu	30	0	30
2	Walter Eze Memorial secondary school Ukpo	16	19	35
3	Community Secondary school Umunnachi	7	4	11
4	Nneamaka Secondary school Ifitedunu	38	62	100
5	Community secondary school Ukpo	2	5	7
6	Community secondary school ukwulu	8	12	20
7	ST. Kizito Girls secondary school Umudioka	0	60	60

8	Community High school Nawgu	3	1	4
	TOTAL	104	163	267

ANAOCHA LGA

S/N	NAME OF SCHOOLS	MALE	FEMALE	TOTAL
1	Girls High school Agulu	0	70	70
2	Flora A.M.C. secondary school Neni	17	10	27
3	Community secondary school Obeledu	-	-	-
4	Community secondary school Ichida	5	1	6
5	Community High school Aguluzigbo	0	0	0
6	Bubendorff M.G.S. Adazi-Nnukwu	35	0	35
7	Community secondary school Agulu	4	10	14
8	Ojiako Memorial Grammer school Adazi-Ani	9	3	12
9	Union secondary school Agulu	4	5	9
10	Community High school Adazi	0	0	0
11	Community High school Akwaeze	6	16	22
12	Agulu Grammar school Agulu	13	0	13
13	Lake-city secondary school Nri	9	4	13
14	Girls secondary Adazi-Nnukwu	0	7	7
15	Regal secondary school Nri	10	5	15
16	Loretto special science secondary school Adazi-Nnukwu	0	195	195
	TOTAL	112	326	438

AWKA NORTH LGA

S/N	NAME OF SCHOOL	MALE	FEMALE	TOTAL
1	Community secondary school Amansea	18	12	30
2	Community secondary school Isuaniocha	8	5	13
3	Community secondary school Ebenebe	45	9	54
4	Community secondary school Mgbakwu	7	10	17
5	Community secondary school Achalla	3	4	7
6	Community secondary school Amanuke	0	0	0
7	Community secondary school Urum	0	0	0
8	Community secondary school Awbaofemili	4	3	7
	TOTAL	85	43	128
	GRAND TOTAL	766	1055	1821

SOURCE: Post primary school service Commission (PPSSC), Awka 2016/2017

APPENDIX E

Male Senior Secondary Schools Offering Chemistry in Awka Education Zone

S/N	**Name of School**	**LGA**
1.	Igwebuike Grammar School, Awka	Awka South
2.	Comprehensive Secondary School,Nawfia	Njikoka
3.	Nnamdi Azikiwe Secondary School, Abagana	Njikoka
4.	St. Michael’s Model Comprehensive Secondary School, Nimo	Njikoka
5.	St. Mary’s High School, Ifitedunu	Dunukofia
6.	Agulu Grammar School, Agulu	Anaocha
7.	Budenorff M. G. S Adazi-Nnukwu	Anaocha

Source: *Post Primary School Service Commission (PPSSC), Awka 2015*

APPENDIX F

Female Senior Secondary Schools Offering Chemistry in Awka Education Zone

S/N	Name of School	LGA
1.	St. John of God Secondary School, Awka	Awka South
2.	Girls' Secondary School, Awka	Awka South
3.	Girls' Secondary School, Enugwu-Agidi	Njikoka
4.	Girls' Secondary School, Nimo	Njikoka
5.	Girls' Secondary School, Abagana	Njikoka
6.	St. Kizito Girls' Secondary School, Umudioka	Dunukofia
7.	Girls' High School, Agulu	Anaocha

8.	Loretto Special Secondary School, Adazi-Nnukwu	Anaocha
9.	Girls' Secondary School, Adazi-Nnukwu	Anaocha

Source: *Post Primary School Service Commission (PPSSC), Awka 2015*

APPENDIX G

Sample Distribution According to Gender

NAME OF SCHOOL	NUMBER OF SS2 STUDENTS IN CHEMISTRY CLASSES			
	Experimental Group		**Control group**	
1. Igwebuike grammer school	**male**	**Female**	**male**	**female**

Awka.	41	0	-	-
2. St. John of God sec. school Awka.	0	39	-	-
3. Comprehensive sec. school Nawfia	-	-	35	0
4. Girls' sec. school Enugu-Agidi	-	-	0	9
TOTAL	41	39	35	9

APPENDIX H

Chemistry Personal Interest Scale (CPIS) Pre-Test

Instruction:

Please indicate by ticking (√) the extent of your agreement or disagreement to the underlisted statements using the following response option Strongly Agree (SD), Agree (A), Disagree (D) and Strongly Disagree (SD)

1. Name:__________________________________
2. School:__________________________________
3. Sex: Female ☐ ☐

	As a chemistry student I like	**SA**	**A**	**D**	**SD**
1.	chemistry more than other science subjects				
2.	the ways chemistry is taught				
3.	visiting chemistry laboratory				
4.	carrying out chemistry projects				
5.	reading materials in chemistry				
6.	using apparatuses in chemistry laboratory				
7.	discussing any topic in chemistry				
8.	reading my chemistry note immediately after the lesson				
9.	calculating any mathematical problem in chemistry				
10.	answering questions in chemistry class				
11.	asking questions in chemistry class				

APPENDIX I
Learners' Participation Questionnaire (LPQ) Pre-test

Please indicate by ticking (X) to the extent of your agreement or disagreement to the underlisted statements using the following response options: Disagree (DA), Strongly Disagree (SD), Agree (A) and Strongly Agree (SA)

	During chemistry class I normally participate in:	**SA**	**A**	**D**	**SD**
12.	class discussions				

13.	asking questions				
14.	answering questions				
15.	carrying out simple demonstrations				
16.	performing simple experiments in the laboratory				
17.	Presenting and explaining some assigned project/materials.				
	Outside the chemistry class, I normally study chemistry by:				
18.	Asking questions to my parents/guidance/friends and relatives.				
19.	Visiting the internet and textbooks.				
20.	Using charts or models to study some concepts				
21.	Developing any projects assigned to me.				
22.	Group discussions				

APPENDIX J

Chemistry Achievement Test (CAT) Pre-Test

Class: *SS2*

Time: *1hour*

Instruction: *Answer all questions.Each question is followed by four responses labelled A, B, C and D. Choose the response that best answers the question and write the letter against the number of the question on the answer sheet provided.*

Name:__________________________
School:_________________________
Gender:_________________________

1. Which of the following elements belongs to a noble gas? (A) $_{17}W$(B) $_{18}W$(C) $_{19}Y$(D) $_{20}Z$
2. The periodic table shows a diagonal division of elements into (A) halogens and rare gasses(B) transition elements and halogens(C) metals and non-metals (D) lanthanides and actinides
3. In the periodic table, the transition elements occur between (A) groups 1 and 2(B) groups 2 and 3(C) groups 3 and 4(D) groups 4 and 5
4. The following are properties of transition metals except (A) tendeny to form complex ions (B) formation of coloured ions (C) ability to act as catalyst (D) low melting points
5. The horizontal rows of the periodic table are numbered from (A) 0 to 8 (B) 1 to 7 (C) 1 to 9 (D) 0 to 9
6. The horizontal rows of elements in the periodic table are called (A) halogens(B) noble gases(C) groups(D) periods
7. Which of the following is not a halogen? (A) bromine (B) iodine (C) silicon (D) fluorine
8. The position of an element in the periodic table is determined by (A) its atomic radius (B) its relative atomic mass (C) the number of protons in its atom (D) the number of neutrons in its atom
9. Which of the following electronic structures belongs to a noble/rare gas? (A) $1S^2\ 2S^2$ (B) $1S^2\ 2S^2\ 2P^3$ (C) $1S^2\ 2S^2\ 2P^5$ (D) $1S^2\ 2S^2\ 2P^6\ 3S^2\ 3P^6$
10. Groups 1 and 2 of the periodic table make up the (A) s-block(B) p-block(C) d-block(D) f-block
11. What is the likely formula of compound formed between element M in group two and element X in group seven? (A) $M_7\ X_2$(B) M_2X(C) $M_2\ X_7$(D) MX_2
12. The alkali metals exhibits similar chemical properties because (A) they occur in the combined state (B) they have the same number of valence electron's (C) their salts are soluble in water (D) they are highly reactive
13. When an atom gains an electron, it becomes (A) chemically inactive (B) positively charged (C) negatively charged (D) oxidized
14. Which of the following cannot be deduced from the electronic configuration of a transition metal? (A) possession of magnetic property(B) ability to form complex ions(C) position in the periodic table (D) variable oxidation states
15. Elements that can ionize by loss of one electron belong to the family of (A) alkali metals (B) halogens (C) alkali earth metals (D) rare gases
16. Alkali earth metals belong to (A) period 3 (B) period 2 (C) group 3 (D) group 2
17. When we move from one element to the next across a period, electrons are (A) being shared in the same shell at about the same distance from the nucleus(B) being removed in the same shell at about the same distance from the nucleus (C) being added to the same shell at about the same distance from the nucleus (D) being transferred in the same shell at about the same distance from the nucleus
18. Electronegativities of elements (A) increase across a period but decrease down a group(B) decrease across a period but increase down a group(C) increase across a period and also down a group (D) decrease across a period as well as down the group
19. The energy change which accompanies the addition of an electron to a gaseous atom is (A) ionization(B) atomization(C) electronaffinity(D) electronegativity

20. Which of the following statements about the behaviour of an atom is correct? (A) atomic size decreases down the group(B) atomic size increases across the period(C) anions are smaller than the parent atom(D) cations are smaller than the parent atom
21. The energy required to remove a valence electron from an atom of an element to form an ion is known as (A) electrical energy (B) heat energy (C) ionization energy (D) bond energy
22. The ionic radii of positive ions are (A) similar to the corresponding atomic radii (B) smaller than the corresponding atomic radii (C) greater than the corresponding atomic radii (D) none of the above
23. The size of atoms of elements in the same period decreases steadily as the (A) mass number decreases (B) mass number increase (C) atomic number decreases (D) atomic number increases
24. Study carefully the reaction represented by the equation below $2H_2O(i) \longrightarrow O_2(g) + H_2O(i)$ which of the following will not increase the reaction rate? (A) heating the hydrogen peroxide (B) adding a pinch of MnO_2 to the reaction (C) increasing the concentration of the H_2O_2 (D) adding water to the reactant
25. A reaction that is continually supplied with an external source of energy for activating the reactant particles as well as to form the products is known as (A) irreversible reaction (B) exothermic reaction (C) equilibrium reaction (D) endothermic reaction
26. Reaction occurs when the colliding reactant particles (A) have energy less than the energy barrier (B) have energy equal or greater than the energy barrier (C) have energy less than effective collision (D) have energy greater than that of the products
27. What do we do to increase the surface area of the reactants (A) breaking them into chips (B) subjecting the reactants to high pressure (C) altering the direction of the reaction (D) using reactants to different densities
28. Rate of chemical reaction depends on the following factors except (A) rate at which gas is evolved (B) rate at which products are formed (C) rate at which colour of reactions change (D) rate which the reactants diminish
29. The minimum amount of energy required for effective collisions between reacting particles is known as (A) kinetic energy (B) activation energy (C) bond energy (D) potential energy
30. The rate of chemical reaction of solids are not affected by (A) catalyst (B) particle size (C) temperature (D) pressure
31. A catalyst increase the rate of chemical reaction by (A) decreasing the temperature of the reaction (B) increasing the surface area of the reactants (C) decreasing the activation energy of the reaction (D) decreasing the surface area of the product
32. “The rate of a reaction is proportional to the number of effective collisions occurring per second between the reactants” This statement is associated with the (A) kinetic theory (B) rate law (C) atomic theory(D) collision theory

APPENDIX K

Table of Specification on CAT

Contents	Knowledge 25%	Comprehension 20%	Application 20%	Analysis 5%	Synthesis 20%	Evaluation 10%	Totals
Periodic laws, groups and periods of							

common elements, blocks of metals, non-metals, metalloids and transition metals	2	2	1	1	1	1	8
Families-electronic configuration according to groups, alkaline earth metals and other families, properties of elements in periodic table	2	1	2	-	3	-	8
Atomic/ionic radii – change down the groups and ionization energy, electron affinity and electronegativity down and across the periods	3	-	1	1	-	3	8
Chemical reaction – reactants, products, action time, reaction rate, collision theory, factors affecting rates of chemical reactions	-	3	2	1	2	-	8
Total	**7**	**6**	**6**	**3**	**6**	**4**	**32**

APPENDIX L

Content Analysis of CAT Items

Cognitive	Question No.	Questions/Items
Knowledge	3	In the periodic table, the transition elements occurs between (A) groups 1 and 2 (B) groups 2 and 3 (C) groups 3 and 4 (D) groups 4 and 5

	7	Which of the following is not a halogen? (A) bromine (B) iodine (C) silicon (D) fluorine
	8	The position of an element in the periodic table is identified by (A) it's atomic radius (B) it's relative atomic mass (C) the number of protons in it's atom (D) the number of neutrons it's atom
	14	Which of the following cannot be deduced from the electronic configuration of a transition metal? (A) possession of magnetic property (B) ability to form complex ions (C) position in the periodic table (D) variable oxidation states
	15	Elements that can ionize by loss of one electron describes the family of (A) alkali metals (B) halogens (C) alkali earth metals (D) rare gases
	18	Electronegativity of elements are identified by it's (A) increase across a period but decrease down a group (B) decrease across a period but increase down the group (C) increase across a period and also down the group (D) decrease across a period as well as down the group
	19	The energy change which accompanies the addition of an electron to a gaseous atom is (A) ionization (B) atomization (C) electronaffinity (D) electronegativity
Comprehension	1	Which of the following elements illustrates a noble gas? (A) $_{17}W$ (B) $_{18}W$ (C) $_{19}Y$ (D) 20^{Z}
	6	The horizontal rows of elements in the periodic table are generalized by (A) halogens (B) noble gases (C) groups (D) periods
	11	What is the likely formula of a compound that summarized the reaction between element M in group two and element X in group seven? (A) M_7 X_2(B) M_2 X (C) M_2 X_7 (D) MX_2
	25	A reaction that illustrates a continual supply of an external source of energy for activating the reactant particles as well as to form the product (A) irreversible reaction (B) exothermic reaction (C) equilibrium reaction (D) endothermic reaction
	27	Which of the following illustrates an increase in the surface area of reactants (A) breaking them into chips (B) subjecting the reactants to high pressure (C) altering the direction of the reaction (D) using reactants to different densities
	32	"The rate of a reaction is proportional to the number of effective collisions occurring per second between the reactants", this statement is paraphrased with the (A) kinetic theory (B) rate law (C) atomic theory (D) collision theory
Application	2	The periodic table describes a diagonal division of elements into (A) halogens and rare gasses (B) transition elements and halogens (C) metal and non-metals (D) lanthanides and actinides
	9	Which of the following electronic structures apply to a noble/rare gas? (A) $1S^2$ $2S^2$(B) $1S^2$ $2S^2$ $2P^3$(C) $1S^2$ $2S^2$ $2P^5$(D) $1S^2$ $2S^2$ $2P^6$ $3S^2$ $3P^6$
	16	Alkali earth metals demonstrates (A) period 3 (B) period 2 (C) group 3 (D) group 2
	17	When we operate from one element to the next across a period,

		electrons are (A) being shared in the same shell at about the same distance from the nucleus (B) being removed in the same shell at about the same distance from the nucleus (C) being added to the same shell at about the same distance from the nucleus (D) being transferred in the same shell at about the same distance from the nucleus
	26	Which statement demonstrates that: reaction occurs when the colliding reactant particles (A) have energy less than the energy barrier (B) have energy equal or greater than the energy barrier (C) have energy less than effective collision (D) have energy greater than that of the products
	30	The rate of chemical reaction of solids are not modified by (A) catalyst (B) particle size (C) temperature (D) pressure
Analysis	5	The horizontal rows of the periodic table are broken down from (A) 0 to 8 (B) 1 to 7 (C) 1 to 9 (D) 0 to 9
	21	The energy required to separate a valence election from an atom of an element to form an ion is known as (A) electrical energy (B) heat energy (C) ionization energy (D) bond energy
	29	The minimum amount of energy required for effective collisions between reaching particles is classified as (A) kinetic energy (B) activation energy (C) bond energy (D) potential energy
Synthesis	4	The following are properties which transition metals are composed of except (A) tendency to form complex ions (B) formation of coloured ions (C) ability to act as catalyst (D) low melting points
	10	Groups 1 and 2 of the periodic table composed of (A) s-block (B) p-block (C) d-block (D) f-block
	12	The alkali metals produce similar chemical properties because (A) they occur in the combined state (B) they have the same number of valence electrons (C) their salts are soluble in water (D) they are highly reactive
	13	When an atom gains an electron, it produces (A) chemically inactive particle (B) positively charged particle (C) negatively charged particle (D) oxidized particle
	28	Rate of chemical reaction constitutes the following factors except: (A) rate at which gas is evolved (B) rate at which products are formed (C) rate at which colour of reactions change (D) rate at which the reactants diminish
	31	A catalyst reconstructs the rate of chemical reaction by (A) decreasing the temperature of the reaction (B) increasing the surface area of the reactants (C) decreasing the activation energy of the reaction (D) decreasing the surface area of the product
Evaluation	20	Which of the following statements justifies the behaviour of an atom? (A) atomic size decreases down the group (B) atomic size increases across the period (C) anions are smaller than the parent atom (D) cations are smaller than the parent atom
	22	Which of the following supports the ionic radii of positive ions (A) smaller to the corresponding atomic radii (B) smaller than the corresponding atomic radii (C) greater than the corresponding atomic radii (D) none of the above

	23	The size of atoms of elements in the same period supports a steady decrease as the (A) mass number decreases (B) mass number increases (C) atomic number decreases (D) atomic number increases
	24	Study carefully the reaction represented by the equation below $2H_2O(i) \rightarrow O_2(g) + H_2O(i)$ which of the following will not increase the reaction rate? (A) heating the hydrogen peroxide (B) adding a pinch of MnO_2 to the reaction (C) increasing the concentration of the H_2O_2 (D) adding water to the reactant

APPENDIX M

Answers to the Questions on Chemistry Achievement Test [Pre-Test]

1. C
2. C
3. D
4. B
5. D

6. B
7. C
8. B
9. D
10. A
11. A
12. C
13. B
14. D
15. A
16. D
17. D
18. D
19. B
20. C
21. D
22. C
23. A
24. C
25. D
26. C
27. D
28. B
29. C
30. A
31. B
32. D

APPENDIX N

Instrument for Chemistry Personal Interest Scale (CPIS) Post-Test

Instruction:

Please indicate by ticking (√) the extent of your agreement or disagreement to the underlisted statements using the following response option Strongly Agree (SD), Agree (A), Disagree (D) and Strongly Disagree (SD)

Name:____________________________

School:___________________________

Sex: Female ☐e ☐

As a chemistry student I like	SA	A	D	SD
chemistry more than other science subjects				
the ways chemistry is taught				
reading materials in chemistry				
discussing any topic in chemistry				
visiting chemistry laboratory				
using apparatuses in chemistry laboratory				
carrying out chemistry projects				
reading my chemistry note immediately after the lesson				
calculating any mathematical problem in chemistry				
answering questions in chemistry class				
asking questions in chemistry class				

APPENDIX O
Instrument for Learners' Participation Questionnaire (LPQ) Post-Test

Please indicate by ticking (X) to the extent of your agreement or disagreement to the underlisted statements using the following response options: Disagree (DA), Strongly Disagree (SD), Agree (A) and Strongly Agree (SA)

	During chemistry class I normally participate in:	SA	A	D	SD

12.	class discussions				
13.	carrying out simple demonstrations				
14.	asking questions				
15.	answering questions				
16.	performing simple experiments in the laboratory				
17.	Presenting and explaining some assigned project/materials.				
	Outside the chemistry class, I normally study chemistry by:				
18.	Visiting the internet and textbooks.				
19.	Asking questions to my parents/guidance/friends and relatives.				
20.	Using charts or models to study some concepts				
21.	Developing any projects assigned to me.				
22.	Group discussions				

APPENDIX P

Chemistry Achievement Test (CAT) Post-Test

Class: *SS2*
Time: *1hour*
Instruction: *Answer all questions.Each question is followed by four responses labeled A, B, C and D. Choose the response that best answers the question and write the letter against the number of the question on the answer sheet provided.*

Name:__________________________
School:_________________________
Gender:_________________________

1. Alkali earth metals belong to (A) period 3 (B) group 2 (C) group 3 (D) period 2
2. When an atom gains an electron, it becomes (A) negatively charged (B) positively charged (C) chemically inactive (D) oxidized
3. What is the likely formula of compound formed between element M in group two and element X in group seven? (A) $M_7 X_2$(B) M_2X(C) MX_2(D) $M_2 X_7$
4. Which of the following electronic structures belongs to a noble/rare gas? (A) $1S^2\ 2S^2\ 2P^6\ 3S^2\ 3P^6$ (B) $1S^2\ 2S^2\ 2P^3$ (C) $1S^2\ 2S^2\ 2P^5$ (D) $1S^2\ 2S^2$
5. Study carefully the reaction represented by the equation below $H_2O_2(i)O_2(g) + \rightarrow H_2O(i)$ which of the following will not increase the reaction rate? (A) adding water to the reactant (B) adding a pinch of MnO_2 to the reaction (C) increasing the concentration of the H_2O_2 (D) heating the hydrogen peroxide
6. When we move from one element to the next across a period, electrons are (A) being shared in the same shell at about the same distance from the nucleus(B) being removed in the same shell at about the same distance from the nucleus (C) being transferred in the same shell at about the same distance from the nucleus (D) being added to the same shell at about the same distance from the nucleus
7. Which of the following statements about the behaviour of an atom is correct? (A) atomic size decreases down the group(B) atomic size increases across the period(C) cations are smaller than the parent atom(D) anions are smaller than the parent atom
8. Electronegativities of elements (A) decrease across a period as well as down the group(B) decrease across a period but increase down a group(C) increase across a period and also down a group (D) increase across a period but decrease down a group
9. "The rate of a reaction is proportional to the number of effective collisions occurring per second between the reactants" This statement is associated with the (A) collision theory (B) rate law (C) atomic theory(D) kinetic theory
10. The rate of chemical reaction of solids are not affected by (A) catalyst (B) particle size (C) pressure(D) temperature
11. Rate of chemical reaction depends on the following factors except (A) rate at which colour of reactions change (B) rate at which products are formed (C) rate at which gas is evolved (D) rate which the reactants diminish
12. The ionic radii of positive ions are (A) similar to the corresponding atomic radii (B) none of the above (C) greater than the corresponding atomic radii (D) smaller than the corresponding atomic radii
13. The periodic table shows a diagonal division of elements into (A) metals and non-metals(B) transition elements and halogens(C) halogens and rare gasses (D) lanthanides and actinides
14. The horizontal rows of elements in the periodic table are called (A) halogens(B) periods (C) groups(D) noble gases
15. The following are properties of transition metals except (A) tendeny to form complex ions(B) formation of coloured ions (C) low melting points (D) ability to act as catalyst
16. The position of an element in the periodic table is determined by (A) its atomic radius (B) the number of protons in its atom (C) its relative atomic mass (D) the number of neutrons in its atom

17. A catalyst increase the rate of chemical reaction by (A) decreasing the temperature of the reaction (B) decreasing the activation energy of the reaction (C) increasing the surface area of the reactants (D) decreasing the surface area of the product
18. What do we do to increase the surface area of the reactants (A) subjecting the reactants to high pressure (B) breaking them into chips (C) altering the direction of the reaction (D) using reactants to different densities
19. The size of atoms of elements in the same period decreases steadily as the (A) mass number decreases (B) mass number increase (C) atomic number increases (D) atomic number decreases
20. A reaction that is continually supplied with an external source of energy for activating the reactant particles as well as to form the products is known as (A) endothermic reaction (B) exothermic reaction (C) equilibrium reaction (D) irreversible reaction
21. The minimum amount of energy required for effective collisions between reacting particles is known as (A) kinetic energy (B) bond energy (C) activation energy (D) potential energy
22. In the periodic table, the transition elements occur between (A) groups 1 and 2(B) groups 4 and 5(C) groups 3 and 4(D) groups 2 and 3
23. Which of the following is not a halogen? (A) silicon (B) iodine (C) bromine (D) fluorine
24. Reaction occurs when the colliding reactant particles (A) have energy less than the energy barrier (B) have energy greater than that of the products (C) have energy less than effective collision (D) have energy equal or greater than the energy barrier
25. The energy change which accompanies the addition of an electron to a gaseous atom is (A) ionization(B) electronaffinity(C) atomization(D) electronegativity
26. The energy required to remove a valence electron from an atom of an element to form an ion is known as (A) ionization energy (B) heat energy (C) electrical energy (D) bond energy
27. Which of the following cannot be deduced from the electronic configuration of a transition metal? (A) ability to form complex ions(B) possession of magnetic property(C) position in the periodic table (D) variable oxidation states
28. Groups 1 and 2 of the periodic table make up the (A) p-block(B) s-block(C) d-block(D) f-block
29. Which of the following elements belongs to a noble gas? (A) ${}_{18}W$(B) ${}_{17}W$(C) ${}_{19}Y$(D) ${}_{20}Z$
30. The horizontal rows of the periodic table are numbered from (A) 0 to 8 (B) 1 to 9 (C) 1 to 7 (D) 0 to 9
31. The alkali metals exhibits similar chemical properties because (A) they occur in the combined state (B) they are highly reactive (C) their salts are soluble in water (D) they have the same number of valence electron’s
32. Elements that can ionize by loss of one electron belong to the family of (A) alkali earth metals (B) halogens (C) alkali metals (D) rare gases

APPENDIX Q

Answers to CAT (Post-Test)

1. A
2. A
3. C

4. A
5. A
6. D
7. C
8. D
9. A
10. C
11. A
12. D
13. A
14. B
15. C
16. B
17. B
18. B
19. C
20. A
21. C
22. D
23. A
24. D
25. B
26. A
27. B
28. B
29. A
30. C
31. D
32. C

APPENDIX R

Lesson Noteson Flipped Classroom Instruction for Experimental Group

Week 1: Lesson 1

OUTSIDE CLASS ACTIVITIES

Subject: Chemistry
Period: 1and 2(Double periods)
Topic: Periodic Table (PT)
Duration: 80minutes
Class: SS2
Age Average: 17

Objectives: Before coming to the classroom for Topic 1, students should be able to:

- Identify the periodic table (PT),
- State the periodic law.
- Identify the groups and periods in the periodic table.
- Say the general properties of a group.

Procedure: STEP 1 The researcher sends the following hints/guides to the students through bulk sms. The research assistant equally gives the same guide direct to the students as take-home assignment.

- ♦ A periodic table chart
- ♦ Look at the periodic table (PT) carefully
- ♦ What is the periodic table (PT) made up of?
- ♦ Name the first thirty elements of the periodic table
- ♦ The periodic table (PT) has eight vertical columns known as groups and seven horizontal rows known as periods.
- ♦ How many groups and periods do we have in the periodic table?
- ♦ Name two elements from each group and two from each period
- ♦ Find out the general properties of elements in the same group
- ♦ Find out the general properties of elements in the same period

STEP 2 The researcher also sent a video teaching that highlight's the points on Topic 1 and study guide sent to the students through internet:- utilizing multimedia processes such as pictures, audio and video

STEP 3 The teacher/research assistant advises the students to use the internet, text-books, parents, peer-group study, and other resource persons to find out more about the topic before the day the topic was treated in the classroom

INSIDE CLASSROOM ACTIVITIES

Instructional Objectives: By the end of the lesson, students should be able to:

- ▪ Say what a periodic table is
- ▪ Identify the groups and periods in the periodic table
- ▪ Mention the common elements in different groups and periods
- ▪ Say the general properties of different groups in the periodic table.

Instructional Materials: Periodic table chart, chalkboard, lesson note, chemistry textbook and duster

Previous Knowledge: (a) The students have learnt about elements and their symbols.

(b)The students have studied the topic with the aid of study guide/hints given to them by the researcher and research assistant/teacher through bulk SMS and take home assignment.

(c) They have also watched a video-teaching of the topic through the internet

Procedure:

Activity One: Group discussion, mapping out groups and periods from the periodic table chart and draw the periodic table

Step 1: The teacher allows the students to mention the topic for the lesson

Step 2: The teacher places the students in small groups and ask them to discuss the periodic table under the study guide line/hints given to them previously -

- ♦ Look at the periodic table (PT) carefully
- ♦ Who was the first scientist to construct a PT?
- ♦ What is the periodic table (PT) made up of?
- ♦ Define a periodic law
- ♦ Name the first thirty elements of the PT
- ♦ How many veridical columns and horizontal rows has a periodic table?
- ♦ What is the general name for the vertical columns and that of horizontal rows?
- ♦ Name two elements from each vertical columns and two from horizontal rows

NOTE: Every students is expected to write down points from the discussion and make a sketch of the periodic table

Step 3: During the group discussion, the teacher goes round the different groups to ensure that order is maintained and facts are being discussed

Activity Two: Class discussion and interaction

Step 4: The teacher calls the different groups together for a general discussion/interaction on the periodic table using the same study guide lines/hints. Ask the students to map out blocks of elements from the displayed PT chart

Step 5: The teacher moderate/directs the discussion; using the periodic table chart and study guide/hints above, the teacher ensures that every aspect is well discussed

Step 6: The teacher encourages the students to ask questions concerning the topic, as well as stating the challenges they encountered during the outside class activities

Summary: Teacher with the students make a comprehensive summary of the lesson

Evaluation: The teacher asks the following questions to the students:

(a) Define a periodic table

(b) What is the general name for the vertical columns and horizontal rows of the PT

(c) Say the general properties of element in groups, 1,2,7,0

WEEK 1 LESSON 2,
OUTSIDE CLASS ACTIVITIES

SUBJECT: Chemistry
TOPIC: metals, metalloids, non-metals and transition metals of the periodic table and their distinguishing characteristics.
Period: 3 (single period)
Duration: 40minutes
Class: SS2
Average Age: 17
Objectives: Before coming to the classroom for the above topic, students should be able to:

- Identify the metals, metalloids, non-metals and transition metals of the PT.
- Name different groups of metals, metalloids and non-metals.
- Say the properties of metals and non-metals.

Procedure:
STEP 1: The researcher sends the following hints/study guides to the students through bulk SMS. The research assistant equally gave the same study guide to the students as take home assignment.

- ♦ A periodic table chart
- ♦ Look at the periodic table chart carefully
- ♦ Blocks of elements/metals, metalloids, non-metals and transition metals of the periodic table
- ♦ Find out the groups/periods of these block elements
- ♦ What are the characteristics of these different block elements?

STEP 2: The researcher also sends a video teaching, highlighting the points on the study guide/topic sent to the students through internet; utilizing multimedia processes such as pictures, audio and video.

STEP 3: The research assistant encourages the students to use internet , chemistry text books, peer-group study, parents etc to find out more about the topic before the day the topic will be treated in the classroom.

INSIDE CLASSROOM ACTIVITIES

Instructional objectives: By the end of the lesson students should be able to;

- ♦ Identify the metals, metalloids, non-metals and transition metals from the periodic table chart
- ♦ Name the different elements from the identified metals, metalloids, non-metals and transition metals.
- ♦ Name different groups of metals , metalloids, non-metals and transition metals
- ♦ Say the characteristics of the different groups of metals, metalloids, non-metals and transition metals

Instructional materials: Periodic table chart, chalkboard, lesson note, chemistry textbook and duster.
Previous knowledge:

(a) Students have learnt the meaning of groups and periods of the periodic table
(b) Students have studied the topic with the aid of the study guide given to them by the research assistant
(c) The have also watched a video teaching of the topic.

Instructional procedure:

Activity one; Group discussion, mapping out blocks of elements from the periodic table chart.

Step 1: The teacher allows the students to say their findings from the study guide/hints.

Step 2: The teacher places the students in small groups of four to six and ask them to discuss the block element of the periodic table under the study guide/hints given to them previously

- Identify the metals, metalloids, non-metals,and transition metals from the periodic table
- Find out the general properties of these block elements
- What are the characteristics of these different elements?

NOTE: Every students is expected to write down points from the group discussion.

Step 3: During the group discussion, the teacher goes round the different groups to ensure that order is maintained and facts are being discussed.

Activity two : Class discussion and interaction

Step 4: The teacher calls the different groups together for a general discussion/interaction on the block elements using the same study guideline/hint. Ask the students to map out the blocks of elements from the displayed periodic table chart.

Step 5: The teacher moderates/directs the class discussion, and ensures that every aspect of the topic is well discussed.

Step 6: The teacher encourages the students to ask questions as well as stating the challenges they encountered during the outside class activities.

Summary : The teacher and the students make a comprehensive summary of the lesson.

Evaluation : Ask the students the following questions

(a) Give the characteristics of metals, and non-metals.

(b) Say the features of the transition metals

LESSON ON FLIPPED CLASSROOM
OUTSIDE CLASS ACTIVITIES

WEEK 2

Subject: Chemistry

Period: 1 and 2 (Double period)

Topic: Electronic Configuration according to groups of Elements in the Periodic Table(PT)
Duration: 80minutes
Class: SS2
Average age: 17
Objectives: Before coming to the class for the above topic, students should be able to:
- Identify the alkali metals, alkali earth metals, halogens and noble gases from the PT.
- Write the electronic configuration of elements in different groups of the PT.

Procedure:
STEP 1: The researcher supplies the following materials to the students through bulk sms. The teacher also gives the same study guideline to the students directly

The Hints/study guide on the topic are as follows
- ♦ Different families of the periodic table (PT) include alkali metals (group 1), alkaline earth metals (group 2), the halogens (group 7 elements), the noble/rare gases (group 0 elements), lanthanides and actinides (occur between groups 2 & 3)
- ♦ Write down the outer most electronic configurations of atoms in groups 1 to 7 and 0
  Eg. Group 1 = one S electrons
  Group 3 = two S electrons + one P electron
- ♦ Find out the groups that belong to s-block, those that belong to p-block, those for d-block and those that belong to f-block, properties of elements in the PT

STEP 2:The researcher also sends to the students a video teaching that highlights the points as regards the topic through the internet: utilizing multimedia processes such as pictures, audio and video
STEP 3: The teacher encourages the students to use the internet, chemistry textbooks, peer-group study, parentsetc to find out more about the topic

INSIDE CLASSROOM ACTIVITIES

Instructional Objectives: By the end of the lesson, students should be able to:
- ▪ Identify/name the different families of the periodic table (PT) – alkali metal, alkaline-earth metal, halogens, noblegases
- ▪ Write the outermost electronic configuration of the atoms in different groups of the periodic table

Instructional Materials: Periodic table chart, chalkboard, duster, lesson note, chemistry textbooks
Previous Knowledge:
- Students have learnt the major components of the periodic table
- Students have studied the topic with the aid of the study guide/hints given to them by the researcher and the teacher through bulk SMS and take-home assignment respectively.
- They have also watched a video-teaching of the topic through the internet

Procedure:
Activity One:
- Group discussion/peer debate,
- Draw electronic configurations,

- Grouping of elements,
- Mapping out blocks of elements from the periodic table chart.
- Identify families of elements and draw periodic table in blocks

Step 1: The teacher allows the students to introduce the topic for the lesson and ask them to bring out their findings concerning the topic

Step 2: The teacher goes round the class to take a glance of the students' exercises outside the classroom

Step 3: The teacher places the students in small groups and ask them to discuss the topic using the study guide/hints given to them previously

- ♦ Write down the different families in a periodic table
- ♦ From each group of the PT, write an outermost electronic configuration of the atoms
- ♦ Find out the groups/periods that belong to s-book, p-block, d-block and f-block

Step 4: As the group discussion is going on, the teacher moves around the different groups to ensure that order is maintained,offers assistance where necessary and reminds every group to make a summary of their discussion

Activity Two:
- Class interaction-presentation by different groups, discussion and summary;
- Identification of families in the PT
- Write/draw electronic configuration of different atoms from different groups/periods and draw periodic table in block form

Step 5: The teacher moderates and directs the presentation of summaries by every group

<u>Periodic Table in Block</u>

Groups**1** **2**

Periods**S-Block** **3** **4** **5** **6** **7** **0**

1 **1S**H **P-Block** He P- BLOCK H

2 **2S**LiBe **2p** B C N O F Ne

3 **3S**K Mg **d-Block** **3p** Al Si P S Cl A

4 **4S**KCa**3d**Sc Ti V Cr Mn Fe Co Ni Cu Zr**4p**GaGe As SrBr K Lanthanides

5 **5S**RbSr **4d** Y Zr Nb Mo TcRu Rh Pd Ag Cd **5p** In SnSbTe I Xe

6 **6S**Cs Ba **5d**La Hf Ta W Re OsIrPt Au Hg **6p** Ti Pb Bi Po At Rn Actinides

7 **7S**Fr Ra **6d**Ac

f-Block

4fCePrNd Pm SmEuGd Tb Dy Ho Er Tm Yb Lu

5fTh Pa U NpPu Am Cm BkCfEsFmMdNbLw

Step 6: Using the periodic table that is in block form, the teacher calls for

- ♦ identification of different families
- ♦ Write the outermost electronic configuration of atoms from different groups

- ♦ Pointing out the groups/periods that belong to s-block, p-block, d-block and f-block

Step 7: The teacher encourages the students to ask questions as well as stating the challenges they encountered during the outside class activities

Evaluation: Ask the students the following questions

- ♦ Name the different families in the periodic table
- ♦ Write the outermost electronic configuration of $_{11}Na$, $_{12}Mg$, $_{5}B$, $_{14}Si$, 7N, $_{17}Cl$ and $_{10}Ne$

WEEK 2 LESSON 2
OUTSIDE CLASS ACTIVITIES

Subject: Chemistry
Topic: properties of halogen, noble gases, alkaline earth metals.
Period: 3(single period)
Duration: 40 minutes
Class: SS2
Average Age: 17
Objectives: Before coming to the classroom for the topic above, students should be able to:

- State the properties of halogens, noble gases, and alkaline earth metals.
- Name the elements that are called the halogens, noble gases and alkaline earth metals.

Procedure:
STEP 1: The researcher sends the following hints/study guide lines to the students through bulk SMS. The teacher also gave the same hints directly to the students as assignment.

- A periodic table chart
- From the PT chart, find out the elements known as the halogens, noble gases and alkaline earth metals.
- Find out the general properties of the halogens, noble gases and alkaline earth metals.

STEP 2: The researcher also sends a video teaching that highlights the points in the study guide sent to the students through bulk SMS.

STEP 3: The research assistant directs the students to use internet, chemistry textbooks, peer-group study, parent/more capable relations to find out more about the topic before the day the topic is to be treated in the classroom.

INSIDE CLASS ACTIVITES

Instructional objectives: By the end of the lesson students should be able to;

(a) Identify the halogens, noble gases and alkaline earth metals from the PT chart
(b) Name the elements that are called halogens, noble gases and alkaline earth metals.
(c) Say their general properties

Instructional materials: periodic table chart, lesson note, chalkboard, duster and chemistry textbooks.

Previous knowledge:

(a) students have learnt the meaning of periodic table(PT)
(b) students have studied the topic with the aid of the study guide line given to them by the teacher.
(c) They have also watched a video-teaching of the topic sent to them through the phone numbers they supplied.

Instructional procedure;
ACTIVITY ONE: Group discussion, mapping out the halogens, noble gases and alkaline earth metals from the periodic table chart.

STEP 1: The teacher allows the students to say their finding during the outside class activities.
STEP 2: The teacher places the students in groups of five and ask them to discuss the topic based on the study guide/hint given to them for outside class activities.
NOTE: Every student is expected to write down points from the group discussion
STEP 3: The teacher goes round the different groups to ensure that order is maintained and facts are being discussed.
ACTIVITY TWO: Class interaction
STEP 4: The teacher calls the different groups together for a general discussion/ interaction on the topic. Ask the students to identify the halogens, noble gases and the alkaline earth metals from the periodic table chart.
STEP 5: The teacher moderates the class interaction and ensures that every aspect of the topic is well discussed.
STEP 6: The teacher encourages the students to ask questions as well as stating the challenges they encountered during the outside class activities.
SUMMARY: The teacher and the students makes a comprehensive summary of the lesson.
Evaluation: Ask the students the following questions:

(a) To what group in the periodic table can you find; (i)halogens (ii) noble gases (iii) Alkaline earth metals
(b) Define (i) halogens (ii) noble gases (iii) alkaline earth metals
(c) Give the properties of halogen, noble gases and alkaline earth metals.

LESSON NOTE ON FLIPPED CLASSROOM INSTRUCTION (Experimental group)

OUTSIDE CLASS ACTIVITES

Week 3

Subject: Chemistry
Period: 1 and 2 (Double period)

Topic: Change in Size (atomic radii/ionic radii)
Duration:80 minutes
Class: SS2
Average Age: 17
Objectives: Before coming to the class for the above topic, students should be able to:

- Differentiate between atomic radii and ionic radii.
- Define ionization energy, electron affinity and electron-negativity.

Procedure: STEP 1:The researcher supplies the following materials to the students through bulk SMS, The teacher equally gives the same materials directly to the students to ensure that every student got the materials.

The Hints/study guide on the topic are as follows

- ♦ Difference between atomic radii and ionic radii
- ♦ How are ions of elements formed?/What is an ion?
- ♦ What happens to atomic size across a period and atomic size down a group – ionization energy, electron affinity
- ♦ Compare the ionic radii of positive ions and that of negative ions
- ♦ Write down the changes in ionization energy, electron affinity and electro negativity down the groups and across the periods

(c) The researcher also sends to the students a video teaching that highlights the points in the topic through the internet: utilizing multimedia such as pictures, audio and video

(d) The teacher encourages the students to make use of:

- ♦ Mobile phones
- ♦ Internet
- ♦ Chemistry textbooks
- ♦ Peer-group study
- ♦ More capable peers
- ♦ Parents and a host of others to find out more about the topic

INSIDE CLASSROOM ACTIVITIES

Instructional Objectives: By the end of the lesson, students should be able to:

- ▪ Differentiate between atomic radii and ionic radii
- ▪ Say the changes (atomic and ionic sizes) that occur down the groups and across the periods
- ▪ Differentiate between the following: ionization energy, electron affinity and electron-negativity
- ▪ Write down their (that is ionization energy, electron affinity and electro negativity) changes down the groups and across the periods

Instructional Materials: Periodic table chart, lesson note, chalkboard, duster, chemistry textbook

Previous Knowledge: The students have

- ▪ Used a study guide/hints to study the topic
- ▪ Watched a video-teaching of the topic

- Studied meaning, features, families etc of the periodic table during the last two weeks lessons

Procedure:

Activity One: Writing down points and group discussion

Step 1: The teacher introduces the lesson by asking the students to name the materials/items that were sent to them through bulk SMS, and internet

Step 2: The teacher goes round the class to take a glance at the students' responses to the exercise given to them

Step 3: The teacher places the students in small groups and ask them to discuss their different findings in the outside classroom activities using the following study guide/hints:

- ♦ Differences between atomic radii and ionic radii
- ♦ How are ions of elements formed?/What is an ion?
- ♦ What happens to atomic size across a period and atomic size down a group – ionization energy, electron affinity
- ♦ Compare the ionic radii of position ions that of negative ions
- ♦ Write down the changes in ionization energy, electron affinity and electro negativity down the groups and across the periods

Step 4: The teacher moves round the groups to ensure:

- Orderliness
- Proper organization of the discussion

Activity Two: Class discussion, interaction, write down points and presentation of summary discussion by every group

Step 5: Students' interaction and discussion.

As these activities are going on, students are encouraged to keep carefully all that they put down, and discuss them with their peers and note the answers to the questions in the study guide

Summary: A comprehensive summary of the lesson is made jointly by the teacher and the students

Evaluation: Ask the students the following questions

(a) Differentiate between atomic radii and ionic radii

(b) Brief explain the following

- ♦ Ionization energy
- ♦ Electron affinity
- ♦ Electronegativity

LESSON NOTE ON FLIPPED CLASSROOM INSTRUCTION
OUTSIDE CLASS ACTIVITIES

Week 4

Topic: Chemical Reactions
Duration: 80minutes
Subject: Chemistry
Period: 1 and 2 (Double period)
Class: SS2
Average Age: 17

Objectives: Before coming to the classroom for the above topic, students should be able to:

- Define reactants, product and chemical reactions.
- State a collision theory.
- Name factors affecting rate of chemical reactions.

Procedure: STEP 1: The researcher supplies the following to the students through bulk sms, multi-media formats, mobile phones and a host of others. The teacher also gives the same study guid/hints directly to the studentsas a take-home assignment.

The Hints/study guide on the topic -

$Zn_{(s)} + 2HCl_{(aq)} \longrightarrow ZnCl_{2(s)} + H2_{(g)}$

The above equation represents a chemical reaction

- ♦ Name the reactants and products of the above reaction
- ♦ Name common reagents and apparatus
- ♦ What is rate of a chemical reaction
- ♦ There is always collision between reactant particles for a chemical reaction to occur (that is collision theory)
- ♦ Find out the meaning of effective collisions, activation energy and energy barrier
- ♦ What are the factors affecting rates of chemical reactions

STEP 2 The researcher equally sends a video teaching to the students that highlights the point in the topic through the internet utilizing multimedia processes such as pictures, audio and video

STEP 3The teacher encourages the students to make use of their mobile phones, internet, chemistry textbooks, more capable peers, peer-group study, parents and a host of others to get more acquainted with the topic

INSIDE CLASSROOM ACTIVITIES

Instructional Objectives: By the end of the lesson, students should be able to:

- ▪ Name reactants and products of a chemical reaction
- ▪ Write names of reagents
- ▪ Identify simple apparatus
- ▪ Define a chemical reaction
- ▪ Explain briefly the collision theory
- ▪ Explain the factors affecting rates of chemical reaction

Instructional Materials: Common reagents like

- ▪ Sodium hydroxide
- ▪ Potassium hydroxide
- ▪ Sodium metal,

Apparatus like

- Beakers
- Burners
- Test tubes
- Conical flask,

Others include:

- Lesson note,
- Chalkboard, duster and chemistry textbooks

Previous Knowledge: The students have:

- Used a study guide/hints to study the topic
- Watched a video-teaching of the topic
- Studied writing and balancing of a chemical equation

Procedure:

Activity One:
- Class discussion
- Interaction
- Writing down points
- Identification of common reagents and apparatus

Step 1: The teacher invites any of the students to:

- Write the topic on the chalkboard
- State any of the study guidelines/hints on the chalkboard
- Say any challenge encountered during the outside classroom activities

Step 2: The teacher goes round the class to look at the activities carried out by the students during the outside the class activities

Activity Two: Peer/group discussion, write down points

The discussion will be guarded be the following:-

$Zn_{(s)} + 2HCl_{(aq)} \longrightarrow ZnCl_{2(s)} + H_{2(g)}$

The above equation represents a chemical reaction

- ♦ Name the reactants and products of the above reaction
- ♦ Name common reagents and apparatus
- ♦ What is rate of a chemical reaction
- ♦ There is always collision between reactant particles for a chemical reaction to occur (that is collision theory)
- ♦ Find out the meaning of effective collisions, activation energy and energy barrier
- ♦ What are the factors affecting rates of chemical reation

Step 3: The teacher goes round the different groups to monitor and direct the discussion

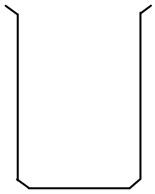
Activity Three:
- Class interaction
- Presentation of finding from the group/peer discussion

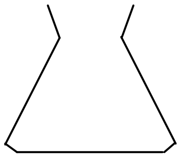
Step 4: The teacher calls the different groups together for an interactive session which will be based on the study guideline/hints above

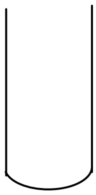
The teacher ensures that every student contributes to the interactive session

Activity Four:
- Identification of common apparatus
- Write names of common reagents

Step 5: Different apparatus like


Beaker


Conical flask


Test tube

Step 6: Common reagents like

- Sodium hydroxide
- Potassium hydroxide
- Sodium metal
- Calcium hydroxide

Summary: The teacher with the students make comprehensive summary of the lesson

Evaluation: Ask the students the following questions

(a) Name and explain the factors affecting rates of chemical reaction

(b) What is

(i) Activation energy

(ii) Effective collision

(iii) Energy barrier

WEEK FOUR LESSON 2

OUTSIDE CLASS ACTIVITIES

Subject: Chemistry
Topic: Exothermic and Endothermic Reactions
Period: 3 (single period)
Duration: 40minutes
Class: SS2
Average Age: 17

Objectives: Before coming to the classroom for the above topic, students should be able to:

- Name different types of reactions.
- Define exothermic and endothermic reactions.
- Give different examples of exothermic and endothermic reactions.

Procedure:

STEP 1: The researcher sends the following study guide to the students through bulk SMS. The class teacher also gives the same study guide lines directly to the students as a take-home assignment;

- Find out types of chemical reactions
- A chemical reaction that gives out heat to the surrounding is known as exothermic reaction
- Name different examples of exothermic reaction
- What is endothermic reaction?
- Exothermic and endothermic reactions are represented by negative ΔH(-ve) and positive heat changes ΔH(+ve) respectively.

STEP2: The researcher also sends a video teaching that highlights the points in the study guide sent to the students through bulk SMS.

STEP 3: The research assistant directs the students to use internet, chemistry, textbooks, peer-group study, parents/more capable peers to find out more about the topic before the day the topic is to be treated in class.

INSIDE CLASS ACTIVITES

Instructional objectives: By the end of the lesson, students should be able to;

(a) Name different types of chemical reactions
(b) Define an exothermic and endothermic reactions
(c) Name different examples of exothermic and endothermic reactions

Instructional materials: common reagents like NaOH, KOH, sodium metals, apparatus like beakers, burner, lesson notes, chalk board and duster.

Previous knowledge:

(a) Students have learnt about chemical reactions and balancing of chemical reactions
(b) Students have studied the topic during the outside class activities

Instructional procedure:

Activity one: Group Discussion

STEP 1: The teacher allows the students to say what they have done during the outside class activities

STEP 2: The teacher places the students in groups and ask them to discuss the topic using the study guide/hint given to them for the outside class activities.

NOTE: Every student is expected to write down points from the group discussion.

STEP 3: The teacher goes round the different groups to ensure that order is maintained and that facts are being discussed.

ACTIVITY TWO: Class Interaction

STEP 4: The teacher calls the different groups together for a general interactions on the topic. Shows the students different reagents and then ask any of the students to dissolve sodium hydroxide pellet in water. The solution formed becomes hot. Allow the students to feel the beaker containing the solution and then identify the type of reaction that has taken place.

STEP 5: The teacher also allows any of the students to dissolve ammonium chloride crystals in water. The solution formed becomes cold. Ask the students to identify the type of reaction that has taken place.

STEP 6: The teacher moderates the class interaction and ensures that every aspect of the topic is well discussed.

SUMMARY: A joint comprehensive summary of the lesson is made by the teacher and the students.

EVALUATION: Ask the students the following questions;

(a) Name different types of chemical reactions
(b) Explain briefly (i) Exothermic reaction (ii) Endothermic reaction
(c) Give different examples of exothermic and endothermic reactions.

APPENDIXS

Lesson Notes on Direct Instruction

Class: SS2
Subject: Chemistry
Topic: Periodic Table – Periodic Law, Groups and Periods of Common Elements
Duration: Two periods (double lesson) of 80 minutes
Specific Objectives: At the end of the lesson, the students should be able to:

- Give a brief history of the periodic table
- Define periodic table, groups and periods in periodic table
- Identify elements and associate same with their groups
- Discuss periodic law
- Draw periodic table

Previous Knowledge: Students have learnt about metals, non-metals and symbols of elements in general
Instructional Materials: Periodic table chart, chalk, chalkboard, duster, new school certificate chemistry textbook etc
Set Induction: The teacher displays the periodic table chart on the chalkboard and ask any of the students to say the content of the chart

Instructional Procedure:

Content Development	Teacher's Activities	Student's Activities	Instructional Strategies
Step One Brief history about the periodic table	Teacher explains thus – Menedelee, a Russian scientist, was the first to construct a Periodic Table in 1869. He arranged the elements in order of increasing relative atomic mass. His periodic table had gaps. He predicted that there were undiscovered elements which could fill these gaps. He equally predicted the possible properties of these elements. Elements like scandium, gallium etc were later discovered, which not only fitted exactly into Mendeleev's table, but also had the properties he predicted	Students listen to the teacher's explanation and jot down points	Explanation and questioning skills
Step Two Concept of periodic table, groups and periods in the periodic table and periodic law	The teacher explains thus: The most important classification in chemistry is the arrangement of the elements in the Periodic Table. The systematic arrangement of electrons gives rise to what is known in chemistry as the periodic table. The modern periodic law states that the properties of the elements are a periodic function of their atomic number. From the	The students listen to the teacher's explanation and put down points, ask questions when need arises and answer questions as may be directed by the teacher	Lecture/explanation and questioning skills

	periodic Table chart, the teacher points out the following: Groups: The vertical columns of elements or groups are numbered from 1 to 8 or 0. Elements in the same group have the same number of electrons in the outermost shell of their atoms. Hydrogen does not fit into any group, but for convenience, it is placed in Group 1 because of the single electron. Apart from the eight main groups, there are also the transition groups of elements. These lie between Groups 2 and 3 in the Periodic Table. Periods – The horizontal raws of elements are known as periods and are numbered from 1 to 7. Elements in the same period have the same number of electron shells, for example, elements of Period 2 have two electron shells (K, L)	Students draw the periodic table and identify the group elements Students identify the different periods in the Periodic Table	Explanation and questioning skills

Evaluation: The teachers give the following questions to the students:
(a) Give a brief history of the periodic table
(b) Define periodic table, groups and periods
(c) Name two elements from groups 1 and 7

Class: SS2
Subject: Chemistry
Topic: Classification of Elements into Metals, Non-metals, Metalloids and Transition metals and their Distinguishing Characteristics
Duration: One period of 40 minutes
Specific Objectives: At the end of the lesson, the students should be able to:

- Name five metals and their groups
- Enumerate non-metals and their groups
- Identify the transition elements from the periodic table chart
- Explain the metalloids
- Say their characteristics

Previous Knowledge: Students have learnt about
(a) The history and meaning of periodic table
(b) Elements, groups and periods in the periodic table
Instructional Materials: Periodic table chart, chalk, chalkboard, duster, chemistry textbook
Instructional Procedure:

Content Development	Teacher's Activities	Student's Activities	Strategies
Step One Metal in the	The teacher explains thus:– The Periodic Table shows a diagonal	The students listen to the teacher's	Explanation and questioning skills

periodic table	division of the elements into metals and non-metals. The metals are found on the left side of the periodic table while the non-metals are on the right side. Group 1 elements are the strongest metals (e.g Na, K, Li followed by the Group 2 elements (e.g Be, Mg, Ca). Along a period, we pass from metals on the left through the metalloids to the non-metals on the right side. Reactivity of metals decreases from left to right while that of non-metals increases. Reactivity of metals increases from top down the group while that of the non-metals decrease from top down the group	explanation and put down points, ask questions when need arises and answer questions as may be directed by the teacher	
Step Two Concept of metalloids and transition elements	The teacher explains thus: Metalloids are those elements like silicon, germanium that are intermediate in properties between that of a metal and a non-metal, especially those that exhibit the external characteristics of a metal, but behaves chemically more as a non-metal. Transition metals – These are found between Groups 2 and 3 of the periodic table. They are those metallic elements that have an incomplete inner(d) election shell, they have multiple valencies and form coloured compounds as well as stable complex ions. The elements include scandium to copper and those lying below them in the periodic table	The students listen to the teacher's explanation and put down points, ask questions when need arises and answer questions from the teacher	Explanation and questioning skills

Evaluation: Ask the students the following questions:

(d) Name five metals and their group

(e) Identify the transition metals from the periodic table chart

(f) Give the characteristics of transition metals

(g) Name non-metals and their groups in the periodic table

LESSON NOTES ON DIRECT INSTRUCTION/LECTURE FOR SECOND WEEK

Class: SS2
Subject: Chemistry
Topic: Families – Electronic Configuration According to Groups I – VIII i.e group IA – alkali metals group IIA – alkaline-earth metals and other groups
Duration: A double period of 80 minutes
Specific Objectives: At the end of the lesson, students should be able to:

(a) Identify the different families in the periodic table – alkali metals, alkaline-earth metals etc
(b) Name the four orbits
(c) Write the number of electrons each orbital can accommodate
(d) Write the electronic configuration of two elements from each group
(e) Draw the shells or orbits and label each

Previous Knowledge: Students have learnt about arrangement of electrons in an atom using K, L, M etc shells
Instructional Materials: Periodic table chart, chalkboard, chalk, duster, lesson note etc
Instructional Procedure:

Content Development	Teacher's Activities	Student's Activities	Instructional Strategies
Step One Different families in the periodic table	The teacher points out and explains the different families from the periodic table chart – alkali metals, alkaline-earth metals, halogens, noble gases etc	Listen to the teacher and put down the different families	Explanation, questioning and discussion
Step Two The four orbitals	The teacher writes the four orbitals (s, p, d, f orbitals) on the chalkboard and explains them	Listen to the teacher, answer questions as may be directed and put down points	Explanation and questioning
Step Three Electronic configuration of elements from each family	Draws, writes and explain the electronic configuration of elements from different families on the chalkboard	Draw and write down the electronic configurations	Explanation and questioning skills
Step Four Blocks of elements	The teacher explain thus – In the modern periodic table, atoms of the elements in groups 1 to 7 and 0 have the following electronic configuration in their outermost energy levels Group 1 = one s electrons Group 2 = two s electrons } s-block Group 3 = two s elections + one p electron Group 4 = two s elections + two p electron Group 5 = two s elections + three p electron } p-block Group 6 = two s elections + four p electron Group 7 = two s elections + five p	Listen and write the outermost electronic configuration of some elements in different groups and put down other points	Explanation, discussion and questioning skills

	electron Group 0 = two s elections + six p electron		

Evaluation: The teacher asks the following questions:
(a) Name the different families in the periodic table
(b) Give the four orbitals and the number of electrons each can accommodate
(c) Write the electronic configuration of the following elements
(i) $11^{23}Na$ (ii) $12^{24}Mg$ (iii) $17^{35}Cl$ (iv) $10^{20}Ne$

Class: SS2
Subject: Chemistry
Topic: Characteristics/Properties of Elements in the Periodic Table
Duration: A period of 40 minutes
Specific Objectives: At the end of the lesson, the students should be able to:

- Give to the properties of group 1 elements
- Discuss the properties of group 2 elements
- Name the properties of group 7 and other groups

Previous Knowledge: The students are familiar with groups, periods, elements and their symbols, alkali metals, alkaline-earth metals and non-metals
(c)The history and meaning of periodic table
(d) Elements, groups and periods in the periodic table
Set Induction: The teacher writes the symbol of two common elements on the chalkboard and asks the students to mention their names and their groups
Instructional Materials: Periodic table chart, chalkboard, chalk, duster, lesson note
Instructional Procedure:

Content Development	Teacher's Activities	Student's Activities	Instructional Strategies
Step One Properties of each group in the periodic table	The teacher discusses the properties of every group in the periodic table chart	Listen to the teacher, put down points, ask questions and answer questions	Discussion and questioning
Step Two Differences between groups	Discuses the differences between metals (groups 1-2) and non-metals (groups 3-7)	Listen and write down the points	Discussion and questioning

Evaluation: The teacher asks the students the following questions:
(a) Discuss two properties of group 1 elements
(b) Discuss two properties of group 7 elements

LESSON NOTES ON DIRECT INSTRUCTION/LECTURE FOR THIRD WEEK

Class: SS2
Subject: Chemistry
Topic: Change in Size, Down the Groups and Across the Periods (ionic and atomic radii)
Duration: Double period of 80 minutes
Specific Objectives: At the end of the lesson, students should be able to:

- Define ionic radii
- Define atomic radii
- Say the changes (atomic and ionic sizes) that occur down the groups and across the periods
- Draw the radius of an atom and an ion

Previous Knowledge: Students have learnt about groups and periods using the periodic table chart
Set Induction: The teacher calls one of the students to draw a radius of a circle
Instructional Materials: Periodic table chart, chalkboard, chalk, duster, Chemistry textbook etc

Instructional Procedure:

Content Development	Teacher's Activities	Student's Activities	Instructional Strategies
Step One Ionic and atomic radii	The teacher uses the radius of a circle to discuss radius of an ion	Listen and write down points	Explanation and questioning skills
Step Two Ionic and atomic radii	Draws electronic orbitals of some elements when they loss or gain electron/s	Write down points and answer questions	Explanation, discussion and questioning skills
Step Three Changes down the group and across the periods	Discusses the changes that occur down the groups and across the periods on the periodic table chart	Put down points	Discussion and questioning skills

Evaluation: The teacher asks the students the following questions:
(a) What is atomic radius?
(b) Define ionic radius
(c) How does atomic radius occur down the groups and across the periods?

Class: SS2
Subject: Chemistry
Topic: Ionization Energy, Electron Affinity and Electro negativity down the Groups and Across the Periods
Duration: One period of 40 minutes
Specific Objectives: At the end of the lesson students should be able to:

- Define ionization energy
- Explain electronegativity
- Define electron affinity
- Discuss these trends down the groups and across the periods

Previous Knowledge: Students are familiar with electrons, ions, energy, groups and periods
Set Induction: The teacher asks the students to draw the shells/orbits of a named element and locate the electrons on the orbita/shells
Instructional Materials: Periodic table chart, chalkboard, chalk, chemistry textbook, duster, lesson note
Instructional Procedure:

Content Development	Teacher's Activities	Student's Activities	Instructional Strategies
Step One Ionization energy, electron affinity and electronnegativity	The teacher defines and explains these terms on the chalkboard	Write down the definitions in the notes	Explanation repetitions and questioning skills
Step Two Ionization energy down the groups and across the periods	The teacher explains these trends down the groups and across the periods using periods table chart	Answer questions, ask questions and write down points	Explanation, repetitions and questioning skill

Evaluation: The teacher asks the students the following questions to the students:

- Define (i) ionization energy (ii) electronegativity (iii) Electronaffinity
- Explain how ionization energy occur down the groups
- Discuss how electron affinity occur across the periods

LESSON NOTES ON DIRECT INSTRUCTION/LECTURE FOR FOURTH WEEK

Class: SS2
Subject: Chemistry
Topic: Chemical reactions
Duration: Double period of 40 minutes each
Specific Objectives: At the end of the lesson, students should be able to:

- Define reactants
- Define products
- Identify reactants and products from a chemical equation
- Define reaction rates and time
- Explain factors affecting rate of chemical reactions

Previous Knowledge: Students have studied chemical symbols, chemical formular, writing and balancing of chemical equations
Set Induction: The teacher asks the students to name two elements that combine to form water
Instructional Materials: Chalkboard, chalk, duster, Chemistry textbook, periodic table chart etc
Instructional Procedure:

Content Development	Teacher's Activities	Student's Activities	Instructional Strategies
Step One Identifications of reactants and products	The teacher uses symbols of elements to write different chemical equations like $H_2 + O_2 = H_2O$. The teacher identifies and explains the reactants and products	Identify the reactants and products from other equations	Explanation and questioning skills
Step Two Rates of chemical reactions	Defines and explains the rate of chemical reactions	Write the definition in the note book	Explanation and questioning skills
Step Three Factors affecting rates of chemical reactions	Names and discusses the various factors that normally affect rates of chemical reactions	Write down the factors, answer and ask questions	Discussion and questioning skills

Evaluation: Ask the students the following questions:

- Identify the reactants and products in the equation below
  $Zn_{(s)} + 2HCl_{(aq)} = ZnCl_{2(s)} + H_{2(g)}$
- How does the surface area of reactants affect the rate of a chemical reaction?
- Explain the effect of catalyst, temperature, concentration, pressure on rate of chemical reactions.

Class: SS2
Subject: Chemistry
Topic: Introduction to Collision Theory, Endothermic and Exothermic Reactions
Duration: A period of 40 minutes
Specific Objectives: At the end of the lesson students should be able to:

- Explain collision theory
- Define exothermic and endothermic reactions
- Draw energy profiles for both reactions
- Locate activation energy from the energy profile diagram

Previous Knowledge: Students are familiar with reactants, products, chemicals reactions and chemical equations
Instructional Materials: Chalkboard, chalk, duster, a chart containing energy profile diagrams for exothermic and endothermic reactions
Instructional Procedure:

Content Development	Teacher's Activities	Student's Activities	Instructional Strategies
Step One Collision theory	States and discusses effective collisions, activation energy and energy barriers	Write down the points, answer questions	Discussion, repetition and questioning skills
Step Two Exothermic and endothermic reactions	States and explains exothermic and endothermic reactions. Uses the energy profile chart to discuss changes in energy content during the chemical reaction	Draw the energy profile diagrams and answer questions	Explanation, illustrations and questioning skill

Evaluation: The teacher asks the following questions to the students:
- Differentiate between exothermic and endothermic reactions
- What is effective collisions?

APPENDIX T

VALIDATORS' REPORT

Validation of instrument on the Topic:
Effect of flipped classroom instruction on students' interest, participation and academic achievement in chemistry.

This is to certify that I Prof. F. C. Ofoegbu validated the above mentioned instrument and made corrections/recommendation on the following areas:
Only minor corrections were effected on the body of the work; Question 17 has a minor error on the equation.

After the amendments, I considered the instruments fit/~~unfit~~ for the study which it is designed for.

Signature: [signature]
Date: 19/4/16

Validation of instrument on the Topic:
Effect of flipped classroom instructional model on students' interest, participation and academic achievement in Chemistry.

This is to certify that I Prof. [illegible]

Validated the above mentioned instrument and made corrections/recommendations on the following areas:

1. Note that your study is on an instructional model so the second variable should also be another instructional model not a teaching method.
2. Be specific on what you call traditional method.
3. Change the response options on the Likert scale to SA — SD if the items will be retained as constructed.
4. Your lesson plans should be based on lessons not on unit.
5. Use tabular format for lesson plan for the control group to bring out all the parts of the lesson procedure.

After the amendments, I considered the instruments fit/~~unfit~~ for the study which it is designed for.

Signature: [signature]

Date: 29/3/2016

APPENDIX V

Validaors' Report

Validation of instrument on the Topic:

An Investigation into the Effect of Flipped Classroom on Students interest, Participation and Academic Achievement in Chemistry in ANKG Education Zone.

This is to certify that I Dr Nkiru N-C Samuel

validated the above mentioned instrument and made corrections/recommendations on the following areas:

Only question 17 in CAT, all others were appropriate. Question 17 was corrected and the right equation was added.

Both instruments CAT and CPIS were appropriate for the study.

The lesson notes were clearly written and were explicitly designed for the experimental and Control group.

After the amendments, I considered the instruments fit/~~unfit~~ for the study which it is designed for.

Signature: [signature]

Date: 14/03/16

APPENDIX U
COMPUTATION OF RELIABILITY COEFFICIENTS FOR THE INSTRUMENTS

A. Reliability of Achievement Test Using Split-Half Method

Correlations

		Test Scores for Odd Number Items	Test Scores for Even Number Items
Test Scores for Odd Number Items	Pearson Correlation	1	.795**
	Sig. (2-tailed)		.000
	N	19	19
Test Scores for Even Number Items	Pearson Correlation	.795**	1
	Sig. (2-tailed)	.000	
	N	20	20

**. Correlation is significant at the 0.01 level (2-tailed).

Using Spearman-Brown Prophecy Formula, the Reliability for the total achievement test was determined as follows:

$$\text{Reliability of Achievement Test} = \frac{2 \times \text{Reliability of } \tfrac{1}{2} \text{ Test}}{1 + \text{Reliability of } \tfrac{1}{2} \text{ Test}}$$

$$= \frac{2 \times .795}{1 + .795}$$

$$= \frac{1.59}{1.795}$$

Reliability of Achievement Test = **0.886**

B. Reliability of Questionnaires Using Cronbach's Alpha

Scale: Chemistry Personal Interest Scale (CPIS)

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded[a]	0	.0
	Total	20	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.908	11

APPENDIX V

RAW DATA USED FOR STATISTICAL ANALYSIS

S/N	School	Teaching Approach	Sex	Pretest Chemistry Achievement	Posttest Chemistry Achievement	Pre 1	Pre 2	Pre 3	Pre 4	Pre 5	Pre 6	Pre 7	Pre 8	Pre 9	Pre 10	Pre 11	Pre 12	Pre 13	Pre 14	Pre 15	Pre 16	Pre 17	Pre 18	Pre 19	Pre 20	Pre 21	Pre 22	Post 1	Post 2	Post 3	Post 4	Post 5	Post 6	Post 7	Post 8	Post 9	Post 10	Post 11	Post 12	Post 13	Post 14	Post 15	Post 16	Post 17	Post 18	Post 19	Post 20	Post 21	Post 22	Pretest Interest Scores	Posttest Interest Scores	Pretest Participation Scores
1	St.John	1	1	7	15	3	1	4	3	4	4	3	4	4	3	4	3	2	4	3	4	3	3	3	2	3	2	4	4	3	4	4	4	3	3	3	3	3	1	3	3	4	4	4	3	4	3	4	3	37	38	32
2	St.John	1	1	10	17	3	2	3	4	4	4	4	4	3	3	3	4	3	3	3	3	4	4	4	3	4	2	4	3	3	3	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	38	40	37
3	St.John	1	1	9	18	2	3	3	3	3	2	3	3	3	2	3	2	3	2	3	4	2	2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	30	35	30
4	St.John	1	1	7	16	4	4	3	3	3	3	3	4	3	2	3	3	3	2	2	3	2	2	3	3	3	3	4	4	4	4	4	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	35	42	39
5	St.John	1	1	8	19	3	3	3	4	4	4	4	4	4	4	3	3	4	4	3	3	2	4	4	3	4	4	4	4	4	4	4	4	4	4	5	4	5	4	4	4	4	4	4	4	4	4	4	4	40	43	38
6	St.John	1	1	9	15	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	4	4	4	3	4	4	4	4	4	2	3	3	4	4	2	4	4	4	4	4	4	4	4	4	39	44	42
7	St.John	1	1	8	21	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	4	4	3	3	4	4	3	3	4	4	3	3	4	3	4	4	3	4	4	3	3	4	3	4	4	4	3	37	40	37
8	St.John	1	1	10	18	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	3	4	3	3	3	3	4	4	3	3	4	4	4	4	40	43	39
9	St.John	1	1	7	15	4	4	4	3	4	3	3	3	[illegible]	4	4	4	4	4	3	4	3	4	4	3	3	4	4	4	4	4	4	3	4	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	40	44	40
10	St.John	1	1	9	19	3	2	2	3	4	2	4	4	3	4	4	4	4	4	4	3	4	4	4	3	3	3	4	4	4	4	3	3	4	4	4	4	4	3	4	4	4	4	3	4	3	4	4	4	35	42	37
11	St.John	1	1	8	16	4	2	4	4	4	4	4	4	[illegible]	4	4	3	3	4	4	1	2	4	2	2	4	4	4	2	3	3	3	4	4	5	3	3	3	4	3	3	3	3	3	4	3	4	4	3	35	42	33
12	St.John	1	1	8	21	3	4	4	3	4	4	3	2	4	2	2	3	3	3	3	3	3	4	4	3	3	2	3	3	2	3	4	4	4	3	4	4	3	4	4	4	2	4	4	4	4	4	4	2	35	37	34
13	St.John	1	1	11	20	1	2	3	3	3	3	4	4	4	4	4	4	4	4	3	3	4	4	4	4	4	4	3	4	4	3	4	3	4	3	3	4	3	4	4	3	4	3	4	4	4	4	4	4	35	38	39
14	St.John	1	1	8	19	3	2	3	3	2	2	3	3	3	3	3	3	2	3	2	2	2	3	3	2	3	3	3	2	4	4	4	4	4	3	4	4	4	4	2	4	4	4	4	4	3	4	3	3	30	40	33
15	St.John	1	1	11	20	2	2	4	3	3	4	3	2	4	2	3	3	2	2	3	4	2	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3	2	2	2	3	3	3	3	4	3	4	4	4	32	33	29
16	St.John	1	1	9	18	1	3	3	4	3	4	3	4	4	4	4	4	4	4	3	1	4	4	4	3	4	3	4	3	3	4	4	4	4	3	4	3	4	4	3	3	3	4	3	4	3	4	3	4	37	40	38
17	St.John	1	1	7	26	2	3	3	4	4	3	3	4	3	3	3	4	3	3	4	3	2	4	4	4	4	3	4	2	3	4	4	4	4	4	4	3	4	4	4	4	4	4	3	3	3	3	4	3	35	40	38
18	St.John	1	1	9	20	3	4	4	4	3	4	2	4	4	2	2	2	2	4	2	2	4	4	4	4	4	2	4	3	4	3	4	3	4	4	2	4	4	4	3	3	4	4	3	4	4	4	4	4	36	39	34
19	St.John	1	1	7	18	4	3	4	3	2	4	2	4	3	4	4	4	4	4	3	4	3	4	3	2	4	4	3	2	4	3	4	4	3	3	3	4	4	3	4	3	4	3	4	3	4	4	4	3	33	37	29
20	St.John	1	1	10	16	4	4	4	4	2	4	4	3	3	4	3	2	4	4	2	2	4	4	4	2	4	4	3	2	3	3	3	4	4	3	3	3	4	2	3	3	3	3	3	4	3	4	4	3	35	39	35
21	St.John	1	1	6	19	1	3	3	3	4	4	3	3	3	3	3	3	3	3	4	4	3	4	3	4	3	4	4	2	3	4	3	4	4	3	4	4	4	4	3	4	4	4	3	3	3	4	4	4	33	39	33
22	St.John	1	1	7	15	3	4	4	4	4	3	4	3	4	1	3	4	4	2	3	2	2	1	2	3	4	4	4	4	3	4	4	4	4	3	4	4	4	4	4	4	2	4	4	4	4	4	4	4	37	42	31
23	St.John	1	1	6	16	3	3	4	3	3	4	3	4	4	2	3	4	3	3	4	4	3	3	2	2	4	4	4	3	3	4	4	4	4	4	3	4	3	3	4	4	3	4	3	4	4	3	3	3	36	40	36
24	St.John	1	1	8	19	1	2	3	3	3	4	4	3	3	3	3	3	3	3	4	4	3	2	3	3	3	4	3	3	4	4	4	4	4	3	4	4	4	4	3	4	4	4	4	4	4	4	4	3	32	41	35
25	St.John	1	1	7	16	3	4	4	4	4	4	4	3	4	4	3	4	3	4	3	3	3	4	2	3	4	4	4	3	4	3	3	4	4	3	3	4	4	4	3	4	3	3	4	3	3	3	4	4	39	41	37
26	St.John	1	1	5	11	3	3	3	3	3	3	4	4	4	4	3	3	3	4	4	3	3	4	4	3	3	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	37	43	38
27	St.John	1	1	5	9	2	3	3	3	2	3	3	3	3	4	4	3	4	4	2	3	3	4	3	3	4	13	4	4	4	4	4	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	33	42	36
28	St.John	1	1	5	10	2	4	4	3	3	3	3	3	4	4	4	3	3	4	4	4	3	4	4	3	3	4	4	3	4	3	3	4	4	3	3	4	4	4	3	4	3	3	4	3	3	3	4	4	37	39	39
29	St.John	1	1	5	16	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	32	43	39
30	St.John	1	1	7	16	4	3	3	3	4	3	4	3	4	3	4	4	3	4	3	3	3	4	3	3	4	4	4	4	4	4	4	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	38	42	38
31	Igwebike	1	2	11	17	3	3	4	4	4	4	3	4	4	4	4	1	3	4	3	4	3	3	4	3	3	3	3	3	3	4	3	4	3	4	4	4	4	4	4	3	3	4	4	4	3	4	3	4	39	41	34
32	Igwebike	1	2	15	25	2	3	4	4	4	3	3	2	3	3	3	3	3	3	3	3	3	2	3	2	3	3	3	4	4	3	3	4	3	4	4	4	3	4	3	4	4	3	4	4	3	4	3	3	34	39	31
33	Igwebike	1	2	11	25	4	4	3	4	4	4	4	4	4	4	4	3	4	4	3	4	3	2	3	2	4	4	4	4	4	3	3	3	4	4	4	4	4	4	3	4	3	4	3	3	4	4	3	2	41	43	36
34	Igwebike	1	2	10	16	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	3	3	3	3	4	4	3	3	3	3	3	4	4	4	4	3	4	4	4	3	40	44	40
35	Igwebike	1	2	12	23	2	3	4	2	4	3	4	3	3	4	4	3	3	4	3	4	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	39	44	38
36	Igwebike	1	2	15	20	3	4	4	4	3	4	3	3	4	3	3	4	3	4	4	4	3	3	3	3	4	2	3	4	4	3	4	4	3	3	2	4	3	3	4	4	4	3	4	2	4	4	4	3	37	39	37
37	Igwebike	1	2	12	20	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	4	3	4	4	3	3	3	4	3	4	3	3	4	3	3	4	4	32	37	33
38	Igwebike	1	2	11	17	4	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	3	4	3	4	4	4	3	3	4	4	3	3	4	4	4	3	1	3	4	4	3	40	43	39
39	Igwebike	1	2	12	26	3	3	4	4	3	4	3	3	4	4	4	4	3	3	4	4	4	2	3	1	4	4	4	3	4	3	4	3	3	2	3	4	3	3	4	4	4	3	4	3	4	4	4	2	36	39	36
40	Igwebike	1	2	13	20	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	1	4	4	4	3	3	4	4	3	4	4	3	4	3	1	3	4	4	3	4	2	3	4	4	3	39	44	35
41	Igwebike	1	2	12	17	3	3	4	3	3	4	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	4	4	3	2	4	4	4	4	3	3	4	4	3	3	3	3	3	3	3	4	4	4	2	35	39	35
42	Igwebike	1	2	15	26	2	3	4	3	3	4	3	4	3	3	4	1	4	4	3	3	4	4	4	3	4	4	4	4	3	4	3	4	3	2	4	3	4	4	3	4	4	3	3	4	3	4	3	4	36	38	33
43	Igwebike	1	2	10	18	2	4	4	4	4	4	5	5	4	4	4	4	3	3	3	3	2	4	4	2	4	4	4	3	4	3	4	4	4	3	4	4	3	4	4	4	4	4	4	4	4	4	4	4	40	44	35
44	Igwebike	1	2	12	22	3	3	4	4	3	3	3	4	3	3	3	3	4	3	3	3	4	3	4	4	3	4	4	3	4	3	4	4	4	3	4	4	4	4	3	3	3	2	4	4	3	2	1	1	36	41	33
45	Igwebike	1	2	11	19	2	3	4	4	4	3	3	2	3	3	3	3	3	3	3	3	3	2	3	2	2	3	3	3	2	2	3	3	4	4	3	4	3	3	2	3	3	3	3	1	2	3	3	3	34	44	37
46	Igwebike	1	2	8	18	3	3	3	3	4	4	4	3	4	4	4	3	3	4	3	3	3	3	4	3	3	3	4	3	2	4	4	3	4	4	4	3	4	4	4	3	4	3	4	4	3	4	4	2	39	44	35
47	Igwebike	1	2	13	17	3	4	4	3	4	4	2	3	4	3	4	1	4	3	2	4	1	4	4	2	3	3	4	3	4	4	4	4	3	4	4	3	4	4	4	4	4	4	4	4	4	4	3	4	38	41	36
48	Igwebike	1	2	8	21	2	3	3	3	3	3	3	3	2	3	3	1	3	3	3	3	3	3	3	2	3	3	4	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	31	39	36
49	Igwebike	1	2	12	19	4	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	4	3	4	3	4	4	3	3	9	4	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	34	44	34
50	Igwebike	1	2	12	23	2	3	3	4	3	4	2	3	4	3	2	2	2	3	3	4	2	2	3	3	4	3	3	4	4	4	3	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	4	3	33	42	31
51	Igwebike	1	2	13	22	2	3	3	3	3	3	4	3	3	4	3	3	3	4	4	4	2	3	3	3	3	4	4	3	4	4	4	4	4	3	3	4	4	4	4	4	4	4	3	4	3	4	4	3	34	41	35
52	Igwebike	1	2	10	26	2	3	3	3	4	3	3	4	2	3	3	3	3	2	4	3	3	2	3	3	4	3	3	3	3	3	4	3	3	4	3	4	4	4	4	3	4	4	3	3	3	3	3	4	33	37	[illegible]
53	Igwebike	1	2	11	25	3	3	4	3	4	3	4	2	2	4	3	4	4	4	3	2	2	4	4	4	4	4	4	3	3	4	4	2	4	3	4	4	4	4	4	4	4	4	4	3	4	4	4	3	35	39	[illegible]
54	Igwebike	1	2	12	22	3	3	4	4	4	4	4	3	4	4	4	3	3	3	3	3	3	2	3	3	3	3	4	2	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	3	4	4	4	4	39	41	[illegible]
55	Igwebike	1	2	8	17	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	1	2	3	3	3	3	4	4	4	4	4	4	4	3	4	4	4	4	3	4	4	4	3	4	4	4	4	3	33	43	31
56	Igwebike	1	2	10	20	3	4	4	4	4	4	3	3	4	3	4	3	4	3	3	4	4	4	4	4	4	4	3	2	3	3	4	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	34	40	36
57	Igwebike	1	2	5	16	1	4	4	4	3	4	4	3	4	4	3	3	4	4	3	3	4	3	4	4	3	3	4	3	4	3	4	3	4	4	3	4	3	4	3	4	3	4	3	3	3	4	3	2	38	39	38
58	Igwebike	1	2	7	25	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	2	3	4	3	3	4	4	3	4	3	4	3	4	3	4	3	3	3	4	3	2	36	44	37
59	Igwebike	1	2	7	17	3	3	4	4	3	4	4	2	4	3	4	3	4	4	4	4	4	3	3	3	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	38	43	40
60	Igwebike	1	2	10	19	4	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	2	4	4	4	4	4	4	4	4	4	3	4	4	4	4	41	42	39
61	Igwebike	1	2	11	24	4	3	3	4	4	4	4	3	3	4	4	4	4	3	4	3	3	3	3	3	3	3	4	3	3	4	3	4	3	3	4	3	4	4	4	3	4	4	4	4	3	3	4	3	38	43	36

62	Irwebike	1	2	14	20	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	3	4	4	4	3	4	4	4	4	4	4	4	3	4	4	4	4	41	44	39
63	GSS	2	1	4	7	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	3	4	4	4	4	3	3	4	4	3	4	4	3	4	3	4	4	4	3	40	43	38
64	GSS	2	1	12	14	4	4	4	4	4	4	4	4	4	4	4	4	3	3	4	4	4	3	4	4	4	4	4	3	4	4	4	4	4	4	3	4	4	4	3	4	4	4	4	4	4	4	4	4	42	44	41
65	GSS	2	1	11	12	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	4	3	3	3	3	4	4	4	3	4	4	4	4	3	4	3	4	4	3	4	4	4	4	3	4	4	3	33	33	36
66	GSS	2	1	8	10	4	4	4	4	4	4	4	3	4	4	4	3	4	4	3	4	4	4	4	4	4	4	4	3	4	4	4	2	4	4	4	4	3	4	2	3	4	3	4	3	4	4	3	4	31	36	33
67	GSS	2	1	8	15	4	4	4	4	4	4	4	3	4	4	3	4	4	4	4	4	3	4	4	3	4	4	4	3	3	4	3	4	3	4	4	2	2	1	2	3	4	3	4	3	1	3	3	2	36	41	32
68	GSS	2	1	10	12	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	2	3	3	3	4	3	3	3	3	3	2	3	3	3	3	3	3	2	2	3	2	33	36	29
69	GSS	2	1	8	11	4	4	3	3	3	4	4	3	4	4	4	4	4	3	3	4	4	3	4	4	3	3	4	3	4	3	4	4	3	4	3	4	3	3	3	4	4	3	3	3	4	4	4	3	39	40	33
70	GSS	2	1	7	13	4	4	3	3	3	4	4	3	4	4	4	4	4	3	3	4	4	3	4	4	3	3	4	2	4	4	4	4	4	4	4	4	4	2	4	4	4	4	4	4	4	4	4	4	37	37	33
71	GSS	2	1	8	9	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	4	3	2	3	2	3	4	3	4	4	3	4	4	4	3	4	4	4	4	3	4	4	4	3	4	3	4	33	35	31
72	Comprehensive	2	2	12	13	3	4	4	4	4	4	4	3	4	3	3	4	3	3	3	3	3	3	3	3	3	4	3	3	3	4	4	3	3	3	3	4	4	3	3	3	3	3	3	3	3	3	3	4	37	40	35
73	Comprehensive	2	2	4	7	4	3	4	3	3	4	4	3	3	4	4	1	3	4	3	4	3	2	4	3	3	1	3	3	4	4	4	3	4	3	4	4	3	1	3	3	3	4	3	2	1	3	3	3	39	39	29
74	Comprehensive	2	2	7	10	3	4	4	4	4	4	4	4	4	4	4	1	4	3	4	4	4	4	4	3	4	1	3	3	3	3	4	4	4	4	3	4	4	1	4	4	3	3	4	3	1	3	3	4	39	39	36
75	Comprehensive	2	2	8	12	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	2	3	3	4	4	3	4	3	3	3	3	33	37	35
76	Comprehensive	2	2	7	11	4	4	3	4	4	4	4	4	4	4	4	3	3	4	3	4	4	4	4	4	4	4	4	3	3	3	3	3	4	4	4	3	3	1	3	3	3	3	3	4	2	4	4	3	35	37	33
77	Comprehensive	2	2	7	9	4	3	3	3	3	3	3	3	3	3	3	1	3	3	4	3	3	3	3	3	3	1	4	3	3	3	3	2	3	3	3	3	3	1	3	3	3	3	2	3	1	3	3	3	31	33	30
78	Comprehensive	2	2	8	12	4	3	3	3	3	4	4	3	3	4	4	1	4	4	3	3	3	2	3	3	4	4	3	3	3	3	3	2	3	3	4	3	3	2	3	3	3	3	3	3	2	3	3	3	31	33	26
79	Comprehensive	2	2	5	8	3	3	3	3	3	3	3	3	3	4	4	4	4	3	3	3	3	3	3	3	3	3	3	4	3	3	4	2	4	3	3	3	3	2	3	4	3	3	3	2	1	3	4	4	35	35	32
80	Comprehensive	2	2	9	11	3	4	3	4	4	4	4	3	4	4	4	3	4	4	3	4	3	3	4	3	4	3	3	4	3	3	3	2	4	3	3	3	2	2	3	4	2	4	3	3	2	2	3	4	36	39	32
81	Comprehensive	2	2	5	12	3	4	3	3	4	3	3	2	3	3	3	4	4	3	3	4	4	4	4	3	3	3	3	3	3	3	3	2	3	3	3	3	2	2	4	3	3	3	4	3	2	4	3	3	31	34	39
82	Comprehensive	2	2	12	9	3	3	3	3	3	3	2	3	3	3	3	2	4	3	4	4	4	4	4	3	3	3	3	3	4	4	4	2	3	3	3	3	3	1	3	3	3	4	3	3	2	2	3	3	32	35	30
83	Comprehensive	2	2	12	12	4	4	4	3	4	3	4	3	3	4	4	4	4	4	3	4	3	3	2	4	3	4	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	4	3	3	2	3	3	3	31	33	32
84	Comprehensive	2	2	8	9	3	3	3	3	4	3	3	4	4	4	4	3	4	4	4	3	4	4	3	3	3	4	3	3	3	3	3	3	3	2	3	3	4	1	2	3	3	3	2	4	2	3	3	3	31	33	29
85	Comprehensive	2	2	11	13	3	3	3	3	3	4	3	3	3	3	4	2	3	3	3	4	3	3	3	2	3	3	4	4	4	4	3	3	3	3	3	3	1	1	3	3	2	3	3	3	1	3	3	3	35	35	28
86	Comprehensive	2	2	11	10	4	4	4	4	4	4	4	3	3	3	4	4	3	3	3	3	3	4	4	3	4	4	2	3	2	3	3	4	4	2	3	4	4	2	3	4	1	3	2	4	2	2	3	3	29	31	29
87	Comprehensive	2	2	9	12	2	3	2	3	4	2	4	4	4	3	3	3	4	3	3	1	3	4	3	2	2	3	5	4	4	4	4	4	4	4	4	4	4	1	3	4	2	3	4	2	2	3	3	3	34	35	30
88	Comprehensive	2	2	4	7	3	3	4	3	4	3	4	4	2	3	3	3	2	3	3	3	4	4	4	3	4	2	3	3	3	4	3	2	1	3	3	4	4	2	3	3	3	3	4	2	1	2	3	3	33	36	25
89	Comprehensive	2	2	7	12	3	4	3	4	4	3	4	4	3	3	4	4	4	3	4	3	3	4	4	3	4	4	4	3	3	3	3	2	3	3	3	4	3	2	3	3	3	4	3	3	2	3	3	3	34	37	32
90	Comprehensive	2	2	7	9	3	4	2	4	3	2	4	3	4	4	3	3	4	4	3	2	4	4	4	3	4	3	3	3	3	4	3	1	3	3	3	3	3	2	3	4	3	4	3	3	1	2	3	3	32	36	31
91	Comprehensive	2	2	7	12	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3	2	2	3	3	2	8	1	3	3	2	4	2	1	4	3	3	2	4	2	3	3	2	4	3	2	2	3	3	3	31	33	26
92	Comprehensive	2	2	5	10	4	4	4	4	4	4	4	4	4	4	4	3	4	4	3	3	3	4	4	4	4	3	3	3	3	3	4	4	3	4	3	3	3	1	3	4	4	3	3	3	1	2	4	4	36	39	32
93	Comprehensive	2	2	6	12	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	4	3	3	3	3	3	3	2	3	3	3	3	3	1	3	3	2	3	3	2	1	2	3	3	40	41	26
94	Comprehensive	2	2	7	8	3	4	3	4	3	4	4	3	4	3	4	1	4	3	3	3	3	4	3	3	3	4	3	3	3	3	2	3	3	3	3	4	1	1	3	4	3	2	3	4	1	4	3	3	35	38	31
95	Comprehensive	2	2	7	13	4	4	4	4	4	4	4	2	4	4	4	4	4	4	3	2	2	4	4	4	4	2	3	3	2	3	3	2	3	3	3	2	3	1	3	3	3	4	3	3	2	2	3	4	35	36	30
96	Comprehensive	2	2	5	16	3	4	4	3	3	4	3	3	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	2	4	3	3	2	2	4	3	3	3	3	2	2	3	1	38	31	28
97	Comprehensive	2	2	4	14	4	3	4	2	4	3	3	2	1	4	4	4	4	4	3	4	3	3	3	4	3	4	4	3	3	3	3	1	2	3	3	3	3	2	2	3	3	4	3	3	1	3	4	3	34	31	31
98	Comprehensive	2	2	5	16	3	3	3	3	4	4	2	4	4	4	2	3	3	3	4	4	3	3	3	3	3	3	3	3	3	3	3	1	2	2	2	3	3	1	2	4	2	4	3	3	1	2	4	2	28	34	28
99	Comprehensive	2	2	9	15	4	3	4	2	4	3	3	2	1	4	4	4	4	4	3	4	3	3	3	4	3	4	4	3	3	3	3	1	2	2	2	3	3	1	2	3	3	3	3	2	1	2	3	3	31	31	26
100	Comprehensive	2	2	10	15	3	3	3	3	4	4	2	4	4	4	2	3	3	3	4	4	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	1	2	3	2	3	2	1	2	2	3	2	32	34	23

APPENDIX W

Statistical Package/Analysis of Findings/Results

Descriptive

Teaching Approach	Sex		Pretest-Interest Scores	Posttest Interest Scores
Flipped Classroom Instruction	Female	Mean	35.6000	40.2667
		N	30	30
		Std. Deviation	2.81131	2.59885
	Male	Mean	36.6563	41.4063
		N	32	32
		Std. Deviation	2.90283	2.32600
	Total	Mean	36.1452	40.8548
		N	62	62
		Std. Deviation	2.88493	2.50800
Direct Instruction	Female	Mean	36.0000	38.3333
		N	9	9
		Std. Deviation	3.77492	3.80789
	Male	Mean	33.7241	35.3448
		N	29	29
		Std. Deviation	3.04603	2.88191
	Total	Mean	34.2632	36.0526
		N	38	38
		Std. Deviation	3.32626	3.32840
Total	Female	Mean	35.6923	39.8205
		N	39	39
		Std. Deviation	3.01010	2.98127
	Male	Mean	35.2623	38.5246
		N	61	61
		Std. Deviation	3.29597	3.99836
	Total	Mean	35.4300	39.0300
		N	100	100
		Std. Deviation	3.17902	3.67480

Descriptive

Teaching Approach	Sex		Pre-Participation Scores	Posttest-Participation Scores
Flipped Classroom Instruction	Female	Mean	36.3667	41.0333
		N	30	30
		Std. Deviation	3.12370	3.15664
	Male	Mean	36.1875	41.2500
		N	32	32
		Std. Deviation	2.44207	2.19971

	Total	Mean	36.2742	41.1452
		N	62	62
		Std. Deviation	2.77086	2.68479
Direct Instruction	Female	Mean	34.0000	37.1111
		N	9	9
		Std. Deviation	3.70810	4.88478
	Male	Mean	30.2759	32.8276
		N	29	29
		Std. Deviation	3.41108	3.56640
	Total	Mean	31.1579	33.8421
		N	38	38
		Std. Deviation	3.78851	4.26505
Total	Female	Mean	35.8205	40.1282
		N	39	39
		Std. Deviation	3.37071	3.92817
	Male	Mean	33.3770	37.2459
		N	61	61
		Std. Deviation	4.16799	5.14022
	Total	Mean	34.3300	38.3700
		N	100	100
		Std. Deviation	4.04034	4.89208

Descriptive

Teaching Approach	Sex		Pretest Chemistry Achievement	Posttest Chemistry Achievement
Flipped Classroom Instruction	Female	Mean	7.7667	17.1333
		N	30	30
		Std. Deviation	1.71572	3.40115
	Male	Mean	11.0313	20.6875
		N	32	32
		Std. Deviation	2.38928	3.29650
	Total	Mean	9.4516	18.9677
		N	62	62
		Std. Deviation	2.64685	3.77206
Direct Instruction	Female	Mean	8.4444	11.4444
		N	9	9
		Std. Deviation	2.35112	2.50555
	Male	Mean	7.5172	11.3448
		N	29	29
		Std. Deviation	2.47301	2.51106
	Total	Mean	7.7368	11.3684
		N	38	38
		Std. Deviation	2.44600	2.47606
Total	Female	Mean	7.9231	15.8205
		N	39	39

		Std. Deviation	1.86920	4.00573
		Mean	9.3607	16.2459
	Male	N	61	61
		Std. Deviation	2.98905	5.53972
		Mean	8.8000	16.0800
	Total	N	100	100
		Std. Deviation	2.69305	4.98012

Between-Subjects Factors

		Value Label	N
Teaching Approach	1.00	Flipped Classroom Instruction	62
	2.00	Direct Instruction	38

Tests of Between-Subjects Effects

Dependent Variable: Posttest Interest Scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	880.149[a]	2	440.075	93.456	.000
Intercept	215.151	1	215.151	45.691	.000
Pretest_Interest_Scores	336.827	1	336.827	71.530	.000
Teaching_Approach	289.535	1	289.535	61.487	.000
Error	456.761	97	4.709		
Total	153671.000	100			
Corrected Total	1336.910	99			

a. R Squared = .658 (Adjusted R Squared = .651)

Teaching Approach

Dependent Variable: Posttest Interest Scores

Teaching Approach	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Classroom Instruction	40.421[a]	.280	39.865	40.978
Direct Instruction	36.760[a]	.362	36.042	37.478

a. Covariates appearing in the model are evaluated at the following values: Pretest-Interest Scores = 35.4300.

Between-Subjects Factors

		Value Label	N
Teaching Approach	1.00	Flipped Classroom Instruction	62
	2.00	Direct Instruction	38

Tests of Between-Subjects Effects

Dependent Variable: Posttest-Participation Scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1866.083[a]	2	933.042	179.849	.000
Intercept	108.539	1	108.539	20.922	.000
Pretest_Participation_Scores	609.519	1	609.519	117.489	.000
Teaching_Approach	159.378	1	159.378	30.721	.000
Error	503.227	97	5.188		
Total	149595.000	100			
Corrected Total	2369.310	99			

a. R Squared = .788 (Adjusted R Squared = .783)

Estimated Marginal Means

Teaching Approach

Dependent Variable: Posttest-Participation Scores

Teaching Approach	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Classroom Instruction	39.627[a]	.321	38.989	40.265
Direct Instruction	36.319[a]	.434	35.457	37.182

a. Covariates appearing in the model are evaluated at the following values: Pretest-Participation Scores = 34.3300.

Between-Subjects Factors

		Value Label	N
Teaching Approach	1.00	Flipped Classroom Instruction	62
	2.00	Direct Instruction	38

Tests of Between-Subjects Effects

Dependent Variable: Posttest Chemistry Achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1612.910[a]	2	806.455	92.856	.000
Intercept	772.895	1	772.895	88.991	.000
Pretest_Chemistry_Achievemt	252.328	1	252.328	29.053	.000
Teaching_Approach	907.653	1	907.653	104.508	.000
Error	842.450	97	8.685		
Total	28312.000	100			
Corrected Total	2455.360	99			

a. R Squared = .657 (Adjusted R Squared = .650)

Estimated Marginal Mean

Teaching Approach

Dependent Variable: Posttest Chemistry Achievement

Teaching Approach	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Classroom Instruction	18.561[a]	.382	17.804	19.319
Direct Instruction	12.031[a]	.494	11.052	13.011

a. Covariates appearing in the model are evaluated at the following values: Pretest Chemistry Achievement = 8.8000.

Between-Subjects Factors

		Value Label	N
Teaching Approach	1.00	Flipped Classroom Instruction	62
	2.00	Direct Instruction	38
Sex	1.00	Female	39
	2.00	Male	61

Tests of Between-Subjects Effects

Dependent Variable: Posttest Interest Scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	880.642[a]	3	293.547	61.763	.000
Intercept	215.480	1	215.480	45.338	.000
Pretest_Interest_Scores	336.949	1	336.949	70.895	.000
Teaching_Approach	267.752	1	267.752	56.336	.000
Sex	.493	1	.493	.104	.748
Error	456.268	96	4.753		
Total	153671.000	100			
Corrected Total	1336.910	99			

a. R Squared = .659 (Adjusted R Squared = .648)

Estimated Marginal Means

1. Teaching Approach

Dependent Variable: Posttest Interest Scores

Teaching Approach	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Classroom Instruction	40.424[a]	.282	39.865	40.983
Direct Instruction	36.799[a]	.383	36.038	37.560

a. Covariates appearing in the model are evaluated at the following values: Pretest-Interest Scores = 35.4300.

2. Sex

Dependent Variable: Posttest Interest Scores

Sex	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Female	38.686[a]	.371	37.949	39.422
Male	38.537[a]	.280	37.982	39.092

a. Covariates appearing in the model are evaluated at the following values: Pretest-Interest Scores = 35.4300.

Between-Subjects Factors

		Value Label	N
Teaching Approach	1.00	Flipped Classroom Instruction	62
	2.00	Direct Instruction	38
Sex	1.00	Female	39
	2.00	Male	61

Tests of Between-Subjects Effects

Dependent Variable: Posttest-Participation Scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1866.798[a]	3	622.266	118.878	.000
Intercept	107.246	1	107.246	20.488	.000
Pretest_Participation_Scores	579.837	1	579.837	110.772	.000
Teaching_Approach	156.497	1	156.497	29.897	.000
Sex	.714	1	.714	.136	.713
Error	502.512	96	5.235		
Total	149595.000	100			
Corrected Total	2369.310	99			

a. R Squared = .788 (Adjusted R Squared = .781)

1. Teaching Approach

Dependent Variable: Posttest-Participation Scores

Teaching Approach	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Classroom Instruction	39.640[a]	.325	38.995	40.284
Direct Instruction	36.351[a]	.445	35.468	37.234

a. Covariates appearing in the model are evaluated at the following values: Pretest-Participation Scores = 34.3300.

2. Sex

Dependent Variable: Posttest-Participation Scores

Sex	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Female	38.086[a]	.389	37.314	38.859
Male	37.904[a]	.304	37.302	38.507

a. Covariates appearing in the model are evaluated at the following values: Pretest-Participation Scores = 34.3300.

Between-Subjects Factors

		Value Label	N
Teaching Approach	1.00	Flipped Classroom Instruction	62
	2.00	Direct Instruction	38
Sex	1.00	Female	39
	2.00	Male	61

Tests of Between-Subjects Effects

Dependent Variable: Posttest Chemistry Achievement

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1650.026[a]	3	550.009	65.564	.000
Intercept	806.701	1	806.701	96.163	.000
Pretest_Chemistry_Achievemt	157.300	1	157.300	18.751	.000
Teaching_Approach	919.262	1	919.262	109.581	.000
Sex	37.115	1	37.115	4.424	.038
Error	805.334	96	8.389		
Total	28312.000	100			
Corrected Total	2455.360	99			

a. R Squared = .672 (Adjusted R Squared = .662)

Estimated Marginal Means

1. Teaching Approach

Dependent Variable: Posttest Chemistry Achievement

Teaching Approach	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Classroom Instruction	18.600[a]	.376	17.855	19.346
Direct Instruction	11.567[a]	.533	10.508	12.625

a. Covariates appearing in the model are evaluated at the following values: Pretest Chemistry Achievement = 8.8000.

2. Sex

Dependent Variable: Posttest Chemistry Achievement

Sex	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Female	14.391[a]	.524	13.350	15.432
Male	15.776[a]	.376	15.029	16.523

a. Covariates appearing in the model are evaluated at the following values: Pretest Chemistry Achievement = 8.8000.

Between-Subjects Factors

		Value Label	N
Teaching Approach	1.00	Flipped Classroom Instruction	62
	2.00	Direct Instruction	38
Sex	1.00	Female	39
	2.00	Male	61

Tests of Between-Subjects Effects

Dependent Variable: Posttest Interest Scores

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	903.083[a]	4	225.771	49.440	.000
Intercept	237.591	1	237.591	52.028	.000
Pretest_Interest_Scores	278.310	1	278.310	60.945	.000
Teaching_Approach	197.637	1	197.637	43.279	.000
Sex	6.315	1	6.315	1.383	.243
Teaching_Approach * Sex	22.441	1	22.441	4.914	.029
Error	433.827	95	4.567		
Total	153671.000	100			
Corrected Total	1336.910	99			

a. R Squared = .676 (Adjusted R Squared = .662)

Estimated Marginal Means

1. Teaching Approach

Dependent Variable: Posttest Interest Scores

Teaching Approach	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Classroom Instruction	40.440[a]	.276	39.892	40.989
Direct Instruction	37.161[a]	.410	36.348	37.975

a. Covariates appearing in the model are evaluated at the following values: Pretest-Interest Scores = 35.4300.

2. Sex

Dependent Variable: Posttest Interest Scores

Sex	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Female	39.090[a]	.407	38.282	39.898
Male	38.512[a]	.274	37.967	39.057

a. Covariates appearing in the model are evaluated at the following values: Pretest-Interest Scores = 35.4300.

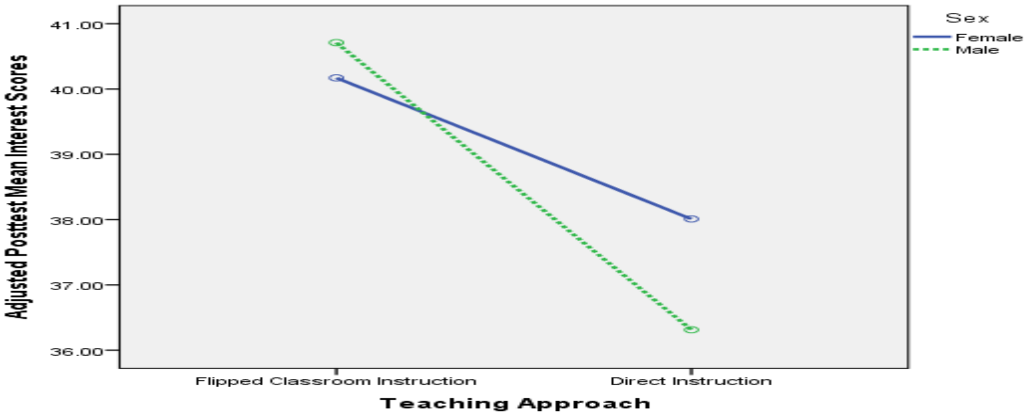
3. Sex * Teaching Approach

Dependent Variable: Posttest Interest Scores

Sex	Teaching Approach	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Female	Flipped Classroom Instruction	40.170[a]	.390	39.395	40.945
	Direct Instruction	38.010[a]	.714	36.593	39.426
Male	Flipped Classroom Instruction	40.710[a]	.388	39.940	41.481
	Direct Instruction	36.313[a]	.416	35.488	37.138

a. Covariates appearing in the model are evaluated at the following values: Pretest-Interest Scores = 35.4300.

Profile Plots



MEANS TABLES=Pretest_Participation_Scores Posttest_Participation_Scores BY Teaching_Approach BY Sex

/CELLS MEAN COUNT STDDEV.

Between-Subjects Factors

		Value Label	N
Teaching Approach	1.00	Flipped Classroom Instruction	62
	2.00	Direct Instruction	38
Sex	1.00	Female	39
	2.00	Male	61

Tests of Between-Subjects Effects

Dependent Variable: Posttest-Participation Scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1882.334[a]	4	470.583	91.802	.000
Intercept	122.046	1	122.046	23.809	.000
Pretest_Participation_Scores	499.017	1	499.017	97.349	.000
Teaching_Approach	134.088	1	134.088	26.158	.000
Sex	5.990	1	5.990	1.169	.282
Teaching_Approach * Sex	15.536	1	15.536	3.031	.085
Error	486.976	95	5.126		
Total	149595.000	100			
Corrected Total	2369.310	99			

a. R Squared = .794 (Adjusted R Squared = .786)

Estimated Marginal Means

1. Teaching Approach

Dependent Variable: Posttest-Participation Scores

Teaching Approach	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Classroom Instruction	39.695[a]	.323	39.054	40.336
Direct Instruction	36.598[a]	.462	35.680	37.516

a. Covariates appearing in the model are evaluated at the following values: Pre-Participation Scores = 34.3300.

2. Sex

Dependent Variable: Posttest-Participation Scores

Sex	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Female	38.438[a]	.435	37.574	39.302
Male	37.855[a]	.302	37.256	38.454

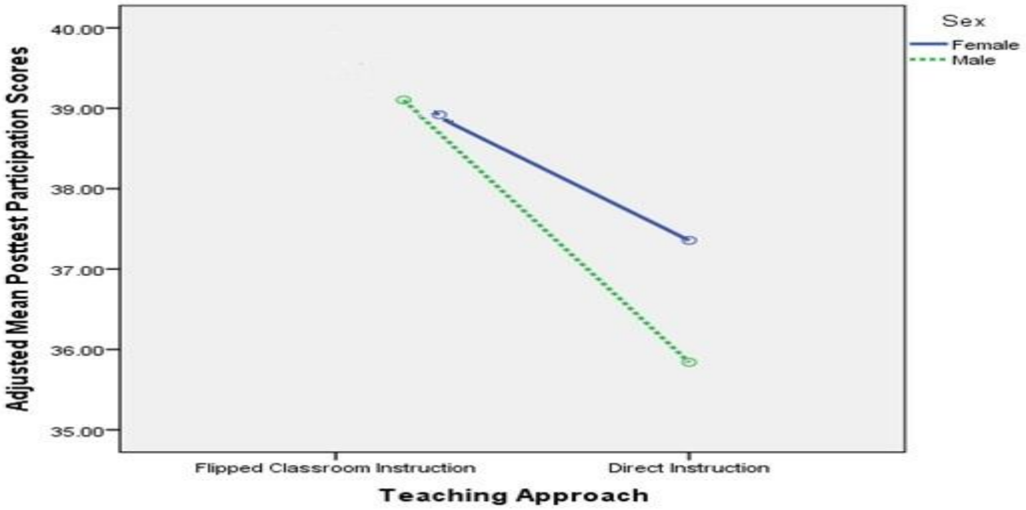
a. Covariates appearing in the model are evaluated at the following values: Pre-Participation Scores = 34.3300.

3. Sex * Teaching Approach

Dependent Variable: Posttest-Participation Scores

Sex	Teaching Approach	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Female	Flipped Classroom Instruction	39.520[a]	.441	38.645	40.395
	Direct Instruction	37.356[a]	.755	35.857	38.855
Male	Flipped Classroom Instruction	39.870[a]	.424	39.028	40.711
	Direct Instruction	35.840[a]	.520	34.809	36.872

a. Covariates appearing in the model are evaluated at the following values: Pre-Participation Scores = 34.3300.



Profile plots

Univariate Analysis of Variance

Between-Subjects Factors

		Value Label	N
Teaching Approach	1.00	Flipped Classroom Instruction	62
	2.00	Direct Instruction	38
Sex	1.00	Female	39
	2.00	Male	61

Tests of Between-Subjects Effects

Dependent Variable: Posttest Chemistry Achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1661.537[a]	4	415.384	49.711	.000
Intercept	716.285	1	716.285	85.721	.000
Pretest_Chemistry_Achievemt	105.292	1	105.292	12.601	.001
Teaching_Approach	826.797	1	826.797	98.946	.000
Sex	25.075	1	25.075	3.001	.086
Teaching_Approach * Sex	11.511	1	11.511	1.378	.243
Error	793.823	95	8.356		
Total	28312.000	100			
Corrected Total	2455.360	99			

sa. R Squared = .677 (Adjusted R Squared = .663)

Estimated Marginal Means

1. Teaching Approach

Dependent Variable: Posttest Chemistry Achievement

Teaching Approach	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Flipped Classroom Instruction	18.629[a]	.376	17.883	19.375
Direct Instruction	11.779[a]	.562	10.663	12.895

a. Covariates appearing in the model are evaluated at the following values: Pretest Chemistry Achievement = 8.8000.

2. Sex

Dependent Variable: Posttest Chemistry Achievement

Sex	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Female	14.615[a]	.557	13.509	15.721
Male	15.794[a]	.376	15.047	16.540

a. Covariates appearing in the model are evaluated at the following values: Pretest Chemistry Achievement = 8.8000.

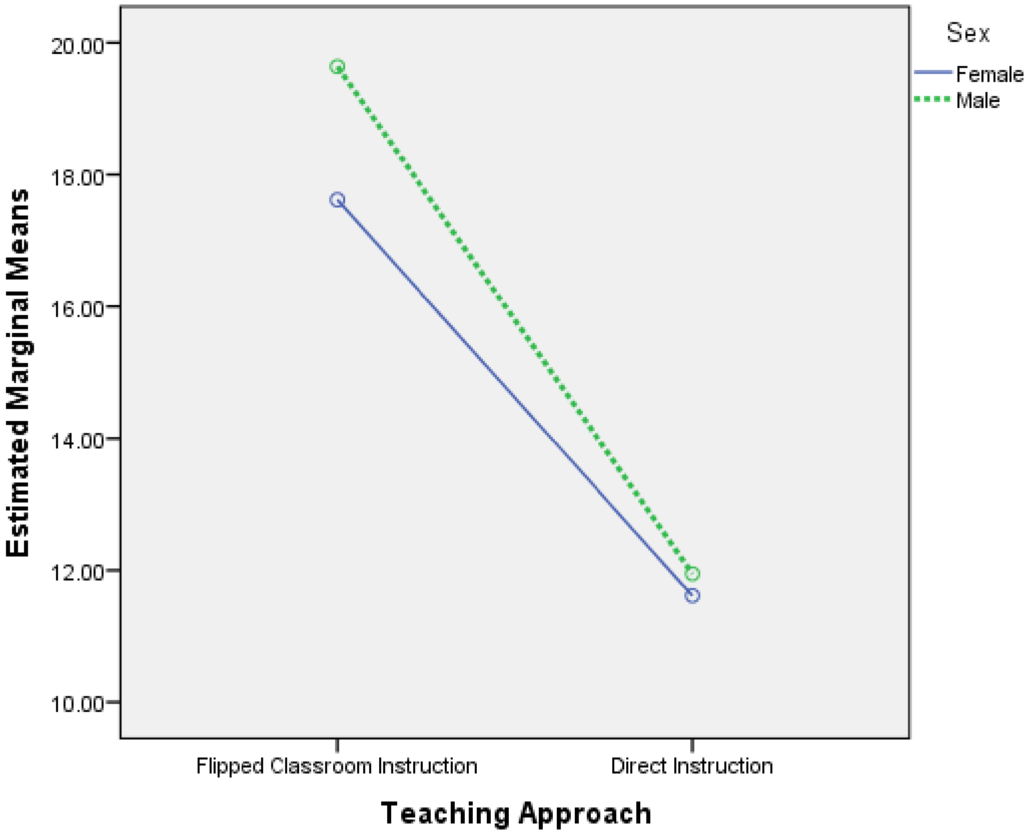
3. Teaching Approach * Sex

Dependent Variable: Posttest Chemistry Achievement

Teaching Approach	Sex	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Flipped Classroom Instruction	Female	17.618[a]	.545	16.536	18.701
	Male	19.640[a]	.590	18.469	20.812
Direct Instruction	Female	11.611[a]	.965	9.696	13.527
	Male	11.947[a]	.563	10.829	13.065

a. Covariates appearing in the model are evaluated at the following values: Pretest Chemistry Achievement = 8.8000.

Profile Plots



Covariates appearing in the model are evaluated at the following values: Pretest Chemistry Achievement = 8.8000

Between-Subjects Factors

		Value Label	N
Method	1	FCI	62
	2	DI	38
Gender	1	Female	39
	2	Male	61

Descriptive Statistics

Dependent Variable: Posttest

Method	Gender	Mean	Std. Deviation	N
FCI	Female	40.27	2.599	30
	Male	41.41	2.326	32

	Total	40.85	2.508	62
	Female	38.33	3.808	9
DI	Male	35.34	2.882	29
	Total	36.05	3.328	38
	Female	39.82	2.981	39
Total	Male	38.52	3.998	61
	Total	39.03	3.675	100

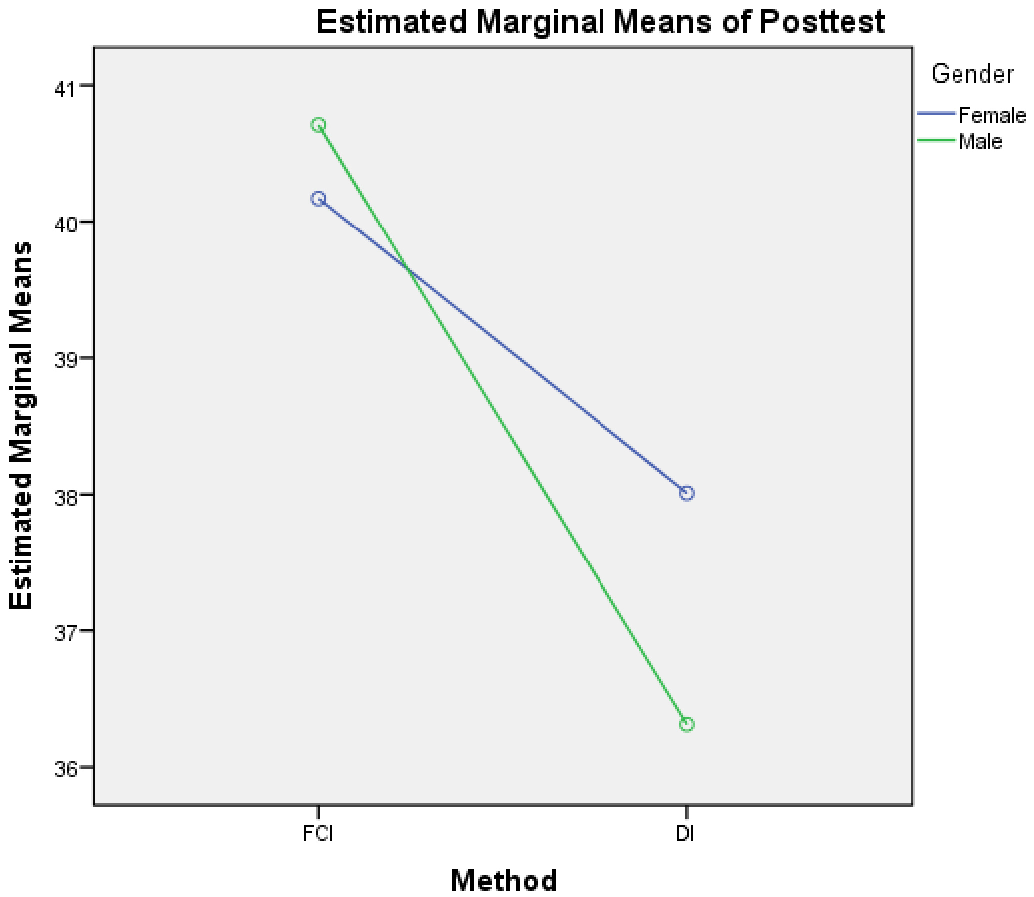
Tests of Between-Subjects Effects

Dependent Variable: Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	903.083[a]	4	225.771	49.440	.000
Intercept	237.591	1	237.591	52.028	.000
PretestINT	278.310	1	278.310	60.945	.000
Gender	6.315	1	6.315	1.383	.243
Method	197.637	1	197.637	43.279	.000
Method * Gender	22.441	1	22.441	4.914	.029
Error	433.827	95	4.567		
Total	153671.000	100			
Corrected Total	1336.910	99			

a. R Squared = .676 (Adjusted R Squared = .662)

Profile Plots



Covariates appearing in the model are evaluated at the following values: Pretest (Interest) = 35.43

Between-Subjects Factors

		Value Label	N
Method	1	FCI	62
	2	DI	38
Gender	1	Female	39
	2	Male	61

Descriptive Statistics

Dependent Variable: Posttest

Method	Gender	Mean	Std. Deviation	N
FCI	Female	41.03	3.157	30
	Male	41.25	2.200	32
	Total	41.15	2.685	62
DI	Female	37.11	4.885	9
	Male	32.83	3.566	29

	Total	33.84	4.265	38
	Female	40.13	3.928	39
Total	Male	37.25	5.140	61
	Total	38.37	4.892	100

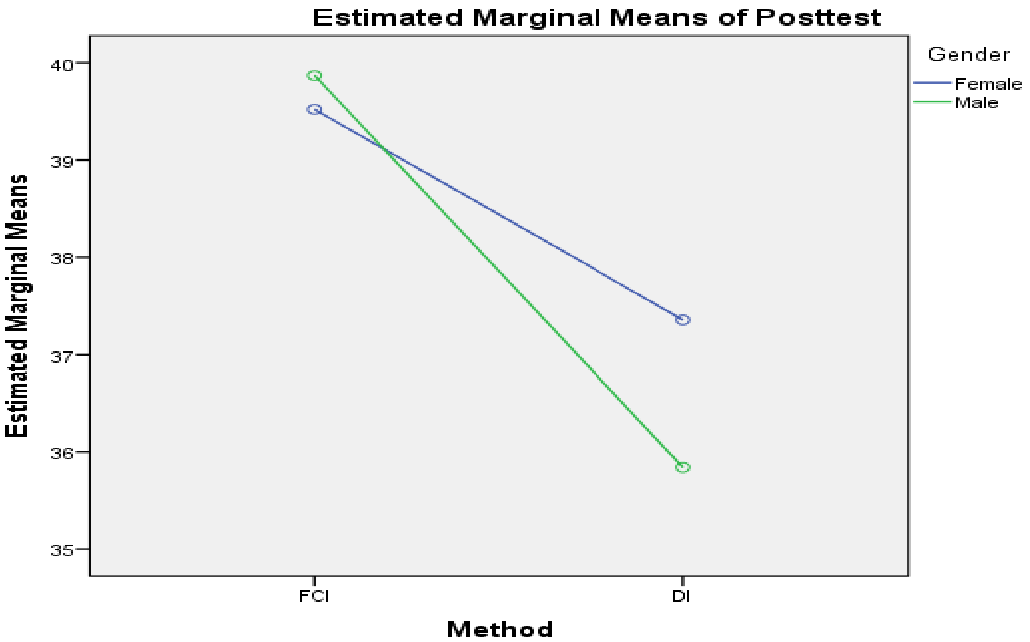
Tests of Between-Subjects Effects

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1882.334[a]	4	470.583	91.802	.000
Intercept	122.046	1	122.046	23.809	.000
PretestPAR	499.017	1	499.017	97.349	.000
Gender	5.990	1	5.990	1.169	.282
Method	134.088	1	134.088	26.158	.000
Method * Gender	15.536	1	15.536	3.031	.085
Error	486.976	95	5.126		
Total	149595.000	100			
Corrected Total	2369.310	99			

a. R Squared = .794 (Adjusted R Squared = .786)

Profile Plots



Covariates appearing in the model are evaluated at the following values: Pretest (Participation) = 34.33

Between-Subjects Factors

		Value Label	N
Method	1	FCI	62
	2	DI	38
Gender	1	Female	39
	2	Male	61

Descriptive Statistics

Dependent Variable: Posttest

Method	Gender	Mean	Std. Deviation	N
FCI	Female	17.13	3.401	30
	Male	20.69	3.297	32
	Total	18.97	3.772	62
DI	Female	11.44	2.506	9
	Male	11.34	2.511	29
	Total	11.37	2.476	38
Total	Female	15.82	4.006	39
	Male	16.25	5.540	61
	Total	16.08	4.980	100

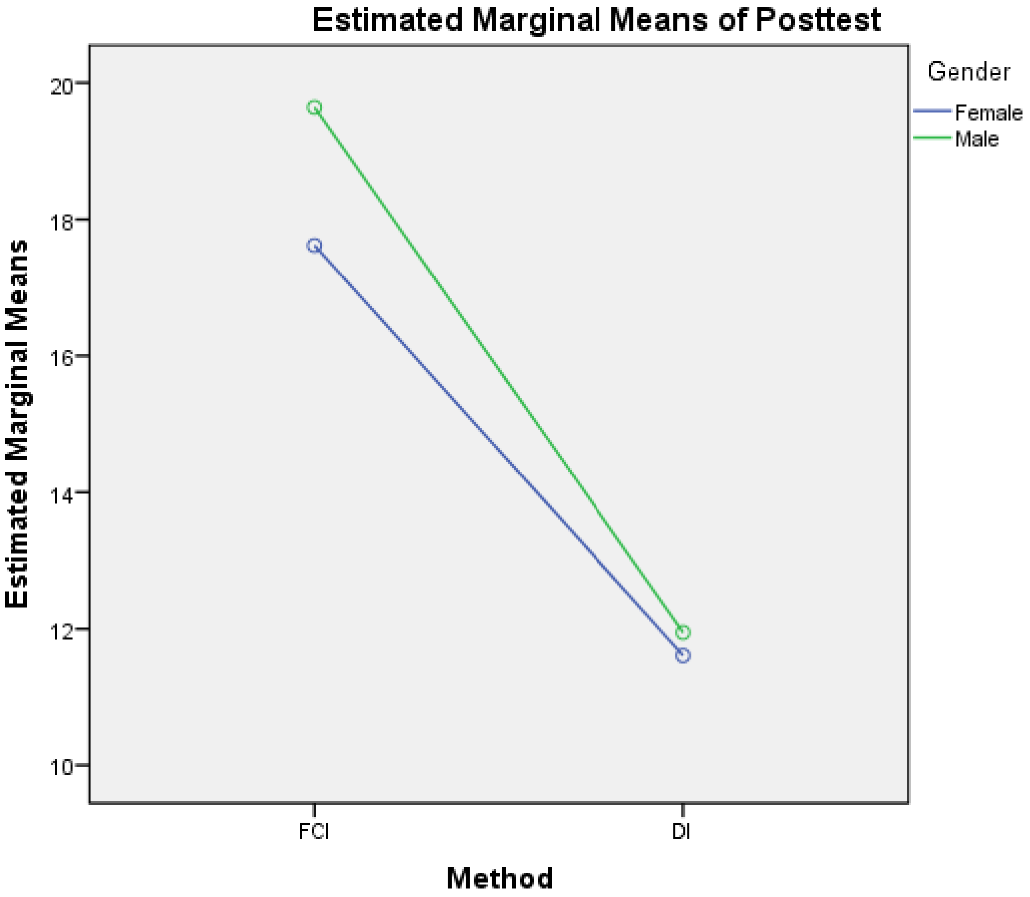
Tests of Between-Subjects Effects

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1661.537[a]	4	415.384	49.711	.000
Intercept	716.285	1	716.285	85.721	.000
PretestACH	105.292	1	105.292	12.601	.001
Gender	25.075	1	25.075	3.001	.086
Method	826.797	1	826.797	98.946	.000
Method * Gender	11.511	1	11.511	1.378	.243
Error	793.823	95	8.356		
Total	28312.000	100			
Corrected Total	2455.360	99			

a. R Squared = .677 (Adjusted R Squared = .663)

Profile Plots



Covariates appearing in the model are evaluated at the following values: Pretest (Achievement) = 8.80