EFFECT OF FORMATIVE ASSESSMENT ON ACADEMIC ACHIEVEMENT IN SENIOR SECONDARY CHEMISTRY STUDENT IN IKWO LOCAL GOVERNMENT AREA.

BY

AGU MATTHEW CHINONSO

2017/ED/6074

DEPARTMENT OF SCIENCE EDUCATION,

FACULTY OF EDUCATION,

ALEX EKWUEME FEDERAL UNIVERSITY NDUFU ALIKE, EBONYI STATE

DECEMBER, 2021.

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A PROJECT SUBMITTED TO THE

DEPARTMENT OF SCIENCE EDUCATION, FACULTY OF EDUCATION, ALEX EKWUEME FEDERAL UNIVERSITY NDUFU ALIKE, EBONYI STATE

IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF

DEGREE OF BACHELOR OF SCIENCE EDUCATION B.Sc. (Ed.)

IN CHEMISTRY EDUCATION.

DECEMBER, 2021.

DECLARATION

I hereby declare that I am responsible for the work submitted in this research project. The original work is mine except as specified in the acknowledgements and references; this project has not been submitted in part or in full for the award of any other degree in this University or any other institution.

_____ _____

Agu, Matthew Chinonso **Date**

(Researcher)

CERTIFICATION

This is to certify that the research project with research title: Effect of formative assessment on student academic achievement in secondary school chemistry students in Ikwo Local Government Area was carried out by Agu Matthew Chinonso with the registration number 2017/ED/6074 under our supervision in the Department of Science Education, Alex Ekwueme Federal University, Ndufu- Alike Ikwo, Ebonyi State.

_____ _____

Dr. Chidebe C. Uwaleke **Date**

(Project Supervisor)

_____ _____

Dr. E. N. Obande-Ogbuinya **Date**

(Head of Department)

APPROVAL

This is to certify that the research project prepared by Agu Matthew Chinonso, with registration number **2017/ED/6074**, titled: Effect of formative assessment on student academic achievement in secondary school chemistry students in Ikwo Local Government Area submitted in partial fulfillment of the requirements for the award of Bachelor of Education (B.Ed.) Degree in Chemistry Education complies with the regulation of the University and approved by the Department Student Project Committee.

_____ _____

Dr. Chidebe C. Uwaleke **Date**
(Project Supervisor)

_____ _____

Dr. E. N. Obande-Ogbuinya **Date**
(Head of Department)

_____ _____

Dr. Francisca Ogba **Date**
(Dean, Faculty of Education)

_____ _____

External Examiner **Date**

DEDICATION

This research project is dedicated to my Father, Mr Agu Francis

ACKNOWLEDGEMENTS

The researcher is grateful to the Lord, God Almighty, who by His infinite grace and mercy kept me alive and enabled me to complete this study. My gratitude goes to my supervisor, Dr. Chidebe C. Uwaleke, for his wonderful guidance, careful and thorough supervision of this work. I also extend my appreciation to the Head of Department, Dr. (Mrs.) E. N. Obade-Ogbuinya. I would like to thank all the principals, chemistry teachers and chemistry students of the school used for this research for their cooperation and assistance throughout the period of the work.

Central to his success so far is the tremendous contributions my parents (Mr. and Mrs Agu) have given to my life, their advice and resources of which they showered me. My most sincere appreciations to you and May the lord give you the grace to enjoy the fruits of your labour.

My appreciation goes to Dr. A.C Ekennia, for exposing me to the knowledge of chemistry. God bless you Sir. Furthermore, Immeasurable thanks go to Dr. Mercy I. Ani, Dr Solomon O. A. Obih, Dr. DaveMaria Onyemaechi, Dr. David Udu, Dr. Ijeoma Kalu, Dr Duru, Mr Emmanuel Nwigboji, Mr. Peter Uzosike, Mr. Sonde, Mr Ohanaka Chibuikem. I appreciate the priceless inputs you have all made to my life and other academic and non-academic staff of the Department of Science Education, for their contributions to the completion of this work.

And to his ever loving senior colleagues Anthony Anyanwu, Sarafadeen Habeeb, I appreciate all your efforts and motivations towards this research. I appreciate my very own Bro. Kelechi for his support, correction, advice and for taking me as his brother; your love for me is beyond this space. Also my undiluted appreciation goes to, Tony Moore, Gideon Chibuike, for their support, may the Lord bless you all. I appreciate the support of my siblings and friends who the Lord blessed me with; Philomena Agu, Hannah, Emmanuel, and my ever loving caring jewel in whom I am well pleased in person of Ambassador J. You guys are simply the best one can have.

To the best courserep (Frankline), my ever-loving course mates, all my friends and loved ones; Okporie Uzoma, Obasi Josephine, Ifeanyi, the whole FOE 2021 set. Thank you all for your support.

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ABSTRACT

The study of Chemistry is compulsory in all science secondary schools in Nigeria because of the vital role it plays in the scientific and technological development and growth of the nation. A shortfall in the knowledge of the students in chemistry means that the goal may not be realized, hence the need to improve instructional practices for solving the problem of poor performance in the subject. This study investigated Effect of Formative assessment on Academic Achievement of Senior Secondary Chemistry Students in Ikwo Local Government Area of Ebonyi State. The researchers adopted a quasi-experimental design, precisely the pretest-posttest control group design. The population of the study consists of 5862 Senior Secondary school students duly registered in public secondary schools (2020/2021 secondary school student enrolment) in Ikwo Local Government Areas of Ebonyi State, Nigeria. A total of 60 Senior Secondary Two (SS2) students' (30 males and 30 females respectively) were sampled through random sampling technique in the two selected schools in Ikwo Local Government Area, two intact classes were assigned to experimental groups and control group. Students' in the experimental groups were subjected to the Formative Assessment methods of teaching, while students' in the control group were subjected to the traditional assessment method. Two research questions and two hypotheses were postulated for the study. A 20 item instrument titled: "Chemistry Achievement Test" (CAT) developed by the researchers was used for data collection. The instrument was duly validated by two science education specialists and one expert in educational measurement and evaluation from department of Educational Foundation. A reliability coefficient of 0.71 was obtained using Kuder Richardson-20. Research questions were answered using descriptive statistics (mean, and standard deviation), research hypothesis were analysed using analysis of covariance (ANCOVA). The analysis of data was done using SPSS software. The result of the study revealed that: Formative assessment effectively improved Chemistry achievement of students'. Formative Assessment has a significant effect on Chemistry academic achievement of students. Based on the results of the study, the following recommendation among others was made by the researchers: a critical review of classroom assessment methods is advocated, especially in the aspect of comments made by teachers concerning learning outcome of students'.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Education is a purposeful or deliberate activity that is geared towards achievement of a range of objectives which vary from country to country. Some common objectives of education include the instillation of knowledge into an individual so that they can be able to think rationally and independently, realization of economic benefit both to the state and individuals, and the formation of a sustainable community. According to Okpala, (2021) Education is the right of every citizens of a nation as it helps people in improving students' abilities, attitude, confidence, decision making, and ultimately, in attaining a good job. The improvement in students' abilities and psychological skills can be achieved through improved teaching and learning. However, a good employment opportunity depends upon quality education. Education systems, in general, focus on the completion of the course rather than the extent of knowledge gained by the students.

Chemistry is defined as a branch of science that studies the nature, composition and properties of matter and the changes matter undergoes under different conditions. It is a natural science that covers the elements that make up matter to the compounds composed of atoms, molecules and ions. Chemistry helps us to understand the world around us. It helps us understand current events, including news about petroleum, product recalls, pollution, the environment and technological advances.

Chemistry as a branch of science is highly important in modern societies because of its requirement as a prerequisite to the study of many other science oriented courses. It thus appears that for a nation to develop in science and technology, the teaching and learning of chemistry

need to be improved. It is therefore becomes pertinent that performances in chemistry and in science generally should be of high levels. However, this seems not to be the case in Nigeria because students' performances have not been encouraging (Aluko, 2008). There are several attempts through the use of effective learners assessment to improve the status of chemistry teaching and learning. Despite all these efforts, students' performance in chemistry has remained persistently poor at the Senior Secondary Certificate Examination (SSCE), (Aluko, 2008).

Chemistry education plays an important role in enhancing the quality of teaching, research and development as well as ensuring that students are equipped with good knowledge to produce intensive good and services to meet human needs for food, health care products and other materials aimed at improving the quality of life. Learning chemistry allows students to learn about the scientific method and gain skills in critical thinking, deductive reasoning, problem-solving, and communication.

Learning is a process resulting in some change or modification in the learner's thinking, feelings and doing. The change may be temporary or permanent. In learning process, assessment is very important. It is vital part of the education process. It helps us to know the success of specific teaching and students' progress. Assessment is an approach to teaching and learning that creates feedback which is then used to improve students' performance. Students become more involved in the learning process and from this gain confidence in what they are expected to learn and to what standard. Black and William (1998) being the father of formative assessment defined assessment as all those activities undertaken by teachers, and their students to modify teaching and learning activities in which the students are engaged. Under this definition, assessment helps to gather relevant information about students' performance or progress, or to determine student interest to make judgments about their learning process. After receiving this

information, teachers can reflect on each student's level or achievement, as well as on specific inclination of the group to customize their teaching plans.

Johnson (2009) defined assessment as the use of a variety of procedures to collect information about learning and instruction. There are different types of assessments but the most commonly used assessments are the summative and formative assessment. Summative assessments are used to evaluate student learning, skill acquisition, and academic achievement at the conclusion of a defined instructional period typically at the end of a project, unit, course, semester, program, or school year, while formative assessment is commonly referred to as assessment for learning, in which the focus is on monitoring student response to, and progress with instruction. Assessment Reform Group (2002) explained assessment for learning (formative assessment) as any assessment for which the first priority in its design and practice is to serve the purpose of promoting pupil's learning. Formative assessment provides immediate feedback to both the teacher and the student regarding the learning process. Assessment become formative when the information is used to adapt teaching and learning to meet student needs. When teachers know how students are progressing and where they are having trouble, they can use this information to make necessary instructional adjustments, such as re-teaching, trying alternative instructional approaches, or offering more opportunities for practice. These activities can lead to improved student success (Dandekar, 2015).

The goal of formative assessment in chemistry is to monitor student learning to provide ongoing feedback that can be used by chemistry teachers to improve their teaching and by students to improve their learning. It does not contribute to the final mark given for the students; instead it contributes to learning through providing feedback. Ajogbeje, (2012) cited that one of the key factors which seems to contribute more to the problem of poor students' academic achievement

in Chemistry is the essence of using test and other evaluation instruments during the instructional process which is to guide, direct and monitor students' learning and progress towards attainment of subject objectives.

The main objective of this study was to investigate the effect of the type of assessment teachers applied in teaching chemistry to students. It is estimated that there are different opinions among participants and discrepancies between what is considered helpful and what is used in the practice of assessment and feedback in learning Chemistry. Hence, the present study therefore investigated the effect of formative assessment on secondary school chemistry student academic achievement in Ikwo Local Government Area.

1.2 Statement of the Problem

British researchers Paul Black and Dylan Wiliam are said and believed to be the fathers of formative assessment. In 1998, Black and Wiliam published two works on formative assessment and they suggested that if formative assessment is well applied in teaching and learning in the classroom, learning will improve.

Frequent failure of Nigeria students in Chemistry subject has been the concerned of all stakeholders in education industry. Some suggest a number of factors that hinder good performances. Such factors include insufficient teaching/learning facilities, teachers motivation, learners entry behavior and many others. Little has been mentioned about learners preparation for summative examinations. Being considered among the foundation tools for good performances in summative examinations. The effect of formative assessment on student academic achievement need to be examined to determine the current assessment practices that are being used on student performance during teaching and learning process.

1.3 Purpose of the Study

The main purpose of the study was to determine the effect of formative assessment on secondary school student academic achievement in Ikwo Local Government Area. Specifically, the research sought to:

1. Determine the effect of formative assessment on the academic achievement of students in chemistry
2. Determine the effect of formative assessment on the academic achievement of male and female students in chemistry

1.4 Research Question

This study attempts to find answers for the following research questions:

1. What are the effects of formative assessment on secondary school students academic achievement in chemistry
2. What is the effect of formative assessment on male and female secondary school student academic achievement in chemistry

1.5 Research Hypotheses

The following null hypotheses (Ho) were formulated and will be tested at 0.05% level of Significance:

1. There is no significant difference in the mean scores of the students who receive formative assessment and those who do not receive formative assessment
2. There is no significance difference in the academic achievement scores of male and female students when exposed to formative evaluation testing in chemistry.

1.6 Significance of the study

The outcome of this study will be of great benefit to students and teachers in the field of science education. This study is significant for it will be of immense importance to Chemistry teachers as this will help identify the best form of assessment to boost students' understanding and achievement in Chemistry.

It will be of great importance to student because it gives students evidence of their current progress to actively manage and adjust their own learning. This also provides our students the ability to track their educational goals.

To teachers, help teachers to anticipate in advance treating the gaps of the students and changing these methods, if necessary, in the learning process. This allows our students to be part of the learning environment and to develop self-assessment strategies that will help with the understanding of their own thought process. When teachers constantly monitor student growth and adjust instruction to ensure continuous improvement, they find it easier and more predictable to progress towards meeting the standards on summative assessments.

By understanding exactly what their students know before and during instruction, educators have much more power to improve student mastery of the subject matter than if they find out after a lesson or unit is complete.

1.7 Scope of the Study

This study investigates the effect of formative assessment on secondary school student academic achievement in chemistry in Ikwo Local Government Area, Ebonyi State. It involves senior secondary school class two (SS2) chemistry students in selected government owned secondary

schools in Ikwo Local Government Area of Ebonyi State. SS2 students are to be used because they are not in the examination class and are available for the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 INTRODUCTION

This chapter deals with the review of related literatures and contains information gathered from books, online source, journals and other periodicals that provides the researcher with necessary background knowledge. The review of literature is presented under the following headings and subheadings namely; Conceptual Framework, Theoretical framework, Empirical Studies and Summary of literature review.

2.1 Conceptual Framework:

2.1.1 Concept of Assessment

2.1.2 Concept of Formative assessment

2.1.3 Students' Academic Achievement in chemistry

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2.2 Theoretical Framework:

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2.3.1 Studies on formative assessment on student's achievement and interest in Chemistry

2.3.2 Studies on influence of gender on student's achievement and interest in Chemistry

2.4 Summary of Literature Review

2.1 CONCEPTUAL FRAMEWORK

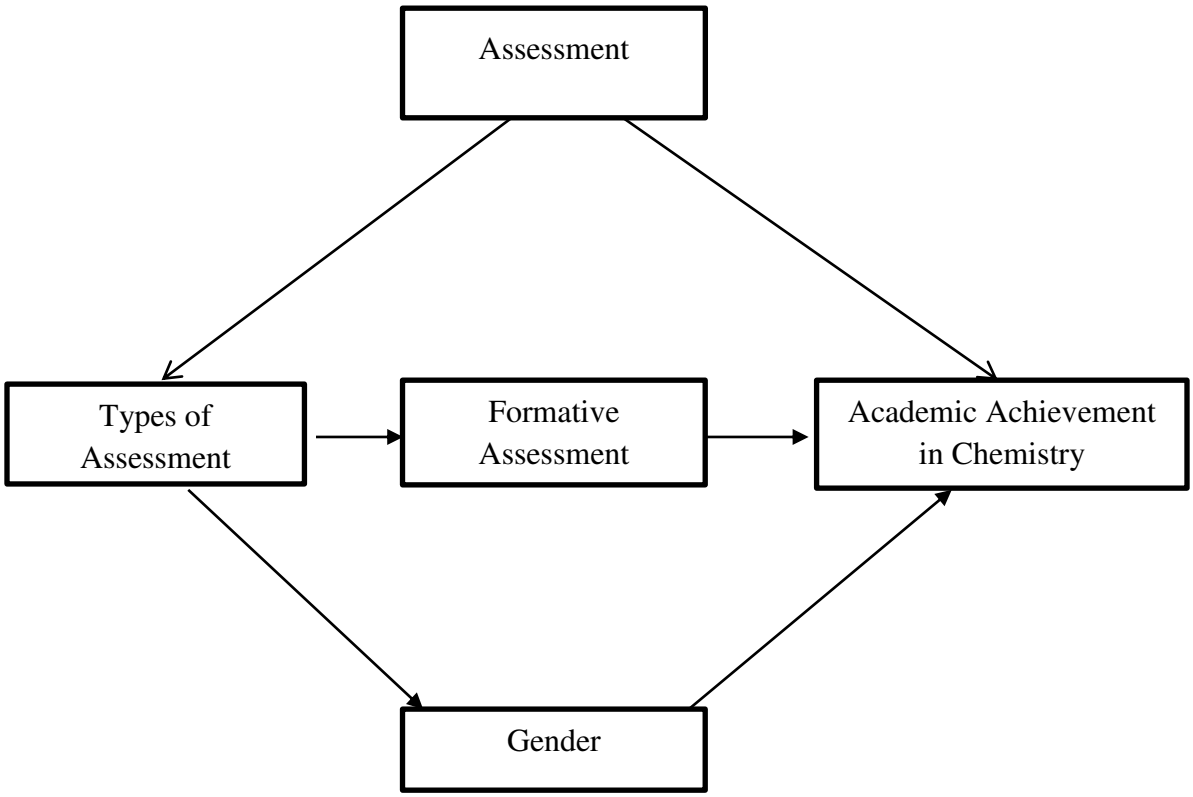

Fig. 2.1: Schematic diagram of the Relationships among the Study Variables

Assessment is the process of defining, selecting, designing, collecting, analysing, interpreting, and using information to increase students' learning and development. Among the different types of assessment, formative assessment was considered for this study. The variables of the study include: academic achievement, gender, formative assessment. The study revealed the effects of formative assessment on students' achievement in chemistry.sss

2.1.1 Concept of Assessment

In the past, assessment was not considered part of the learning process. It was a mechanism that established how much a student had learnt, without contributing to the process that students must follow to gain abilities, knowledge and competences (López-Pastor, 2009). Assessment in any educational system ascertains the extent to which educational learning outcomes are achieved and also the extent to which students have mastered the subject matter. Educators, through assessment can determine whether students are developing desired competencies and values, or whether the curriculum provides the vital knowledge and skills of the discipline, and whether students can integrate learning from individual courses into a complete educational experience that prepares them for future careers. In higher institutions of learning, assessment of student learning is a fundamental phenomenon and it is also a continuous process geared towards promoting and understanding students' learning outcomes. However, in recent times, a trend has emerged in secondary education to disassociate assessment from the concept of grading, and instead incorporate it into students' learning process (Brown, 2015). In their view Kallaghan and Greaney (2001), observed "that teachers' assessment of their students in the classroom deserves a second consideration in terms of improving the quality of education". Assessment from educational perspective according to Ukwuije (2012) "is a process of documenting, usually in measurable terms, knowledge, skills, attitudes, beliefs, practice or generally what behaviour a learner does or does not have, acquire or develop before, during and at the end of instruction, or a course of study". Furthermore, assessment has been defined as; "a process of obtaining information used to make educational decisions about students, to give feedback to the students about his or her progress, strengths and weaknesses, to judge instructional effectiveness and curricular adequacy and inform policy" (American Federation of Teachers (AFT), National

Council on Measurement in Education (NCME); and National Education Association (NEA), in Kallaghan and Greaney (2001).

According to Huba and Freed (2000), Assessment is the process of gathering and discussing information from multiple and diverse sources in order to develop a deep understanding of what students know, understand, and can do with their knowledge as a result of their educational experiences; the process culminates when assessment results are used to improve subsequent learning. Falchikov (2005) viewed assessment as any process that can be used to appraise students' knowledge, abilities or skills, comprehension, understanding of the concepts learnt. Marzano (2000) also suggested that assessment should be vehicles for gathering information about students' achievements or behaviour about their learning outcomes. Linn and Miller (2005) define assessment as any of the variety of procedures used to obtain information about student performance. It is the process of defining, selecting, designing, collecting, analyzing, interpreting, and using information to increase students' learning and development. According to Ohia(2011) in Palomba and Banta (1999) describe assessment as the systematic collection, review, and use of information about educational programs undertaken for the purpose of improving student learning and development.

Boud (2009) explained that assessment in secondary education is always implemented in a traditional way; revolving around examinations, assignments and other kinds of tests. Boud (2000) warned that some current assessment in secondary education were unlikely to help prepare students for lifelong learning. Boud and Falchikov (2006) stressed that "secondary education has traditionally focused on preparing students for acquisition of knowledge rather than participation in learning".

As cited by Yambi, 2018 in Brown, 1990 maintains, in classroom assessment, since teachers themselves develop, administer and analyze the questions, they are more likely to apply the results of the assessment to their own teaching. Therefore, it provides feedback on the effectiveness of instruction and gives students a measure of their progress. Two major functions can be pointed out for classroom assessment: One is to show whether or not the learning has been successful, and the other one is to clarify the expectations of the teachers from the students.

Assessment is a process that includes four basic components:

1. Measuring improvement over time.
2. Motivating students to study.
3. Evaluating the teaching methods.
4. Ranking the students' capabilities in relation to the whole group evaluation.

2.1.1.1 Why Assessment is Important

First and foremost, assessment is important because it drives students learning (Yambi, 2018). Whether we like it or not, most students tend to focus their energies on the best or most expeditious way to pass their 'tests.' Based on this knowledge, we can use our assessment strategies to manipulate the kinds of learning that takes place. For example, assessment strategies that focus predominantly on recall of knowledge will likely promote superficial learning. On the other hand, if we choose assessment strategies that demand critical thinking or creative problem solving, we are likely to realize a higher level of student performance or achievement. In addition, good assessment can help students become more effective self-directed learners (Darling-Hammond 2006). As indicated above, motivating and directing learning is only one purpose of assessment. Well-designed assessment strategies also play a critical role in

educational decision-making and are a vital component of ongoing quality improvement processes at the lesson, course and/or curriculum level.

2.1.1.2 Nature of Assessment

Assessment is embedded in the learning process. It is tightly interconnected with curriculum and instruction.

As teachers and students work towards the achievement of curriculum outcomes, assessment plays a constant role in informing instruction, guiding the student's next steps, and checking progress and achievement.

The following are the nature of assessment:

i. Classroom assessment involves students and teachers in continuous monitoring of students' learning.
ii. It gives students a measure of their progress as learners.
iii. It provides opportunity for close observation of students in the process of learning.
iv. It helps in collection of frequent feedback on students' learning and how they respond to particular teaching approaches.
v. Assessment has profound impact on the self-esteem of pupils, which is critical influence on learning.
vi. Uses variety of strategies.

Although, teachers and administrators can select assessment forms and tasks, the purpose of assessment varies among various education stakeholders such as students, teachers, parents, schools and policy makers.

2.1.1.3 Type of Assessment

There are different types of assessment according to Okoye Udogu and Igboegwu, (2015), which include the following:

1. **Formative Assessment:**

Formative assessment is generally carried out throughout a course or project. Formative assessment also known as "educative assessment' is used to aid learning. Formative assessments can take the form of diagnostic, standardized tests. It is an integral part of teaching and learning. It does not contribute to the final mark given for the module; rather it contributes to learning through providing feedback. It indicates what is good and how the work could be improved. Effective formative feedback affects what next the students and the teachers do.

2. **Summative Assessment:**

Summative assessment is generally carried out at the end of a course or project. In an educational setting, summative assessments are typically used to assign grades to students' class work. Summative assessments are evaluative. They measure learning outcomes and report those outcomes to students, parents and administrators. Assessment usually occurs at the conclusion of a class, course, semester or academic year. Summative assessment demonstrates the extent of a learner's success in meeting the assessment criteria used to measure the intended learning outcomes of a module or programme. It is used to qualify achievement, to reward achievement and to provide data for selection. For all these reasons, the validity and reliability of summative assessment are of the greatest importance.

3. **Diagnostic Assessment:**

This is an integral part of formative assessment. It improves the learner's experience and their level of achievement. It looks backwards, assesses what the learner already knows and the nature of difficulties that the learner might have. It measures students' current knowledge and skills for the purpose of identifying a suitable programme of learning. For instance, self-assessment is a form of diagnostic assessment which involves students assessing themselves.

4. **Dynamic Assessment:**

Dynamic assessment measures what the student achieves when given some teachings in an unfamiliar topic or field. It can be used to assess general learning potential for students who have a particular disadvantaged background.

5. **Criterion – Referenced Assessment:**

This occurs when students are measured against defined criteria. However, it is not always used to establish a person's competence.

6. **Ipsative Assessment:**

This is assessment against the student's own previous standard. It can measure how well a particular task has been undertaken against the students' average attainment, best work or against most recent piece of work.

To achieve optimal students' achievement in chemistry, formative assessment must be used while teaching chemistry. Chemistry teaching can only be result-oriented when students are

willing and teachers are in a position to use the appropriate methods and resources in teaching chemistry.

2.1.2 Concept of Formative Assessment

Educators have long taken the beneficial effect of formative assessment for granted. Numerous sources tout the ability of these strategies to improve student academic achievement. However, the definition of formative assessment remains amorphous and comprises a significantly variable set of practices. When teachers begin to aim at assessing students in the classroom to improve learning and achievement far more than collecting information to assign grades or certifying mastery, therefore, perhaps of greatest importance is formative assessment.

According to McManus (2008) formative assessment is a process used by teachers and students during instruction that provides feedback to adjust ongoing teaching and learning to improve students' achievement of intended instructional outcomes. Marsh (2004) states that" formative assessment provides data about instructional units in progress and students in action, they help to develop or form the final curriculum product and help students adjust to their learning tasks through the feedback they receive." Sutton (1992) states that formative assessment is an "ongoing process conducted both formally and informally, by which information and evidence about a child's learning is absorbed and used to plan the next step, or guide a given task".

Ojugo (2013) stated that formative assessment is useful to both the students as it helps to diagnose students' learning difficulties and the prescription of alternative remedial measure all towards improvement in the academic achievement in the subject concerned, and to the teacher as means of locating the specific difficulties that students are experiencing within the contents of the subject and forecast the appropriate teaching strategies to help the students understand the

difficulties in the contents in order to improve their academic achievements in the subject. Ugodulunwa and Uzoamaka (2015) opined that the key requirements for successful formative assessment include the use of quality assessment tools and the subsequence use of the information derived from these assessments to improve teaching and learning instructions.

Ajogbeje, (2013) emphasis that the utilization of formative testing in the teaching-learning process involve breaking up the subject matter content or course into smaller hierarchical units for instruction; specifying objectives for each formative test; offering a group based remediation in areas where students are deficient before moving to another units and then administration of summative test on completion of all units. Ojugo, (2013) stated that the breaking up of subject or course into small units makes for adequate preparation for the test by the students. Moreover, such frequent test enable the student to get more involved and committed to the teaching-learning process thereby enhancing their performance. Philias (2012) when quoted Bloom, Hasting, and Madus, (1971) whom were of the opinion that formative evaluation is useful to both the students (as a way of diagnosing students' learning difficulties and the prescription of alternative remedial measures) and to the teacher (as means of locating the specific difficulties that the students are experiencing within subject matter content and forecast summative evaluation result.

Ajogbeje, (2013) also cited Gronlund and Linn (1990), that formative evaluation serves three specific uses namely:

i. To plan corrective action for overcoming learning deficiencies.
ii. To aid in motivating learners and
iii. To increase retention and transfer of learning.

Formative assessment is commonly referred to as assessment for learning. Assessment Reform Group (ARD, 2002) explained assessment for learning as any assessment for which the first priority in its design and practice is to serve the purpose of promoting pupils' learning. It differs from assessment designed primarily to serve the purpose of accountability, or for ranking or of certifying competence. William, Lee, Harrison, and Black (2014) argued that assessment for learning occurs when assessment is used to enhance student achievement. Assessment for learning is one in which assessment information is to be used by the teacher and learners to identify areas of difficulty and then execute on-target instruction to assist the learners to adequately fix the issue that is of concern. It requires careful design on the part of teachers so that they use the resulting information to determine not only what students know, but also to gain insights into how, when, and whether students apply what they know. Teachers can also use this information to streamline and target instruction and resources, and to provide feedback to students to help them advance their learning (Afemikhe, 2018).

For Pophan (2008), assessment for learning is a planned process in which evidence of students' status is used by teachers to modify their ongoing instructional procedures or used by students to adjust their current learning strategies. Assessment for learning is intended to assist learning while instruction and learning are taking place. It is practiced to close the gap between learners' current status and their intended learning goals (Heritage, 2012).

Clarke (2001), using findings from Black and Wiliam's study (1998), suggests that the key elements of formative assessment include:

i. The provision of effective feedback to pupils
ii. The active involvement of students in their own learning

iii. Adjusting teaching to take account of the result of assessment

In Formative Assessment, the emphasis is on transferable learning, here, assessment becomes a much more transparent process, which is based on critical information that is shared with learners, and thus the learners are responsible for their own learning and assessment". Based on research findings and interviews conducted with teachers who had practiced Formative Assessment in their classrooms Black, Harrison, Marshall, Lee and Wiliam (2003) identified the following Formative Assessment strategies:

1. Teachers use of questioning: refers to the use of questions by teachers to diagnose and extend students' ideas and to scaffold students' thinking. The teacher adjust questioning to accommodate students' contributions and thinking in a neutral rather than evaluative manner" (Chin, 2006a).

2. Feedback through marking: refers to the use of written comments instead of grades to inform students on their area of strength and weaknesses. This approach guides the students to analyse their strengths and improve on their weakness.

3. Peer and Self-assessment by Students: is defined as "the process whereby groups of individuals rate their peers. While self-assessment refers to "the involvement of learners in making judgments about their own learning, particularly about their achievements and the outcomes of their learning"

4. Formative use of summative assessment: refers to the use of items from past examination and test papers that are relevant to the topics being taught by the teacher to assess on-going learning process".

The researchers have observed from most researched work in most developing countries, such as Nigeria, assessment practices focus primarily on examinations (summative assessment) in which little or no emphasis on classroom assessment methods are made. Most teachers appear to focus more on the activities, laid- out for teaching in order to end scheme of work than on outcome/master y. Most teachers administer classroom assessment specifically to generate mandatory terminal continuous assessment scores. The evaluation functions are high-lighted, whereas the guidance and learning processes are not high-lighted. A high priority is accorded the collection of marks for records, rather than enquire into learners activities to detect learning requirements and assessment strategies that would improve and enhance learning. Therefore, these affect the academic achievement of student.

2.1.3 Students' Academic Achievement in Chemistry

In this era of scientific knowledge and development, much demand is placed and emphasis is laid on the teacher, the learner, the curriculum and the environment in the whole process of learning chemistry. According to Lewis, as cited by Ashu and Ayadema (2011), behavior or experience is an interactive function (F) of the person and the environment. Their Mathematical Formula B=F (P, E) indicates that behavior (B) reflects the environment (E) and the person within the environment (P). This formula stressed the need for new research strategies in which behavior is considered to be a function of the person and the environment, because the environment also plays an active role in the academic achievement of student.

According to Narad and Abdullah (2016), academic achievement is the knowledge gained which is assessed by marks by a teacher and/or educational goals set by students and teachers to be achieved over a specific period of time. They added that these goals are measured by using

continuous assessment or examination results. Annie, Howard and Mildred (as cited in Arhad, Zaidi and Mahmood, 2015) also indicated that academic achievement measures education outcomes. They stressed that it shows and measures the extent to which an educational institutions, teachers and students have achieved their educational goals. Again Martha (2009) emphasized that academic achievement of students is defined by a student's performance in an examination, test and in course work/class work. In the educational system, a poor or an under achiever is someone whose performance is constantly below average. According to Okoro (2012), results of Chemistry in Nigeria indicate that achievement in chemistry is poor.

Explaining the factors affecting students' achievement in various science subjects such as chemistry has become a subject that interests a great number of researchers. Studies of this kind are carried out intensively in the field of science. The reason for this is that students' achievement in the field of science most especially in chemistry is low (Martin, Mullis, Foy, Olson, Erberther, Prenschoff and Gaha, 2008). Recently, studies have been carried out to investigate the possible cause of low achievement and how to increase students' learning of the subject. Many variables like inadequate number of teachers, lack of teaching and learning material, improper teaching methods, teachers' competency and students attitudes towards science subjects such as chemistry are considered to contribute to low achievement have been discussed (Danjuma, 2009).

Academic achievement is an important parameter in measuring students' learning outcome in various school disciplines, it is commonly measured by assigning scores to the outcome of continuous assessments and examinations (Yucel, 2007). The most dominant factor of value in any educational system, according to Ndioho (2007), is achievement. That is why the teacher applies different forms of achievement tests to students in order to classify them into different

levels of achievement based on their potentialities. Ndioho classified students into two categories;

• **High–achievers:** these are those whose academic potentials are above class average and their performance is described as good.

• **Under-achievers:** these are students whose academic potentials are below the class average. Their performance is described as poor.

Presently in Nigeria, it is the West African Examination council (WAEC) and National Examination Council (NECO) that perform the role of grading students at the end of their secondary school education. WAEC and NECO conduct achievement examinations to show how much the students have achieved after completion of the secondary school program.

Studies over the years have shown that there is a disparity in the achievement of males and females in chemistry.

2.1.4 Influence of Gender on Achievement of Students in Chemistry

The problem of student underachievement in secondary schools in Nigeria has been a much discussed educational issues. In solving any problems, it is pertinent to understand the causes of such problems. Many causes have been studied and advanced as the etiological starting point for investigating the phenomena of students' failure or success. These causes are looked into from several perspectives including the role of the students, teachers, parents, school environment, society and Government. Gender has been advanced as one of such factors that may have a considerable influence on student academic achievement especially in science subjects such as Chemistry (Filgona and Sababa, 2017).

According to Filgona (2017) gender is the range of physical, biological, mental and behavioural characteristics pertaining to and differentiating between the feminine and masculine (female and male) population. Gender can also be referred to as the socially, culturally constructed characteristics and roles which are ascribed to male and females in any society, Okeke (2008). Gender in common usage refers to the sexual distribution between male and female, while the Social scientists however refer to the term as a social construction rather than a biological phenomenon (Leonard, Benjamin and Sagary, 2011).

The relationship between gender and the academic achievement of students has been discussed for decades (Eitle, 2005). The influence of gender on students' achievement has long time been a concern to many educational researchers, but surprisingly no consistent results have been obtained (Adesoji and Babatunde, 2008; Mohammad, 2008; Ajaja and Eravwoke, 2010).

What has remained the main focus of great concern in the field of chemistry are the biases and misconceptions about women and chemistry, i.e. Chemistry is a male enterprise (Enriosho, 2006). Many researches have been carried out on gender issues in chemistry (Bilesanmi-Awoderu, 2002; Enriosho, 2006). There is a strong association between gender and response to chemistry. The likely influence of gender factors on students' academic achievement in chemistry when taught using formative assessment will be examined by this study.

Okoye, Udogu and Igboegwe (2015), in their study carried out a research on The Efficacy of Formative Assessment on Chemistry Students' Achievement and Knowledge Retention found out there is no significant difference in the achievement scores of male and female students who were taught Chemistry using formative assessment technique. In short the notion of influence of gender on students' academic achievement has continued to be an unending debate among

educators. That is perhaps the reason why Usman (2010), maintained that the issue of gender in science teaching seems to be a controversy.

Okpala (2021) also carried out a research on determinants of Students Lack of Interest and Achievement in Chemistry in Secondary Schools in Enugu State, the result of the study shows that there is no significance difference in the gender effect of students achievement in chemistry.

Also, Oludipe (2012) conducted a study on gender difference in Nigerian junior secondary students' academic achievement in Basic Science. He found that female students perform slightly better than the male students. In their own study, Jegede and Inyang (2000), worked on gender differences and academic achievement in chemistry in Senior Secondary Schools. They confirmed that males performed better than females. They affirmed that males demonstrated significantly more positive attitudes towards science than females. Owuamanam and Babatunde (2007) noted that the girls tend to go for courses that do not require more energy and brain tasking such as home making while boys looked for jobs in management, engineering, banking and other brain-tasking professions.

However, in another research conducted by Joel and Sesugh (2006), on gender differences and achievement in calculating reacting masses from chemical equations among secondary school students in Makurdi Metropolis. The results have shown that boys perform better than girls in chemistry problem solving which requires the use of mathematics/calculation. Thus, in this study, it will be determined whether gender affects academic achievement of SSS 2 Chemistry students in Ikwo Local Government Area of Ebonyi State.

2.2 Theoretical Framework

The theories relevant to this study are;

- Gagne's Theory of Learning Hierarchy and
- Bruner's Theory of Learning by Discovery

2.2.1 Gagne's Theory of Learning Hierarchy

Robert Mills Gagné (1916-2002), was an American educational psychologist, he is a prominent educational psychologist whose ideas on the "conditions of learning' are generally employed in every teaching learning process. Gagne postulated that learning is best achieved when teaching is organized from simple to complex. He described learning as a change in the behavior of an individual that makes possible a corresponding change in his or her behavior in a particular situation. According to him, learning is a process that takes place inside an individual's brain (comparable to organic processes such as digestion and respiration). The most important aspects of learners are 'his senses, his central nervous system, and his muscles'.

Learning has been defined as a relatively permanent change in a behavioural tendency, the result of reinforced practice. Learning an inferred state of organism, should be distinguished from performance, an observed state of the organism, should be distinguished from performance. Learning events consists of stimuli, learner and responses (Maheshwari, 2013).

Gagne's theory combined a basic behaviourist position with elements of cognitive thought and builds a hierarchical model of the different types of learning. Although he refers to this hierarchy as learning types, he is primarily interested in the observable behavior and performance which are the products of the condition of this hierarchy. In this hierarchy, the lowest four orders tends

to focus on the more behavioural aspects of learning, while the highest four focus on the more cognitive aspects.

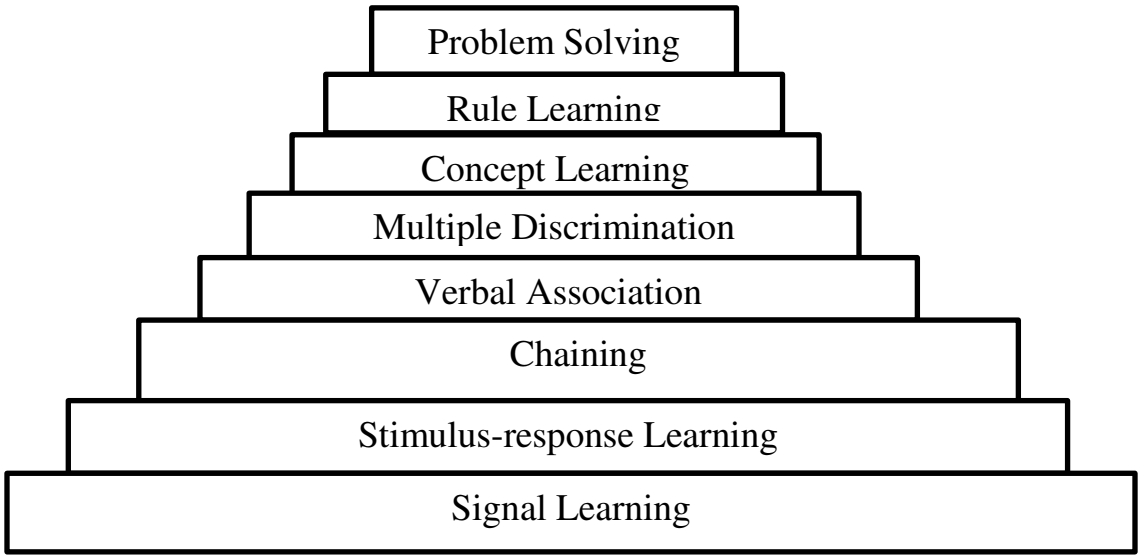

Fig 2.2: Schematic diagram of Gagne's hierarchy of learning

1. **Signal Learning:** This is the simplest form of learning and consists essentially of the classical conditioning first described by the behavioural psychologist Pavlov. In this type of learning, the animal or individual acquire a conditioned response to a given signal. Examples are the withdrawal of the hand upon sight of a hot object.
2. **Stimulus-response Learning:** This is a more sophisticated form of learning, which is also known as operant conditioning, it was originally discovered by Skinner. In this type of learning, the individual makes response to specific stimuli; the correct response is rewarded.
3. **Chaining:** This is a more advanced form of learning in which the subject develops the ability to connect two or more previously-learned stimulus-response bonds into a linked sequence

4. **Verbal Association:** It's a form of chains that are verbal. Examples is when a child identifies an object and call it by its original name.
5. **Multiple Discrimination:** The learners learn to distinguish between motor and verbal chain he/she has already acquired
6. **Concept Learning:** A common response to a class of stimuli
7. **Rule Learning:** In learning a rule, we relate two or more concepts. For example, at 100 degree Celsius, water will boil.
8. **Problem Solving:** The learner used the rule learned to achieve some goal.

Mishra (2017) found out that Gagne's theory of learning has three broad education implication and they include:

1. **Prerequisite behaviour:** Gagne advocated that processes of learning move from the simple to the complex. The learner has to develop prerequisite capabilities before he/she acquires new terminal behaviour. Thus the use of a hierarchy of learning and task analysis are integral parts of instructional transactions.
2. **Learners' characteristics:** Learners' individual differences, readiness and motivation to learn are the important issues to be considered before designing instructional activities.
3. **Cognitive process and instruction:** The transfer of learning, the self-management skills of the learner, and teaching learners the skills of problem solving are integral parts of the internal conditions of learning, applicable to instruction. The skill of learning 'how to learn' should be developed in the learner and the emphasis should be on the learner's individuality.

Gagne suggests that concepts acquisition takes place in an orderly, sequential, integrative and hierarchical manner. The present study employed Gagne's theory in the arrangement of the learning tasks within the Formative Assessment Package. As a result, the tasks in the learning package are sequentially and hierarchically structured moving from simple task to complex ones and from known to unknown (Ugodulunwa and Okolo, 2015). Efforts are also made by teachers before teaching any concept to ascertain what prior knowledge students had and to use that as prerequisite for new learning.

2.2.2 Bruner's Theory of Learning by Discovery

Jerome S. Bruner (1966) is a proponent of cognitive learning and a developmental psychologist who is primarily interested in the development of mental abilities. His approach to psychology is eclectic (i.e. he selects the best or the most useful features from the various conflicting theories available). He looks at human being as information processors, thinkers and creators, and treats the learner as a reactive organism who actively selects, structures, retains and transforms learning information to achieve certain goals.

Learning is an active social process in which students constructs new ideas or concepts based on current knowledge. The student selects information, originates hypotheses, and makes decisions in the process of integrating experiences into their existing mental constructs. By organizing the cognitive structure, using schema and mental models, the learner can provide meaning and organization to experiences and go beyond the information given.

Bruner maintains that learning follows a similar sequence no matter the age of the learner. There are three ways in which human beings interpret the world around them. In learning, we move through each stage to develop a more comprehensive understanding of what we are experiencing,

but these stages are very integrated, occurring together in some cases, and only loosely sequential as one translates into the other. In these three stages which are enactive (action-based), iconic (image-based), and symbolic (language based), learners faced with new information move through each stage of representation as they grasp the concept of what is being learned.

Both Jean Piaget, Bruner's mentor, and Bruner himself conceptualized thought processes as being subdivided into distinct modes of reasoning. While Piaget related each mode to a specific period of childhood development, Bruner saw each mode as dominant during each development phase, but present and accessible throughout. Bruner, unlike Piaget, did not contend that these stages were necessarily age-dependent.

Bruner maintains that knowing is a process, therefore, his work focuses on

(a.) the importance of understanding the structure of the subject being studied; and,

(b.) the need for active learning as the basis for understanding.

Bruner argues that when learners are presented with perplexing situations they will want to figure out the solution. This was the basis for his discovery learning theory. Discovery learning is inquiry-based: learning takes place in problem solving situations where the learner draws on his or her own past experience and existing knowledge to discover facts and relationships to be learned. Students interact with the world by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments.

The structure of learning is more important than simply memorizing facts. Learners should be able to make connections between concepts. Schools often do a disservice to students, says Bruner, by limiting teaching to only important information. Learners need time to think

analytically about information and not simply use their intuition to solve a problem. There needs to be an analytical process to investigate the information presented.

This study is related to Bruner's theory of learning by discovery because its promotes the acquisition of knowledge through discovery. This becomes necessary where the instructional strategy is learner-centered. Learners have to respond to the teachers' questions to enable them discover new ideas, theories and concepts in science (chemistry) (Ugodunlunwa and Okolo, 2015). The lessons within the formative assessment package is learner-centred and designed in such a way that teachers will teach to foster deductive learning and also help to reduce anxiety level in students and improve performance in chemistry.

2.3 Review of Related Empirical Studies

In this section, related empirical studies carried out by other researchers were reviewed. Many empirical studies have been conducted in the area of formative assessment and how it influences students' achievement, at many places, in different times. In the present study, some of the empirical studies are reviewed and presented.

2.3.1 Studies on formative assessment on student's achievement and interest in Chemistry

Okoye et al., (2015) investigated the efficacy of formative assessment on chemistry students' achievement and knowledge retention. The study adopted quasi-experimental pretest-posttest control group design. A total sample size of eighty one students participated in the study. Four research questions and two hypotheses guided the study. The instrument used for data collection was chemistry achievement test which was also used as retention test. The reliability coefficient was calculated using (Cronbach) alpha with reliability coefficient of 0.85. For data analysis, the research questions were analyzed with mean and standard deviation. Z-test analysis was used to

test the two hypotheses at 0.05 level of significance. Findings showed use of formative assessment in teaching chemistry has a significant effect on students' achievement and knowledge retention. Some recommendations were made based on the findings. For example, science teachers (chemistry) should encourage formative assessment as a type of assessment to be used in chemistry classroom as it helps to improve students' achievement and knowledge retention. Furthermore, the reviewed study was carried out in Enugu State, but this study was carried out in Ebonyi State and it investigated not only on formative assessment but also its effect on student academic achievement, unlike the reviewed study that looked into efficacy of formative assessment on chemistry students' achievement and knowledge retention.

2.3.2 Studies on influence of gender on student's achievement and interest in Chemistry

Some studies have investigated the influence of gender on academic achievement of students. Ifeakor (2008), evaluated the influence of gender on students' academic achievement in Chemistry using a commercially produced computer assisted instruction package. Six research questions were posed and six hypotheses were formulated and tested at 0.05 level of significance. The non-randomized control group design involving four intact classes was used. The sample for the study consisted of 140 senior secondary one (SSI) Chemistry students from two private secondary schools. The instrument for data collection namely Chemistry Achievement Test (CAT) was developed and validated. An internal consistency for CAT was computed as 0.89 using Kuder Richardson formula (KR-20). The data obtained were analyzed using mean, standard deviation to answer the research questions and analysis of covariance (ANCOVA) for testing the hypotheses. The result of the analysis indicated that gender was a significant factor in the students' overall cognitive achievement in Chemistry. In the present study, the influence of gender on students' achievement in chemistry when exposed to formative

assessment was investigated. In the present study, a total of 60 students responded to a twenty-five-item Chemistry Achievement Test (CAT), and the present study will use mean, standard deviation and analysis of covariance on data analysis, unlike the reviewed study, a total of 38 students responded to a five-item Chemistry Achievement Test (CAT). Also, the present study instrument's reliability was tested using Kuder Richardson formula (K-R20), unlike the reviewed study that used Pearson r to test the reliability of the instrument.

2.4 Summary of Literature Review

The review was done under conceptual framework, theoretical framework and related empirical studies. In the conceptual review, the concepts of assessment, concept of formative assessment, students' academic achievement in chemistry, and gender were highlighted. Accordingly, the concept of assessment was highlighted as the process of defining, selecting, designing, collecting, analysing, interpreting, and using information to increase students' learning and development. It is also a process of gathering and discussing information from multiple and diverse sources in order to develop a deep understanding of what students know, understand, and can do with their knowledge as a result of their educational experiences; the process culminates when assessment results are used to improve subsequent learning. The concept of formative assessment reviewed is define as the process used by teachers and students during instruction that provides feedback to adjust ongoing teaching and learning to improve students' achievement of intended instructional outcomes. This concept of formative assessment is used by the teacher and learners to identify areas of difficulty and then execute on-target instruction to assist the learners to adequately fix the issue that is of concern. It requires careful design on the part of teachers so that they use the resulting information to determine not only what students know, but also to gain insights into how, when, and whether students apply what they know. Accordingly,

the concept of academic achievement in chemistry was highlighted as an important parameter in measuring students' learning outcome in various school disciplines, it is commonly measured by assigning scores to the outcome of continuous assessments and examinations. The concept of gender reviewed indicates that gender in chemistry refers to classification of the roles of the males and females in chemistry classroom. Gender and chemistry learning have been a focus of concern in various studies and there has continued to be controversy over students' achievement according to gender. This study is also an attempt to make contribution in the area of gender and academic achievement in chemistry. Student's academic achievement reveals that success or failure of a school depends on many factors such as inadequate number of teachers, lack of teaching and learning material, improper teaching methods, teachers' competency and students' attitudes towards the subjects being taught.

The theoretical framework highlighted two theories namely Gagne's Theory of Learning Hierarchy and Bruner's Theory of Learning by Discovery. Gagne's theory promotes learning as a process that takes place inside an individual's brain (comparable to organic processes such as digestion and respiration). The most important aspects of learners are 'his senses, his central nervous system, and his muscles'. The theory supports arrangement of learning tasks within the formative assessment package. As a result, the tasks in the learning package are sequentially and hierarchically structured moving from simple task to complex ones and from known to unknown. The theory has relevant to the present study since it emphasizes on formative assessment. Bruner believes that learning follows a certain sequence no matter the age of a learner. The theory of learning by discovery promotes the acquisition of knowledge through discovery. This becomes necessary where the instructional strategy is learner-centered. Learners have to respond to the teachers' questions to enable them discover new ideas, theories and concepts in science

(chemistry). The lessons within the formative assessment is learner-centred and designed in such a way that teachers will teach to foster deductive learning and also help to reduce anxiety level in students and improve performance in chemistry. This theory stimulates that learners need time to think analytically about information and not simply use their intuition to solve a problem. There needs to be an analytical process to investigate the information presented. Learning is more of an active social process in which students constructs new ideas or concepts based on current knowledge. The student selects information, originates hypotheses, and makes decisions in the process of integrating experiences into their existing mental constructs.

The review of related empirical studies highlighted the findings of previous studies on effect of formative assessment on academic achievement. However none of the reviewed study was able to find the effect of formative assessment mode of teaching on academic achievement of chemistry students. Thus, the present study investigated the effect of formative assessment on students' academic achievement in chemistry.

CHAPTER THREE

METHOD OF STUDY

3.1 Introduction to the Chapter

This chapter presents the methods that were used in carrying out the study on "effect of formative assessment on student academic achievement in chemistry in Ikwo Local Government". The procedures employed in this study are discussed under the following sub headings: Research design, area of study, population of the study, sample and sampling techniques, instruments for data collection, validity and reliability of the instrument, method of data collection and method of data analysis.

3.2 Research Design

This study adopted quasi experimental design, precisely the pre-test, post-test, control group design. The reason for adopting quasi experimental was because in the design, two or intact groups which are not equivalent are assigned randomly to treatment conditions (Nworgu, 2015). Also, this design is considered most appropriate to give sufficient experimental results on the effects of formative assessment on student academic achievement in chemistry in ikwo local government. A pre-test was administered to determine the equivalence in ability level of these two groups (experimental and control groups). The experimental groups were exposed to expository class teaching followed by formative class test with feedback and remediation, while the control groups were exposed to only expository class teaching. At the end of the four-week treatment period, the posttest was administered to both experimental and control groups. The design of the study is presented as follow;

EG → O1 → X1 → O2

CG → O1 → XO → O2

Where;

EG = Experimental Group

CG= Control Group

O1 = Pretest

O2 = Posttest

XO = No Treatment

X1 = Treatment

3.3 Area of the Study

The area of the study is Ikwo Local Government Area of Ebonyi state. The people in this area are educationally conscious and there are good numbers of senior secondary schools in the zone. The choice of Ikwo Local Government for this study was premised on the fact that the academic achievement of chemistry students in this state at large, over the years is dismally poor, and efforts has been made to proofer solution which leads to the identification of factors that affect students' achievement in chemistry, which include teaching method. Thus, based on the aforementioned reason and the scarcity of such studies on students' achievement in chemistry using formative assessment in this area leads to the reason why this area of study was chosen.

3.4 Population of the Study

The population of this study is composed of two government owed secondary schools out of the 23 in Ikwo Local Government of Ebonyi State, Nigeria. The total population of students in all the government owned schools in Ikwo L.G.A is 5862, which comprises of 2698 males, and 3164 females (2020/2021 secondary school student enrolment Ikwo LGA). SSS2 students were

considered appropriate for the study because they have studied chemistry for at least one year at the senior secondary school level. The SS3 students could not be used for the study at the time of the research because they have covered much of the syllabus in Chemistry. In each of the two schools selected, thirty (30) students were randomly chosen as the study sample, thus the sample consisted of one hundred and twenty (60) Chemistry students from the science classes of both schools. One school was randomly assigned the training and remediation group while the other was the control group.

3.5 Sample and Sampling Techniques

Random sampling technique was used in selecting two (2) governments owned secondary schools, out of the schools in Ikwo Local Government Area. Then using a flip of coin, one school was chosen as the control group, while the other school was the experimental group. Purposive sampling was used in selecting the participating students from the selected secondary schools, as only chemistry students were sampled in this study. Sixty (60) students were purposively sampled from the selected schools in Ikwo Local Government Area, Ebonyi State. Thus, the sample size used for this study was sixty (60), which comprised of 30 males and 30 females.

3.6 Instrument for Data Collection

The instruments used in this study were Chemistry Achievement Test (CAT), which was designed by the researcher with the use of table of specification, it contained two sections. Section A contained biodata information of the students, while section B contained 20 objective items questions to which the students were expected to provide the correct answer by choosing the correct option. The questions were administered to the students before and after being taught with formative assessment package, and was used to determine the achievement on learning

outcomes of the students in Chemistry. The 20-item questions were based on four topics; Type of reactions, Catalytic Reaction, Oxidation and reduction, Oxidizing and reducing agent.

3.7 Validation of the Instrument

The Chemistry Achievement Test (CAT) and the instructional manuals/packages (lesson notes) were face validated by presenting them to two experts in Science education in the Department of Science Education, and one expert in measurement and evaluation in the Department of Education Foundation both in Alex-Ekwueme Federal University Ndufu Alike, Ebonyi State.

The items were scrutinized by these experts in terms of scope of coverage, content relevance, ambiguity and vagueness of expression. They also checked the answers to the CAT for correctness or otherwise. They also scrutinized the instructional packages designed for the study. Corrections and suggestions arising from these experts were used to review the instrument and the instructional packages. Items that were considered either too difficult or too simple were restructured, while those that were not relevant were eliminated based on the experts' advice. After this review, all the 20 items of CAT sailed through. To develop the content validity of the CAT, it was developed based on the test blueprint/table of specification

3.8 Reliability of the Instrument

Chemistry Achievement Test (CAT) was trial-tested to establish the reliability coefficient of the instrument by administering it to 20 SS II students from a senior secondary school which was outside of the schools selected for this study. Test retest procedure was used in administering the instrument on the students. The kuder-Richardson formula 20 (K-R 20) was used to determine the internal consistency of a multi choice questions. According to Nworgu (1991) cited in Jirgba

(2008) the standard for reliability coefficient valve of above 0.5 infers that, the reliability estimate is appropriate. Using Kuder-Richardson formula, the scores obtained from the pilot test was calculated so as to get the reliability index, which was found to be 0.71. Based on this therefore, the test retest results satisfy the minimum prescribed reliability coefficient.

3.9 Method of Data Collection

Data were obtained for this study following acceptable method of data collection. An introductory letter was obtained from the Head of Department of Science Education, AE-FUNA, introducing the researcher to the authority of the selected senior secondary schools as a student researcher of the department. The instrument used (Chemistry Achievement Test) was administered to students before and after being taught with Formative assessment. Research showed that students in secondary schools are usually being taught with the traditional teaching method, which is the lecture method, where students only listen and not allowed to contribute their ideas to the instruction process. The researcher therefore administered the achievement tests to the students, score them, and then find the mean score. The researcher then taught the students using formative assessment package which is a teaching method used to monitor student learning to provide ongoing feedback that can be used by instructors to improve their teaching and by the student to improve their learning. This was carried out for a period of four (4) weeks after which the same set of achievement tests were shuffled and re-administered as posttest to the students and their mean score were taken. This showed the significance and effect of Formative assessment on students' understanding and achievement in Chemistry.

3.9.1 Experimental Procedure

The conduct of the study took place during the normal school lesson periods. The normal time-tables of the schools used for the study were followed. Before the commencement of the actual treatment, the researcher used two days for the training of the Chemistry teachers who served as research assistants. The orientation programme covered the following areas:

1) The purpose of the research;
2) The Chemistry concepts to be taught and
3) Procedure for administering the instrument.

The orientation programme was to ensure the uniformity of instructional situation across the groups. The orientation for the experimental groups only differed from that of the control group by the use of formative assessment respectively.

Two research assistants were employed and trained by the researcher for two days to teach the instructional units. The experimental group was taught using formative assessment method of evaluation respectively while the control group was taught using lecture method. CAT was administered in form of pre-test to the two groups before treatment to ascertain their background knowledge. After 4 weeks of teaching the pre-test was reshuffled and administered as post-test to ascertain the stability of the instrument. The post-test was scored and compared with the pre-test scores to see if there could be any correlation relationship between the two scores of the test.

3.10 Method of Data Analysis

The data collected were analysed using mean and standard deviation for research questions. The researcher compared the mean scores, that is, the mean score of the results of the students when taught with lecture method and the mean score of their results when taught with formative

assessment. This is because mean is the most reliable and representative measure of central tendency and standard deviation is the most reliable estimate of variability (Nworgu, 2015).

The data collected for this study was also used to test the hypotheses stated in chapter one, using analysis of covariance (ANCOVA) for the hypotheses. The hypotheses were tested at 0.05alpha level of significance. The analysis of covariance (ANCOVA) was appropriate because the experiment involve the pretesting of the subjects, and in order to ensure initial group differences.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

This chapter presents the result of the research carried out on the effect of Collaborative and Project-Based Teaching Strategy (CPBTS) and Conventional Teaching Strategy on the academic achievement of Chemistry students in Senior Secondary Schools in Abakaliki Education Zone. It basically involves the presentation and analysis of data gathered through the use of a Chemistry Achievement Test (CAT) distributed to the respondents.

4.1 Answers to Research Questions

Research question 1: What are the effects of formative assessment on secondary school student's academic achievement in chemistry

Table 4.1.1: Mean and Standard deviations of the Pre and Post Achievement Scores of the Experimental and Control Groups.

VARIABLES		PRE-TEST		POST-TEST		
	N	MEAN	S.D	MEAN	S.D	MEAN GAIN
EXPERIMENTAL GROUP	30	4.83	2.21	14.56	2.89	9.73
CONTROL GROUP	30	4.33	2.10	8.96	2.14	4.63

Table 4.1.1 shows that the group taught chemistry using formative assessment had a pretest achievement mean of 4.83 with a standard deviation of 2.21 and a posttest achievement mean of 14.56 with standard deviation of 2.89. The difference between the pretest and posttest achievement mean for formative assessment was 9.73. The group taught chemistry without formative assessment had a pretest achievement mean of 4.33 with a standard deviation of 2.10 and a posttest achievement mean of 8.96 with a standard deviation of 2.14. The difference between the pretest and posttest achievement mean for those taught without formative assessment was 4.63. However, in each group, the posttest achievement means are greater than the pretest achievement means with experimental group having the highest mean gain. Therefore, there was a significant difference between the post achievement scores of the two groups in favour of the experimental group.

Research Question 2: What is the effect of formative assessment on male and female secondary school student academic achievement in chemistry?

Table 4.1.2: Mean and Standard deviations on Pre and Post Achievement Scores of Males and Females Taught Using Formative Assessment.

GENDER		**PRE-TEST**		**POST-TEST**		
	N	**MEAN**	**S.D**	**MEAN**	**S.D**	**MEAN GAIN**
MALE	**15**	**4.46**	**1.92**	**13.93**	**2.63**	**9.46**
FEMALE	**15**	**5.20**	**2.48**	**15.20**	**3.09**	**10.00**

Table 4.1.2: shows that male students who were taught using formative assessment had a pretest achievement mean of 4.46 and standard deviation of 1.92 and a posttest mean achievement score of 13.93 with Standard Deviation of 2.63. The difference between the pretest and posttest achievement mean for males in formative assessment was 9.46. While the female students who were taught using the same type of assessment had a pretest achievement mean of 5.20 and standard deviation of 2.48 and a posttest mean achievement score of 15.20 with Standard Deviation of 3.09. The difference between the pretest and posttest achievement mean for females in formative assessment was 10.00. Hence, the female students performed better than the male students. This indicates that method of assessment and gender interacts to effect students' achievement in chemistry.

4.2 Test of Hypotheses

Hypotheses

Research Hypothesis 1: There is no significant difference in the mean scores of the students who receive formative assessment and those who do not receive formative assessment

Table 4.2.1 Analysis of Covariance (ANCOVA) of mean achievement scores of student who receive formative assessment

Dependent Variable: Posttest					
Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Corrected Model	614.369[a]	4	153.592	36.355	.000
Intercept	766.844	1	766.844	181.510	.000
Pretest	130.303	1	130.303	30.842	.000
Group	407.731	1	407.731	96.509	.000
Gender	3.952	1	3.952	.935	.338
Group * Gender	.838	1	.838	.198	.658
Error	232.364	55	4.225		
Total	9154.000	60			
Corrected Total	846.733	59			

The result in table 4.2.1 shows that with respect to the mean achievement scores of students receive formative assessment methods of teaching; an F-ratio of 96.509 was obtained with associate exact probability value of 0.00. Since the associated probability was less than 0.05 set as the level of significant, the null hypotheses which stated that there is no significant difference

in the mean scores of the students who receive formative assessment and those who do not receive formative assessment is rejected. Thus, inference drawn is that there is a significant difference in the mean achievement scores of the students who receive formative assessment in teaching with those who do not receive formative assessment having a higher mean gain. This shows that formative assessment in teaching has more effect on students' achievement in chemistry.

Research Hypothesis 2: There is no significance difference in the academic achievement scores of male and female students when exposed to formative evaluation testing in chemistry.

Table 4.2.2 Analysis of covariance (ANCOVA) for the male and female academic achievement when exposed to formative evaluation testing in chemistry.

The result in Table 4.2.1 also shows that with respect to the achievement mean scores of male and female students who receive formative assessment in teaching, an F-ratio of 0.935 was obtained with associated probability value of 0.338. Since the associated probaioloility value was greater than 0.05 which is the significance level, the null hypothesis which stated that there is no significance difference in the academic achievement scores of male and female students when exposed to formative evaluation testing in chemistry was accepted. Thus, inference drawn is that male and female students differ in their mean achievement scores in chemistry when exposed to formative evaluation testing in chemistry.

4.3 Summary of Findings

This section of the chapter is a summary of the findings of the study according to each of the tested hypotheses. From the data analysis and interpretation of the results, the following findings emerged;

a. Students assessed using formative assessment had higher mean achievement scores than their counterparts who are not assessed with formative assessment.

b. Female students taught chemistry had higher mean achievement score than their male counterparts taught chemistry using the same method of assessment. This indicates that method of assessment and gender has effect on students' achievement in chemistry.

4.4 Discussion of Findings

The result of the study showed that formative assessment has a significant effect on the secondary school chemistry students' academic achievement. Thus, there is a strong significant difference in the mean achievement scores of Chemistry students in secondary school taught using formative assessment which also enhanced the performance of students' academic achievement.

The findings of this study is in line with findings by Ajogbeje, (2013) who stated that with effective utilization of formative assessment, it enables adequate preparation of the students for the test and such frequent test enables the students to get more involved and committed to the teaching-learning process thereby enhancing their academic performance in the subject. The result of this study is also in line with the findings of Okoye et al (2015), which revealed that the use of formative assessment in teaching chemistry has a significant effect on students' achievement and knowledge retention. The students taught separation technique in chemistry using formative assessment performed significantly better than those taught the same concept without the use of formative assessment. This therefore, implies that teaching using formative assessment enhanced students' achievement as well as knowledge retention in chemistry.

Moreover, Olagunju (2015) in Marsh, (2007) stated that formative assessment is an evaluation method designed to correct the student's difficulties on the content of subject with the aim of enhancing the performance of students in the subject. While Christana et all, (2015) stated that if formative assessment is effectively used there is tendency for the student's achievement to be constantly improved.

Lastly, the result from this research concluded that there is no significant gender difference in the achievement scores of Chemistry students that are exposed to formative assessment. This finding agreed with Ajobgeje, (2013) who stated that gender difference is not significant issue in the use of formative assessment among male and female students when enumerating problem of poor performance in Chemistry. He concluded that the performance of the students depends on how the evaluation / assessment strategies have been effectively implemented and dedication of students to their learning process. The female can even perform far better than male if the male students are not dedicated to their learning process.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter presents Discussion of the major findings of the study, Conclusion, Recommendations, Implications of the Study, Suggestions for further studies and Summary of the study.

5.1 Summary of the Study

The study investigated the effect of formative assessment on academic achievement of secondary school chemistry students in Ikwo Local Government Area. Relevant literatures were reviewed under conceptual framework, theoretical framework, and empirical studies. The result of the review showed that there is a relationship between formative assessment and students' academic achievement. Some studies conducted revealed significant relationship between forms of assessment and students' achievement while others showed no significant relationship. Two research questions and two null hypotheses guided the study.

The quasi-experimental design was adopted for the study. Specifically the pre-test, post-test, control group design. The study was carried out at Ikwo Local Government Area. The sample for the study comprised 60 SSII students from two intact classes in two secondary schools in Ikwo Local Government Area of Ebonyi State, drawn using random sampling techniques. The experimental group was assessed in the process of teaching using formative assessment, while the control group was assessed using summative assessment evaluation. The instrument used for data collection was Chemistry Achievement Test (CAT) and was developed by the researcher. This instrument was subjected to be validated by two specialists in Science Education from the Department of Science Education, and one specialist from Educational Measurement and

Evaluation from Educational Foundations Department, from Alex Ekwueme Federal University, Ndufu-Alike (AE-FUNA) respectively. Thereafter, the items were trial tested. The reliability of these instruments was established using Kuder Richardson formula (K-R20). The reliability index was found to be 0.70. Mean and standard deviation were used to provide answers for the research questions while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

The result of the study, revealed the following:

- Formative assessment is superior to other forms of assessment in facilitating students' achievement in chemistry.
- There was no significant difference in the mean scores of male and female students in chemistry after the treatment, although female students performed slightly better than their male counterpart.
- On the mode of assessment, it was revealed that formative assessment and gender had a significant ordinal effect on students' achievement in chemistry

5.2 Conclusions

Based on the findings of this study, it could be concluded that when formative assessment are used for diagnostic purposes, it improve the academic achievement of the students on the subject and also enable them to understand the contents of the subject more better than the use of summative test only. Also formative test serve as a basis for finding out the sources of difficulties on the contents of the subject. In this way, the teacher is able to give necessary remediation and correctives measure to improve the understanding of students on the contents of the subject in order to improve their academic achievements in the subject concerned. The study

has revealed that those students who are not exposing to formative assessment have no significance difference in their achievement score in Chemistry.

5.3 Recommendations

The following recommendations have been made based on the findings of this study.

1. The school administrators should emphasize to their teachers on regular basis that the teaching of Chemistry in secondary school should be carried out by providing regular formative assessment for regular diagnostic of students learning difficulties on the contents of the subject and adequate feedback and remediation for learners to improve their academic achievement.
2. The government and school administrators should allow and provide incentives for teachers to attend seminars, workshops, conferences and in-service trainings to enhance their performances and to acquire necessary skills for constructing formative tests, and how to blend formative assessment with classroom procedures.
3. Chemistry teachers should endevour to note that gender does not account for students' achievement, rather the method of assessment used by teachers in teaching a particular subject. Therefore, Chemistry teachers should adopt the methods of assessment that are students centered in order to enhance students' achievement and interest in Chemistry in senior secondary schools in Nigeria.
4. Curriculum designers should take into cognizance while designing tasks for learners that learning in Chemistry is not solely a cognitive affair. Hence, Chemistry curriculum should be designed to include the use of methods / strategies and material media which would make the learning of Chemistry very active, investigative and adventurous.

5.4 Implications of the Study

The findings of this study have provided empirical evidence for the methods of assessment in chemistry teaching. It has some implications for teachers and students, policy makers, curriculum developers as well as various examination bodies.

One of the implications of this study is that Chemistry teachers could promote academic achievement of students in chemistry by developing and sustaining students' zeal, passion and performance in chemistry. This can be achieved through the process of assessing student before, during and after teaching. The teaching strategy has different approaches embedded in it that will encourage students of different background and gender to learn Chemistry effectively.

Furthermore, the use of formative assessment in teaching students will assist the teacher in monitoring student learning to provide ongoing feedback which can be used by the teacher to improve teaching and students to improve their learning.

For curriculum planners, this study suggested a careful reappraisal of Chemistry curriculum implementation strategies to ensure the incorporation of activities that will encourage the use of collaborative and project-based teaching strategy in teaching Chemistry.

5.5 Limitations and Suggestion for Further Research

Limitation of the study

The generalizations made with respect to this study are however subject to the following limitations:

1. Since different teachers were used for different groups, it could be assumed that they might not have been of equal attributes in terms of method, cognition, personality and affective functioning. This might have introduced error in the study.

2. There was also the problem of absenteeism among the students. The fact that some students skipped classes may have influenced their performance.

Suggestions for Further Research

Based on the limitations and findings of this study, the researcher has the following suggestions for further study.

1. A replication of this study in other local government and states of the federation.
2. Similar study should be carried out using other related science subjects like Agriculture, geography and Physics among others especially in senior secondary schools.
3. The researcher also suggests that another study of this nature should be carried out to include private schools in the state to compare findings of the present study.

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APPENDICES

APPENDIX A

ALEX EKWUEME FEDERAL UNIVERSITY, NDUFU-ALIKE, EBONYI STATE.

P.M.B 1010

FACULTY OF EDUCATION

DEPARTMENT OF SCIENCE EDUCATION

ACHIEVEMENT TEST ON THE EFFECT OF FORMATIVE ASSESSMENT ON ACADEMIC ACHIEVEMENT OF SENIOR SECONDARY SCHOOL CHEMISTRY STUDENT IN IKWO LOCAL GOVERNMENT AREA

SECTION A: STUDENTS PERSONAL INFORMATION (DEMOGRAPHIC DATA)

Name of School: _____

Sex: Male ( ) Female: ( )

Class: SS 1 ( ) SS2 ( ) SS3 ( )

SECTION B

Instruction: Select the most appropriate answer from the options lettered **A to D** for each question.

1. _____ is not a type of chemical reaction.

(a) Double decomposition (b) Enzymes (c) Reversible (d) Combination reaction

2. What type of reaction does the following equation represent $H_3O^+_{(aq)} + OH^-_{(aq)} \quad 2H_2O$

(a) Hydrolysis (b) Neutralization (c) oxidation (d) Reduction

3. A substance which oxidizes itself and reduces others is known as _____

(a) oxidizing agent (b) reducing agent (c) Both of these (d) None of these

4. Which of the compound can be used as a reducing agent in a reaction?

(a) $KMnO_4$ (b) $K_2Cr_2O_7$ (c) MnO_2 (d) Na_2SO_3

5. Which statement best describes the process of oxidation? (a) Addition of hydrogen (b) loss of oxygen (c) loss of electrons (d) gain of electrons

6. The two types of catalyzed reactions include _____ and _____

(a) Positive and Negative (b) Homogenous and Heterogeneous (c) Oxidation and reduction (d) organic and inorganic

7. Which of the following catalyst does not increase the rate of a reaction (a) Positive (b) Organic (c) Enzymes (d) Negative

8. _____ alters the rate of chemical reactions (a) catalyst (b) organic (c) chemicals (d) enzymes

9. $H_2S_{(g)} + Cl_{2(g)} \longrightarrow 2HCl_{(g)} + S_{(s)}$. Oxidizing agent in the reaction above is

(a) H_2S (b) HCI (c) CI_2 (d) S.

10. In which of the following reactions has the oxidation number of nitrogen increases

(a) $2NO_{(s)} + Br_{2(l)} \rightarrow 2NOBr_{2(g)}$ (b) $FeSO_{4(aq)} + NO_{(g)} \rightarrow Fe(NO)SO_{4(aq)}$ (c) $2NO_{(g)} + Cl_2 \rightarrow 2NOCI$

(d) $2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$

11. $Cu_2S_{(s)} + O_{2(g)} \rightarrow 2Cu_{(s)} + SO_{2(g)}$. What is the change in the oxidation number of copper in the reaction above? (a) +1 to 0 (b) 0 to +2 (c) +2 to +1 (d) 0 to +l

12. $3Cu_2 + 8HNO_{3(aq)} \longrightarrow 3Cu(NO_3)_2 + 4H_2O_{(l)} + 2NO_{(g)}$ In the equation above, copper is

(a) a base (b) an oxidizing agent (c) a reducing agent (d) an electron acceptor

13. What is the value of x is the following equation? $MnO^-_4 + 4H^+ + xe^- \quad MnO_2 + 2H_2O$

(a) 2 (b) 3 (c) 4 (d) 7

14. $Fe_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Fe^{2+}_{(aq)} + Cu_{(s)}$ From the reaction above, it can be inferred that

(a) Fe is the oxidizing agent (b) Fe is reduced (c) Cu^{2+} loses electrons (d) Cu^{2+} is the oxidizing agent.

15. The chemical reaction which occur when two or more compounds combine to form one single compound is called _____ (a) Neutralization (b) hydrolysis (c) combination (d) dissociation

16. In which of the following reaction does hydrogen peroxide act as a reducing agent?

a) $H_2S + H_2O \longrightarrow S + 2H_2O$
b) $PbSO_3 + H_2O \longrightarrow PbSO_4 + H_2O$
c) $2I^- + 2H^+ + H_2O_2 \longrightarrow I_2 + 2H_2O$
d) $SO_2 + H_2O_2 \longrightarrow H_2SO_4$

17. $X + Y \longleftrightarrow Z$ is an equilibrium reaction. The addition of a catalyst

a) Increase the amount of Z produced at a given time
b) Increases the rate of change in concentration of XY and Z
c) Increases the rate of disappearance of X and Y
d) Increases the rate of forward reaction.

18. _____ is an organic catalyst which controls the rate of biochemical reaction in a living organism. (a) Diatase (b) Chemical (c) Enzymes (d) Catalysis

19. How many electrons are transferred in reducing one atom of Mn in the reaction?
$MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$
a) 2 b) 3 c) 4 d) 5

20. $H^-_{(s)} + H_2O \longrightarrow H_{2(g)} + OH^-_{(aq)}$
From the above equation above it can be inferred that the
a) Reaction is a double decomposition
b) Hydride ion is a reducing agent
c) Hydride ion is an oxidizing agent
d) Reaction is neutralization.

APPENDIX B

CHEMISTRY ACHIEVEMENT TEST

MARKING SCHEME (1mark each=20marks)

1. B
2. B
3. B
4. D
5. C
6. B
7. A
8. A
9. C
10. D
11. A
12. C
13. C
14. B
15. C
16. D
17. D
18. C
19. A
20. C

APPENDIX C

TABLE OF SPECIFICATION/TEST BLUE PRINT ON CONTENTS OF CHEMISTRY ACHIEVEMENT TEST (CAT)

CONTENT/ OBJECTIVE PERIOD	**Contents**	**Comprehension 40%**	**Application 20%**	**Analysis 20 %**	**Knowledge 20%**	**Total 100%**
DURATION IN WEEKS	Topics					
WEEK 1	Introduction to the type of chemical reaction. 2 periods (25%)	**2**	**1**	**1**	**1**	**5**
WEEK 2	Catalytic Reaction 2 periods (25%)	**2**	**1**	**1**	**1**	**5**
WEEK 3	Oxidation Reaction 2 periods (25%)	**2**	**1**	**1**	**1**	**5**
WEEK 4	Oxidizing and reducing agent 2 periods (25%)	**2**	**1**	**1**	**1**	**5**
TOTAL	**8 periods 100%**	**8**	**4**	**4**	**4**	**20**

APPENDIX D

LESSON PLAN

School:
Subject: Chemistry
Topic: Types of Reaction
Class: SS2
Sex: Mixed gender
Time: 45 mins
Age: 16+
No of students:
Name of teacher:
Date:
Week: 1

LESSON OBJECTIVES

By the end of the lesson the students should be able to:

- Define Chemical Reaction.
- List the different type of chemical reaction.
- Mention the examples of some chemical reaction

INSTRUCTIONAL MATERIALS

Instructional Chart

INSTRUCTIONAL TECHNIQUES:

Demonstration, Explanation and Illustration

ENTRY BEHAVIOR:

The students should have previous knowledge on what a chemical reaction is.

SET INDUCTION:

The teacher will set induce the students with questions from previous lesson.

INSTRUCTIONAL PROCEDURE:

S/N	Content development	Teachers activities	Learners activities	Teaching strategies
1	Introduction	The teacher introduces the lesson after testing the students' knowledge on chemical reaction and it states: What is a reaction or chemical reaction? The teacher describes chemical reaction after which the student have answered it as those substances that undergo chemical changes in which new substances are formed	The students attempt the question.	
2	Meaning and Types of Reaction	The teacher describes chemical reaction as those substances that undergo chemical changes in which new substances are formed. The teacher demonstrates a chart showing different types of reactions.	The students passively listen while the teacher describes reaction and in turn repeat what the teacher said about chemical reaction.	Explanation and Illustration

		And they include; ➢ Combination reaction ➢ Decomposition reaction ➢ Displacement reaction ➢ Double reaction ➢ Reversible reaction ➢ Thermal dissociation reaction ➢ Catalytic reaction ➢ Oxidation and reduction reaction	The students also focus on the chart and list the types of chemical reaction that we have.	
3	**Combination reaction**	The teacher explains combination reaction as those reactions where two or more compounds combine to form one single compound. Combination can occur in any of the following ways. i. Element + Element → Compound e.g $Fe_{(s)} + S_{(s)} \rightarrow FeS_{(s)}$ $4Na_{(s)} + O_{2(g)} \rightarrow 2Na_2O_{(s)}$ ii. Compound + Compound → Bigger Compounds e.g $PbO_{2(s)} + SO_{2(s)} \rightarrow PbSO_{4(s)}$ $Na_2O_{(s)} + H_2O_{(l)} \rightarrow 2NaOH_{(aq)}$	The students observe what the teacher is doing for further practice and they also ask questions where necessary	Explanation and illustration
4	**Decomposition reaction**	The teacher explains decomposition reaction as a type of reaction that is characterized by the splitting up of a single compound into two or more simple substances. When heat is required to bring about the decomposition, the reaction is known as **thermal decomposition** e.g $2Pb(NO_3)_{2(s)} \xrightarrow{heat} 2PbO_{(s)} + 4NO_{2(s)} + O_{2(s)}$ $2Al(OH)_{3(s)} \xrightarrow{heat} Al_2O_{3(s)} + 3H_2O$ Other example $2AgNO_{3(s)} \xrightarrow{heat} ? + ? + ?$	The students observe what the teacher is doing and also memorise the stated definition, jot down note and ask questions where necessary	Explanation and illustration
5	**Displacement reaction**	The teacher explains Displacement reaction as another type of reaction that involves the replacement of one element (or radicals) by another element (or radicals) in a compound.	The student listen, jot down note and ask questions where necessary	Explanation and illustration

		A+BC ⟶ B + AC Where the ability of an element (or radicals) to displace another is determined by their position in the electrochemical series e.g the more electropositive zinc will displace the less electropositive salt from an aqueous solution of a copper (ii) salt. i. $Zn_{(s)} + CuSO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + Cu_{(s)}$ ii. $Cl_{2\,(g)} + 2KBr_{\,(aq)} \longrightarrow$? + ?		
6	**Double decomposition reaction**	In double decomposition reaction, the reactants decompose to form new substance by the exchange of a radical. **AB + CD ⟶ AD + CB** The two reactants are soluble and one of the products is soluble while the other is insoluble, volatile or gaseous. e.g $AgNO_{3(aq)} + NaCl_{(aq)} \longrightarrow AgCl_{(s)} + NaNO_{(s)}$ $KNO_{3(aq)} + H_2SO_{4(aq)} \longrightarrow$? + ?	The student listen, jot down note and ask questions where necessary	Explanation and illustration
8	**Reversible reaction**	The teacher explain a reversible reaction as a reaction in which the products can react to give the reactant $CaCO_{3(s)} + H_2O_{(l)} + CO_{2(g)} \longrightarrow Ca(HCO_3)_{2(aq)}$		
9	**Thermal dissociation**	In thermal dissociation, each molecule of a substance dissociate into two simpler molecules or atoms on the application of heat. Unlike thermal decomposition, thermal dissociation is reversible. Example: $NH_4Cl_{(s)} \rightarrow NH_{3(g)} + HCl_{(g)}$		
7	Evaluation	The teacher evaluate the topic taught to the students and ask them the following questions 1. What do you understand by reaction 2. List the different type of reaction 3. Relationship between decomposition reaction and thermal decomposition reaction	The students pay attention, copy the question, and attempt answering the question.	Questioning
8	Summary	In this lesson you have learnt that: • Chemical reaction as those substances that undergo chemical changes in which new substances are formed. • Different type of chemical reaction and they include:		

		➢ Combination reaction ➢ Decomposition reaction ➢ Displacement reaction ➢ Double reaction ➢ Catalytic reaction ➢ Reversible reaction ➢ Thermal dissociation reaction ➢ Oxidation and reduction reaction		

LESSON PLAN

School:
Subject: Chemistry
Topic: Catalytic reaction
Class: SS2
Sex: Mixed gender
Time: 45 mins
Age: 16+
No of students:
Name of teacher:
Date:
Week: 2

Lesson objectives

By the end of the lesson the students should be able to:

- State the meaning of catalytic reaction
- Illustrate with the aid of a diagram the type of catalyst we have
- Type of catalytic reaction
- Characteristic of a catalytic reaction
- What is an enzymes

Instructional materials

Pipette, burrete, retort stand, soap, sample of water from different sources, gas cylinder, kettle, etc.

Instructional techniques:

Explanation, illustration and Questioning

Entry behavior:

The students should have previous knowledge on water and it sources.

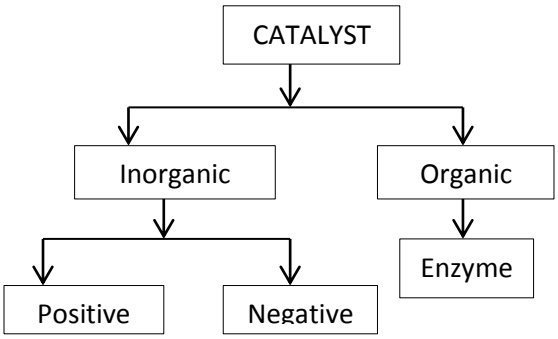
Set induction:

The teacher will set induce the students with simple locomotors movement.

Instructional procedure:

S/N	Content development	Teachers activities	Learners activities	Teaching strategies
1	Introduction	The teacher introduces the lesson after testing the students knowledge on reaction by asking them the type of reaction we have	The students attempt the question.	
2	Catalytic Reaction	The teacher explains what a catalytic reaction	The student pay	Explanation

		is and **Catalytic reaction** defined it as any type of chemical reaction which make use of catalyst and this catalytic reaction include catalytic combination, catalytic decomposition, catalytic reversible reaction, catalytic redox reaction and catalytic displacement reaction. Where a catalyst is a substance which alters the rate of chemical reaction, but itself remains chemically and quantitatively unchanged at the end of the reaction.	attention, ask questions and also take down note	method
3	Types of catalyzed reaction	The teacher states the two types of catalyzed reaction and they include: 1. Homogenous catalysis 2. Heterogeneous catalysis **Homogenous catalysis** Homogenous catalysis is a reaction in which the catalyst reactant and products are all in the same phase. e.g. The oxidation of sulphur(iv) oxide using nitrogen (ii) oxide as a catalyst occurs in a gaseous phase. $2SO_{2(g)} + O_{2(g)} \xrightarrow{NO_{(g)}} 2SO_{3(g)}$ **Heterogeneous Catalysis** In heterogeneous catalyst, reactant and products are in different phase. Most catalytic reactions are in this category. $N_{2(g)}\ 3H_{2(g)} \xrightleftharpoons{Fe_{(s)}} 2NH_{3(g)}$ The formation of margarine from vegetable oil in the presence of a nickel catalyst is also an example of heterogeneous catalysis. Vegetable $oil_{(l)} + H_{2(g)} \xrightarrow{Ni_{(s)}}$ Margarine	The students Listen and jot down important point	Explanation
4	**CHARACTERISTICS OF A CATALYST**	The teacher state and explain the characteristic of a catalyst and it include: 1. A catalyst alters the rate of a chemical reaction 2. A catalyst remains unchanged in chemical nature and mass at the end of a reaction. 3. A catalyst is specific in action i.e. a given catalyst will act on only one particular reaction. 4. A catalyst cannot start a reaction. It is effective only in a reaction which is already in progress.	The students pay attention and take down note.	

		5. A catalyst has no effect on the equilibrium of a reversible reaction. 6. A catalyst does not affect the types of products formed in a reaction. 7. A catalyst will affect the rate of a reaction even though it is present in very small amount. 8. The effect of a solid catalyst is improved by increasing its surface area.		
5	**TYPES OF CATALYST**	The teacher state and explain the two types of catalyst which we have and they are: 1. Organic catalyst 2. Inorganic Catalyst  **Positive catalyst:** this is a catalyst which increases the rate of a reaction e.g Maganese (IV) oxide which speeds up the decomposition of potassium trioxochlorate (V). $2KClO_{3(s)} \xrightarrow{MnO_2} 2KCl_{(s)} + 3O_{2(g)}$ **Negative catalyst:** it is a catalyst which decreases the rate of reaction. For example tetraoxophosphate (V) acid decreases the rate of decomposition of hydroge peroxide. $2H_2O_2 \xrightarrow{\text{hindered by } H_3PO_4} 2H_2O_{(l)} + O_{2(g)}$	The student listen, jot down note and ask questions	Explanation and illustration
6	**ENZYMES**	The teacher defines enzymes to the students and it defined as an organic catalyst which controls the rate of biochemical reactions in living organism. In other words, it is also defined as a biological catalyst which brings about chemical reactions in living cells. Enzymes help to digest food we eat. They cause blood to clot and fruit juice to ferment. $2(C_6H_{10}O_5)_{n(s)} + nH2O_{(l)} \xrightarrow{\text{diastase}} nC_{12}H_{22}O_{11(aq)}$ starch maltose	The students Listen and jot down important point	Explanation

<table>
<tr>
<td></td>
<td></td>
<td>Examples of catalysts for some common reactions.
<table>
<tr><th>Reaction</th><th>Catalyst</th></tr>
<tr><td>Thermal decomposition of potassium trioxochlorate (V)
$2KClO_{3(s)} \rightarrow 2KCl_{(s)} + 3O_{2(g)}$</td><td>Manganese (IV) Oxide (MnO_2)</td></tr>
<tr><td>Synthesis of sulphur(VI)Oxide
$2SO_{2(g)}+O_{2(g)} \rightleftharpoons 2SO_{3(g)}$</td><td>Vanadium (IV) Oxide (V_2O_5)</td></tr>
<tr><td>Formation of margarine from vegetable oil.
Vegetable $oil_{(l)}+H_{2(g)} \rightarrow$ Margarine</td><td></td></tr>
</table>
</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evaluation</td>
<td>The teacher evaluate the topic taught to the students and ask them the following questions
1. define the term catalyst
2. give five characteristic of a catalyst</td>
<td>The students pay attention, copy the question, and attempt answering the question.</td>
<td>Questioning</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>In this lesson you have learnt that:
• Catalytic reaction defined it as any type of chemical reaction which make use of catalyst.
• We have two type of catalytic reactions and they include homogenous and heterogeneous reaction
• There are different characteristic of a catalyst
• We have two types of catalyst and they include organic and innorgaic catalyst.
• Enzymes are organic catalysts which control the rate of biochemical reaction in a living organism.</td>
<td></td>
<td></td>
</tr>
</table>

LESSON PLAN

School:
Subject: Chemistry
Topic: Oxidation and Reduction Reaction
Class: SS2
Sex: Mixed Gender

Time: 45 mins
Age: 16+
No of students:
Name of teacher:
Date:
Week: 3

Lesson objectives

By the end of the lesson the students should be able to:

- Define oxidation and reduction using different methods
- Find out the oxidation number of different element
- Show the relationship between IUPAC naming and Oxidation number

Instructional techniques:

Illustration, Demonstration and Explanation

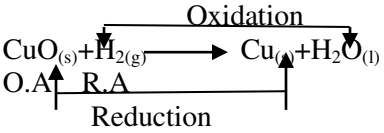
Entry behavior:

The students should have previous knowledge on water and it sources.

Set induction:

The teacher will set induce the students with simple locomotors movement.

Instructional procedure

S/N	Content development	Teachers activities	Learners activities	Teaching strategies
1	**Introduction**	The teacher introduces the lesson after testing the students knowledge on mixture and compounds. 1. What is mixture? 2. What is compound? 3. Give examples of each	The students attempt the question.	
2	**Meaning of Oxidation and Reduction reaction**	The teacher explains oxidation and reduction in different areas: **i. addition of oxygen:** Oxidation is simply a reactions by which oxygen combines with another substance, while reduction is that by which oxygen is removed from a substance.  From the reaction above, the hydrogen is oxidized to water (since oxygen has been added to it) while the copper (II) oxide has been reduced to metallic copper (since oxygen has been removed from it). In such a reaction, the copper (II) oxide is described as the **oxidizing agent (O.A)** and the hydrogen as the **reducing agent. (RA).** **ii. Removal of hydrogen:** the definition is extended to mean the removal of hydrogen,	The students pay attention. Focus on the chart presented and then supply the answer individually according to the teacher command.	Demonstration

while, that of reduction means the addition of hydrogen.

e.g Oxidation

$H_2S_{(g)} + Cl_{2(g)} \longrightarrow 2HCl_{(g)} + S_{(s)}$

R.A O.A

Reduction

iii. Addition of electronegative elements: The concept of oxidation is further extended to include the addition of electronegative elements and the removal of electropositive elements, while reduction includes the removal of electronegative elements and addition of electropositive elements.

Electronegative elements tend to attract electrons to themselves to become negative ions. e.g. non-metals like fluorine. The electropositive elements tend to lose electrons and become positive ions. e.g. metals like potassium.

In a reaction where two electronegative elements are present, the more electronegative of the two is regarded as the oxidizing agent. e.g

Oxidation

$H_2S_{(g)} + Br_{2(g)} \longrightarrow 2HBr_{(g)} + S_{(s)}$

R.A O.A

Reduction

iv. Transfer of electron: The current definition of both oxidation and reduction look at the two concepts in terms of electron transfer. Oxidation is a process involving loss of electron(s), while reduction is a process involving gain of electron(s).

This is the most concise definition of oxidation and reduction, because the concept of redox reactions in terms of electron gains or loss can be extended to all reactions, e.g. iron (II) chloride reacts with chlorine to form iron (III) chloride.

Oxidation

$2FeCl_{2(s)} + Cl_{2(g)} \longrightarrow 2FeCl_{3(s)}$

R.A O.A

Reduction

The fundamental change in this reaction is that Iron (II) ion, Fe^{2+} changes to Iron (III) ion, Fe^{3+} which corresponds to the change from Iron (II) oxide to Iron (III) oxide. Hence, it is clearly an

		example of oxidation reaction. Similarly, changes such as the conversion of copper (I) to copper (II), lead (II) to lead (IV) and so on, are all regarded as oxidation reactions. In all these changes, the charge on a positive ion is increased, while that on a negative ion is decreased. $Cu^{+} \longrightarrow Cu^{2+}$ $I^{-1} \longrightarrow I^{0}$ A substance loses electrons when it is oxidized and gains electrons when it is reduced, while a redox reaction is basically a transfer of electrons from the reducing agent to the oxidizing agent.		
3	**Relationship Between Oxidation Number and IUPAC Naming**	The teacher explains the **Relationship Between Oxidation Number and IUPAC Naming**. **Relationship Between Oxidation Number and IUPAC Naming**. The oxidation number or state of an element in a neutral compound or radical (ion) is defined as the electrical charge it appears to have as determined by a set of arbitrary rules.	The students pay attention, observe what the teacher is doing and ask question where necessary.	Demonstration
4	**Rules of determining Oxidation Numbers**	The teacher states rules of determining oxidation number and it include: 1. The oxidation number of all uncombined element is zero e.g Na, Cl 2. The oxidation number of an ion consisting of a single element is the same as the ionic charge on it. E.g Oxidation number of Na^{+} is +1, Cl^{-} is -1 3. The oxidation number of an ion consisting of more than one element (radical) is the algebraic sum of the oxidation number of all the elements in the ion. Example for OH^{-} [oxidation number of O] + [oxidation number of H] = [oxidation number of OH^{-}] (-2) + (+1) = -1 **Worked example:** find the oxidation number of NH_4^{+} 4. The oxidation number of a neutral compound is zero and it is the algebraic sum of the oxidation number of all the elements in the compound. Example: $MgCl_2 = 0$ [ox. No. of Mg] + 2[ox. No. of Cl] = [ox. No. of $MgCl_2$] +2 + 2x(-1) = +2-2 = 0	The students pay attention	

		Worked examples: find the oxidation number of manganese atom in $KMnO_4$ and give the IUPAC name of the compound. Solution: $KMnO_4 = 0$ $(+1) + Mn + 4(-2) = 0$ $+1 + Mn - 8 = 0$ $Mn - 7 = 0$ $Mn = +7$ The oxidation state of manganese in $KMnO_4$ is +7. Hence, the IUPAC name of the compound is Potassium tetraoxomanganate (IV)		
5	**Identifying redox reaction using oxidation number**	The teacher explains to the students that Redox reaction can be identified with the aid of oxidation number. For a redox reaction, oxidation number of an element on the reactant side is different on the product side. There must be changes in oxidation numbers. Example: $C + ZnO \rightarrow CO_2 + Zn$ Redox 0 +2 +4 0 or $NaOH + HCl \rightarrow NaCl + H_2O$ Not Redox +1-2+1 +1-1 +1-1 +1x2-2	The student pays attention, ask question and jot down notes	
	Evaluation	The teacher evaluate the topic taught to the students by asking them the following questions 1. What is oxidation and reduction in terms of the following • Addition of oxygen • Removal of hydrogen • Transfer of electron	The student answered the question asked by the teacher	
	Summary	In this lesson we have learnt that: 1. oxidation and reduction can be define inn different methods which include: • Addition of oxygen • Removal of hydrogen • Transfer of electron • Addition of electronegative element 2. rules for determining oxidation number 3. ways of identifying redox reaction using Oxidation number		

LESSON PLAN

School:
Subject: Chemistry
Topic: Oxidizing and Reducing agent
Class: ss2

Sex: mixed gender
Time: 45 mins
Age: 16+
No of students:
Name of teacher:
Date:
Week: 4

Lesson objectives

By the end of the lesson the students should be able to:

- Define oxidizing and reducing agent
- Identify an oxidizing and reducing agent
- Balancing of redox reaction

Instructional techniques:

Demonstration.

Entry behavior:

The students should have previous knowledge on the concept of oxidation and reduction reaction

Set induction:

The teacher will set induce the students with the definition of oxidation ad reduction reaction

Instructional procedure

S/N	Content development	Teachers activities	Learners activities	Teaching strategies
1	Introduction	The teacher introduces the lesson after testing the students knowledge on solution, solute and solvent 1. Define solution with example 2. Give 3 examples of solvent and solute	The students attempt the question.	
2	Meaning of Oxidizing and Reducing agent	The teacher explains the meaning of this concepts as: **Oxidizing agent** An oxidizing agent is defined as a substance which loses oxygen or electronegative element to another substance. Or an oxidizing agent is a substance which gains electron from a substance. Consider the reaction below: $C_{(s)} + ZnO_{(s)} \rightarrow CO_{2(g)} + Zn_{(s)}$ ZnO is the oxidizing agent because it loses oxygen to C. A reducing agent is defined as substance, which removes and accepts oxygen from other substances. Or a reducing agent is defined as a substance, which removes and accepts electronegative element from another substance. Or a reducing agent is defined it removes and accepts oxygen from ZnO. In an oxidation and reduction, the oxidizing	The students pay attention as the observe what the teacher is doing	Demonstration

<table>
<tr><td></td><td></td><td>agent is the reduced species while the reducing agent is the oxidized species.</td><td></td><td></td></tr>
<tr><td>3</td><td>Identification Of Oxidizing And Reducing Agent</td><td>The teacher explains how an oxidizing and reducing agent can be identified and also draws a tabular form showing the summary of the test.
IDENTIFICATION OF OXIDIZING AGENT: The presence of an oxidizing agent can be detected using any of the following reagents.
1. Iron(II) Chloride solution($FeCl_2$)
2. Hydrogen sulphide gas (H_2S)
SUMMARY OF TEST
<table>
<tr><th>S/NO</th><th>TEST</th><th>OBSERVATION</th><th>INFERENCE</th></tr>
<tr><td>1</td><td>O.A + $FeCl_{2(aq)}$</td><td>Green colour of Fe^{2+} solution turns to reddish-brown of Fe^{3+}</td><td>O.A is present</td></tr>
<tr><td>2</td><td>O.A + $H_2S_{(g)}$</td><td>Formation of yellow deposits of sulphur</td><td>O.A is present</td></tr>
</table>
TEST OF REDUCING AGENT: Reducing agent is detected in the laboratory using any of the following reagents
1. Acidified potassium tetraoxomanganate(vii)
2. Acidified potassium heptaoxodichromate (vi)
Summary of the test
<table>
<tr><th>S/NO</th><th>TEST</th><th>OBSERVATION</th><th>INFERENCE</th></tr>
<tr><td>1</td><td>R.A + Acidified $KMnO_4$</td><td>Purple solution of $KMnO_4$ turns colorless on addition of R.A</td><td>R.A is present</td></tr>
</table>
</td><td>The students examine the graph carefully and make some deduction form it.
The students pay attention and take down notes.</td><td>Demonstration</td></tr>
</table>

		2 | R.A + Acidified $K_2Cr_2O_7$ | Orange solution of $K_2Cr_2O_7$ turns green solution on addition of R.A | R.A is present Common oxidizing agents are: concentrated HNO_3, H_2SO_4, $KMnO_4$, $K_2Cr_2O_7$, O_2, Cl_2 etc Common reducing agents are: concentrated HCl, pure metals, carbon, H_2, SO_2, H_2S		
4	BALANCING OF REDOX EQUATIONS	The teacher solves some problems involving the determination of solubility of some solute. Guild the students to solve some other problems and make some correction when necessary. Step I (a) Tetraoxomanganate (VII) is the oxidizing agent. It is reduced to manganese (I) ion. $MnO^-_{4(aq)} \longrightarrow Mn^{2+}_{(aq)}$ (b) Iron (II) ions is the reducing agent. It is oxidized to iron (III) ion. $Fe^{2+}_{(aq)} \longrightarrow Fe^{3+}_{(aq)}$ Step II **(a) Reduction half equation** i. Balance the number of atoms by adding the correct number of H^+ and H_2O on the appropriate sides of the equation. $MnO^-_{4(aq)} + 8H^+_{(aq)} \longrightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$ ii. Balance the number of charges. Total number of charges on the left- hand side = (-1)+(+-8)= +7 Total number of charges on the right- hand side= +2 To balance the charges, add $5e^-$ to the left hand side. $MnO^-_{4(aq)} + 8H^+_{(aq)} + 5e^- \longrightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$ **(b) Oxidation half equation** i. $Fe^{2+}_{(aq)} \longrightarrow Fe^{3+}_{(aq)}$ The number of atoms is balanced ii. Balance the number of charges. Total number of charges on the left- hand side = +2 Total number of charges on the right- hand side= +3 To balance the charges, add one electron, e^-, to the right-hand side. $Fe^{2+}_{(aq)} \longrightarrow Fe^{3+}_{(aq)} + e^-$ Step III (a) Reduction half-equation $MnO^-_{4(aq)} + 8H^+_{(aq)} + 5e^- \longrightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$ (b) Oxidation half - equation	The students pay attention, take down the question and with the help of the teacher attempt getting the expected answer.	Illustration ad explanation

		Multiply the half equation by 5 $5Fe^{2+}_{(aq)} \rightarrow 5Fe^{3+}_{(aq)} + 5e^-$ Combine both the half - equations to eliminate the electrons. $MnO^-_{4(aq)} + 5Fe^{2+}_{(aq)} + 8H^+ + 5e^- \rightarrow$ $Mn^{2+}_{(aq)} + 5Fe^{3+}_{(aq)} + 4H_2O_{(l)} + 5e^-$ The overall ionic equation for the redox reaction is $MnO^-_{4(aq)} + 5Fe^{2+}_{(aq)} + 8H^+ \rightarrow$ $Mn^{2+}_{(aq)} + 5Fe^{3+}_{(aq)} + 4H_2O_{(l)}$ Note: For each oxygen that is needed, 20H ions are added to the side of the half- equation that is deficient and one H,O molecule to the opposite side, and for each hydrogen that is needed, one H,O molecule is added to the side that is deficient and one OH ion to the opposite side.		
	Evaluation	1. What is an oxidizing and reducing agent 2. list some common oxidizing and reducing agent	The student answers the question asked by the teacher	
	Summary	In this lesson we have learnt that: • An oxidizing agent is defined as a substance which loses oxygen or electronegative element to another substance. • A reducing agent is defined as substance, which removes and accepts oxygen from other substances. • There are two methods used to balance a redox reaction and they include the reduction half method and oxidation half method	The students pay attention.	

APPENDIX E

COMPUTATION OF RELIABILITY COEFFICIENT FOR THE CAT USING KUDER- RICHARDSON FORMULA 20 (K-R20)

$$K\text{-}R_{20} = \frac{N}{N-1}\left[1 - \frac{\sum PQ}{S.D^2}\right]$$

Where,
N = Number of items in the test
P = Proportion of test takers who scored the items correct
Q = Proportion of test takers who scored the items wrong
S^2= Variance of the test
$\sum$ = Summation sign

OVERALL RELIABILITY
KR20 = **Kuder Richardson Formula 20 (KR20)**

$$K\text{-}R_{20} = \frac{N}{N-1}\left[1 - \frac{\sum PQ}{S.D^2}\right]$$

Where K=20, ΣPQ= 5.31, $S.D^2$=16.08

$$= \frac{20}{20-1}\left[1 - \frac{5.31}{16.10}\right]$$

$$= 1.053\ (1 - 0.329)$$
$$= 1.053 \times 0.671$$
$$K\text{-}R_{20} = 0.706 = 0.71$$

APPENDIX F

OUTPUT ANALYSIS

Univariate Analysis of Variance

[DataSet0]

Between-Subjects Factors

		Value Label	N
Group	1.00	Control group	30
	2.00	Experimental group	30
Gender	1.00	Male	30
	2.00	Female	30

Descriptive Statistics

Pretest Posttest * Group

Group		Pretest	Posttest
Control group	Mean	4.3333	8.9667
	N	30	30
	Std. Deviation	2.10637	2.14127
Experimental group	Mean	4.8333	14.5667
	N	30	30
	Std. Deviation	2.21411	2.89689
Total	Mean	4.5833	11.7667
	N	60	60
	Std. Deviation	2.15730	3.78833

Descriptive Statistics

Dependent Variable: Pretest

Group	Gender	Mean	Std. Deviation	N
Control group	Male	4.2000	1.65616	15
	female	4.4667	2.53170	15
	Total	4.3333	2.10637	30
Experimental group	Male	4.4667	1.92230	15
	female	5.2000	2.48424	15
	Total	4.8333	2.21411	30
Total	Male	4.3333	1.76817	30
	female	4.8333	2.49252	30
	Total	4.5833	2.15730	60

Descriptive Statistics

Dependent Variable: Posttest

Group	Gender	Mean	Std. Deviation	N
Control group	Male	8.7333	1.98086	15
	female	9.2000	2.33605	15
	Total	8.9667	2.14127	30
Experimental group	Male	13.9333	2.63131	15
	female	15.2000	3.09839	15
	Total	14.5667	2.89689	30
Total	Male	11.3333	3.49713	30
	female	12.2000	4.07177	30
	Total	11.7667	3.78833	60

Levene's Test of Equality of Error Variances[a]

Dependent Variable: Posttest

F	df1	df2	Sig.
1.112	3	56	.352

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Pretest + Group + Gender + Group * Gender

Tests of Between-Subjects Effects

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	614.369[a]	4	153.592	36.355	.000	.726
Intercept	766.844	1	766.844	181.510	.000	.767
Pretest	130.303	1	130.303	30.842	.000	.359
Group	407.731	1	407.731	96.509	.000	.637
Gender	3.952	1	3.952	.935	.338	.017
Group * Gender	.838	1	.838	.198	.658	.004
Error	232.364	55	4.225			
Total	9154.000	60				
Corrected Total	846.733	59				

a. R Squared = .726 (Adjusted R Squared = .706)

Estimated Marginal Means

1. Group

Estimates

Dependent Variable: Posttest

Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control group	9.142[a]	.377	8.387	9.896
Experimental group	14.392[a]	.377	13.637	15.146

a. Covariates appearing in the model are evaluated at the following values: Pretest = 4.5833.

2. Gender

Estimates

Dependent Variable: Posttest

Gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
male	11.508[a]	.377	10.754	12.263
female	12.025[a]	.377	11.270	12.780

a. Covariates appearing in the model are evaluated at the following values: Pretest = 4.5833.

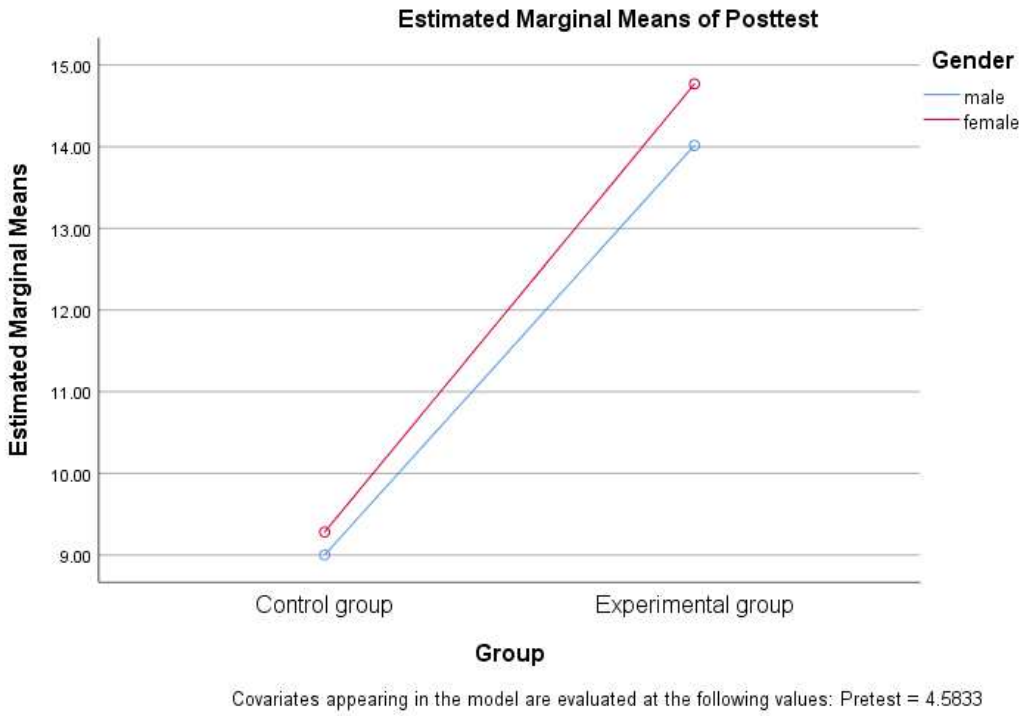
3. Group * Gender

Dependent Variable: Posttest

Group	Gender	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control group	Male	9.001[a]	.533	7.934	10.069
	female	9.282[a]	.531	8.218	10.346
Experimental group	Male	14.015[a]	.531	12.951	15.079
	female	14.769[a]	.536	13.694	15.844

a. Covariates appearing in the model are evaluated at the following values: Pretest = 4.5833.

Profile Plots



APPENDIX G

Department of Science Education
Faculty of Education
Alex Ekwueme Federal University Ndufu Alike.
Ebonyi State.
26th October, 2021.

Dear Sir/Madam,

LETTER FOR VALIDATION

I am an undergraduate student of chemistry education, department of science education in Alex Ekwueme Federal University Ndufu Alike. In order to fulfill the degree requirements I am undertaking a project on: Effect of formative assessment on academic achievement in senior secondary chemistry student in Ikwo Local Government Area

This research work adopts quasi experimental design of which chemistry achievement test is the tool/instrument for data collection. However, I kindly seek for your expectise for the validation of the instrument. Thanks.

Looking forward to receive your corrections and approval.

.

Yours faithfully,

Agu Matthew Chinonso
08156549634

APPENDIX H

ALEX EKWUEME FEDERAL UNIVERSITY NDUFU ALIKE

Department of Science Education,

Alex Ekwueme Federal University Ndufu Alike.

Ebonyi State.

18th October, 2021

To whom it may concern.

Sir / Madam.

INTRODUCTORY LETTER

Ref: Agu Matthew Chinonso 2017/ ED/6074

I write to introduce the above named undergraduate as my student. He is currently conducting his final year project research. Kindly assist him with all necessary information to enable him complete him research work.

Thanks for your anticipated cooperation.

Yours faithfully,

Dr Edith Nkiru Obande Ogbunaya
Head of Department