RELATIONSHIP BETWEEN SYMBOLIC LANGUAGE OF CHEMISTRY AND CHEMISTRY ACHIEVEMENT OF SENOIR SECONDARY SCHOOL STUDENTS IN KONTAGORA LOCAL GOVERNMENT AREA, NIGER STATE.

BY:

AROH Uzoamaka

(2016/3/64481BE)

PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIRMENTS FOR AWARD OF THE DEGREE OF BACHELOR OF TECHNOLOGY (B. TECH) IN SCIENCE EDUCATIION

TO

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION, DEPARTMENT OF SCIENCE EDUCATION,

NIGER STATE

NOVEMBER, 2019

ABSTRACT

The study was on the Relationship Between Symbolic Language Of Chemistry And Chemistry Achievement Of Senior Secondary School Student In Kontagora Local Government Area, Niger State. The aim of the study was to discover how symbolic language of chemistry affects the chemistry achievement of senior secondary students. The design adopted for the study is correlational research design. The reliability value was calculated using Cronbachs Alpha and a coefficient of 0.73 was obtained. 75 students were used for the study. The instrument used for data collection consists of twenty achievement test questions, ten for symbolic language of chemistry and ten for non-symbolic language of chemistry. The data was analysed using mean and standard deviation for the research questions and statistical package for social sciences (SPSS) was used for the hypothesis at a significance level of 0.01. Findings revealed that the symbolic language of chemistry has no negative effect on the chemistry achievement of students.

TABLE OF CONTENT

CHAPTER FIVE: CONCLUSSION AND RECOMMENDATION

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Chemistry is the branch of science that deals with the properties, synthesis and uses of matter (Osei, 2011). Chemistry is the study of laws of nature that govern the behavior of the universe, from the very smallest scales of sub- atomic particles to the very largest scales of cosmology (Emendu and Okoye, 2015). Chemistry handles the study of composition and properties of natural substances (Baanu*et al*., 2016).

Chemistry is noted to be one of the most important disciplines in the school curriculum; its importance in the general education has recieved worldwide recognition. Chemistry as a branch of science is a rational and mathematical discipline where certain measurement and controlled inputs lead to certain predictable output (learning Things 2014). It is worthy to emphasize that the field of Chemistry are related to the economic heart of every highly developed industrialized society (Burmeister et al. 2012).For instance, human beings have used organic compounds and their reactions for years in the manufacture of many valuable products for men use e.g. soap, oils, hydrogenated oil, kerosene, petrol, plastic, lubricants, Vaseline, ceramics and detergents. More so, the ancient Egyptians used organic compounds to dye cloths which are products of scientific discovery. Chemistry is regarded as the hub of science and it is considered as a service subject as reported by Baanu*et al*. (2016).

The role of chemistry in the development of the scientific base of a country cannot be overemphasized and Nigeria is not an exception (Nbina, 2012).Chemistry has been identified as a very important school subject and its importance in scientific and technological development of any nation has been widely reported. Chemistry was made a core-subject among the natural sciences and other science-related courses in Nigerian education system as a result of the recognition given to Chemistry in the development of the individual and the nation. It's inclusion as a core subject in science in secondary school calls for the need to teach it effectively. This is because effective teaching of science can lead to the attainment of scientific and technological greatness. Ability to achieve this greatness requires proper conceptualization of chemistry concepts. This will require teaching and learning approaches that will make students practice science knowledge gained, achieve good grades in chemistry and apply the learned concepts in their daily lives as scientists to be. Chemistry teaching can only be result oriented when students are willing and the teachers are favorably disposed, suing the appropriate method and resources in teaching the students. With the current increase in scientific knowledge over the world, much demand is placed and emphasis is laid on the teacher, the learner, the curriculum and the environment in the whole process of teaching and learning of chemistry as a subject.

Chemistry involves in all facets of our lives. Yet, it is cursed as much as it is praised. The mission of any high school chemistry teacher is to sell chemistry as an intellectual pursuit, as a creative science. Unfortunately, many students experience the chemistry curriculum as abstract, difficult to learn and unrelated to the world they live in. Chemistry is widely perceived as difficult because of its specialized language, mathematical and abstract conceptual nature, and the amount of content to be learned. For the past decade, chemistry scholars and researchers have been trying to explain how students should be helped to understand it but students are facing difficulty in understanding chemistry concepts due to the abstract level, symbolic level, unobservable, particulate basis of chemistry. Studies of [Modic, 2011 and Baah, 2012] argued that success in studying Chemistry depends upon the familiarity of students with a few basic ideas, conventions, and methods upon which later studies are built. When a student has achieved mastery of them, further studies can be pursued with greater confidence. One of the studies [Modic, 2011] further adds that without mastery of these concepts, it is difficult for students to find higher levels of study in Chemistry. Specially, the use of chemical symbols, Formulae writing chemical equations, calculations involving moles (solids, gases, and solutions) etc. are areas where students of chemistry face most challenges.

Chemistry is a difficult subject for students. The difficulties may lie in the capabilities of human learning as well as in the intrinsic nature of the subject. Chemistry is a world filled with interesting phenomena, appealing experimental activities, and fruitful knowledge for understanding the natural and manufactured world. However, it is complex, as a result of the difficult and complex nature of chemistry and also the fact that it is one of the most conceptually difficult subjects on the school and higher institution curricula; it is of major importance that anyone teaching chemistry is aware of the areas of difficulty in the subject. The concepts and principles in chemistry range from concrete to abstract. Many students of chemistry find certain concepts difficult to comprehend. The root of many of these difficulties that students have in learning chemistry is traceable to inadequate Understanding of the underlying concepts of the atomic model, and how these are used to explain macroscopic properties and laws of chemistry (Ukpahi and Olorundare2012).Difficulties faced in writing chemical symbols and Formulae Difficulties in the learning of chemistry can be precipitated by a lack of chemistry language skills. Students experienced greater problem in interpreting symbols correctly than words. The understanding of valency, appreciation of concepts of polyatomic ions and molecules and ultimately the production of correct chemical formulae will depend on student’s knowledge of bonding. Unfortunately, concepts in chemical bonding are highly abstract and it appears that only the most able students will be in a position to apply their knowledge of bonding effectively to scaffold the writing of chemical formulae

Students' difficulties in solving stoichiometric problems are partly associated with their inability to represent chemical equations correctly. Chief Examiners' (CE) reports available through the West African Examinations Council (WAEC) confirm that senior high school students experience difficulty when writing chemical equations. The 1994 CE report showed that most candidates were unable to write balanced chemical equations for the Senior Secondary School Certificate Examination (SSSCE) chemistry paper. The 1995 SSSCE report followed suit and reiterated that many candidates demonstrated problems when writing chemical equations. In 1999, the CE report indicated that students were unable to write equations for reactions between Bronsted-Lowry bases and concentrated HCl. In 2001, the SSSCE reported that the writing of ionic equations was poorly handled by candidates (Barke, 2001). The 2004 chemistry theory paper required candidates to write a balanced chemical equation for the production of oxygen when KClO is heated and then calculate the volume of the dry oxygen gas evolved (Ababio, 2004),. The examiners' CE report for the above question noted that candidates had problems writing the equation correctly and hence could not get the correct mole ratio (Baah, 2012).Based on the above, it is clear that over the years, students have experienced serious problems when writing chemical equations even though this is a basic requirement in chemistry. Without the proper writing of the chemical equation, students cannot subsequently solve or analyze equations and this affects the academic achievement of students as the performance of Nigerian students in the subject at the secondary school level to remain a dismal failure (Nbina, 2012)**.**

As a result of the difficult and complex nature of chemistry and also the fact that it is one of the most conceptually difficult subjects on the school and higher institution curricula, it is of major importance that anyone teaching chemistry is aware of the areas of difficulty in the subject. The concepts and principles in chemistry range from concrete to abstract. Many students of chemistry find certain concepts difficult to comprehend. The root of many of these difficulties that students have in learning chemistry is traceable to inadequate understanding of the underlying concepts of the atomic model, and how these are used to explain macroscopic properties and laws of chemistry (Upahi and Olorundare, 2012). Chemistry education should be emphasized at the secondary school in terms of teaching and learning. This is because chemistry as an academic disciple plays a very important role in unifying other science subjects. This emphasis seem not to be in place as there has been consistent decline in the performance of students in public examinations conducted by the West African Examination Council (WEAC) in sciences across the country over the years (Samba and Eriba, 2012).

Taskin and Bernholt (2014) have comprehensively reviewed numerous research reports on students' understanding of chemical formulas and their use. They identified three categories of students' problems and difficulties, of which the first and third are relevant to the study reported here: language based problems, problems due to conceptual understanding, and problems due to the inadequate selection and interpretation of formulae.

The Secondary School system in Nigeria is the link between the Primary School and tertiary institutions. It receives its population from the Primary school and prepares them for entry into the University. According to Suleman, Aslam and Hussain (2014) in determining the effectiveness of a national system of Education, Secondary education is universally acknowledged as a fundamental stage. Since the quality of Higher Education depends upon the quality achieved at this level, many countries of the world focus their attention on exploring better solutions to the escalating and emerging problems encountered by adolescents at this level of education. It is therefore imperative to study academic achievement at the Secondary School and piece out factors affecting it.

Academic achievement represents performance outcomes that indicate the extent to which a person has accomplished specific goals that were the focus of activities instructional environments (Steinmay et al, 2014) especially in School, College and University. Because of the importance attached to achievement at the Secondary School level of education, Suleman, Aslam and Hussain (2014), Kpolovie, Joe &Okoto (2014) conclude that Secondary Education is the foundation stone for further studies and also for the development of a nation. This conclusion is very true of Nigeria where academic achievement in Secondary school Certificate Examination determines who proceeds to higher institutions. Many prospective grandaunts of Secondary Education have been frustrated out of further education for the simple reason of not being able to acquire the much needed grades to qualify them for the almighty Unified Tertiary Matriculation Examination,(UTME). One therefore begins to wonder why the desired optimum academic achievement has become very elusive. This has led many educators and academic researchers to investigate into what has been responsible for this. Factors identified are indecisive with multiple variables. For instance Farooq, Chaudhry, Shafia & Berhann (2011), Ezike and Bamiro (2015) found that socioeconomic status and parents' education have a significant effect on students' overall academic achievement. Others include study habit, attitude, self-efficacy, teacher quality, English Language proficiency, academic interest, personality factors, class attendance, age, learning styles, class size etc. Another factor is improper understanding of the subject taught especially in chemistry where symbolic language of chemistry has the highest degree of difficulty.

1.2 Statement of the problem

The importance of chemistry in our world today is inevitable. This same chemistry cannot be taught in schools by teacher and learnt by students without the use of symbolic language of chemistry, Several factors have been advanced to affect students academic achievement such include the student factor, teacher factor, societal factor, the governmental infrastructural problem, language problem, examination body related variables, curriculum related variables, test related variables, textbook related variables and home related variables. The purpose of every educational research is to see how to make teaching and learning easier for better understanding in order for the students to get the best academic achievement with the goal of making them attain an excellent academic achievement.

Having seen all these contributing factors that affects student's academic achievement, the problem this study will like to handle is to show how a particular factor that has been identified as a difficult and problematic factor in the teaching and learning of chemistry which is the symbolic language of chemistry is related to the Chemistry achievement of senior secondary school students in Kontagora local government area, Niger state.

1.3 Aim and objective

This study is aimed at determining the relationship between symbolic language of chemistry and chemistry achievement of senior secondary school students in Kontagora local government area, Niger State.

1.4 Specific objective:

1. To determine how symbolic language of chemistry affects students achievement in chemistry.

1.5 Research Question

1. What is the mean relationship in the achievement scores of students who answered the test questions prepared using symbolic language of chemistry and non-symbolic language of chemistry?
2. What is the effect of symbolic language of chemistry on the Chemistry achievement of students?

1.6 Research Hypotheses

Ho_1 There is no significant relationship between the mean achievement score of students who answered the test questions prepared using symbolic language of chemistry and those prepared using words.

Ho_2 The symbolic language of chemistry has no significant effect on chemistry achievement of secondary school students.

1.7 Significance of the study

The crux of the matter is that most of the few students who choose to study science in our secondary schools are noted for having problems learning the sciences especially chemistry since its introduction as reported by Lohdip et al. (2011). These may become barriers to students learning. Every good schools and teachers desire is to teach their student to understand in other to have excellent academic achievement. Therefore this study will be relevant in the following regard

1. This research will be useful to teachers as it will help them discover student's assimilation ability of symbolic language used in teaching chemistry.

2. It will also help teachers see how the use of symbolic language affects secondary school student's academic performance in chemistry
3. It will serve as a source of resource material to educational administrators and others who want to carry out more research related to symbolic language or student's academic achievement.

1.8 Scope and limitations of the study

This study deals with the relationship between symbolic language of chemistry and chemistry achievement of senior secondary school students in Kontagora Niger State.

Kontagora is a city found in Niger, Nigeria. It is located 10.40 latitude and 5.47 longitudes and it is situated at elevation 339 meters above sea level. Kontagora has a population of 98,754 making it the 4th biggest city in Niger. It operates on the WAT time zone, which means that it follows the same time zone as Minna, the capital of Niger state. The geographical distance between Minna and Kontagora is 147 km.

1.9 Operational definition of terms

1. **Chemistry: t**his is the branch of Science that deals with the identification of the substances of which matter is composed; the investigation of their properties and the ways in which they interact, combine and charge; and the use of these processes to form new substances.
2. **Symbol**: this is a mark, sign or word that indicates or signifies an idea, object, or relationship.

3. **Language**: it a system of communication by speaking, writing, or making a signs in a way that can be understood, or any of different system of communication used particular region or fields.

4. **Achievement**: it is something which someone has succeeded in doing, especial after a lot of efforts.

5. **Relationship**: this is defined as a connection between variables.

CHAPTER TWO

2.0 REVIEW OF RELATED LITERATURE

2.1 CONCEPTUAL FRAME WORKS

2.1.1 Concept of Chemistry

Chemistry is one of the science subjects that students are taught in secondary schools to prepare them for science - based courses at the tertiary levels and if not properly handled affects their performances at higher levels (Uchegbu*et al*., 2016), Chemistry education should be emphasized in the secondary schools in terms of teaching and learning, because Chemistry as an academic discipline plays a very significant role in unifying other science subjects. But the problem is that students fail chemistry at alarming rates in secondary schools for years now according to the report of Uchegbu*et al*. (2016).

Chemistry has been one of the cornerstones of science, technology and industry, it is apparent that chemistry plays a greater role in national development through industry in the world. As such it helps to provide some social amenities and has been the pivot of science and hence the most needed tool, scientifically, for human, capital and national development.

The wheel of progress has in no small way slowed down, thereby hindering the overall development of science and chemistry education in the nation. The concept of chemistry as a science is centred on life and this encompasses the three states of matter-solid, liquid and gas in a give and take processes (Shamsuddin *et al.*, 2017)

Chemistry is a popular subject among senior secondary school students in Nigeria due to its nature. It addresses the needs of majority through its relevance and functionality in content, practice and application. What many nations like Nigeria need now is a functional chemistry education that will assist in national development. Chemistry education has been identified to be one of the major bedrock for the transformation of our national economy (Shamsuddin *et al*., 2017), it also a discipline that contributes to uplift humankind's living standards through the provision of health and other social amenities. Thus, chemistry education, education in particular, must be every country's gateway to technical and industrial growth (Hanson, 2017).

2.1.2 The interconnectivity of chemistry to other sciences

Chemistry is sometimes referred to as "the central science" due to its interconnectedness with a vast array of other STEM disciplines (STEM stands for areas of study in the science, technology (Abubakar & Eze, 2010), engineering, and math fields. Chemistry and the language of chemists play vital roles in biology, medicine, materials science, forensics, environmental science, and many other fields (Flowers, *et al*., 2018). The basic principles of physics are essential for understanding many aspects of chemistry, and there is extensive overlap between many subdisciplines within the two fields, such as chemical physics and nuclear chemistry. Mathematics, computer science, and information theory provide important tools that help us calculate, interpret, describe, and generally make sense of the chemical world. Biology and chemistry converge in biochemistry, which is crucial to understanding the many complex factors and processes that keep living organisms (such as us) alive. Chemical engineering, materials science, and nanotechnology combine chemical principles and empirical findings to produce useful substances, ranging from gasoline to fabrics to electronics. Agriculture, food science, veterinary science, and brewing and wine making help provide sustenance in the form of food and drink to the world's population. Medicine, pharmacology, biotechnology, and botany identify and produce substances that help keep us healthy. Environmental science, geology, oceanography, and atmospheric science incorporate many chemical ideas to help us better understand and protect our physical world. Chemical ideas are used to help understand the universe in astronomy and cosmology (Flowers, *et al*., 2018).

Below is a diagram showing the connection between chemistry and other science subjects.

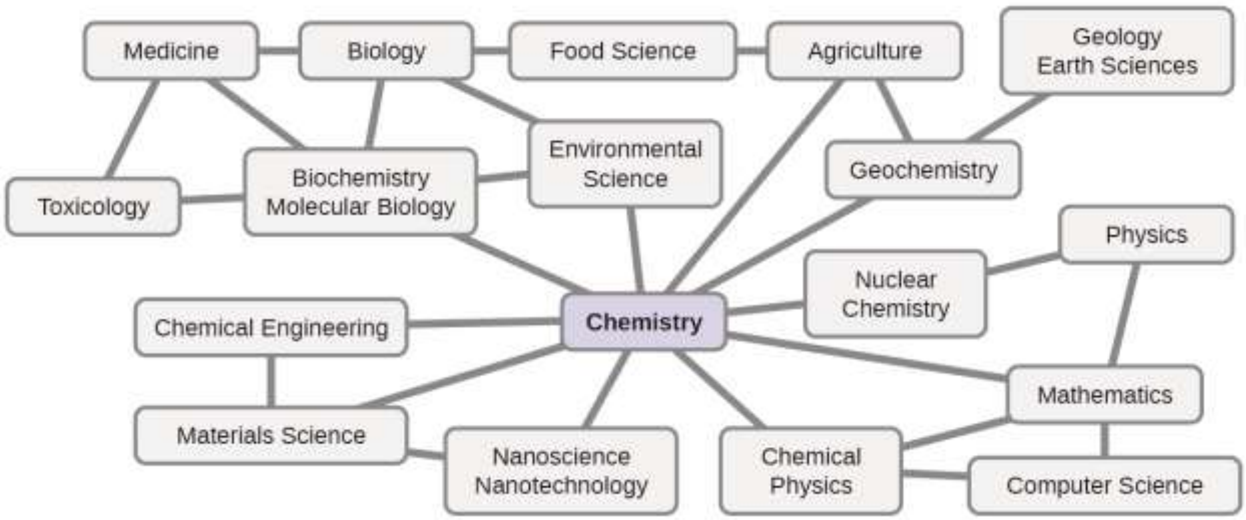

Figure 1: Knowledge of chemistry is central to understanding a wide range of scientific disciplines. This diagram shows just some of the interrelationships between chemistry and other fields.

2.1.3 The Domains of Chemistry

Chemists study and describe the behaviour of matter and energy in three different domains: macroscopic, microscopic, and symbolic. These domains provide different ways of considering and describing chemical behaviour (Flowers, *et al*., 2018). Rees *et al.* (2018) report described this domain as three level of learning chemistry : macroscopic, that is what can be seen, touched and smelled; sub-microscopic, that is atoms, molecules, ions and structures; and symbolic meaning, representations of formulae, equations, mathematical expressions and graphs. A successful learner must develop competence in inter-relating these three aspects, learning to move between levels often without notice or explanation. For a novice chemist complexity of thinking required may be too great (Rees *et al.*, 2018).

Macro is a Greek word that means “large.” The macroscopic domain is familiar to us: It is the realm of everyday things that are large enough to be sensed directly by human sight or touch (Flowers, *et al*., 2018). In daily life, this includes the food you eat and the breeze you feel on your face. The macroscopic domain includes everyday and laboratory chemistry, where we observe and measure physical and chemical properties, or changes such as density, solubility, and flammability (Flowers, *et al*., 2018).

The microscopic domain of chemistry is almost always visited in the imagination. *Micro* also comes from Greek and means “small.” Some aspects of the microscopic domains are visible through a microscope, such as a magnified image of graphite or bacteria. Viruses, for instance, are too small to be seen with the naked eye, but when we’re suffering from a cold, we’re reminded of how real they are (Flowers, *et al*., 2018).

De Jong *et al*. (2013) reported an addional model called process domain. In all, there are now four domains. The process domain mainly deals with the way any reaction occurs, such as processes of breaking and forming of bonds, energy changes, and so on. It can be related to each of the other three domains for acquiring a deeper insight in chemistry. In the dissolution example, this domain deals with disruption of the ionic lattice by water molecules and rearrangement and hydration of ions leading to an endothermic reaction (ΔH is positive).

However, most of the subjects in the microscopic domain of chemistry—such as atoms and molecules—are too small to be seen even with standard microscopes and often must be pictured in the mind. Other components of the microscopic domain include ions and electrons, protons and neutrons, and chemical bonds, each of which is far too small to see. This domain includes the individual metal atoms in a wire, the ions that compose a salt crystal, the changes in individual molecules that result in a colour change, the conversion of nutrient molecules into tissue and energy, and the evolution of heat as bonds that hold atoms together are create (Flowers, *et al*., 2018).

The symbolic domain contains the specialized language used to represent components of the macroscopic and microscopic domains. Chemical symbols (such as those used in the periodic table), chemical formulas, and chemical equations are part of the symbolic domain, as are graphs and drawings. We can also consider calculations as part of the symbolic domain. These symbols play an important role in chemistry because they help interpret the behaviour of the macroscopic domain in terms of the components of the microscopic domain. One of the challenges for students learning chemistry is recognizing that the same symbols can represent different things in the macroscopic and microscopic domains, and one of the features that makes chemistry fascinating is the use of a domain that must be imagined to explain behaviour in a domain that can be observed.

A helpful way to understand the three domains is via the essential and ubiquitous substance of water. That water is a liquid at moderate temperatures will freeze to form a solid at lower temperatures, and boil to form a gas at higher temperatures (Figure 2) are macroscopic observations. But some properties of water fall into the microscopic domain—what we cannot observe with the naked eye. The description of water as comprised of two hydrogen atoms and one oxygen atom, and the explanation of freezing and boiling in terms of attractions between these molecules, is within the microscopic arena. The formula H_2O, which can describe water at either the macroscopic or microscopic levels, is an example of the symbolic domain. The abbreviations (*g*) for gas, (*s*) for solid, and (*l*) for liquid are also symbolic.

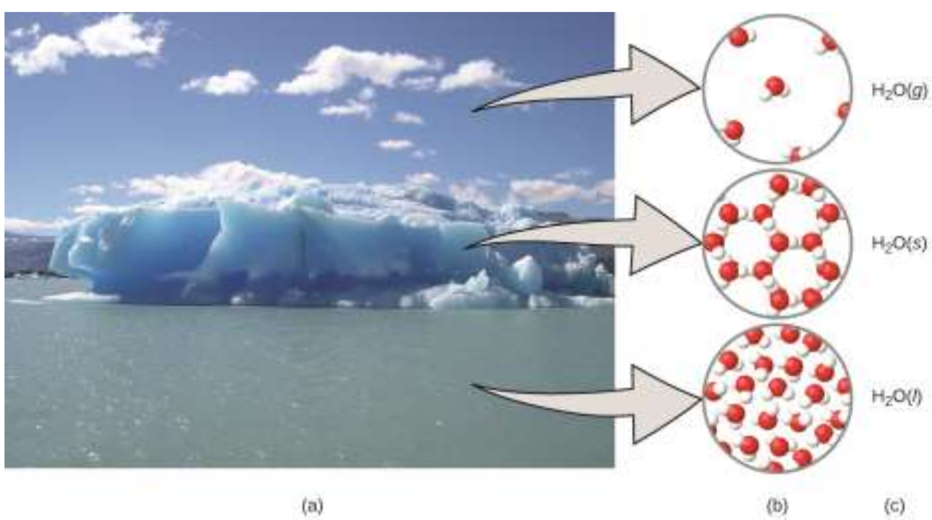

Figure 2:

(a) Moisture in the air, icebergs, and the ocean represent water in the macroscopic domain. (b) At the molecular level (microscopic domain), gas molecules are far apart and disorganized, solid water molecules are close together and organized, and liquid molecules are close together and disorganized. (c) The formula H_2O symbolizes water, and (g), (s), and (l) symbolize its phases. Note that clouds are actually comprised of either very small liquid water droplets or solid water crystals; gaseous water in our atmosphere is not visible to the naked eye, although it may be sensed as humidity. Sources: (Flowers, *et al*., 2018).

2.1.4 Language of chemistry

Chemistry has a vocabulary that describes and explains chemical phenomena to which students are introduced. Understanding this decodes the wondrous sub microscopic world of atoms, molecules and their reactions (Rees *et al*., 2018). However, the unfamiliarity of chemical language means students meet many chemical snozzcumbers throughout their education, which may become a barrier to understanding. Developing fluency in using and understanding specialist vocabulary is essential if students are to learn chemistry. (Rees *et al*, 2018). Dula, (2018) attest to this fact that Student should be familiar with the language of chemistry so that they can easily balance chemical equation. Knowing symbols, knowing the difference between ions, atoms, molecules and compound will invariably play important role.

The specific yet varied challenges of chemical language are recognised (Markic and Childs, 2016). These may become barriers to student learning, particularly among students who are diverse in terms of culture, language and prior knowledge (Cinkand Song, 2016). Brown highlighted potential identity conflicts in which students may avoid scientific language as a tactic to maintain their cultural identity. These students employed several strategies to avoid using science discourse, University level chemistry students' familiarity with and competence in chemical language is often assumed, but evidence indicates their fluency is mistaken as reported by Rees *etal*. (2018). Undergraduate and graduate chemistry students (Vladus*et al*., 2016) experience chemistry linguistic challenges. At all stages of education, students meetnew concepts via linguistic terms they interpret and assimilate. The success of university chemistry education depends on recognising and addressing these challenges by implementing effective pedagogical strategies.

Scientific language is dense, cognitive language that is rich in technical terminology and discourse structures specific to context. This makes learning science challenging for students from diverse background as reported by Rees *et al*. (2018).

Studies of Markic and Childs (2016) argued that success in studying Chemistry depends upon the familiarity of students with a few basic ideas, conventions, and methods upon which later studies are built. When a student has achieved mastery of them, further studies can be pursued with greater confidence. Rees *et al.* (2018) reported further that without mastery of these concepts, it is difficult for students to find higher levels of study in Chemistry. Specially, the use of chemical symbols, Formulae, writing chemical equations, calculations involving moles (solids, gases, and solutions) etc. are areas where students of chemistry beginners face most challenges.

2.1.5 Report on the Assessment of senior secondary school chemistry

Gongden *et al*, (2011) carried out a study on "Assessment of the difficult areas of the senior secondary school 2 (two) chemistry syllabus of the Nigerian Science curriculum". The senior secondary two chemistry course content of the Nigerian science curriculum was assessed using co-selected secondary school in north central Nigeria to determine areas of difficulty, magnitude and reasons for such perceived difficulty. Correlations between the students' perceived difficulty and their achievement in a test and the relationship between the students set and their perception of difficulties were also examined using a difficult rating scale questionnaire and a chemistry achievement test. A total of 10 out of 24 topics identified were perceived as difficult. Reasons given for the perceived difficulty included unfamiliarity with ideas, confusing language, ideas too demanding, insufficient explanation and practical work, topics too mathematical and lack of interest among both sexes.

Jimoh (2010) carried out a research on, “perception of difficult topics in chemistry curriculum by students in Nigeria Secondary schools”. In his study, five hundred and sixty SS III Chemistry students were randomly selected from 28 senior secondary schools in seven states of the federation and a 20- item questionnaire was administered to respondents. Findings showed that SS 3 chemistry students perceived 13 topics (65%) difficult to comprehend. The study also revealed that students’ gender and school location have no influence on their perception of difficult topics in chemistry curriculum, while school nature influenced perception of chemistry topics. It was recommended that the SSCE chemistry curriculum be reviewed by examination bodies.

Agogo and Onda, (2014) carried out a study on “Identification of students’ perceived difficult concepts in senior secondary school chemistry in Oju L.G.A of Benue state.” In their study, 95 SS II chemistry students were used. The instrument for data collection was the chemistry students’ concept difficulty assessment questionnaire. Four research questions and three hypotheses were raised and formulated. The work was analyzed using percentages and mean scores while the hypotheses were analyzed using chi- Square at 0.05 level of significance. Their findings revealed that students find some topics difficult and there is no significant difference between male and female in their perception of difficult concept in SS II chemist.

Gabriel et al. (2018) reported that students' poor academic achievement in Chemistry has been noted in the West African Examination Council (WAEC) Chief Examiners' Reports from 2010 to 2017. From the analysis of the students' performance in WAEC shows that the raw students' mean scores from 2010 to 2017 never exceeded 40%. The problem of poor academic achievement in science seems to be the central focus of attention in most science education research nowadays. Most of the researchers aim at finding the solution to students' continuous poor achievement reported in science subjects including Chemistry. However, the reports on gender as a factor in students' achievement in sciences are mixed. While some findings indicated no significant effect of gender in chemistry achievement (Adekoya, 2010).Some researchers reported significant influence of gender on academic achievement (Gabriel et al., 2018).

2.5 Difficulties Faced in Writing Chemical Symbols and Formulae

According to report of Dula (2018), chemical symbols and formulae were the major challenges with secondary school chemistry as reported below: difficulties in the learning of chemistry can be precipitated by a lack of chemistry language skills. Students experienced greater problem in interpreting symbols than words correctly. From the Study on the effects of working memory space and field-dependency on the learning of chemistry by Greek students. Learning not only of chemistry, but of all new information will fail if the working memory space is overloaded. This could occur if students are given too much information at once. Moreover, if students study chemistry in a language other than their mother tongue, difficulties experienced in chemical language could be linguistic, contextual or cultural in nature. The understanding of valency, appreciation of concepts of polyatomic ions and molecules and ultimately the production of correct chemical formulae will depend on student's knowledge of bonding. Unfortunately, concepts in chemical bonding are highly abstract and it appears that only the most able students will be in a position to apply their knowledge of bonding effectively to scaffold the writing of chemical formulae.

However, studies have shown that the ability to write chemical equations correctly is not a simple one. It is one that requires a functional understanding of the requisite subordinate concepts of atoms and atomicity, molecules and molecular formula, atomic structure and bonding, valency, use of brackets, radicals, subscripts and coefficient and molar ratio. He equally reported that chemistry students often have great difficulties in both acquiring and using the skills required to balance chemical equations.

2.6 Misconceptions in chemistry

Some of the reasons for occurrence of misconceptions in chemistry could be traced to problems of the specific terminology and used wording, especially when introducing the concepts of substances, the particles of which they consist and chemical symbols used for their representation (macroscopic, sub-microscopic and symbolic respectively).

Many school-made misconceptions are due to the fact that students do not distinguish between macroscopic and sub-microscopic explanations. (Treagust *et al.*, 2011). There are, at least, two possible reasons for the emerging of misconceptions when dealing with the three mentioned levels of representation. The first is the risk of "overloading the working memory space" when students are introduced to all three levels *simultaneously*. Secondly, neglecting the sub-microscopic level during teaching may also lead to the appearance of certain misconceptions. Seemingly, it would be better that chemistry concepts are taught progressively: starting with macroscopic observation, through the sub-microscopic interpretations and *only then* work with the symbolic representations as reported by Stojanovska*et al*. (2017).

Many basic chemistry concepts are difficult to teach because "the definitions of these concepts given in textbooks either lack precision, or invoke ideas that beginners are not familiar with, and have to accept on trust". Conceptual knowledge about chemical reactions (a subject present in any chemistry textbook) implies awareness of the three levels of representation. Students have to be able to go from the macroscopic level (observations, experiments) to the sub-microscopic level in order to understand the changes that happen during chemical reactions and then learn to present the acquired knowledge in a symbolic way. Unfortunately, chemicals reactions are being taught, most of the time, only through chemical equations, thus stimulating only the low-level knowledge (memorizing and/or recognizing) (Salame *et al*., 2011). In the last few decades many misconceptions concerning various chemistry (and science in general) topics have been documented and many science misconceptions and difficulties in learning and understanding chemical concepts have been reported

(Taber *et al.*, 2011). The misconceptions regarding the three levels of representation are closely related not only to the false ideas about the chemical reactions (Naah and Sanger, 2012), but also to the ideas involving the particulate nature of matter. (Badrian, *et al*., 2011), the law of conservation of matter, the physical and chemical changes the solutions etc. (Naah and Sanger, 2012).

Particle theory concepts are an integral part of the eighth-grade (secondary-school) curriculum in the Republic of Macedonia. At the very beginning of learning chemistry as a subject, students encounter the bulk properties (physical and chemical) of substances and then their structure. Chemical symbols, formulae and equations come later. Nonetheless, as will be shown, the results of our investigation showed that many students have not developed an accurate understanding of these concepts and the consistency in reasoning among students of different levels of study confirmed the fact that they retained their misconceptions over the years.

Sadly, this is not the case only of our students but vagueness is present even in the presentations of the periodic table of elements. If one looks closely, it can be noticed that some data refer to the *atoms* of the elements (e.g. electronic configuration) and other are related to the *elementary sub-stances* that are composed of these particles (e.g. density)

Treagust*et al*., 2011). All three levels of representation are present and mixed (obviously, in an unfortunate manner) in the published form of the periodic table, so it undoubtedly brings some confusion among students.

The interference of macroscopic (colour, density, melting point or solubility) and sub-microscopic concepts (size and mass of the particles) by students may be due to these lack of ability to adequately describe the learned concepts but is, even more likely, a result of a confusion of ideas. Thus, in many cases, the ideas of students that when a gas is being compressed (macroscopic representation), the particles (sub-microscopic representation) are not only pushed closer together but also compressed themselves are present (Treagust*et al*., 2011). Misconceptions originating from interference between the three levels of representation in the chemistry teaching process are present not only among students, but also among teachers, educators and researchers and even among respected authors of scholarly papers, as well as authors of textbooks. Thus, in many textbooks statements can be found in which a *substance* reacts with one or more particles (atoms, molecules, ions …), such as: "This ion reacts with the glucose, oxidizing it to form an acid and the ion itself reduces to elementary silver". Similar (basically incorrect) notions are present in statements such as: "When forming ionic com-pounds, iron gives off three electrons.", "The elementary substance phosphorus consists of four atoms of element phosphorus.", "Acid molecules comprised of one hydrogen atom are called monoprotic acids.".

2.7 History of Symbol and its challenges

Chemists describe reactions in terms of disappearance and appearance of substances, in terms of rearrangements of particles, in terms of reaction equations expressed in symbols (De Jong *et al*., 2013) Geleta, *et al*. (2014) gave the report that symbols of elements used today were first suggested by the Swedish Chemist Berzelius. The name of the element is usually derived from English, German, Latin or Greek words. Therefore, these chemical symbols are the short hand representation of the full name of an element. This way the symbol of an element represents a definite quantity of that element too, for instance one atom. The symbol of an element is the short way representation for the name of an element. Names and symbols of the chemical elements are parts of the language of chemistry.

They constitute about 91 naturally occurring elements found on earth. It is further argued that once someone is familiar with the name and symbols of elements, it will be easy to write chemical formulas and to do some chemical calculations too. The symbols of chemical elements are abbreviations that are used to denote chemical elements as reported by Geleta, *et al*. (2014)

Pictographic symbols were employed to symbolize elements known in ancient time, for instance to the alchemists . Some of the earliest symbols were those used by the ancient Greece to represent the four elements: earth, fire, air and water. These were adopted by Plato using the Pythagorean Geometric Solids. As other chemical substances were defined, symbols of the planets were used. Over the centuries, a great many symbols came into use (Geleta, *et al*., 2014).

A chemical formula is a group of symbols which denote one molecule of an element or of a compound and represent the elements which form that compound and the ratio of their atoms. In writing chemical formulas of compounds, we need first know the valences of elements and different radicals in which valence is known as the combining power of atoms in a chemical formula. In fact, valences have more meaning underlying than merely numeric combination of atoms (Geleta, *et al*. 2014).

Geleta, *et al*. (2014) reported the highlight: the major problems students face in learning chemical symbols and formulas are summarised as follow:

- ✓ In symbolizing elements, we can use first letter only or first and second letter only or first and the second prominent letter in the name of an elements but this over loads students with huge information and need care not to lead students to confusion.
- ✓ The primary barrier to understanding chemistry is not the existence of the three levels of representing matter (Macro-level, sub micro-level and symbolic level). It is that chemistry instruction occurs predominantly on the most abstract level (the symbolic level).
- ✓ Students do not understand the meaning of Roman numerals that are put in brackets of IUPAC names. Examples Iron (II) sulphide was written as FeS^2. Also in the same compound, Iron was written as Fe^2, in Copper (II) tetraoxophosphate (V), Copper was written as Cu^2 etc.
- ✓ Students have problem with what valences are and do not understand the role they play in writing of chemical formulae.
- ✓ Writing the correct formula of some radicals and some ions is also a problem to the students.

- ✓ Combination of some cations and anions to form neutral compounds is a big problem to the students due to the problem they have with valence.
- ✓ The correct names of some radicals are a problem to students.

2.8 Challenge Faced in Writing Chemical Equations

Chemical equations can be defined as symbolic and quantitative representations of the changes that occur in the process of chemical reactions, based on the principle that matter is neither created nor destroyed during chemical reactions (Dula*et al*., 2018). For example, the chemical equation: shows that A and B are the reactants while C and D are the products. The subscripts x, y, p and q are the stoichiometric coefficients which represent the relative amount of substance of the reactants and products. The single-headed arrow indicates the direction of the reaction and shows that the reaction is an irreversible one. The arrow means “gives”, “yields” or “forms” and the plus (+) sign means “and”. However, studies have shown that the ability to write chemical equations correctly is not a simple one. It is one that requires a functional understanding of the requisite subordinate concepts of atoms and atomicity, molecules and molecular formula, atomic structure and bonding, valency, use of brackets, radicals, subscripts and coefficient and molar ratio. Dul*a et al*. (2018) reported that chemistry students often have great difficulties in both acquiring and using the skills required to balance chemical equations. A similar study conducted in Scotland revealed that students in senior high schools are rarely confident about writing chemical equations and then carrying out calculations based on them as reported by Dula *et al*. 2018).

2.9 The influence of chemistry curriculum

Gabriel *et al*. (2018) reported that the overloaded content of the chemistry curriculum as perceived by secondary school teachers has been a subject of interest. Content areas such as “Models of Atoms” and “Chemistry of Space” are perceived by some secondary school teachers to constitute curriculum overload. For these teachers, the basic knowledge about the concepts should be taught. Students should be exposed to more content areas at higher institution when they chose the aspect of chemistry they want to study. To meet up with the perceived overloaded curriculum, conventional methods of teaching becomes the easiest way. Teachers may just write lesson notes on the board and have students copy the note while she reads from the board and explain. Some teachers’ use of conventional method may comprise giving out the lesson notes to the students to copy on their own and the teacher comes to teacher thereafter. Whatever the approach, the method is often teacher-centred. Conventional method as a teacher-centred approach makes for students’ passivity and therefore leads often times to poor academic achievement (Gabriel.*et al.*, 2018).

2.10 Factors Influencing Effective Teaching of Chemistry

A greater deal of work has been done in an effort to identify problem that are inherent in the teaching of chemistry in secondary schools. These factors influence the effective teaching of chemistry which in turn plays a vital role in the lives of the students as it affects their performance. These include: physical classroom and laboratory: instructional arrangement and school management as reported by Ejidike and Oyelana (2015).The physical classroom and laboratory indicated the presence of good ventilation, availability of good chalkboard, preparatory room, enough chairs and tables, charts and clean environment. The other factors include the presence of instructional materials in the laboratory such as apparatus and chemicals (Owoeye and Yara 2011).The dissemination of information with to students through bulletin boards, posters, and charts, if well organized and accessible to students will enhance assimilation and performance in their academics. Finally, the school management or organization is another vital factor that may be considered before anticipating a good result. The school management's responsibility now includes positioning of the school laboratory, school library, provision of essential services like water supply, light, food, vendors, counselor services and first aid services (Owoeye and Yara 2011).

Over the years research has been carried out on students' academic achievements, causes and ways of improving it yet the goal of training student who will practically apply what they have learnt in school to solve problems and improve living in Nigeria have not been majority achieved. The joy of every good teacher and every visionary school in Nigeria is to achieve this goal. This is the reason why researchers are working tirelessly to dig out the causes of students poor performance of which this research is one of them so that solutions can be developed and the goal can be achieved.

2.11 Theoretical frame work

Bruner's learning Theory

Bruner was concerned with how knowledge is represented and organized through different modes of thinking (or representation).In his research on the cognitive development of children. Jerome Bruner proposed three modes of representation:

I. Enactive representation (action-based)

II. Iconic representation (image-based)

III. Symbolic representation (language-based)

Bruner's constructivist theory suggests it is effective when faced with new material to follow a progression from enactive to iconic to symbolic representation; this holds true even for adult learners. Bruner’s work also suggests that a learner even of a very young age is capable of learning any material so long as the instruction is organized appropriately.

Bruner's Three Modes of Representation

Modes of representation are the way in which information or knowledge are stored and encoded in memory, rather than neat age-related stages the modes of representation are integrated and only loosely sequential as they "translate" into each other.

I. Enactive (0 - 1 years)

The first kind of memory; This mode is used within the first year of life (corresponding with Piaget’s sensorimotor stage). Thinking is based entirely on physical actions, and infants learn by doing, rather than by internal representation (or thinking). It involves encoding physical action based information and storing it in our memory. For example, in the form of movement as a muscle memory, a baby might remember the action of shaking a rattle. This mode continues later in many physical activities, such as learning to ride a bike. Many adults can perform a variety of motor tasks (typing, sewing a shirt, operating a lawn mower) that they would find difficult to describe in iconic (picture) or symbolic (word) form.

II. Iconic (1 - 6 years)

Information is stored as sensory images (icons), usually visual ones, like pictures in the mind. For some, this is conscious; others say they don’t experience it, this may explain why, when we are learning a new subject, it is often helpful to have diagrams or illustrations to accompany the verbal information. Thinking is also based on the use other mental images (icons), such as hearing, smell or touch.

III. Symbolic (7 years onwards)

This develops last. This is where information is stored in the form of a code or symbol, such as language. This mode is acquired around six to seven years-old (corresponding to Piaget's concrete operational stage).In the symbolic stage, knowledge is stored primarily as words, mathematical symbols, or in other symbol systems, such as music. Symbols are flexible in that they can be manipulated, ordered, classified etc., so the user isn't constrained by actions or images (which have a fixed relation to that which they represent).Bruner views symbolic representation as crucial for cognitive development, and since language is our primary means of symbolizing the world, he attaches great importance to language in determining cognitive development.

Educational Implications

The aim of education should be to create autonomous learners (i.e., learning to learn).For Bruner the purpose of education is not to impart knowledge, but instead to facilitate a child's thinking and problem-solving skills which can then be transferred to a range of situations. Specifically, education should also develop symbolic thinking in children. In Bruner's text, The Process of Education was published. The main premise of Bruner's text was that students are active learners who construct their own knowledge. Bruner opposed Piaget's notion of readiness. He argued that schools waste time trying to match the complexity of subject material to a child's cognitive stage of development.

This means students are held back by teachers as certain topics are deemed too difficult to understand and must be taught when the teacher believes the child has reached the appropriate state of cognitive maturity. Bruner adopts a different view and believes a child (of any age) is capable of understanding complex information: 'We begin with the hypothesis that any subject can be taught effectively in some intellectually honest form to any child at any stage of development. Bruner explained how this was possible through the concept of the spiral curriculum . This involved information being structured so that complex ideas can be taught at a simplified level first, and then re-visited at more complex levels later on. Therefore, subjects would be taught at levels of gradually increasing difficultly (hence the spiral analogy). Ideally, teaching his way should lead to children being able to solve problems by themselves.

Bruner proposes that learners' construct their own knowledge and do this by organizing and categorizing information using a coding system. Bruner believed that the most effective way to develop a coding system is to discover it rather than being told it by the teacher. The concept of discovery learning implies that students construct their own knowledge for themselves (also known as a constructivist approach).The role of the teacher should not be to teach information by rote learning, but instead to facilitate the learning process. This means that a good teacher will design lessons that help students discover the relationship between bits of information. To do this a teacher must give students the information they need, but without organizing for them. The use of the spiral curriculum can aid the process of discovery learning.

2.12 EMPERICAL FRAME WORK

This section discuses several research work carried out which are related to symbolic language of chemistry and chemistry achievement of senior secondary school student.

(Bello et al, 2015), carried out research work to investigate the difficult concept in chemistry and their effect on the achievement of students in secondary schools in Sokoto metropolis. Total number of 125 students was used, the instrument used for data collection was questionnaire. Data analysis was done using percentage and t-testing, result obtained revealed that concepts students perceived as difficult in chemistry has, little or no effect in the academic achievement of students. This relates to the symbolic language of chemistry which is perceived to be difficult.

(Dual, 2018),investigated on improving the problem of writing chemicals symbol, formulae and chemical equation, the researcher used questionnaire, test and observation for data collection, percentage and t-test was used to analyse the data. 98 students were used for the research work, the researcher concluded that student lacked good background on basic concept of chemistry especially in the basic element of chemistry language and recommended that teachers should ensure that students exposure to chemistry language should be maximized.

(Stojavovska et al, 2014), carried out a study on the use of three level of thinking and representation, multiple-choice and interview was used for data collection, cross table was used to analyse the data collected, the data analysed showed that student have certain difficulties in recognizing symbolic representation and this should be properly looked into because inability to properly recognise or understand symbolic representation of chemistry by students can result in poor performance of students.

(Udo and udofia, 2014), researched on effect of mastering learning strategies on students achievements in symbols, formulae and equation in chemistry. The researcher employed the use of achievement test and student interest scale for collecting data, data collected was analysed using analysis of covariance (ANCOVA), the researcher used one hundred and eighty secondary school students. The recommendation was that chemistry teacher should always adopt mastery learning strategy in teaching symbols, formulae and equation in chemistry.

Summary of review and uniqueness of the study

On the entire, the summary of the review and the uniqueness of the study indicate that symbolic language of chemistry might be a challenge in the teaching and learning of chemistry and the major concern of teachers and researchers in chemistry education is the difficulties of students to understand chemistry at all representational level. However, studies have shown that the ability to write Chemical equations correctly is not a simple one, It is one that requires a functional understanding of the requisite Subordinate concepts of atoms and atomicity, molecules and molecular formula, atomic structure and bonding, valency, use of brackets, radicals, subscripts and coefficient and molar ratio. Chemistry students often have great issue in acquiring and using the skills required to balance chemical equations. This study will show the relationship between symbolic language of chemistry and the students' achievement in chemistry.

CHARPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.0 Introduction

This chapter presents the methodology of the study under the following headings; research design, study population, sample and sampling technique, research instrument, validity of the instrument, reliability of the instrument, data collection and data analysis.

3.1 Research Design

The design used for the study is cor-relational research design.

3.1 Study population

The population for the study comprise 0f (SS3) chemistry students in three senior secondary school in Kontagora metropolis council area of Niger State. The study will covers three schools namely:

1. Mustafa comprehensive school, Kontagora (56 chemistry students)
2. St. Michaels international nursery and primary school, Kontagora (25 chemistry students)
3. Baptist comprehensive school, Kontagora (37 chemistry students)

3.2 Sample and sampling techniques

A random sample and sampling techniques will be used to choose the sample from the target population (3 co-educational senior secondary school in Kotongora local government area of Niger State). 25 students were selected at random from each of the three schools giving a total of 75 students that were used for the study.

3.4 Research instruments

Test instrument was used for the study: Questions were prepared from the students covered syllabus area. The question comprises of the non-symbolic language and symbolic language learnt in chemistry. The questions will be answered by each of the selected students differently and collected at the same time. The non-symbolic and symbolic language questions will be marked and compared to see the students' achievement in each of the question.

3.5 Validity of the instrument

Two lecturers that are expert in the field of chemistry from Federal University of Technology, Minna, Niger State were used for the validation of the instrument.

3.6 Reliability of the instrument

The reliability of the test was conducted at FEMA schools and HASHA International School which were not part of the sample school. Ten SSS3 students from each of the schools were given the test questions to answer, the scores obtained were used to determine reliability coefficient using Cronbach's Alpha and 0.73 is the reliability coefficient obtained.

3.7 Data collection method

The data for this analysis will be collected through the test question answered by the selected students. From the selected thee co-educational schools in Kontagora Niger state.

3.8 Method of data analysis

The methods used for analysing the data collected are mean, and standard deviation to answer the research questions and Pearson product-moment Correlation (PPMC) for testing the hypotheses at the significance level of 0.01 using (SPSS) for the hypothesis to either be retained or rejected.

CHAPTER FOUR

4.0 PRESENTATON AND DISCUSSON OF RESULTS

This chapter deals with presentation of results and discussion of findings obtained from three senior secondary schools in Kontagora. The research questions are answered using mean and standard deviation while Pearson correlation coefficient was used to test the research hypothesis.

4.1 RESEARCH QUESTIONS

4.1.1 Research question one

What is the relationship in the mean achievement score of students who answered test questions prepared using symbolic language and non symbolic language of chemistry?

The relationship in the mean scores is shown in the Table below

Table 4.1 mean and standard deviation of students' achievement score in symbolic and non-symbolic language of chemistry.

Variables	N	Mean	SD	Mean Difference
Symbolic	75	7.53	2.19	
Non-symbolic	75	6.80	1.84	0.73

Table 4.1 shows the mean score of symbolic language of chemistry to be 7.53 with a standard deviation of 2.19 and the mean of students' score in non symbolic is 6.80 with the standard deviation of 1.84.The table shows that the students achieved more in symbolic language.

4.1.2 Research question two

What is the effect of symbolic language of chemistry on chemistry achievement of students?

From table 4.1 the mean achievement score of symbolic language in chemistry is 7.53 with a Standard deviation of 2.19. This indicates that students learn better when taught with symbolic language of chemistry

Hypothesis testing

$H0_1$: There is no significance relationship in the mean achievement scores of students who answered the test questions prepared using symbolic language in chemistry and those who answered test question using non symbolic language.

Table 4.2 Pearson Product Moment correlation coefficient between symbolic and non-symbolic chemistry language.

Variables	**N**	**Mean**	**SD**	**r**
Symbolic	75	7.53	2.19	
Non-symbolic	75	6.80	1.84	0.43

Significance at $P < 0.01$

Table 4.2 reveals the statistics of mean achievement scores of students who answered test questions using symbolic language of chemistry and non symbolic language. From the table the mean difference is 0.73 and the r-value is 0.43, these values are greater than 0.01 significance level for Pearson correlation coefficient therefore the null hypothesis is rejected because there is significant difference in the mean achievement score of students who answered questions on symbolic and non-symbolic language of chemistry.

HO_2: The symbolic language of chemistry has no significance effect in chemistry achievement of the student

Table 4.3 Pearson Product Moment correlation coefficient between symbolic and non-symbolic chemistry language

Variables	N	Mean	SD	r
Symbolic	75	7.53	2.19	
Non-symbolic	75	6.80	1.84	0.43

Significance at $P<0.01$

Table 4.3 reveals the statistics of mean achievement scores of students who answered test questions using symbolic language of chemistry. From the table the r-value is 0.43, these value is greater than 0.01 significant level for Pearson correlation coefficient therefore the null hypothesis is accepted because symbolic language of chemistry has no significance effect on chemistry achievement of the students.

4.2 Summary of Findings

Based on the data collected and analyzed the following findings were made in regards to the research questions and hypothesis.

1. The analysis of research question one and hypothesis one indicate that students who answered symbolic language of chemistry performed better than students who answered test question on non-symbolic language in chemistry.
2. The analysis of research question two shows that students learn better when taught with symbolic language of chemistry.
3. The tested hypothesis also show that symbolic language of chemistry does not affect the academic achievement of students negatively.

4.3 Discussion of Major Findings

The discussion of the finding is based on the result of the analysis done on the research questions and hypothesis.

The findings from table 4.1 indicate clearly that students who answered symbolic language of chemistry performed better than those who answered test question on non symbolic language 0f chemistry. This discovery was confirmed in table 4.2 that the difference in their performance is significant. This performance difference may be due to the fact that they were more exposed to the symbolic aspect of chemistry by their teacher through frequent exercise on the calculations in chemistry, teaching the students to understand bond breaking and bond formation as well as familiarising them with the symbols used in chemistry. This is in line with finding of Bello et al (2015) which indicate that the concepts students' perceived as difficult in chemistry has little or no effect in the academic achievement of students.

Similarly the findings from table 4.1 shows that students learn better when taught with symbolic language of chemistry as it was confirmed in table 4.2 that symbolic language of chemistry has no significant effect on students' achievement. This might be due to frequent practicing using symbolic language for example in organic chemistry. This finding is in contrast with that of

Stojavovska, (2014), which stressed that students have certain difficulties in recognising symbolic representation.

CHAPTER FIVE

5.0 Introduction

This chapter seeks to discuss the findings of this study based on research hypotheses and research questions. The following sub-headings were considered; major research findings, educational implication of the findings, conclusion, recommendations, and suggestions for further investigations.

5.1 Findings of the Study

The following were the major findings of the study

1. There is a significance relationship in the mean achievement score of students who answered test question on symbolic language in chemistry and those who answered test question on non symbolic language of chemistry.
2. Symbolic language of chemistry has no significant effect on the performance of student in chemistry.

5.2 Conclusion

Based on the findings and discussion of the result, the following conclusions were reached

1. Students performed more in the symbolic language of chemistry than in the non symbolic language of chemistry. Which implies that student understand chemistry symbols which is a factor that enhanced their performance this is in contrast to the findings of (Stojavovska, 2014), who opined that students have difficulty in understanding of chemistry symbols and formulae. Therefore the symbolic language of chemistry is not the cause of students poor performance in chemistry.

5.3 Educational Implications of the Study

The result of the study is very important to education in the aspect of teaching and learning of chemistry. The implication of the study strongly focuses on the effect of symbolic language of chemistry (which is a major concept in chemistry) on students' achievement in chemistry.

1. The study reveals that students' performance in symbolic language of chemistry is better than their performance in non symbolic language of chemistry. It is therefore implicit that symbolic language of chemistry has no retarding effect to the effective learning of chemistry. Therefore it should be encourage and taught in the school.

2. Teachers should exposed the students to all they need to know in chemistry without the fear of any aspect of chemistry being difficult or the student having a difficult time to understand it.

3. Teachers should not relent in constantly involving the students in practical exercises involving symbolic language of chemistry because the more a student does or practice something the more he/she gets use to it.

5.4 Recommendation

The following recommendation are made based on the result of the study and its implication to education

I. The teaching and learning of chemistry symbolic language should be more strengthened and sustained for maximal performance.

II. The teaching and learning of non-symbolic concepts of chemistry should be encouraged in the schools.

III. Chemistry teachers should constantly attend workshops, seminars and other development programs to acquire more and concrete knowledge on how to teach chemistry in schools.

5.5 Suggestion for Further study

The following areas can be further researched on;

1. A similar study should be carried out in a different geographical area.
2. Studies on the effect on non-symbolic language of chemistry on chemistry achievement of students can also be conducted
3. Studies should be carried out on teachers' attitude and methods of teaching chemistry in secondary schools.
4. A similar study should be carried out in the same geographical area but this time capturing every school in the area.

REFERENCE

Ababio OY (2004) New School Chemistry for SSS, Onitsha, Nigeria: African First Publishers Ltd, Africa.

Abubakar, R. B., &Eze, F. B. (2010). Female students' academic performance in Mathematics at Federal College of Education (Technical), Omoku, Rivers State. *International Journal of Social and Policy Issues 6(1&2), 48-53.*

Adekoya YM. (2010). Effect of project-based, demonstration and lecture teaching strategies on senior

Adesoji F.A., Olatunbosun S. (2008). *Student, Teacher and School Environmental factors as Determinants of Achievement in Senior Secondary School Chemistry in Oyo State*, Nigeria. UluslararasıSosyalAra_tırmalarDergisi. The Journal of International Social Research, 1(2), 13-34.

Adeyemi, T.O. (2008). Predicting students performance in junior secondary school Certificate Examination in Ondo State. *Humanity and Social Science Journal*, 3(1), 26-36

Agogo, P. O and Onda, M. O (2014). Identification of Students Perceived Difficult Concepts in Senior Secondary School Chemistry in Oju Local Government Area of Benue State, Nigeria. *Global Educational Research Journal*, 2(4), 44–49.

Baah R, Ampiah JG (2012) Senior high school students' understanding and difficulties in writing chemical equations. International Journal of Scientific Research in Education 5(3): 162-170.

Baanu, T.F. Oyelekan,O.S. &Olorundare, A.S. (2016).self-efficacy and chemistry students' academic achievement in senior secondary schools in north-central, nigeria. *Malaysian Online Journal of Educational Science*, 4(1), 43-51

BADRIAN, A., ABDINEJAD, T., & NASERIAZAR, A. (2011). A cross-age study of Iranian students' various conceptions about the particulate nature of matter. Journal of Turkish Science Education , 8(2), 49-63

Barke HD, Temechegn E (2001) "Structural Chemistry and Spatial Ability in Different Cultures." Chemistry Education: Research and Practice in Europe 2(3): 227-239.

Ben-Zvi, R., Eylon, B., & Silberstein, J. (1988). *Theories, principles and laws*. Education in Chemistry, May, 89-92.

Broman, K., &Parchmann, I. (2014). Students' application of chemical concepts when solving chemistry problems in different contexts. *Chemistry Education Research and Practice, 15*(1), 516-529. Certificate of Education 1 (1), 48-58.

Chiu, H. (2005). A national survey of students’ conceptions in chemistry in Taiwan. *Journal of Chememistry Education International*, 6, 1-8.

Cink, R. B., & Song, Y. (2016). Appropriating scientific vocabulary in chemistry laboratories: a multiple case study of four community college students with diverse ethno-linguistic backgrounds. Chemistry Education Research and Practice , 17(3), 604-617

D. F. Treagust, A. L. Chandrasesaran, A. N. M. Zain, E. T. Ong, M. Karpudewan, L. Halim. (2011). Eval-uation of an intervention instructional program to facilitate understanding of basic particle concepts among students enrolled in several levels of study, *Chem. Educ. Res. Pract.*, **12,** 251–261.

De Jong, O., Blonder, R., &Oversby, J. (2013). How to balance chemistry education between observing phenomena and thinking in models. In: Teaching chemistry–A studybook,pp. 97-126.

Emendu, N.B. &Okoye, C.M. (2015).Identifying Problems Associated with Studying of Chemistry in Anambra State, *Nigeria. International Journal of Scientific and Research Publications*, 5(6), 1-7

Flowers, P., Theopold, K., Langley, R., & Robinson, W. R. (2018).Chemistry:OpenStax. https://chem.libretexts.org/Bookshelves/General_Chemistry/Book%3A_Chemistry_(OpenSTAX)/01%3A_Essential_Ideas/1.1%3A_Chemistry_in_Context ….accessed on 16th October 2019

Gabel, D. (1998). The complexity of chemistry and implications for teaching. In: P B. J. Fraser and K. G. Tobin (Eds.), *International handbook of science education,* Vol. 1 (Dordrecht: Kluwer), 233–248.

Gabriel, A.I., Osuafor, M.A., Cornelius, A.N., Obinna, P.P & Francis, E. (2018). Improving Students' Achievement in Chemistry through Cooperative Learning and Individualized Instruction. *Journal of Education, Society and Behavioural Science*, ***26(2): 1-11***

Garza, T., Huerta, M., Spies, T. G., Lara-Alecio, R., Irby, B. J., & Tong, F. (2018). Science classroom interactions and academic Language use with English learners. International Journal of Science and Mathematics Education , 16(8), 1499-1519

Geleta, T. (2014). How can I improve N12 students' ability to write simple chemical entities using chemical symbols and formulas on introductory general chemistry course-1 (chem. 101)?. African Journal of Chemical Education , 4(1), 56-83.

Gongdon, J. J, Gongden, E. J &Lohdip, (2011). Assessment of difficult areas of the Senior Secondary School II Chemistry syllabus of the Nigeria Science Curriculum African Journal of

Hanson R. (2017). Enhancing students' performance in organic chemistry through context-based learning and micro activities- a case study, *European Journal of Research and Reflection in Educational Sciences,5(6)*, 1-15

Hofstein, A., Eilkis, I., &Bybee, R. (2011). Societal issues and their importance for contemporary science education- A pedagogical justification and the state-of-the-art in Israel, Germany, and the USA. *International Journal of Science and Mathematics Education, 9*, 1459-1484.

Jimoh, A. T (2010). Perception of Difficult Topics in Chemistry Curriculum by students in Nigeria Secondary Schools. *Ilorin Journal of Education 4(1), 1-5.*

Johnstone, A.H. (2006). Chemical education research in Glasgow in perspective. *ChemEduc Res Pract* 7(2): 49-63.

KirmanBilgin, A., &Yigit, N. (2017). The investigation of students' responses to revelation of the relation between 'physical and chemical change' concepts and contexts. *YYU Journal of Education Faculty, 4*(1), 289-319.

Korau, Y. (2006). *Educational crisis facing Nigerian secondary schools and possible solutions.* Ibadan, Nigeria: University of Ibadan, Faculty of Education.

Lohdip, Y,N., Gongden, E.J. &Gongden, J.J, (*2011*) Assessment Of The Difficult Areas Of The Senior Secondary School 2 (Two) Chemistry Syllabus Of The Nigeria Science Curriculum. *AJCE, 1(1),* 48-59

Marais, P. and Jordaan, F. (2000). Are We Taking Symbolic Language for Granted? *Journal of Chemical Educatio*n, **77**(10), 1355-1357.

Markic, S., & Childs, P. E. (2016). Language and the teaching and learning of chemistry. *Chemistry Education Research and Practice* , 17(3), 434-438.

Naah, B.M & Sanger, M.J. (2012). Student misconcep-tions in writing balanced equations for dissolving ionic compounds in water, *Chem. Educ. Res. Pract.,* **13,** 186–194.

Nbina, J. B. (2012).Analysis of Poor Performance of Senior Secondary Students in Chemistry in Nigeria**.** International *Multidisciplinary Journal, Ethiopia*, 6 (4), 324-334)

Ogunkola, O.H. (2008). Teachers effectiveness and group discussion in SS practical agricultural sciences in Imo state. *Journal of science Teacher Association of Nigeria.* 36(1-2), 12-17.

Olatoye, R. A. (2002). *A causal Model of School factors as Determinants of Science Achievement in Lagos State secondary Schools.* Unpublished Ph.D Thesis. University of Ibadan, Ibadan.

Omole, C.C. (2002). Effect of constructivism instructional approach on senior secondary school students archievement and interest in mathesmatics. Unpublished M.ed project university of Ngeria*Research*, 1/2.

Owoeye JS, Yara PO 2011. School facilities and academic achievement of secondary school agricultural science in Ekiti State, Nigeria. *Asian Social Science*, 7(7): 64-74

Rees, S., Kind, V. & Newton, D (2018).Meeting the Challenge of Chemical Language Barriers inUniversity Level Chemistry Education. Israel Journal of Chemistry, 58, 1 – 9

Saage, O. (2009). Causes of Mass Failures in Mathematics Examination among Students a Commissioned Paper presented at Government Secondary School. Karu Abuja Science Day 1st March.

Salame, I. I., Sarowar, S., Begum, S., & Krauss, D. (2011). Students' alternative conceptions about atomic properties and the periodic table. Chem. Educator, 16 , 190-194

Samba. R.M.O. &Eriba, J.O, (2012). Laboratory Techniques and the Art of improvisation, Makurdi: His master servant media apostolate publication. Springer.pp. 75-108

Shamsuddin, M.I. Arome, T.A. Aminu, I. &Isah, I.I Adamu, M.A . (2017). Solving the Problems of Chemistry Education in Nigeria:A Panacea for National Development**.** American Journal of Heterocyclic Chemistry, 3(4): 42-46

Stojanovska, M., Petruševski, V. M., &Šoptrajanov, B. (2017). Study of the use of the three levels of thinking and representation. Contributions, Section of Natural, Mathematical and Biotechnical Sciences , 35(1), 37-46

Stojanovska1. M. Petruševski1, M.V, Šoptrajanov, V. (2014). Study of the use of the three levels of thinking And representation 35, No. 1, pp. 37–

T. Garza, M. Huerta, T. G. Spies, R. Lara-Alecio, B. J. Irby, F. Tong, Int. J. Sci. Math. Educ. 2017, 1–21

Taber, K. S. (2009). Learning at the Symbolic Level. In: Gilbert, J. K. &Treagust, D. (eds), *Multiple Representations in Chemical Education.* Dordrecht, The Netherlands: Springer, pp. 75-105.

Taber, K. S. (2011). Models, Molecules and Misconceptions: A Commentary on" Secondary School Students' Misconceptions of Covalent Bonding".Journal of Turkish Science Education (TUSED) , 8(1), 3-18.

Taskin V. and Bernholt S., (2014), Students' Understanding of Chemical Formulae: A review of empirical research, *Int.J. Sci. Educ.*, 36(1), 157–185.

Taskin, V. &Bernholt, S. (2014), Students' Understanding of Chemical Formulae: A review of empirical research, *International Journal Science Education*, 36(1), 157–185.

Uchegbu, I.R., Oguoma,C.C., Elenwoke, E.U. &Ogbuagu, E.O (2016). Perception of Difficult Topics in Chemistry Curriculum by Senior Secondary School (II) Students in Imo State. *AASCIT Journal of Education.* 2(3), 18-23.

Upahi, J.E., Olorundare, A.S. (2012) Difficulties Faced by Nigerian Senior School Chemistry Students in Solving Stoichiometric Problems. *Journal of Education and Practice,* 3(12), 181-189.

Vladušić, R., Bucat, R. B., &Ožić, M. (2016). Understanding ionic bonding–a scan across the Croatian education system. Chemistry Education Research and Practice , 17(4), 685-699