

## APPLICATION OF EPISTEMOLOGICAL CODE METHODS TO TEACHING AND LEARNING OF CHEMISTRY IN NIGERIAN SECONDARY SCHOOLS

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### Abstract

The paper examined the application of epistemological code methods to teaching and learning of chemistry in Nigerian secondary schools. The methodology employed involves the use of primary and secondary sources of data. It was discovered in this work that human brains are natural computers that could be coded for better efficiency and easy retriever of knowledge content. Also, the students taught with epistemological code method possess better confidence to face examinations without any kind of malpractices than those taught with traditional method of teaching. The paper recommended that teachers should be trained and retrained through refresher courses such as conferences, workshops, seminars and symposia on application of Epistemological Code Methods (ECM) in the teaching and learning of chemistry at the secondary level of Nigerian education.

**Keywords:** Traditional, Teaching, Method, Epistemology, Nigeria

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### Introduction

The role of chemistry as the nucleus of existence cannot be under-estimated in human existence and well-being. Chemistry is a branch of science which deals with the study of properties, compositions, uses and the reactions of matters. However, matter is anything that has mass and occupies space. So, virtually everything on the surface of earth belongs to the category of matter. These matters include solid state materials such as stones, rock, wood, cars and man, to mention but a few. The liquid state of matter includes watery substances such as water, wine (ethanol), lubricants, and petroleum products among others. While, the gaseous state includes Oxygen which is inevitable for human survival, Carbon (iv) Oxide which is obligatory for plant growth,

etc. All these illustrations show how relevant the study of chemistry is to human survival and healthy living within the environment.

Secondary school chemistry is an important pre-requisite for the study of Sciences which gives hope for the country in the area of producing both science and technological oriented manpower. However, one of the greatest problems that the country faces in her rapid bid for industrialization is scarcity of skilled and technical man-power. To produce technical man-power, the country first of all ought to start an educational revolution especially in Science education (Babalola (2010). We are living in a rapid changing world in which science and technology are having an ever increasing importance. No one needs to be told that science and technology are smoothly revolutionizing the pattern of human life and thought. The evidence of this abounds everywhere and there is no doubt that tomorrow will see greater and more spectacular change. Many discoveries were made to better human life and existence through science discoveries. Science and Technology have become inseparable in all ramifications of life. Sciences give light to technological innovations to move smoothly in the world of work.

A Nigerian Professor of Veterinary Medicine; Maduiké Ezeibe at Michael Okpara University of Agriculture, Umudike recently discovered a cure for HIV/AIDS epidemic, tested and trusted. This cure; “Aluminum magnesium silicate (AMS)” could be gotten from the combination of three chemical elements such as; Aluminium, magnesium and silicon. It can also be gotten from chemical reaction between Aluminium Silicate and Magnesium Silicate. Maduiké & Ijeoma (2015) said “both Aluminium Silicate and Magnesium Silicate were available in Nigeria but the required AMS was not”. So, there was a great need to produce a synthetic AMS  $\{Al_4(SiO_4)_3 + 3Mg_2SiO_4 \rightarrow 2Al_2Mg_3(SiO_4)_3\}$  needed through chemical reactions. The research started in the year 1998, but tested and proven to be effective in 2015 (Daily Trust, 4<sup>th</sup> of March, 2015). This breakthrough could not have possible without the knowledge of chemistry at the secondary school level. Therefore, if Nigeria must succeed like other developed countries of the world, young age Nigerians must be groomed, encouraged and motivated to study pure sciences especially chemistry through interesting methods of teaching and learning.

Unfortunately, observation of enrolment rate in the Nigerian tertiary institutions of learning especially in the teacher education schools shows that prospective teachers are trying to avoid pure sciences. For instance, the analysis of the students’ enrolment into the faculty of education of Northwest University, Kano in the 2014/2015 Academic section show that students nowadays prefer physics and biology to chemistry. Approximately 80-students enrolled for B. Sc (Ed) Biology, 17-students enrolled for B. Sc (Ed) Mathematics, 47-students for B. Sc (Ed) Physics while 34-students enrolled for B. Sc (Ed) Chemistry. This is perhaps because of the manner at which many Nigerian secondary school teachers present chemistry as being very difficult to students.

### **Conceptual Framework**

According to Tella (2005) teaching can be defined as the conscious and deliberate effort by a matured or experienced person to impart knowledge, information, skills, attitudes; beliefs etc, to an immature or less experienced person with the intention that latter will learn or believe what he taught on a rational basis. However, Ukeje (1998) on his part posits teaching as a systematic

presentation of facts, ideas, skills and techniques to pupils or students or any learners. In a similar vein, Aliyu (2014) asserts that for any activity to qualify as teaching, it has to be performed intentionally and in accordance with professional principles. Generally, teaching can be observed as the conscious, deliberate, intentional and purposeful effort by a trained teacher to impart knowledge, skills and all forms of good behavior to the life of learners in order to make them useful for themselves and the society at large.

Conversely, according to Abdullahi (2014), effectiveness is in fairness, best estimated in relation to your own goals of teaching. A well designed and well-polished lecture which provides solution to a problem may be considered effective if the goal is merely conveying information. She stated further that there is this argument that bad teaching is or can be effective teaching. This is mainly because bad teaching forces students to study more intensely. She concluded that for those concerned with the effectiveness of the teaching/learning process bad teaching essentially reduces motivation, increases negative attitude to learning and to a large extent yields low academic achievement. Mckeachi & Kulik (1975) in Abdullahi (2014) posit in this regard that there are certain features of teaching in which there is consensus among professionals that effective teaching is systematic, stimulating and goal oriented. Generally, effective teaching can be defined simply as a successful teaching. Successful teaching is the one which produces the expected goals of the school; that is, the required excellent academic achievement. Nevertheless, before teaching could take place, it is a truism that the teacher, subject matter and the learners must be mentally, physically and or technologically available and ready.

Wesley (1964) commented that “Teaching involves intentional, deliberate and Purposeful guidance in the learning process”. Clarifying this assertion, Ibukun (2004) stated that teaching in modern method of pedagogy and andragogy, has gone beyond the dishing of facts through lecturing methods of instruction to the pragmatic methods of instruction. So, the role of the teacher is changing. He is now more of a supervisor, director, guardian, group leader, advisor and facilitator rather than the reservoir of all knowledge.

Pedagogical theory assumes more of a primary or influential role of the educator within the classroom and is defined as a teacher dependent educational model (Hiemstra, 2005). This style incorporates a directive leadership format which, though allowing for various levels of student engagement, is still predetermined by the educator’s designs, planning and philosophy (Sadker & Zittleman, 2007). Pedagogy can thereby be seen as an art and practice of teaching children in which it is mostly teacher centered. This is based on an ideology that small children do not have the required ability to act expectedly in the teaching process to promote learning. So, the teacher does the most work in the class. Conversely, Andragogy is best conceptualized along a continuum line with pedagogy, defined as teacher directive, at one end and andragogy at the other (Sean, 2013). This model is described as student centered and was originally conceived for adult learners who have the necessary skill sets to learn from differing formats save primarily that of the teacher directive approach (Hiemstra, 2005).

Traditional method of teaching can be viewed as inborn and general method of teaching. It is a method of teaching other than epistemological code method of teaching. Akinpelu (1981) states that Methods of teaching that is satisfactory in Nigerian Schools is the one which pay due regard to the interest, the willingness and the personal integrity of the learner and also involve his/her

active participation. In this regard that Amaele(2005) stated that Education process is man-oriented and since man himself is dynamic in nature, his education is equally dynamic. An educated man, irrespective of tribe, sex, place of residence, socio-economic background and status must be able to develop the three domains of life; cognitive, psychomotor and affective. In this vein teaching can be defined as the process of developing cognitive, psychomotor and affective domains of learners in order to make them useful for themselves and the society at large.

It was stressed biologically that understanding comes better by sight even better than hearing. Dale Carnegie (1997) commented in this regard that “The nerves that connect the eyes to the brain are twenty five times larger than those that connect the ears to the brain”. Therefore, teachers of chemistry should strive to make the chemistry lesson friendlier by using a method that will make the students hear, see, write, think, talk and touch if possible. Epistemological code methods provides for these criteria for effective teaching.

It has been noticed that all branches of education work together meritoriously while dealing with issues pertaining to knowledge and how it could be transferred from one person to another or from one context to another. Also, it has been noticed by many scholars that one of the major reason while education was necessary, is that educated elites should be able to transfer the knowledge gained in one context into solving problems in a similar or dissimilar ones. Thus; transfer of learning may occur from simple context to simple situation. It may also occur from simple context to complex situations.

However, there is no gainsaying that concept of learning has no universally acceptable definition. This is not withstanding, an attempt has been made by many scholars from various fields of education including psychology to define the concept. It was noted by Lachman (1997), that most textbook definitions of learning refer to learning as a change in behavior that is due to experience. This is essentially a very basic functional definition of learning in that learning is seen as a function that maps experience onto behavior. In other words, learning is defined as an effect of experience on behavior. Many researchers have claimed that such a simple functional definition of learning is unsatisfactory ( Domjan, 2010; Lachman, 1997; Ormrod, 1999, 2008).

Domjan (2010) defines learning as an enduring change in the mechanisms of behavior. Likewise, Lachman (1997) typifies learning as a process that underlies behavior. He argues that learning should not be confused with the product of this process that is, the change in behavior. The change in the organism that is assumed to lie at the core of learning is sometimes described at a very abstract level (Hall, 2003) but sometimes also as involving a specific mental process (Ormrod, 2008).

Considering ontogenetic adaptation, learning according to Skinner (1984) can be defined as changes in the behavior of an organism that are the result of regularities in the environment of that organism. This definition consists of three components: (1) changes in the behavior of the organism, (2) regularity in the environment of the organism, and (3) the causal relationship between the regularity in the environment and the changes in behavior of the organism. Generally, learning can be defined as the permanent change in behavior of an organism (living

thing) as a result of his/her interaction with the regularities or changes in the environment of that organism. This definition proved that learning is not only limited to human but every living thing as described by the scientists. Living things entails plant and animals. A plant covered by a container with a small hole finds its way out of the small hole created in the covering material. This shows that the plant detect changes in the environment, learn from the environment and solve its problem of how to get light needed for photosynthesis in the environment.

Therefore, teaching and learning of chemistry is a process of making both students and the teacher involved familiar and interacts with both regularities and irregularities within the society so as to make them be able to proffer solutions to the societal maladjustments through the manipulation of matters which are the scope of chemistry.

### Philosophy and the Epistemological Codes

Philosophy deals with the study of material world and how the materials in the world exists (metaphysics), the study of knowledge and the nature of knowledge (Epistemology), the study of beauty and the types of beauty (Aesthetics) such as the physical beauty and the spiritual beauty, the study of right and wrong as related to human behavior (Ethics) among others (Amaele, 2005). Philosophers are after the search for the truth concerning all these areas. Thus, they tend to ask questions from people and behave as if they knew nothing and wanted to know. According to Amaele (2005), In the process of asking questions, philosophers move from one place to another in order to find answers to some of their questions. Some of the heroic philosophers of the ages who had paved ways for other philosophers include the Great Aristotle, Plato, John Dewey, White head and Mary Pest lousy.

Epistemology is the branch of Philosophy which deals with the study of knowledge and the nature of knowledge (Amaele, 2005). There are various sources and types of knowledge. These include; revealed knowledge, empirical knowledge, logical knowledge, authoritative knowledge and the like. The fig.1 shows the branches of philosophy which include; Metaphysics, epistemology, logic, aesthetics, and Axiology. All these branches of philosophy has significant share in the overall nature and the structure of the philosophical discipline.

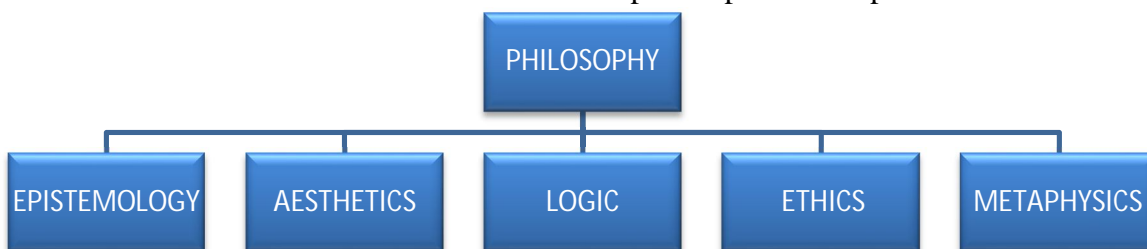


Fig.1: The branches of Philosophy; Source: Adapted from Amaele (2005)

Epistemological codes simply mean the codes of knowledge. Codes may be expressed as the password. To a layman, codes could mean the master key to the secret kept. Computers work by accepting data inform of program, translate it into computer readable codes and interprets the information or output from computer readable codes to human understandable languages. Codes are useless to those that do not know what it means but constitutes power and knowledge to those that understood the codes, their meanings and their applications

### **Review of Related Empirical Literature**

Chemistry is most commonly regarded as the “Central Science” or the “Mother of science” owing to its confluence and influence (Ahiakwo, 2002). Okeke and Ezeannagba (2000) defined chemistry as a branch of science of matter. The relevance of chemistry as a requirement to technological advancement of a nation cannot be underrated. The classification of any nation into developed, developing and underdeveloped could be measured accurately by the number of chemists, physics, engineers, pharmacists, doctors, agriculturists and science educators the nation could produce. Available evidence from West African Examination Council (WAEC) indicates that students’ achievement in chemistry especially at the senior secondary school level worsened as years go by and many students seem to have negative attitude towards the subject (Betikin, 2002 and Oyedepo, 1992).

Relevant research results have reviewed the factors responsible for students poor performance in science and technology in the country such as Wells and Mejija-Arauz (2006), Tytler (2002), Driver and Koshons (1999), Lanke (1991), Balogun (1985), Mustapha (1987). These researches focused on the areas of improving the quality of science teaching and factors militating against students’ performance in science and other researchers try to isolate difficult topics in science.

Difficulty in chemistry has been shown to stem from the amount of time involved in studying it (Ghamaja, 2006), its language and vocabulary with attendant confusion of names especially from IUPAC Nomenclature (Ormerod and Dueckworth, 1999); its conceptual demand (Akinmade and Adisa, 2003) and insufficient time to learn it (Ahmed, 2004). Stone (1999) conducted a research which focused on the teaching facilities in Nigerian schools. He found out that the condition of teaching science were rather unsatisfactory. Weaker (1990) concludes that the type of science teaching done in Nigeria could not prepare students adequately for future careers in Nigeria to improve science and technology. According to Weaker (1990), science teaching was more of memorizing activities than inquiry.

Further studies such as Uried (2007), Adewole (2006), Orisaseri (2005), Oguniyi (2004), Teibo (2003), and Oyedepo (1972) have been carried out on the status of science teaching in Nigerian secondary schools. These studies considered teachers qualifications, teacher’s major field of specialization, number of laboratory facilities and the personnel to manage them. The general conclusion was that science teaching particularly chemistry was unsatisfactory and inadequate.

The reason why students running away from sciences due to their perceptions that chemistry is difficult called for a number of researches such as Teibo (2003), Bajah (2004), Johnstone et al (1999), Ingle and Shayer (2005), Bojesuk (2006) and Ahiakwo (2002) came out with some difficult concepts in chemistry. Dawson (2005) suggested that “when difficulties occur there is need to first identify the difficulties which are causing the problems and attempt to verify them”. Poulton and James (2007) stressed the idea that poor achievement in science is often a joint function of school and home. In contrast to this, Canol (2004) views that aptitude is the amount of attain mastery of a learning task. Taking together “difficulty” has been considered as the strongest attitudinal variable against students studying chemistry and performing well in it

(Ormerod and Duckworth, 1999). When the teacher does not use big words” Seimes (2000), and when the practical session are used in the teaching (Ango,2007). For example, using guided discovery method will improve students’ understanding of chemistry (Haddad, 2008) especially when using local materials accompanied by local and familiar examples in illustrations (Okwu, 2009). Chemistry is hierarchical and so advanced topics are difficult to learn if the basics are not mastered (Akande and Adisa, 2003). The teacher must avoid using highly technical words except where it is unavoidable as it occurs in the case of IUPAC nomenclature in chemistry.

### **Epistemological Code Methods**

This is a method propounded by the researcher in 2008 and officially introduced in an international conference on Islamic University in 2013. The concept of epistemology is a philosophical term meaning “knowledge or wisdom” Epistemology is a branch of philosophy that deals with the study of knowledge. Before anybody can come to school, the person or his/her parents or guidance must be a lover of knowledge. Nevertheless, Codes may be number(s), letter(s), word(s) or sentence(s) which holds the secret of knowledge or understanding or access to something. Babalola (2013), emphasized that Epistemological code methods involves the fabrication of numbers, letters, words or Sentences which serves as a master key to understanding a particular concept. It was based on a truism that “when these number(s), letter(s) or sentence(s) is readily available, the study content of interest could be remembered with little or no efforts”. Normally, funny sentences are difficult to forget (Babalola, 2013).

Epistemological Code methods work on the philosophy that human brain is a natural computer designed for the storage of information. If an artificial computer designed by man can store large amount of information with the use of codes, the human brain which was designed by God when seriously coded can store larger volume of information without any barrier in its retriever. This is highly advantageous to students in the sense that student’s brain follows him/her everywhere.

Artificial computer is disallowed in examination halls while human brain is what needed to be tested and therefore received universal recognitions. The academic challenges of the students in this world of techno-dynamism is not limited to their ability to pass examination in the present class but to still remember after a long period of time to the extent of facing the challenges of labour market without exercising phobia. The man made computer is not allowed during interviews while human brain had gained universal recognition. Therefore, with the growing rate of unemployment in the country, the highly competitive labour market and highly demanding world of work, it become so imperative to fully equip our young generations to face the present and the future challenges through our innovative teaching and learning methods.

There is a significant need to develop human brain through coding to perform duties that artificial computers can perform during interview and other situations where transfer of knowledge is highly required. The way forward is the adoption of epistemological code methods into the practical realm of classroom practices. Epistemological code method can be classified into two categories based on the users. These are;

*(A) Epistemological Code Teaching Method(ECTM)*

This is when epistemological code is used by the teacher during the preparation and dissemination of information to students in a logical and understandable manner. The method keeps the students in suspense at the early stage of the lesson. Student can't afford to miss the class due to the enthusiasm of knowing the secret that is behind the new code to be learned in the class per day. This method makes the class lively, interesting and interactive in nature. The method could be teacher or learner centered in nature depending on the teacher's level of tolerance and time available for the lesson. As we all know, that in this world of technological universalism, the role of teacher is moving from being a lecturer into a facilitator, moderator, group leader, instructor, etc. Both teacher and students can now learn from one another with ease as democracy is migrating into the class structure. Sometimes, the teacher may write the content to be learnt on the blackboard and ask the students to provide funny and interesting code best fit to remember the content of the study.

Epistemological code Method is the best method for such courses where listing of concepts serially is required. The teacher, during the preparatory section of the class must be creative enough to fabricate interesting and funny codes which could be used for the logical explanations of the concepts. When the researcher used this method during his teaching practice, supervisors forgot themselves in the classroom because they were learning new method. When the class was over, the supervisor commented thus, excellent introduction, excellent presentation, and excellent knowledge of subject matter, neat, smart and enthusiastic. When the teaching practice was over the supervisor asked "which method were you using then in your teaching practice class?" "Epistemological code method" replied by the researcher.

*"I have been supervising students of teaching practice for years no teaching method had ever captured my attention as such. The method was fantastic, interesting, arouse the student interest, above all, your students were able to answer my questions without any mistake. You would have to come and teach me those codes that you were using" (Omodara, 2008)*

In that year, the researcher scored the highest mark in the teaching practice and he was appointed the Chairman academic committee of the student chemical society of Nigeria. This is a new method which had been tested and trusted with chemistry at secondary school level. Epistemological Code Teaching Method (ECTM) is a method that looks so childish but reasonable because nonsense word(s) or sentence(s) were transformed into reasonable knowledge.

### ***Advantages OF Epistemological Code Teaching Methods***

Advantages of Epistemological Codes Methods according to Babalola (2013) include the following;

- 1) The method helps the student to develop interest in classroom attendance.
- 2) The method gives students enough confidence to face any examination without examination malpractices or phobia, "if I forget, my Code will make me remember".
- 3) The methods make the class lively, interesting at the same time creative in nature.
- 4) It involves the use of eyes, ears, hand, mouth and mind. Hence, it is very difficult to forget any body of knowledge learnt through this method.
- 5) The method is flexible as it could be made teacher center, learner center or both.

### ***Disadvantages of Epistemological Code Teaching Method***

- 1) If the teacher's personality does not command respect the class might be poorly managed.
- 2) If the time for the lesson is not properly planned or students are timid to contribute, learner centered epistemological code teaching method may waste time.
- 3) If the teacher failed to prepare well before coming to the class, he/she may turn to a fool when finds it difficult to supply needed codes within a short period of time.

In summary, it is learner centered when the students are allowed to supply the codes, teacher centered when the teacher supplied the codes and both when both the teacher and the learner join hands to supply the codes. Today, due to many technological innovations democracy has migrated into the class structure. Hence, both the teacher and student are at liberty to supply the code of knowledge needed for the lessons.

However, in epistemological code teaching method, the teacher during his/her preparation for classroom fabricate and design interesting codes which could be set of number (s), word(s), or sentence(s) which hold the secret to the understanding and knowledge of concepts in hierarchy or sequence order. Whether the students would be asked to fabricate another one as in the case of learner centered type or not, the teacher is expected to have his own kept closer to himself while in class. This should be done as a backup for the teacher in case if the students failed to fabricate any.

### **Epistemological Code Learning Method**

This is when epistemological code is used by the students while preparation for examination. The students try to convert difficult areas of his/her study into interesting, funny and unforgettable codes, which could be names of fruits, villages, countries and so forth. The codes can also be funny sentence(s). When a student has successfully coded large area of his/her books, such a student has become a natural computer. He will develop a special confidence that he can no longer fail the examination. This relieves him from every emotional stress like examination tension, sudden rise in body temperature and related illnesses.

### **Epistemological Codes Method and its Application in Chemistry**

#### ***A. The Electrochemical Series***

Electrochemical series can also be referred to as the activity/reactivity series. It involves the arrangement of elements in their ionic form in order of their reactivity. An ion is a charged element. A charged element called ion is gotten by removing valence electron from the outermost shell of an atom or by adding electron(s) to the outermost shell of an atom. The number of valence electron(s) removed from the outermost shell of an atom of an element determines the oxidation number of such an element. Ions can be categorized into anions and Cations. Anions are negatively charged ions meaning that an element (acceptor) has accepted additional electron(s) from another metallic element (donor) or atom. The positively charged ions are called Cations while anions are negatively charged ions. Examples of ions include,  $\text{Ca}^{2+}$ ,  $\text{N}^{3-}$ ,  $\text{Cl}^-$ , etc.

#### ***a) Epistemological Codes for electrochemical series of Cations***

The Teacher's Presentation: Let's consider the statement of my town's king "King Nazi" during our preparation when it remains two months to our annual August yam festival;  
(King Nazi Called Me, All Zealous Fellow Son Please Hide Cup High Against August)

Codes	Symbols	Elements	Cations
King	K	Potassium	$K^+$
Nam	Na	Sodium	$Na^+$
Called	Ca	Calcium	$Ca^{2+}$
Me	Mg	Magnesium	$Mg^{2+}$
All	Al	Aluminium	$Al^{3+}$
Zealous	Zn	Zinc	$Zn^{2+}$
Fellow	Fe	Iron (ferium)	$Fe^{2+}$
Son	Sn	Tin	$Sn^+$
Please	Pb	Lead	$Pb^{2+}$
Hide	H	Hydrogen	$H^+$
Cup	Cu	Copper	$Cu^{2+}$
High	Hg	Mercury	$Hg^+$
Against	Ag	Silver	$Ag^+$
August	Au	Gold	$Au^+$

Fig.3: Electrochemical Series of Cations listed through ECM

The above series is the arrangement of metals according to their level of reactivity otherwise known as Electrochemical Series of Cations. However, Cations are positively charged ions. Nevertheless, Ions are the charged elements achieved when metals loss valence electrons from their outermost shell. The position of Cations in this series determines their strength. This is perhaps the reason why element that is higher in this series possess special ability to displace the lower one in a chemical reaction or in a solution. For instance, if Sodium ion ( $Na^+$ ) and Potassium ( $K^+$ ) are together in a solution,  $K^+$  as the King will never leave the solution for his subject which is  $Na^+$ . Hence, Sodium will be discharged while potassium retains its position. This is the wisdom behind some elements being discharged during Electrolysis while others maintain their stand. Also, Electro-positivity decreases from king (potassium) to August (Gold). Conversely, electro-negativity increases from potassium to Gold. Therefore, the element got from king is the most reactive metal and the one from August is the least reactive. The most and least reactive metal respectively is potassium (k) and Gold (Au).

### Questions

- (1) Which metal is the most reactive? (A) Gold (B) Potassium (C) copper
- (2) Which of these metals is more reactive than hydrogen? (A) Copper (B) lead (C) Gold
- (3) Which of these is the least reactive metal? (A) Gold (b) Zinc (c) Potassium
- (4) Which of these Cations can displace  $Na^+$  from brine ( $NaCl_{aq}$ )? (A)  $K^+$  (B)  $Ca^{2+}$  (C)  $Mg^{2+}$

### b) Epistemological Codes for electrochemical series of Anions

This statement was made by a man to his son who is matured enough for marriage "son, No-one Can Bring Idiot Home".

Epistemological Codes	Anions	IUPAC Names
Son	$SO_4^{2-}$	Tetraoxosulphate (vi) ion

No-one	$\text{NO}_3^-$	Trioxonitrate (v) ion
Can	$\text{Cl}^-$	Chloride ion
Bring	$\text{Br}^-$	Bromide ion
Idiot	$\text{I}^-$	Iodide ion
Home	$\text{OH}^-$	Hydroxide ion

It is however, important to note that when an anion contains more than one element in their formation, the anion becomes a radical.  $\text{SO}_4^{2-}$ ,  $\text{NO}_3^-$ , and  $\text{OH}^-$  could better be expressed as radicals. As far as this arrangement is concerned, the anions or radical that is higher has ability to displace the lower ones during chemical reaction. In a simple term, tetraoxosulphate (vi) ion is the strongest among the radicals and other anions. Therefore, all radicals and anions must respect tetraoxosulphate (vi) ion during chemical reaction. The same ideology also accounts for the reason why in most  $\text{OH}^-$  which the least positioned anion in the electrochemical always sent out of the solution in form of Oxygen liberation in the name of discharge if other conditions remain constant. However, this epistemological code of anions holds many secrets in the field of electrolysis, electrochemical cell, chemical reactions, chemical equations and stoichiometry. Therefore, when a student is equipped with this code, the application is thinkable when facing examination challenges.

#### ***Epistemological Codes For the First Transition Series***

Transition metals have gained much grand in the field of chemistry for their inevitable uses and their distinctive characteristics. The chemistry of transition metal is one of the most interesting aspects of chemistry. But, the most unfortunate part is that many secondary school chemistry teachers have jeopardized the interest of students towards this friendly topic. Transition metals have the characteristics such as ability to form complex ions, possession of variable oxidation states, high melting and boiling points, possession of magnetic properties, formation of coloured compounds and ability to form catalyst readily. The knowledge of this transition metals and their coloured compound formation provides chemists with the bases for predicting the colour of many compounds in the field of Chemistry education. Nevertheless, the Code which can be used to remember the first transition series in chemistry is; **“STiVe Cry My Fellow Country Nike Call Zinab”**

Note that our point of interest in this case is the upper case letters in the statements.

Atomic Number	Epistemological Code	Symbols	Names
21	S	Sc	Scandium
22	T	Ti	Titanium
23	V	V	Vanadium
24	Cry	Cr	Chromium
25	My	Mn	Manganese
26	Fellow	Fe	Iron (Ferium)
27	Country	Co.	Cobalt
28	Nike	Ni	Nickel
29	Call	Cu	Copper
30	Zinab	Zn	Zinc

Tab.3: The first transition series; Source: writer

The knowledge of these first transition series gives the students ability to understand and write the first thirty elements and their atomic numbers with little or no stress. This will help the students to determine both the atomic and mass number of elements from 21 to 30 atomic numbers and their mass number because there is a cordial relationship between the mass number and atomic number of an atom.

### **Concluding Remarks**

The concept of epistemology as a branch of philosophy and the codes attached to it have been rightly observed in this study to justify the complementarities as it was used in the topic. Chemistry was defined as the branch of science that deals with the study of compositions, uses, properties and the reactions of matter. Physics and chemistry are good friends in the curriculum of senior secondary schools in Nigeria and the bases of fear for students who were running from the pure sciences. It was discovered in this study that bad teaching methods contributed to students' fear of chemistry at the secondary school level in Nigeria. However, the nature and structure of chemistry has made it inevitable for human survival. Purification of water before drinking, cooking of foods and washing of clothes with soap and detergents are the daily activities which portray the relevance of chemistry to wellbeing of man. Many problems of this contemporary world such as climatic changes, HIV/AIDS, Ebola pandemic, bird flu and the like have chemistry explanations and solutions there in.

Consequently, possession of many qualified scientists in Nigeria in the near future depends significantly on the secondary school chemistry teachers' ability to develop learner friendly techniques to motivate many qualified students into sciences. As the technological innovation of this techno-dynamic world depends on science discoveries for development, Nigerian science teachers must find a way to motivate students into science discipline through creativity in teaching and learning. Epistemological code methods have been found relevant as a motivating teaching method worthy of emulation for both practicing and the teachers in training.

This study thereby recommends that;

- 1) Training and retraining of teachers through refresher courses such as conferences, seminars, workshops and symposia on Science teaching methods.
- 2) Epistemological code methods should be adopted by every chemistry teachers especially at the secondary level of Nigerian education to promote students interest in sciences.
- 3) School administrators and counselors should strive to encourage students to employ epistemological code learning method while preparing for examination to reduce students' failures.

These will go a long way in promoting academic integrity among the Nigerian students and examination malpractices shall become a thing of the past in science related courses especially in Chemistry Education.

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