

**INNOVATIONS AND MODIFICATIONS OF CHEMISTRY CURRICULUM CONTENT, IMPLEMENTATION AND REVISION IN RESPONSE TO CHANGES IN SOCIETAL NEEDS: IMPERATIVE FOR IMPROVING SECONDARY CHEMISTRY EDUCATION IN NIGERIA**

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**Abstract**

*Educational systems all over the world place serious emphasis on Science and Technology because of their implications on technological advancement which is tied to national development. This being the case, the curriculum content of science education stands as a life wire through which learners in schools are trained to attain goals in technological advancement. The chemistry curriculum has under gone some innovations and modifications in terms of contents, implementation and revision. The innovations and modifications were as a result of the changing needs of the society, based on three major issues namely; Globalization, Information and Communication Technology (ICT) and Entrepreneurship, which are shaping the development of nations worldwide. This paper ex-rayed the innovations and modifications of chemistry curriculum contents, implementation and revision in response to societal needs. The paper reviewed the chemistry curriculum which was in use till 2008 and the current chemistry curriculum in use in the secondary schools in Nigeria, in terms of objectives, content selection, focus and organization. It also looked at the justifications for the revision of the curriculum. The paper argued that, effective implementation of the revised curriculum is dependent on the teachers' readiness to drive it. The researcher therefore, suggested among other things that the chemistry teachers should be exposed to regular training workshops for effective implementation of the curriculum thereby improving the quality of chemistry education in Nigeria.*

**Keywords: Chemistry Education; Chemistry Curriculum content; Innovation and Modification.**

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**Introduction**

Nigerian educational system has gone through various curriculum developments and changes. The dynamic nature of the curriculum processes lead to the history of curriculum development in Nigeria. Analysis of the education sector in Nigeria reveals the challenges of incoherence in the areas of; policy formulation and implementation; selection and organization of curriculum content, implementation and evaluation; the development, distribution and use of teaching materials; and the relevance of the curriculum to the needs of the society (Okeke, 1996). According to

Onyike (1996), Curriculum is a plan developed with the intention that when it is properly executed, the educational goals will be achieved. Curriculum is not static, it is dynamic and graded level by level, that is, the higher you go, the more in-depth the curriculum. Continuing, Onyike maintained that Curriculum represents the total experiences to which all learners must be exposed to. The content, performance objectives, activities for both teachers and learners, teaching and learning materials and evaluation guide are provided. Furthermore, Curriculum is a course of study offered in schools, colleges and other institutions. It may also be viewed as a set of learning experiences planned to influence learners to bring about the objectives and structured plan of action that guides the process of education (Danmole, 2011).

Meanwhile, the importance of Chemistry as one of the requirements for technological advancement of a nation cannot be underrated. The classification of any nation into developed and developing could be measured accurately by the number of Chemists, Physics, Engineers, Pharmacists, Doctors, Agriculture and Science educators, the nation could produce and also the products that can be obtained by these professionals (Ezeano, 2013). Chemistry is most commonly regarded as the “Central Science” or the “Mother of all Sciences” owing to its confluence and influence (Ahiakwo, 2002). According to Okeke and Ezekannagba (2000), Chemistry is a branch of science that deals with the composition, structure, composition and changes of matter. Chemistry equips the individual with necessary knowledge, skills and attitudes which enables him to interact meaningfully with the environment, and solve life problems in the society. Many of our day-to-day activities revolve around chemistry (Oloyede, 2010). It is therefore important for any nation that aspires to be among the developed nations to take the teaching and learning of Chemistry and other science subjects seriously in her school system (FRN, 2004). The teachers should teach the subject effectively. But, effective teaching stems from a well developed and implemented curriculum. The curriculum therefore, should be planned such that it can address the area of subject relevance and to effectively and adequately cater for individual, collective and community needs and aspirations. In the light of the above, it became necessary to revise the former Chemistry curriculum by introducing innovations and modifications into the content and implementation, based on the societal needs. This paper therefore examined the innovations and modifications of the revised secondary school Chemistry curriculum in terms of content pattern and implementation, all in response to the changes in societal needs. The paper argued that if the objectives and the contents of the curriculum are properly articulated, and the teachers trained to handle them. Hence, the student activities and teacher activities, together with the evaluation would be efficiently and effectively managed by the teachers. This will further improve the quality of secondary chemistry education in Nigeria.

### **Contents of Chemistry Education Curriculum.**

The term content is used to refer to the materials selected to be taught or

learned. It constitutes the subject matter the teacher is expected to assist learners to learn in a discipline. This will include the knowledge, skill, concepts, principles, attitude, values and ethics deemed necessary for the learners to acquire (Onyike, 1996). According to Ehindero (1986), curriculum content involves providing opportunities for students to learn and utilize skills, processes, attitudes and values. Content may be viewed as selected relevant knowledge, skills, attitudes and values considered appropriate for the functional development of the learner. It is necessary that what would be considered good content must be relevant to the learner and help him to be useful to himself and the society.

Meanwhile, tremendous changes have been observed in the Chemistry curriculum contents. Several innovations and modifications of the curriculum, which are in response to the changing needs of the society has been carried out (Okeke & Ezekannagba, 2000). Chemistry is known as a dynamic subject, the curriculum contents changes with time as new discoveries are made. For instance, different names were given to chemical materials at discovery. Since chemical knowledge is universal, it created difficulties in identifying chemical substances and their compositions. These then gave rise to the need for generally acceptable method of naming chemical compounds. The International Union of Pure and Applied Chemistry (IUPAC) was handy to solve the problem, hence the IUPAC nomenclature. The IUPAC gives a clear picture of a compound. Using the Sulphuric Acid which is known by IUPAC as Tetraoxosulphate (vi) Acid ( $H_2SO_4$ ) as an example; the name tells you that it is an acid which has four (4) Oxygen atoms (ie. Tetra), Sulphur is present with oxidation state of +6 (ie. vi). All these information which are derived from the IUPAC nomenclature were not present in the old names. With these changes, textbooks were reviewed in line with the changes in the curriculum to accommodate the changes. The implementation and the teaching pattern changed and were in line with the innovations.

### **Changes in Chemistry Curriculum Contents in Nigeria.**

Following the federal government's reform in education and the need to attain the then Millennium Development Goals (MDGs), the current Sustainable Development Goals (SDGs) and the critical targets of the National Economic Empowerment and Development Strategies (NEEDS), which can be summarized as; value-reorientation, poverty eradication, job creation, wealth generation and using education to empower the people, it was imperative that the existing Chemistry curriculum for senior secondary schools was no longer in tune with the reform programs (FME, 2009). There was therefore need for it to be reviewed and re-aligned to fit into the reform programs. Furthermore, following Nigeria's endorsement of international protocols for Education for All (EFA), the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs); and subsequent adoption of a National Economic Empowerment and Development Strategies (NEEDS); it became imperative to bring in innovations and modifications into the existing Chemistry curriculum to cater for contemporary needs of the nation, as a

country aspiring to be among the first 20 economies in the world by the year 2020.

Furthermore, as it is always said, the only thing that has remained constant is change. All other things have changed including Chemistry curriculum contents. Many reasons have been advanced as responsible for this. These will include but not limited to the following;

**a. Change in National Aspirations/Needs**

According to Okeke (1996), every society has what it wants to transmit to her members in form of education. A change in these societal ideals will result in the change of curriculum content. Since independence, Nigeria has witnessed series of shift in the content of its science curriculum to meet its aspirations in the bid to provide its citizens with basic science education and to catch up with global advancement in science and technology. The country's national policies on education reveal these aspirations at various times.

**b. Knowledge Explosion**

One of the fields of study that has witnessed exponential growth in knowledge over the years is Science. With this knowledge expansion many issues beg for attention while some become obsolete. There is need to sieve through these knowledge for the relevant ones. These account for the changes in the content of Science (Chemistry) education so as to accommodate the need and the ideas and to exclude invalid ideas. This must be considered in line with what is obtainable as the content of Science education at such times.

**c. Development of Theory and Curriculum Design**

Theory is a product of science. Science education like many other fields of learning and particularly educational activities is heavily guided by theories. Theories serve as guide to curriculum planners in the selection of objectives, contents, methods, etc (Onyike, 1996). Many great theorists such as Bloom, Dewey, Piaget and Brunner have in various forms influenced the curriculum process in many fields of study including Science education. Disciples of these theorists have at one time or the other changed Science curriculum content to reflect such theories. Similarly, the choice of curriculum design has also influenced the change in the content of Science education. There are many types of curriculum design such as; teacher-centered, child-centered, integrated or interdisciplinary, compartmentalized designs etc. whichever is adopted at any time, will influence the content (Dung & Nsikak-Abasi, 2010). For instance, what is included as individual science subjects (Biology, Chemistry and Physics) under the compartmentalized design differs from the interdisciplinary design that reflects integration in science.

**d. Global Revolution**

No nation is an Island. The growth and development of science in a nation pose a challenge to the others. A case in point is the launching of the Sputnik by the Soviet Union in 1957. This advancement saw a great revolution in the field of science, especially in the USA. It so challenged the United States that there was a total transformation in the US science education in all ramifications (Offor, 2011).

Nigeria is not left out in the struggle to meet up with the challenges of world science and technology. This is marked by a drastic change from the liberal arts to much concentration on science and technology. These influence the contents of the Science (Chemistry) education curriculum.

### **Review of the former Chemistry Curriculum**

#### *Objectives of the Curriculum*

- The objectives of the then Chemistry curriculum were to;
- i) facilitate a transition in the use of scientific concepts and techniques acquired in Integrated science and Chemistry;
  - ii) provide the students with basic knowledge in chemical concepts and principles, through efficient selection of content and sequencing;
  - iii) show chemistry in its interrelationship with other subjects;
  - iv) show chemistry and its link with industry, everyday life, benefits and hazards; and
  - v) provide a course which is complete for pupils not proceeding for higher education while it is, at the same time, a reasonable and adequate foundation for a post-secondary chemistry course (FME, 2000).

#### *Content Selection, Focus and Organization*

The contents of the former Chemistry curriculum cut across such themes as physical, inorganic, organic, environmental and analytical chemistry as its focus and there were systematically organized under twenty topics, as outlined below;

1. Separation of mixture. 2. Particulate nature of matter. 3. Symbols, formulae & equations.
4. Chemical combination. 5. Gaseous state & gas laws. 6. Acids, Bases & Salts. 7. Carbon and its compounds. 8. Organic Chemistry. 9. Periodic table of elements. 10. Structure & energy level of atoms. 11. Qualitative analysis. 12. Quantitative analysis. 13. Rate of chemical reaction. 14. Chemical equation. 15. Non-metals & their compounds. 16. Thermochemistry. 17. Metals and their compounds. 18. Applied Chemistry. 19. Nuclear Chemistry. 20. Astronomical Chemistry

Critical observation of the above themes and the topics, reveal no direct link to the child's or students' daily interactions with the environment. It was therefore left at the teacher's discretion to develop and link the themes and topics to the daily lives of the students. This task required the teacher's ingenuity and mastery of the subject matter. It equally left the students at the mercy of their Chemistry teachers. Based on these observed shortcomings in the curriculum, there was need for its revision.

### **Review of the Revised Chemistry Curriculum currently in use**

#### *Objectives of the Curriculum*

The current edition of the senior secondary school chemistry curriculum is expected among other things to enable students to;

- i) develop interest in the subject of chemistry;
- ii) acquire basic theoretical and practical knowledge and skills;
- iii) develop interest in science, technology and mathematics;
- iv) acquire basic STM knowledge and skills;
- v) develop reasonable level of competence in ICT applications that will engender entrepreneurial skills;
- vi) apply skills to meet societal needs of creating employment and wealth;
- vii) be positioned to take advantage of the numerous career opportunities offered by chemistry; and
- viii) be adequately prepared for further studies in chemistry (FME, 2009).  
In addition, the curriculum is also expected to;
  - a) facilitate a smooth transition in the use of scientific concepts and techniques acquired in the new basic science and technology curriculum with chemistry;
  - b) provide students with the basic knowledge in chemical concepts and principles through efficient selection of contents and sequencing;
  - c) show chemistry and its inter-relationship with other subjects;
  - d) show chemistry and its link with industry, everyday life activities and hazards; and
  - e) provide a course which is complete for students not proceeding to higher education while at the same time provides a reasonably adequate foundation for a post secondary school chemistry course (FME, 2009).

#### ***Content Selection, Focus and Organization***

There is shift in the structuring of chemistry curriculum into conceptual units or themes and the contents arranged in spiral sequence with each unit treated more exhaustively as the course progresses. In selecting the contents, three major issues shaping the development of nations worldwide and influencing the world of knowledge today were identified, there are; Globalization, Information and Communication Technology (ICT) and Entrepreneurship. The desire for Nigeria to be identified with contemporary development worldwide has called for the organization of the contents of the curriculum around four themes which were derived from the issues outlined above. The themes are; Chemistry and Industry; The Chemical World; Chemistry and Environment; and The Chemistry of Life. Thus, the curriculum is packaged with contents that lead to self-actualization by students. In addition, the curriculum contents focuses on practical activities with emphasis on locally available materials. This is to imbue the learners with the spirit of inquiry. The curriculum, if effectively implemented, will enable the learner achieve his/her maximum potential in the subject of chemistry and its various applications.

Specifically, the first theme in the chemistry core curriculum as seen above is “Chemistry and Industry” which is an attempt to relate chemistry to chemical industries within our environment. It has the following topics in senior secondary 1 (SS1); types of chemical industry, importance to the nation and excursion to the chemical industries. The theme “Chemistry and Industry” was repeated in senior

secondary 2 (SS2) where the topics were treated more exhaustively, as follows; oxidation-reduction (redox reactions), oxidation numbers, connection of oxidation with IUPAC names, oxidizing and reducing agents, and redox equations. Other topics in the theme include; ionic theory electrovalent and covalent compounds; electrolytes and non-electrolytes; weak and strong electrolytes; electrochemical series; and electrolysis. The theme was repeated again in senior secondary 3 (SS3) but with different topics as follows; petroleum; metals and their compounds, Iron; and Ethical, Legal and Social Issues ((FME, 2009).

The second theme in the Chemistry core curriculum is “The Chemical World” which has the following topics in SS1; Introduction to Chemistry; particulate nature of matter; symbols formulae and equations; chemical combination; and gas laws. The theme “The Chemical World” was repeated in SS2 with the following topics; periodic table; chemical reactions; and mass volume relationships. The theme was repeated again in SS3 with the topics, quantitative and qualitative analysis.

The third theme “Chemistry and Environment” is an attempt to relate Chemistry to what is seen in our environment. It is expected to equip the students with necessary knowledge, skills and attitudes which will enable them to interact meaningfully with the environment. The theme has the following topics in SS1; standard separation techniques for mixtures; acids, bases, salts; and water. The theme was repeated in SS2 where the topics were treated more exhaustively as follows; acid - base reactions; water; air; hydrogen; oxygen; halogens; nitrogen; and sulphur.

The forth and last theme in the chemistry core curriculum is “The Chemistry of Life” which dealt with the use of chemistry to solve life problems and tackle many of our other day-to-day activities in the society. The theme has the following topics in SS1; carbon and its compounds. It was repeated in SS2 with the topic; the hydrocarbons alkanols. The theme was repeated again in SS3 with the following topics; fats and oils; soaps and detergents; and giant molecules eg. sugar, starch and proteins (FME, 2009).

### **Imperatives for Improving Secondary Chemistry Education in Nigeria**

Providing the right type of curriculum will enhance the teaching and learning of Chemistry in secondary schools. The innovations and modifications of the Chemistry curriculum currently in use in Nigerian secondary schools is analytical, in the sense that it directs the students and the teachers towards defined tasks and goals. Based on its task analysis, the curriculum is the right type of curriculum which will enhance effective teaching and learning of chemistry if effectively implemented by the secondary school chemistry teachers. It is important to mention once again that the effective implementation of this new curriculum relies heavily on the availability of teachers who are well grounded in the subject matter of chemistry as well as the philosophy and purpose of the curriculum. Thus there is need to build the capacity of the teachers and support staff in the implementation of the curriculum on continuous

basis. The government and school proprietors need to put in place the necessary facilities that will assist the teachers to achieve effective implementation of the curriculum. There is need therefore for interventions, especially at this stage to sensitize the chemistry teachers on the trends of events in our changing world and the need of the learners. There is urgent need for the chemistry teachers to adjust and join the fast moving world of science and technology, in the areas of Computer Literacy, Information and Communication Technology ((ICT), Science Technology and Society Education (STSE), Science Technology and Mathematics Education (STME), and Scientific and Technological Literacy for all. The chemistry teachers need to keep abreast of such societal issues as Population and Family Life Education, Environmental Studies on Environmental Population Degradation, Protection, and Global Warming. The teachers need to be resourceful in implementing the innovations in the curriculum content, especially in terms of methodology. They should emphasize hands-on, minds-on, mapping, child-centered approaches to teaching and learning of chemistry. Moreover, when the curriculum is effectively implemented, the objectives of teaching chemistry as contained in the National policy on education will be achieved. This will consequently improve the quality of chemistry education in Nigeria.

### **Conclusion**

The chemistry curriculum has under gone some innovations and modifications in terms of contents, implementation and revision. The innovations and modifications were as a result of the changing needs of the society. It was observed that the need for the innovations and modifications of the chemistry curriculum was as a result of three major issues shaping the development of nations worldwide and influencing the world of knowledge today which were identified as globalization, information and communication technology (ICT) and entrepreneurship. Nigeria being one of the developing nations does not want to be left out, thus the revision of the chemistry curriculum to be in line with the needs of the Country. Furthermore, the curriculum is packaged with contents that lead to self-actualization by students. In addition, the curriculum content focused on practical activities with emphasis on locally available materials. This is to imbue the learners with the spirit of inquiry. These are all innovations and modifications in the curriculum, because the focus is now on the child doing more of practical activities by him/herself so as to achieve a meaningful learning, as opposed to the traditional lecture method of teaching. Also, the revised curriculum emphasizes innovative methods of teaching and evaluating the learning outcomes of the students, which is geared towards effective learning, thereby improving the quality of secondary chemistry education in Nigeria.

### **Suggestions for Improvement**

1. The chemistry teachers should be exposed to regular training programs on the implementation of the revised curriculum. Because, for the teachers to implement the curriculum, they should be properly trained and prepared for

- it, by participating in workshops, seminars and conferences.
2. The materials needed for the implementation of the curriculum should be provided in all schools by the government, non-governmental organizations (NGOs), Parent Teachers Association (PTA) etc.
  3. Education stakeholders should be enlightened on their involvement in the implementation of the curriculum.
  4. The required infrastructural for the effective implementation of the curriculum should be provided by the government, NGOs, PTA, etc.
  5. Curriculum planners should properly monitor the progress of the revised chemistry curriculum, ensuring that it is being properly implemented.

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