AN EVALUATION OF THE SENIOR SECONDARY SCHOOL CHEMISTRY CURRICULUM IN NIGERIA

Prepared in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy, University of Lagos, Akoka, Nigeria

By

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CERTIFICATION

This is to certify that the Thesis:

AN EVALUATION OF THE SENIOR SECONDARY SCHOOL CHEMISTRY CURRICULUM IN NIGERIA

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is a record of original research carried out

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ATTESTATION

This is to testify that this study, "An Evaluation of Senior Secondary School Chemistry Curriculum in Nigeria" is an original work undertaken by Mrs. Grace Oluyemisi Abidoye, in partial fulfilment of the requirements for the award of the Degree of Doctor of Philosophy (Ph.D.) of the University of Lagos.

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G.O.A

TABLE OF CONTENT

LIST OF FIGURES

APPENDICES

LIST OF TABLES

ABSTRACT

The study, based on the premise that chemistry is a very important subject for the achievement of the national goals, assessed the adequacy of objectives and content, the adequacy of installation, the consistency of the processes, the achievement of the chemistry curriculum goals and the cost implication of operating senior secondary school chemistry curriculum in Nigeria. The study sample consisted of 480 students from 16 schools selected from four geographical zones (North-West, North-East, South-West and South-East) of the Federation and 56 chemistry teachers made up of teachers from the participating schools, teachers attending the SSCE marking and STAN Conferences.

Data for the study were obtained through the use of the following instruments and techniques. These were,(i) Evaluation of Chemistry Curriculum for Senior Secondary Student Questionnaire (ECCSSSQ), (ii) Evaluation for Senior Secondary School Chemistry Teacher Questionnaire (ESSSCTQ), developed by the researcher; (iii) Checklist for the Analysis of Curriculum Objective (CACO), adapted from Champagne and Klopfer (1971); (iv) Science Teaching Observation Schedule (STOS) (Eggleston et al 1976) and (v) Specification of objectives and Checklist for Evaluating Chemistry Textbook (SOCET), adapted from Brown (1984); (vi) Analysis of the reports of school visits conducted by the NERDC and the Implementation Committee on the 6-3-3-4 System of Education in 1996 (vii) analysis of the Senior Secondary School Certificate Examination (SSSCE) results for sixteen years and (viii)analysis of the minimum list of equipment for SSCE chemistry (FMEST, 1993) . Validation of the instruments was done through the conduct of a pilot study and by means of inter-rater analysis.

The following findings emanated from the study. Students' performances fell below expectation in the senior secondary chemistry examination. Only an average of 29.2% of the students obtained credit and above passes in the seventeen years analyzed. This is a negation of the preparatory role of the curriculum for higher education. The curriculum was found to be comparable to other activity-based curricula on philosophical grounds. However, analysis of the expected students' behaviours in all the content areas of the curriculum showed greater concentration of the objectives in the knowledge and comprehension domains (44%), while the other enquiry-based domains such as the processes of scientific enquiry (21.5%), interpreting data and generating hypotheses (8.8%), application of scientific knowledge (5.8%), building and testing theoretical models (2.2%), attitude and interest (2.9%), and orientation (5.9%), had less attention. The curriculum was rated low on the objectives of meeting students' needs for curiosity and achievement as well as appropriateness to the level of the students' understanding of the topics by the teachers. The installation of the curriculum was faulted for not providing adequate, uniform and equal training for all teachers who used the curriculum. Another shortcoming found with the installation of the curriculum was the inadequacy of provision of equipment and materials for all the schools. A direct consequence of these shortcomings was that teachers taught the classes the traditional 'chalk and talk' ways and not much of the students' activities were observed from the analysis of classroom interaction in the schools. Teacher talk still dominated 71% of lesson time. The teachers' and students' responses on factors responsible for poor performances were similar and included. the difficulty of the mathematical language used for chemistry; difficulty of chemistry in comparison with other subjects; practical work not being done concurrently with theory; failure of students to do homework and little or no counselling of students. Chi square values for all these factors were statistically significant at $p < 0.05$.

Recommendations for improving the curriculum included: the organisation of induction courses for all the chemistry teachers on the use of the curriculum; revision of the curriculum to make it more activity-oriented in its design and restructuring of the contents; overhauling of the teacher-preparation programmes to reflect activity-oriented, student-centred approaches and institution of a method of feedback and monitoring and constant evaluation of the teachers and curriculum. Follow-through study on the performances of post-secondary chemistry students to see how the SSS has prepared them for higher education is one of the suggestions for further research.

CHAPTER ONE

INTRODUCTION

The level of development of Science has been a major developmental index for all nations. This is why many developed countries invest and are still investing heavily on science, technology and science education, (UNESCO, 1998). In the United Kingdom, United States of America, many European and Asian countries, the monitoring of performance levels of students and feedback are continual activities for improving the educational system. Thus evaluation of the national or regional curricula is considered vital (Schonherr, 2006).

Nigeria a developing country, is also committed to the education of the citizenry, hence the dramatic and far-reaching changes witnessed in the Nigerian educational scene within the last two decades of the twentieth century. The articulation of a consensus document on the educational direction for the first time in national history was a positive change. The emergence of a National Policy on Education marked the turning point in the development of education in Nigeria. There was change in the system of education from five years to six years at the secondary school level with attendant curricular innovations. The policy document prescribes core subjects for the various streams at the Senior Secondary School level including Chemistry which was identified as one of the important science subjects for the attainment of scientific and technological goals of the nation.

Science has been described a study or knowledge of the physical and natural world based on observation and experiment (Hawker, 2002). It is a systematic process, involving general truths, cumulative in nature and covering the natural facts of the world. Rehman (2004) identified the eight core values that demonstrate the importance of science education; these are intellectual, vocational, aesthetic, practical, moral, psychological values, as well as the attitude for adjustment to life.

The intellectual values relate to how scientific knowledge helps to sharpen the intellect by developing the reasoning abilities of individuals. Vocational values are found in the application of scientific knowledge to all vocations. In addition the study of science is a primary requirement for many essential vocations. Aesthetically, science contributes to the opening up of the mysteries of nature which is the store house of all things. The moral values of truthfulness and honesty which are desirable in all human beings are also developed from the study of science. The practical values have as evidence, the applications of the various scientific principles and laws. Psychologically, the learning of science helps to develop positive attitudes such as open mindedness, tolerance and patience. The learning of science is based on the fundamental principles of learning by doing and observing which are psychological principles. The scientific method helps the individual to develop specific procedure for tackling any problem thus preparing him to face and solve life's problem boldly and successfully.

Science has become an indispensable tool for man's survival. The recognition of the indispensable benefit derivable from science and technology has motivated many developed countries to invest huge resources on science and technology. This has further led to the additional support for science education. In Nigeria, science and technology are highly recognized as important for development. In order for the educational goals to be realized, the philosophy of education is to be geared towards scientific and technological progress among others. This is why science is included at all levels of education.

Chemistry is a branch of knowledge that deals with the composition and properties of matter and the chemical changes involved in it. It is thus the study of all substances and consequently, it has immense influence on our daily lives. The food we eat, the clothes we wear, our building materials, the drugs used for maintaining health, and all other human necessities are dependent on the advancement of chemical knowledge. Other aspects of development, which result from chemistry, include communication, space travel, agriculture and mining to name a few.

Chemistry must be communicated in relevant ways for the actualisation of developmental goals and this is only possible through effective and functional curricula, which are hallmarks of quality education. The recognition of the importance of chemistry as one of the foundational science subjects for the attainment of scientific and technological goals of the nation led to its inclusion as a core science subject in the secondary school curriculum. Without adequate and qualitative background in chemistry, the prospect of students living effectively in our modern age of science and technology or proceeding for higher education as scientists, pharmacists, doctors, nurses, engineers, environmentalists, agriculturists, geologists and science teachers, is very bleak (NPE, 2004).

This bleak outlook projected by the prevailing situation of disinterest. (Aghenta, 2003; Ato, 1981;Baike, 1979; & Comparative Education Study and Adaptation Centre (CESAC), 1982) and poor performances, (Ajayi, 1982; CESAC, 1982 and Ross-Imuenwarin, 1981), in science and chemistry led to the introduction of the senior secondary school chemistry curriculum into the Nigerian schools in 1985. The curriculum was expected to alleviate the factors responsible for the situation. These included teacher-dominated and theoretical classroom transactions, (Ajeyalemi, 1987; Bajah, 1984 and Teibo, 1975), in-adequate laboratories (Olamousi 1984); failure to match course content to the cognitive level of students, (Nwosu, 1985; Heron, 1975; Olamousi, 1984; McKinnon and Renner, 1971 and Teibo, 1975) and lack of relevance of school chemistry to the everyday lives of the students (Abidoye, 1986).

Prior to the introduction of the present curriculum, chemistry was taught based on the general syllabus which was a collection of topics and contents to be emphasized for the then secondary school certificate examination. The present chemistry curriculum had as precursor an alternative West African School Certificate Examination (WASCE) chemistry syllabus, which was originally prepared by the Science Teachers Association of Nigeria (STAN) but adopted by CESAC in 1970, (Busari and Ajeyalemi, 1994). The syllabus operated as an alternative to the then general WASCE Syllabus between 1970 and 1984 (Ivowi, 1993). The students' performances in the alternative syllabus were found to be superior to those of students who offered the general syllabus (Ajayi, 1982, Ivowi, 1993 & CESAC, 1986). This alternative syllabus had been systematically structured by the CESAC, along a five-stage model of curriculum development, which had situation analysis as the first step and summative evaluation, revision and renewal of curriculum as the last stage. Other stages were stating of objectives, determination of curriculum content, trial testing and installation of materials

However, like many other Nigerian lofty ideas and edifices, the absence of maintenance and sustenance observed at the trying out stages once projects are put in place appears to have played out on this curriculum (Federal Ministry of Education (FME), 2000:) Onwueme, 1995; Nwagwu, 2000; Sofolahan, 2000 and FRN, 2001).Students' performances in chemistry still appear to be below expectations, as shown by WASSCE Chief Examiners' reports over the years (WAEC, 1990, 2002, 2003). The curriculum had been in operation for more than two decades and the three-year cycle had been repeated more than sixteen times since inception yet no conscious or empirical study of the senior secondary school chemistry curriculum had been undertaken in a systemic manner to determine its quality and relevance.

Evaluation has been defined as the process of delineating, obtaining and providing information about a programme which is of use in describing and understanding the programme and making judgments and decisions about the programme (Straton 1985). It is a vital component of any programme that strives for relevance and quality. Relevance and quality are in turn essential characteristics for a functional curriculum (Chinapah and Miron, 1990; Cooper, 1976). According to Odunusi (1998) and Rehman (2004), the quality of an educational system is determined by the quality of the curriculum and without curriculum evaluation it is not possible to determine the quality of a curriculum.

Since education is a dynamic process and chemistry is a very important science subject, a situation whereby performances are below expectations and the operations of the curriculum left to chance cannot be allowed to continue unchecked. A systematic curriculum evaluation to authenticate the curriculum proposal and to pinpoint areas for review or renewal is therefore called for.

1.1.0 Statement of the Problem

Curriculum has been defined as a plan or proposal, which communicates the essential principles and features of the opportunities for the engagement of learners (content and learning experiences) with other resources, for the purpose of changing learners' behaviours and insight, within specified time and environment, in a form that can be effectively put into practice and be subjected to critical scrutiny (Stenhouse, 1975: Lewis and Miel, 1972 and Armstrong, 1989).

Since the introduction of the senior secondary school chemistry curriculum, the observed problems prior to the introduction appeared to have continued. Students' still performed poorly in SSSCE chemistry as documented by the West African Senior Secondary Chief Examiners reports over the years. (WAEC, 1990, 1991, 2002, 2003; STAN, 1992 and Adeyegbe, 1993). Students' problems in the examinations included;

i) difficulties in tackling questions dealing with reasoning, deduction, application of principles and calculations;

ii) poor knowledge of fundamental principles and procedures;

iii) poor linkage of practical experiences with theoretical knowledge:

iv) difficulties in answering questions involving practical application and deductions of experimental inferences;

v) lack of familiarity with simple laboratory procedures as well as poor knowledge of handling and storage of chemicals and reagents;

vi) inappropriate use of chemical terminology;

vii) inability to write balanced equation and poor expressions of chemical terms;

viii) poor knowledge of nomenclature of organic compounds and basic chemical principles;

ix) inability to record observations and inferences correctly ;

x) inability to interpret and understand the demands of the questions and

xi) exhibition of poor mathematical skills.

All these shortcomings may have accounted for the Nigerian students' poor performances in comparison to students from other countries. As recorded in the Second International Science Study involving Nigeria and twenty other countries such as Australia, Canada, England, Ghana, Korea, and Norway among others, Nigerian science students' performances were very low when compared to that of the other countries, (Rosier and Keeves 1991). Furthermore, the rate of students who failed to make the acceptable passing grade for higher education in the WASSCE remained high in the first ten years of operating the curriculum as shown in table1.1. The implication of this is that very few students are able to proceed to higher education in chemistry and other allied courses (Akande, 1992; Akintoye, 1992)

Table 1.1 Percentage failure rate in SSSCE chemistry from 1988 -1997

Year	Total number of candidates	Percentage "Failed" (P7- F9)
1988	34508	79.30
1989	35708	89.20
1990	80059	95.90
1991	116526	89.60
1992	140856	81.00
1993	170537	77.00
1994	161232	76.30
1995	133188	63.40
1996	144990	66.54
1997	172383	76.42

Data obtained from West African Examinations Council

Since 1991, six years after the introduction of the curriculum into the school system, subject reviews were recommended to determine the situation of each of the subjects in the school curriculum, at the Curriculum Review Workshop held in 1991 (Robinson, 1991, Akhaine, 1996). This has not been done to improve the system as at the time of this study. Okebukola (1992) also identified the evaluation of the various curricula as a research priority in Science, Technology and Mathematics for the 1990s, while Ivowi (1995) also noted that periodic reviews were essential for curriculum provisions to meet the challenges of both technological and societal changes.

Despite the fact that the lack of coordinated monitoring and evaluation of curricular innovations in the schools were observed to have contributed to the poor implementation and failure to accomplish curricular goals, (Odunusi, 1998), and in spite of the calls for periodic, systematic review of the subject curricula, no such comprehensive evaluation or consistent review has been fed-back into the S.S.S chemistry curriculum in Nigeria. There is therefore a dearth of information on the curriculum and it is thus not possible to determine the feasibility, effectiveness and worth or merit of the curriculum. In many other countries with curriculum reforms, monitoring and evaluation are regarded as vital and are carried out at stipulated intervals of between three and five years for reviewing the curricula (UNESCO, 1998).

Lack of adequate information for planning has been mentioned as one of the problems stunting educational development in Nigeria (Nwangwu, 2000). Only a comprehensive evaluation as undertaken in this study can provide the much-needed information on the chemistry curriculum. In view of the prevailing circumstances and as part of the normal
process of curriculum development, a comprehensive evaluation of the chemistry curriculum was considered necessary in order to identify the strengths and weaknesses of the curriculum. Such comprehensive analysis of the curriculum is further necessitated by the fact that the chemistry curriculum, in the final form at which it was introduced into the schools, did not undergo final trial testing. The systematic periodic reviews and feedback which were expected to take place as the programme functioned in the schools were also absent (Ivowi, 1993).

According to Tanner and Tanner (1995), a new programme, (in this case, a new curriculum) must be regarded as an experiment and the proffered solutions as hypotheses until they had withstood the test of time. This study was therefore undertaken to provide the much-needed information for making decisions relating to the Senior Secondary School Chemistry Curriculum with a view to improve on the chemistry curriculum and by implication chemistry education in Nigeria. For, as suggested by Schwab (1983), it is only by consideration of the present state of the curriculum, the present condition of students and surrounding circumstances, that a decision to favour the continuation, review or rejection of any curriculum is justified.

1.2.0 Purpose of the study

The study examined the Senior Secondary School Chemistry Curriculum in respect of the adequacy and attainment of the aims and the consistency of the processes and procedures with the curriculum guidelines. Specifically, this study sought to:

(i) assess the comprehensiveness and adequacy of the design of the senior secondary school chemistry curriculum in terms of the objectives and content;

(ii) determine by means of consistency of programme delivery checklist, the adequacy of the installation of the chemistry curriculum in the schools;

(iii) assess the extent of compliance of the curriculum process in the schools with the laid down principles of curriculum process;

(iv) assess the achievement of the chemistry curriculum goals in the schools;

(v) analyse the cost implication of operating the chemistry curriculum and assess the adequacy of meeting the cost ;

(vi) identify discrepancies arising between the intended and executed design, installation, process and product of the curriculum

(vii) make suggestions for the improvement of the chemistry curriculum in Nigeria.

1.3.0 Research Questions

The following research questions were addressed in the course of this study: -

(i) How comprehensive and adequate are the objectives and content of the SS chemistry curriculum?

(ii) Has the curriculum been adequately installed in the schools?

(iii) Do the implementation processes comply with that laid down for the curriculum?

(iv) Are the goals of the curriculum being achieved in the schools?

(v) How adequate have the cost implications of the curriculum been especially in terms of materials and equipment input?

(vi) What are the discrepancies arising from the design, installation, process, product and cost evaluation with respect to the officially prescribed curriculum?

(vii) What suggestions could be made for the improvement of the chemistry curriculum in Nigerian Schools?

1.4.0 Hypotheses for the study

(i) The chemistry curriculum objectives and content are comprehensive and adequate.

(ii) The installation of the curriculum is adequate

(iii) There would be no difference between the proposed processes and the observed processes of the curriculum

(iv) There would be no significant difference between the goals and the achievement of the curriculum

(v) There would be no significant difference between the cost implications of the curriculum and the actual inputs.

1.5.0 Significance of the study

This study is expected to provide an empirical basis on which to review, revise or improve the chemistry curriculum. It is also expected to inform decisions on the revision of teaching and learning content and methodology. The findings of the study are also to inform educators. policy makers and other members of the society on the status of the educational goals, materials, instruction and all aspects of the curriculum.

Decision- makers, planners, educators and curriculum designers and teachers stand to gain additional insight on how to bring about changes in the contents, policy formulations, planning and implementation of the chemistry curriculum for making it more relevant and effective. Such improvement is bound to have a corresponding positive impact on the teaching and learning of chemistry and therefore production of better citizens for the technological development of the nation.

Teacher trainers, professional bodies and textbook developers also stand to benefit from the findings of this study, which could be utilised for the production of better-qualified teachers and more relevant and student friendly textbooks for chemistry.

Finally, the study is expected to serve as a basis for further development of the curriculum evaluation process, thereby extending the knowledge base of curriculum evaluation research in Nigeria, especially in the sciences.

1.7.0 Scope and Limitations of the study

Evaluative studies are limited by the cooperation and acceptance by the subject. The participants in this study were assured that the study was an evaluation of the curriculum for improvement. Summative evaluations have limitations I that they are after the fact and as such any suggestion for improvement cannot benefit the respondents. However, in terms of benefits to the system and subsequent users of the curriculum evaluations are invaluable. This is therefore a major limitation of this study.

The study while sampling a number of teachers and students on their use of the curriculum can only make generalisation on this. For example the study cannot vouch for the fact that the schools used for the study were supposed to be the registered well established schools as indicated by the State Ministries of Education.

Another limitation of the study was that the performances of the participating students was not subjected to testing on the skills that they were supposed to have acquired.

1.8.0 Operational definition of terms

The definitions of the terms used in the study are displayed in this section.

Evaluation is the process of delineating, obtaining and providing information about an educational programme which is of use in describing and understanding the programme and making judgements and decisions about the programme (Stranton, 1985).

The various aspects of evaluation in this study are,

Design evaluation - This refers to evaluation of the objectives, content and mode of assessment contained in the SSCE chemistry curriculum.

Installation evaluation is the evaluation focussed on Inputs, logistics of implementation, and whether or not operational activities are in agreement with the implementation plan.

Process evaluation refers to the evaluation of the implementation of the curriculum in the schools; that is, situational analysis of chemistry as it is taught and learned in the schools.

Product evaluation is the evaluation focussed on overall goal and achievement or the outcome of use of the curriculum; comparing the actual attainments against the standards laid down in the curriculum documents and accepted curricular practice.

Cost evaluation is the evaluation of the estimated cost of operating the curriculum against the observed cost.

Curriculum is a plan or proposal which communicates the essential principles and features of the opportunities for the engagement of learners (content and learning experiences) with other resources, for the purpose of changing learners behaviour and insight, within specified time and environment, in a form that can be effectively put into practice and be subjected to critical scrutiny.

Syllabus refers to a statement of the topics or content to be covered by a course of study. It usually is set out as guide for examination as is the case with the SSCE syllabus prepared by WAEC and National Examination Council.

Senior Secondary School (SSS)-refers to the educational establishments where the last three years of the secondary school years are spent and where education is provided for students preparatory to higher education and useful living.

Chemistry Curriculum for Senior Secondary Schools is the chemistry curriculum prescriptions as contained in the Federal Ministry of Education National Curriculum for Senior Secondary schools document.

Discrepancy is the observed gap between the reality and target or standard set. Standard set being that laid down in the curriculum document or the accepted standard of practice for the curriculum.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

An analysis of literature pertinent to this study is attempted in this chapter. The review opens with a discussion on the various perspectives of a curriculum. This is followed by the concept of a curriculum as conceived and used in the study. An exposition on the philosophy and features of the chemistry curriculum for senior secondary schools is also presented. A discussion of the concept of educational evaluation in general and curriculum evaluation in particular has also been attempted. Two evaluation models useful for comprehensive evaluation as well as the model of curriculum development used in the development of the chemistry curriculum are also discussed. A summary of studies conducted son various curricula conclude the chapter.

2.1. 0 The concept of curriculum

Defining the term curriculum has for long been a matter for which there had been no consensus among educators. According to Adegoke and Ajeyalemi (1994), there are many competing definitions and each of these carries certain expectations, emphasis and limitations for curriculum development. Bennett (2003) opined that it is perhaps the comprehensiveness and complexity of the concept that make it difficult to define.

Curriculum, as defined by Marsh and Willis (2003) is all the planned and unplanned activities that are employed for learning. Others have variously defined curriculum in terms of intended learning outcomes, (Johnson, 1967); as activities designed or deliberately planned to meet specific needs or objective, (Hirst, 1974; Hooper, 1973).

Doll (1982) viewed curriculum as the formal and informal content for the acquisition of knowledge and understanding, development of skills and changing attitudes appreciation and values under the school. Wheeler (1978), is of the view that curriculum constitutes the planned experiences offered to the learner under the guidance of the school while Saylor and Alexander (1974), viewed it as a plan for providing sets of learning opportunities to achieve broad goals and related specific objectives for identifiable population.

Adegoke and Ajeyalemi (1994 p.1), referred to curriculum as a "systematic organisation of a set of intentions about learning experiences for certain learners in certain justifiable arrangement of sequence and resources". Ross (2000) on the other hand, perceived the curriculum as what is to be learnt which may include any prescribed activities selected according to accepted norms that result in the transformation of individuals.

The different underlying orientations to which the various definitions could be tagged are that of curriculum as objectives, plan or content of learning. However as opined by Marsh and Willis (2003), there are various forms of curriculum, such as intended, implemented and achieved. A number of definitions exist which further elaborate or combine these three concerns and others in their definition of curriculum. Three of these definitions are those of Stenhouse (1975), Lewis and Miel (1972) and Armstrong (1989).

Stenhouse (1975 p.4) viewed curriculum as

> *"a means of communicating the essential principles and features of an educational proposal in such a form that it is open to critical scrutiny and capable of effective translation into practice."*

To Armstrong (1975, p.4*) a curriculum is* .

> *"a master plan for selecting content and organizing learning experiences for the purpose of changing developing learners' behaviours and insight."*

Lewis and Miel (1972, *p.4) saw curriculum as*

> *"a set of intentions or proposals about opportunities for the engagement of persons-to-be educated with other persons and with things (all bearers of information, processes, techniques and values) in certain arrangement of time and space."*

These three definitions are similar and complementary. Curriculum can thus be conceptualised as a plan or a proposal which communicates the essential principles and features of the opportunities for the engagement of learners (content and learning experiences) with other resources, for the purpose of changing learners' behaviour and insight, within specified time and environment, in a form that can be effectively put into practice and be subjected to critical scrutiny. This combined definition implies the need for a curriculum to be tested out in practice and to be open to critical scrutiny both in design and in use. The present evaluation study is the stage of critical scrutiny.

The definition contains all the six components of the curriculum as proposed by Jackson (1992). These are (i) context (ii) general aims of the total school curriculum (iii) objectives of the curriculum or learning units (iv) curriculum materials with selected content, subject matter and skills placed in particular sequence and forms such as syllabi, teachers' guides, textbooks, workbooks software and other materials; (v) transactions, usually in a setting, in which teachers deliver or teach various aspects of the contents, subject matter, skills, and values that students are expected to experience, acquire or learn, as well as other subject matter, skills and values that may not be intended in the curriculum but to which students are exposed and in a variety of activities in the classroom and outside it; (vi) outcomes or transactions among curricular materials, teachers and students which may be intended or unintended.

The chemistry curriculum for senior secondary schools has met four of these criteria to a large extent. These are the criteria of context, general aims, and objectives, which are specified in the curriculum document. The other criteria of curriculum materials with content, skills, transactions and values are partially met, while the criterion on outcomes has not been met at all as the expected performance outcome was not included in the document.

2.2.0 Analysis of the chemistry curriculum for senior secondary school (CCSSS)

This section gives a brief historical and philosophical account as well as description of the components of the curriculum.

2.2.1 Philosophical and Historical Perspectives of the Chemistry Curriculum for Senior Secondary Schools.

According to Ikeobi (1986) the origin of the articulation of the SSS Curriculum in science was traceable to the National Conference of 1969, recommendations of which formed the basis of the preparation of the National Policy on Education. There had been discontent with the existing curricula in the sciences in terms of relevance, content and methods by professional educators , the society and all concerned with education, prior to the conference. Thus with the National Conference began a new era for Nigerian Education. At the conference, old goals were reviewed and new ones were identified to cater for the needs of the learner, future needs of citizens and meet societal needs as well.

The SSS science curriculum projects were designed to respond to:

"(i) *need to match rapid scientific and technological advance with a more up-to-date curriculum;*

(ii) need to educate a greater proportion of the citizens more scientifically particularly in the context of the change within the educational system and from the 'old' 5-year to the new 6 year (3+3) secondary structure;

(iii) our experience and educational research findings which highlight some inadequacies of the West African Examinations Council (W.A.E.C.) 'O' and 'A' level syllabuses' (Ikeobi.1986 p.1).

The chemistry curriculum as one of the science curricula was also designed to respond to the general national aims and objectives as identified in the National Policy statements on secondary education (FRN, 1998 Rev. 2004 Sec.4). These goals are:

(i) preparation for useful life within society;

(ii) preparation for higher education.

It was further specified that the secondary school should:

(a) provide increasing number of primary school pupils with the opportunity for education of a higher quality;

(b) diversify its curriculum to cater for differences in talents, opportunities and roles possessed by or open to students after their secondary school course;

(c) equip students to live effectively in our modern age of science and technology;

(d) develop and project Nigerian culture, art and languages as well as the world's cultural heritage;

(e) raise a generation of people who can think for themselves, respect the views and feelings of others, respect dignity of labour and appreciate those values specified in the national aims and live as good citizens;

(f) foster Nigerian unity with an emphasis on the common ties that unite us in diversity;

(g) inspire its students with a drive for achievement and self-improvement both at school and in later life.

These National Educational aims and objectives with further consideration of the problem of scientific shortcomings in the Nigerian educational system were utilized by the Comparative Education Study and Adaptation Centre (CESAC) in developing a chemistry syllabus for secondary schools which was utilized as an alternative syllabus to the existing West African School Certificate Examination Syllabus, during the trial testing stage.

This chemistry syllabus existed as a part of the Nigerian Secondary School Science Project (NSSSP) which proved more successful in terms of students performances than the traditional science subject's syllabus [Ajayi, 1982; Oludotun, 1984; and Ivowi, 1982]. The success of these syllabi was attributed to the provision of intensive coordinated training for the teachers, on the use of the scheme and improvisation for equipment not available. The provision of equipment and materials was also a major contributory factor to the success of the syllabus, [Oludotun, 1992 and Ivowi, 1986].

Feedbacks from the pilot testing of the syllabus were utilized for revising the content. This existing reviewed syllabus formed the basis of the draft on which a critique workshop was conducted in 1985 and from which the Chemistry Curriculum for SSS emerged. The progress of this curriculum to the stage of introduction into the school system had already been discussed. The chemistry curriculum for senior secondary schools was designed as a 3-year course for students who opt for chemistry as one of the science courses. The course was believed to be adequate as a foundation for further study in chemistry and to be a complete course for students not proceeding further in their studies. A series of orientation and induction courses that introduced the teachers to the philosophy, objectives and content were held for some of the teachers who were to use the programme.

2.2.2 Features of the Chemistry Curriculum for Senior Secondary School

In this section the special features of the curriculum are discussed. Occasional references are made to differences between the Chemistry curriculum and other global science curricula.

Learner Characteristics

The conceptual age of the learners had been raised in the curriculum. Thus a student must have had three years of science instruction at the Junior Secondary School to study chemistry at the senior secondary level. The conceptual level of the chemistry course had also been raised. Thus the content of the curriculum was deemed to be higher than the former ordinary level chemistry but not up to the Advance Level chemistry (Adeyegbe, 1993), learners are therefore expected to be operating at a higher level than Piaget's concrete operations stage, specifically at the abstract thinking stage. This is the stage of cognitive development whereby students are expected to be able to think and conceptualise in abstraction. This stage is a definite requirement for making meanings of the many models that are encountered in the study of chemistry (Shayer and Adey, 1981). Students are also expected to be able to manipulate chemical apparatus, hypothesize and devise experiments.

Teacher characteristics

The teachers to deliver the curriculum are expected to be professionally qualified, highly knowledgeable and motivated and exposed to the methodology expounded in the chemistry curriculum. In addition it was expected that chemistry teachers trained and inducted in the use of the curriculum would be available in the schools.

Curriculum methodology

Chemistry as a science is a practical subject. The curriculum document therefore prescribes the guided discovery approach premised on the activity of the student as the methodology to use. As proposed by expounded by Swaak, de Jong and van Joolingen (2004) discovery learning is distinct from other methods by the central role of learning processes such as hypothesis generation (induction), experiment design, and data interpretation. This is different from expository instruction which pays more attention to directly exposing definitions and equations to learners. Thus it is expected that the teachers be aware of this change in methodology and be familiar with the proposed guided discovery method. The proposed projects and experiments are proposed to make students acquire hand-on experience in the laboratory.

Instructional materials

As witnessed in many of the innovative curricula of the 80s, the development of the curriculum had always been supported with instructional materials for teachers and students. Thus the Chemical Education Material Study (CHEM Study) and the Nuffield Ordinary level Chemistry had various packages as aids to the teacher and the students (Ingle. 1984A). Although. the Nigerian Junior Secondary School Project had textbooks to go along with it. no materials were developed specifically for the chemistry curriculum at the stage of introduction in 1985 (Olanrewaju ,1987).

A number of the textbooks which existed before the introduction of the curriculum were being used by the schools at the initial introduction of the curriculum. However, these textbooks had been reviewed and used along with others which were developed with the curriculum as focus. The evaluation of the curriculum must therefore include an assessment of the instructional package being utilized by the students and teachers. Hence as exemplified by Johnstone (1974) and AAAS (1999), in the evaluation of the Scottish curriculum and the science curriculum in the United States of America respectively, this study also paid attention to the instructional package available to the teachers in addition to the curriculum document.

The content and objectives of the SSSC Curriculum

According to the information in the curriculum document, the content of the curriculum is focussed on the three concepts of Energy, Periodicity and Structure, covering the fundamental principles of particulate nature of matter, periodicity, and chemical combination, and chemical reaction, rates of reaction, equilibrium, carbon chemistry and industrial application of chemistry. Topics are sequenced in spiral form into instructional units, which are progressively expanded in greater details as the students' progress in the course (FME, 1985).

The topics are arranged to cover the three years of instruction with the units organised under teaching topics, performance objectives, content, activity and notes. The sixteen units have eighty-four topics which are spread over the three years. While some topics appeared in all the three years at various levels of treatment, other topics occurred only in one year. The table 2.1 shows the units and their distribution across the years. The curriculum document in contrast to the examination syllabus had been arranged for instruction although teachers were advised to use it as a guide only.

Table 2.1 Distribution of Contents of S.S.S. Chemistry Curriculum by Units and year

Unit title	No of topics in Year 1	No of topics in Year 2	No of topics in Year 3	Total number of topics
Standard Separation Tech.	5	0	0	5
Particulate nature of matter	4	1	4	9
Symbols, formulae and Equation	6	0	0	6
Chemical combination	2	0	0	2
Gaseous state / Gas Laws	5	0	0	5
Acids, Bases, and Salts.	3	0	0	3
Carbon and Compounds	5	2	6	13
Industrial Chemistry	3	0	0	3
Petroleum /Applied Chemistry	3	0	0	3
Quantitative Aspect of Chemical reaction	0	13	0	13
Rates, Energy and Equilibrium	0	5	0	5
Non-metals and their compounds	0	5	0	5
Metals and their compounds	0	0	9	9
Space and Earth Chemistry	0	0	3	3
Total	36(42.9%)	26(30.9%)	22(26.2%)	84

2.3.0 Curriculum Development Models

Curriculum development has been described by Oriaifor (1993), as the process of planning, execution and dissemination of new curricula aimed at bringing about some changes in the learner and assessing the extent to which changes have taken place. The framework or plan of action for designing or arranging the curriculum elements of objectives, content, methods and evaluation has been termed curriculum development model (Ivowi, 1994).

Various models exist for developing curriculum. Some models premised on the statement of the objectives as the starting point with all other elements deriving from the objectives have been referred to as objectives models (Ivowi, 1994). The objectives models have been criticised on the premise that evaluation has been left to as the last step rather than at every step. Furthermore, not all subjects are suited to the specification of objectives and the absence of relationships between the curriculum elements makes the model very rigid.

Other models at the opposite extreme from the objectives models are the Interaction models. These models are more responsive to the dynamics of the curriculum development process as any of the curriculum elements could be the starting point, in any sequence. Models which are neither fixed and inflexible nor free and flexible but lie mid-way between the continuums have been termed as the process models by Brady (1983). These models do not have the statement of objectives as the starting point. These include the Skilbeck model which starts from situation analysis and has monitoring, feedback and assessment at the end to be fed back into the situation analysis stage for a continuous process of curriculum development.

The model adopted in Nigeria is the process model with differences in details. Thus, a form of the process model known as the CESAC model which was adopted and developed by CESAC has found wide usage. The model bears some resemblance to the Skilbeck model on some aspects. Both models have five major components. However, the CESAC five stages have 18 sub-stages.

A comparison of the CESAC and Skilbeck models as described in Ivowi (1993) is presented in Table 2.2. Both models have four distinct stages which though differing in nomenclature are similar and involve closely related activities. For instance, the first stage of situation analysis on the Skilbeck model is tagged problem identification on the CESAC model and the last stage of both concern the issue of monitoring, evaluation and renewal.

Table 2.2 A comparison between the Skilbeck model and the CESAC model

Stage	Skilbeck Model	CESAC Model
Stage 1	Situation Analysis	Problem identification and formation of curriculum team
Stage 2	Goal Formation	Stating objectives
Stage 3	Programme building	Determination of curriculum content. Development of instructional materials and personnel
Stage 4	Interpretation and implementation	Trial testing, modification and installation of materials.
Stage 5.	Monitoring, feedback, assessment, reconstruction	Summative evaluation and revision cycle.

The first stage for both models relates to contextualizing the existing condition or situation followed by formulation of the goals or objectives of the curriculum. He terminating stage has to do with monitoring, feedback, assessment or evaluation and revision. Mkpa (1993) presented a further breakdown of the CESAC model into 18 steps. The CESAC Process of Curriculum Design stages as presented in Mkpa (1993) are as shown in Figure 2.1. These 18 steps were followed in developing all the curricula prepared by CESAC.

Figure 2.1 CESAC Curriculum Development stages

Stage 1 : Problem identification and formation of curriculum team
1. Review of existing system
2. Problem identification
3. Formation of curriculum development team

Stage 2. Stating objectives
4. Determination of global objectives
5. Statement of specific objectives

Stage 3: Determination of curriculum content, and development of instructional materials and personnel

6. Determination of criteria for content selection and organization
7. Selection and organization of content
8. Production of instructional materials.
9. Orientation of teachers

Stage 4: Trial testing, modification and installation of materials
10. Trial testing of materials
11. Holding of feedback conference
12. Modification of curriculum materials
13. Orientation of teachers
14. Installation of materials in schools
15. In- service training of teachers

Stage 5: Summative evaluation and revision cycle
16. Summative evaluation of materials
17. Collection of data for revision
18. Revision and renewal of curriculum

The CESAC model is very comprehensive and progressive. It starts with problem identification takes cognisance of both the contextual, conceptual as well as personnel details for a curriculum. Trial testing, feedback training and evaluation of material and revision and renewal complete the model. The detailed activities connected with each of these stages are clearly distinguishable. Without doubt if all the stages are implemented in developing a curriculum, such a curriculum is bound to be sound and effective barring unforeseen circumstances.

In spite of the practicability of this model, many curriculum projects in Nigeria have avoided the trial testing and personnel training stages and have proceeded to install project materials in the schools (Ivowi, 1993). The activities of the final stage have also been totally excluded. The SS chemistry curriculum was found to be one of those on which the development cycle was not completed.

2.4.0 The Concept of Evaluation

The concept of evaluation has not lent itself to a common definition among practitioners, thus experts have variously defined evaluation. According to Cooley and Lohnes (1976), many people writing and talking about evaluation are more often than not referring to quite different sets of activities. While some practitioners such as Page, Thomas and Marshal (1979) see evaluation as value judgement on an observation, performance, test or data obtained by direct measurement or inference, others like Cronbach (1963) and Welch (1969) saw evaluation as an information generating process for the purpose of aiding decision about programmes or the object being evaluated.

However, these descriptions have been criticized by Cooley and Lohnes (1976) as not far reaching as that proposed by Beeby (1975), which described evaluation as the systematic collection and interpretation of evidence leading as part of the process to judgement of value with a view to action. Gay and Airasian (2000) defined evaluation as a systematic process of collecting and analysing data for the purpose of determining whether and to what extent objectives are being achieved or to make decisions. On the other hand, Kemmis (1982 p.222) saw evaluation as the "process of marshalling information and arguments which enabled interested individuals and groups to participate in the critical debate about a specific programme." Other definitions of evaluation as a process include that of Scriven (1999), which described evaluation as a descriptive process that entails documenting, an existing or postulated state of affairs or making judgements related to the desirability of the existing or postulated conditions.

Definitions of evaluation can also be grouped in terms of the method of evaluation, the use to be made of the evaluation, the information, the timing of evaluation and the purpose of the evaluation. Definitions abound, as there are practitioners.

The view of evaluation with which this study identifies is that which defines evaluation as the process of delineating, obtaining and providing useful information for judging decision alternatives and which is further defined by Stranton (1985) as the process of delineating. obtaining and providing information about an educational programme which is of use in describing and understanding the programme and making judgements and decisions about the programme.

Whichever definition one considers apt, an evaluation must be able to fulfil the following six purposes as proposed by Raymond (2002);

(i) discover whether or not objectives are being fulfilled and how well objectives are being fulfilled;

(ii) determine the reasons for specific successes and failures;

(iv) uncover the principles underlying a successful programme

(iv) direct the course of experiments with techniques for increasing effectiveness

(v) establish a basis for further research or determination of the reasons for the relative success of alternative techniques.

(vi) redefine the means for use in attaining objectives and even redefinition of sub-goals in light of research findings. All of these purposes were in focus in this study.

2.5.0 Curriculum evaluation

Curriculum evaluation, according to Sanders (1990) is described as the process of studying the merit or worth of some aspects or the whole of a curriculum depending on the definition of curriculum. Hughes (2004) defines curriculum evaluation as the means by which the total process of education is assessed. It involves gathering evidence to judge the degree of realization of aims and to enable decisions to be made on future progress. Relating this definition to Straton's (1985) concept of evaluation in the preceding section, curriculum evaluation could be said to be a process whereby information about some aspects or about the whole of a curriculum is obtained for use in describing and understanding the curriculum and arriving at judgements and decisions about the curriculum. Baiyelo (1992), referred to curriculum evaluation as the processes, strategies and techniques for the estimation, adjustment and control of the fit between the planned activities and the actual outcomes of instruction.

Thus, there must be a definition, the getting of information about the curriculum and the presentation of the information in a useful form for making informed judgements and decisions about the curriculum. This leads on to the issue of the various aspects of curriculum to which evaluation could be directed.

According to Welch (1968), avenues for assessing the impact of national curriculum projects included the determination of the degree of achievement of stated objectives, determination of the contribution of the curriculum to general educational objectives and a determination of the degree to which the course is accepted and used in schools, which Leinhardt (1980) referred to as 'implementability of the curriculum.' Another view of curriculum evaluation focus is that of Cooper (1976) who expects curriculum evaluation to generate information on feasibility, effectiveness and educational value. Stephens (1971), in looking at the curricula developed in America in the 60s identified four approaches to determination of educational effectiveness as:

(i) observation of whether or not students for whom materials are intended appeared to be progressing satisfactorily;

(ii) casual and systematic questioning of the students involved in the programmes,

(iii) periodic examination of students by tests designed to cover new materials and

(iv) comparative testing of students, in new and old programmes.

Walbesser (1963) opined that, it is of less importance to examine what a teacher or curriculum writer says he is doing than what the student says (does, believes, etc) at the end of the course that he would not have said if he had not taken the course. Hendrickson (1969) used this approach in evaluating a teacher fellowship training programme in Mathematics and Science, by getting students to respond to questions on class activities, teaching techniques and attitude of teachers and students.

Another focus of curriculum evaluation is examination. Osborn (1969), described how the standard New York Regents Chemistry examinations had been altered by the new approaches to teaching high school chemistry introduced by the Chemical Bond Approach (CBA) and Chemical Education Material Study (CHEM Study) project. Stufflebeam (1972) in his Context, Input, Process, and Product (CIPP) Evaluation model suggests that evaluation should focus on four variables of the curriculum namely, the context, the input, the process of implementation and its outcome. Provus (1972) in his Discrepancy evaluation model believes that curriculum evaluation focus should be directed at the design, the input, the process, the product and the cost of the curriculum.

Similarly, Osiyale (1991), suggests that subjecting the invariant properties of the curriculum to evaluation would yield useful educational information. These properties could be the formal ones such as the goals, procedures, structure, resources or the informal ones of attitudes, values and feelings. According to Sanders (1990), major components of curriculum on which evaluation could be focused include the design of, the needs for, the process of, the materials for, the objectives of, the environment of, the policies for, the support of and the outcome of educational experiences. Schwab (1983 p.240) aptly described these components thus,

> *"...reflections on the curriculum must take into account what teachers are ready to teach, ready to learn to teach, what materials are available or can be devised: what effects actually ensue from materials and methods chosen, not merely how well they yield intended outcomes but what else ensues."*

A good evaluation, according to Goodlad (1994) should determine the relationship between stated goals and their degree of attainment as well as between an initial concept of the practice designed to achieve them and the practice equally developed. In other words, curriculum evaluation should be able to reveal the differences between the intended curriculum, the translated curriculum and the achieved curriculum. Stake (1995 p.5) opined. "A full evaluation results in a story supported by statistics and profiles. It tells what happened. It reveals perception and judgements that different groups and individuals hold... it tells of merits and shortcomings. as a bonus it may offer generalizations for the guidance of subsequent educational programmes"

2.6.0 Models for evaluating the curriculum

Curriculum evaluation can be classified in numerous ways and various models exist for carrying out curriculum evaluation research. According to Stufflebeam (2001). there are many forms of evaluation, each with its own purpose and set of underlying values. Evaluation which occurs during the development of an entity for improving the components has been termed formative evaluation while that which takes place after the programme has been in use is referred to as summative evaluation (Scriven, 1967).

Various models exist for providing insight and frameworks for conducting evaluations. According to Alkin and Ellet (2004), a descriptive model is a set of statements and generalizations, which describes, predicts or gives an explanation of evaluation activities. The current view of among evaluation practitioners is that evaluation should be directed at more than making summary judgement but should be able to provide information for improving the system. Models from such proponents are referred to as prescriptive, because they attempt to lay out general guidelines for responsible practice which are valuable in a variety of settings. Such models are comprehensive in outlook and delivery. Models which fall in this category include the CIPP evaluation model of Daniel Stufflebeam, the Discrepancy evaluation model of Malcolm Provus and the Responsive evaluation model of Robert Stake among others (Armstrong, 1989). The prescriptive model, consist of a set of rules, prescriptions and guiding frameworks which specify what a good and proper evaluation is and how evaluation should be carried out and the descriptive models is based on observation of various evaluation practices. Prescriptive models serve as exemplars while descriptive models are designed to offer an empirical theory.

2.6.1 Descriptive evaluation models

An example of descriptive model is Lawton's (1980) proposed classification into six categories. These are the Classical (or Agricultural Botany) model, the Research and development model, the Illuminative model, Briefing decision-makers model, Teacher as researcher model and Case study model. According to Baiyelo (1992) these models range from those that are solely based on objectives to those that are eclectic in nature, utilising various methods and obtaining both quantitative and qualitative measures to obtain information useful for various stakeholders. These models are briefly described in the following section.

(i) The Classical or Agricultural Botanical model

This model derives its name from methods being used by botanists and other scientists in controlled laboratories. It is a model that relies heavily on quantitative data and manipulating variables to determine which one would yield the most result. Applied to curriculum issues, students (who are likened to plots of land) are pre-tested (weighed) and then subjected to various experiences or treatments and after a period, the yield is measured with a post-test, to find out the relative efficiency of treatment. Growth is equated with increase in test scores. (Baiyelo, 1994). A major criticism of this model is the predetermination of every step and procedure and the negligence of the effect of extraneous factors. The model is further restricted by the number of manipulations possible given the tightness in the schedule of school programmes. However, many of the earlier evaluations were of this experimental type (Worthen, 1990).

(ii) Research and Development or Industry/Factory Model

As the name suggests, this model is tailored more towards development. It is a stepwise model that is not concerned with too many variables. It utilizes both quantitative and qualitative methods for obtaining information that are used for programme refinement similar to what obtains in an industrial plant. Formative evaluation as proposed by Scriven (1967) is an example of this model which was also used in the Schools Council Classical Project (Baiyelo, 1992). The model has been criticised for not including all the concerns in the school and for not treating the school as an organic whole.

(iii) The Illuminative or Anthropological or Responsive model

This model evolved as an alternative model to the classical and industrial models. The model is a departure from the other purely quantitative models, positing that apart from test results, other evidence are needed to fully illuminate and inform the educational enterprise. According to Partlet and Hamilton (1972), evaluation should yield useful information and be responsive to the various groups being evaluated. Thus the model determines both the strengths and weaknesses of a system. It shows how a system works rather than how well it works. The major methods utilized by this model are those of participant observation, interaction, focus group discussion, and experimental procedure. The model adopts wide audience participation, pooling of opinion and perception for use in arriving at decisions about education. However, the model is criticised for being time consuming and generating large volume of information that may be difficult to manage.

(iv) Briefing Decision-maker Model

According to Baiyelo (1992), this model is premised on the view that evaluation should do more than determine success or failure but should be useful in identifying decision alternatives. The evaluator is expected to obtain a wide range of information about the relative advantages of various decision alternatives to enable the decision maker to make a judgement about which is best in terms of specified criteria, (Worthen, 1990). Thus, this model emphasizes certain shared functions and teamwork between evaluators and decision makers. The major proponent of this approach is Cronbach, (1963). This model has been criticised for its failure to determine in explicit terms the worth of a programme, and its dependence on assumptions about the orderliness and predictability of decision-making process. Furthermore, the success of a decision alternative is not guaranteed until tested out and the outcome of each alternative is subject to variables which are not constant for all alternatives.

v) The Teacher as Researcher or Professional Model

Here the teacher is the evaluator involved in research-based teaching and self-evaluation. This type of research resembles action-research in which change in behaviour is produced in the process of the research rather than being observed and reported upon. Stenhouse (1975) describes the use of this model. The model however is difficult to use as the teacher becomes the one to bring about learning as well as assess success and failure. The objectivity of the model is limited.

(vi) The Case Study Model

This model employs a mixture of both qualitative and quantitative data. It is an eclectic model, which supports the combination of test and non-test technique in the collection and analysis of data and confirmation of evidence, (Baiyelo, 1992).The model is case-specific and may not provide generalizable information.

2.6.2 Prescriptive Evaluation Models

Prescriptive models according to Alkin and Ellet (2004), have three aspects of focus. These are methodology, values and uses. The methodological aspect involves a description or explanation of the various properties of an educational phenomenon perceived as important. The valuation component is concerned with ascribing or determining the value of the object, given that it possesses the important properties. The purposive or utility aspect deals with the evaluation of the purposes or function that the evaluation would serve. Prescriptive evaluation models can therefore be classified on the basis of relative emphasis laid on these three aspects by the proponents. Alkin (1992), proposed four major classifications of prescriptive evaluation models. These are, the *measurement outcome-oriented evaluation model, the research-oriented and methodology-oriented evaluation model, values-oriented evaluation model and the decision-oriented or user-oriented evaluation* model.

(i) **Measurement Outcome-oriented evaluation model**

This model was one of the earliest models of evaluation. The model relies heavily on the measurement of outcomes as a major basis for the conduct of evaluation having as its main goal the determination of whether or not a given programme (or curriculum) achieved its intended objectives. The Tyler Evaluation Model, which utilizes both traditional and non-traditional forms of measurement, is an example of this orientation.

The model has five guidelines that are meant to regulate the evaluation activity. These are

- Determination of the broad goals of the programme.
- Definition of the goals in behavioural terms.
- Identifying situations for showing achievement of objective.
- Development of appraisal techniques and
- Determination by measurement whether or not objectives have been achieved.

The Tylerian model has been criticised for non-consideration of unintended effects of the curriculum process variables and instructional settings. Furthermore. learner variables prior to implementation are not taken into account, (Worthen, 1990). The Tylerian model has also been criticized for its rigidity and reliance on goals as a starting point.

(ii) **Research-Oriented and Methodology-Oriented Evaluation Models.**

This model is dominated by the methodology employed. It utilises experimental research methods in evaluation. Various proponents of the models are associated with the research methodology they favour. According to Alkin (1992), there is a variety of perceptions within this category. Some proponents perceive evaluation as nearly synonymous with experimental methods, while others propose an emphasis on richness of qualitative data as essential to evaluation. Thus, there is an insistence on proper measurement as the essence of quality evaluation. Other major positions are those concerned with causal modelling and quasi-experimental procedures. Proponents of this model include Smith (1981) and Guba and Lincoln (1991).

(iii) Values-Oriented Evaluation Models

Alkin and House (1992) posited that this category of evaluation models have values as their primary concern. Present within this orientation are various positions concerning who should make value judgements about programmes and how best to arrive at such judgements. Proponents of this model maintain that the evaluator should be the one responsible for making value judgements based on his/her personal experience. The model has been criticized for the limitation in fairness that a single evaluator can exhibit in judging the views of all sides.

(iv) Decision-Oriented and User-Oriented Evaluation Model

This model's primary emphasis is on the concerns of decision makers and other users of an evaluation. The common idea of these theorists is that evaluation should not only be directed at making summary judgement but should be able to provide information for improving the system. Thus the model, while not dismissing the important roles played by methodological choice and evaluation of data, however insists on the precedence within the evaluation process of producing data that are relevant for decision making and user audiences. (Alkin 1992). This model is comprehensive in outlook and delivery. Major proponents of this model include Daniel Stufflebeam, Malcom Provus, Robert Stake and Marvin Alkin among others (Armstrong, 1989). This model is the one subscribed to by this study. Two examples of the model, the Provus Discrepancy Evaluation Model and the Stufflebeam's CIPP Model are described briefly in the next section.

2.6.3 The Context, Input, Process, Product (CIPP) Model.

This model provides for systematic comprehensive evaluation (Stufflebeam 1972). According to Stufflebeam and Shinkfield (1985), it is proposed to assist in managing and improving programmes. The model consists of four main parts or stages which are best carried out as any programme evolves and progresses. The four parts are *context evaluation, input evaluation, process evaluation and product evaluation.*

Context evaluation refers to the evaluation of the planning decisions that precede implementation. Specifically it defines the instructional context in terms of the nature and needs of the target population, the problems underlying the needs and determines the responsiveness of the objective to the assessed needs. Context evaluation is also expected to provide a basis for judging outcomes. The 1969 curriculum conference could be classified as a form of context evaluation. Feedback from context evaluation allows for adjustment of programme goals. According to Armstrong (1989), context evaluation provides a reality check that allows instructional designers to ascertain the adequacy of their assumptions about learners and other features of the context in which the completed programme will operate.

Input Evaluation includes an examination of the means proposed to meet the basic goals of a programme. Input evaluation attempts to assess system capabilities and procedural designs for implementing the strategies. Here, the adequacy of instructional design in meeting the goals of the programme is called to question. The implementation of the programme can be judged based on the outcome of the input evaluation.

Process Evaluation monitors instruction to ensure that the programme is being delivered as designed. In short it is more or less an evaluation of the implementation of the programme. Process evaluation is expected to generate constant feedback to the implementers of the programme. It also sheds light on the adequacy of the preparation of the programme implementers and could serve as a basis for suggesting needed modifications for training of future programme implementers. Process evaluation also provides an insight to how well the programme design has been adhered to in implementation.

Under *Product Evaluation*, outcomes are related to objectives. context, input and process information. Here, a clear record of effects both positive and negative can be presented. Product evaluation occurs at the conclusion of a programme and can determine whether the goals of a programme are achieved. Results of product evaluation can be utilised for modification of future programmes and not the particular programme being evaluated. The priority of the CIPP model as proposed by Stufflebeam is for on-going programme improvement, although it had been used otherwise for many evaluation programmes.

2.6.4 The Discrepancy Model for evaluating curriculum

This model is referred to as *Discrepancy evaluation model* (Provus. 1971) because it requires a comparison between reality and some standard or standards. The model describes evaluation as the comparison of what is, - a performance- to an expectation of what should be- a standard often the laid down objective or goal. The comparison often shows differences between the standard and reality; this difference is called discrepancy', (Provus, 1971; p.46).

Five evaluation stages are involved in the discrepancy evaluation process. These are the (1) design, (2) installation, (3) process, (4) product and (5) cost. The model is useful for both formative and summative evaluation. In practice, the model presupposes that there are standards against which the reality of each of the stages could be weighed. and these standards are either specified from the on- set or at the evaluation stage. The model has been used in many evaluation studies for which an evaluation had been built in from inception.

Since this study was a summative study, the Provus stages were regarded as objects of evaluation rather than as stages of evaluation. Thus the design evaluation stage was viewed as an evaluation of the curriculum design. The concerns dealt with for each of the curriculum objects are as follows.

i) Design Evaluation is focussed on goals, priorities, assumptions, comprehensiveness and internal consistency of the design,

ii) Installation evaluation assesses the inputs, logistics of implementation, whether or not operational activities are in agreement with the implementation plan

iii) Process evaluation is concerned with short term goals/objectives of various areas: the extent to which interim objectives are being achieved; assessing the variables to be changed and process used to bring about the change

iv) Product evaluation is focussed on overall goal and achievement; comparing the actual attainments against the standards

v) Cost evaluation is focussed on the estimated cost of operating the curriculum as against the observed cost

According to Provus (1972), the discrepancies are determined by examining three content categories of input, process and output within each stage, and comparing performance information with the defined standards at each stage. The Provus evaluation model was preferable to other models because it affords the intrinsic as well as extrinsic evaluation of the curriculum and is useful for both curriculum improvement and assessment. The model had been used to evaluate the Pittsburg schools in the United States

2.7.0 Evaluation of various curricula

There have been reports of evaluation of the various aspects of the curriculum, as well as evaluation of the whole curriculum using various approaches. However, reports on evaluation of the whole chemistry curriculum have been very few.

2.7.1 Study of Physics in Canadian Secondary Schools

The study reported on the Physics achievement of Canadian Upper Secondary School students and assessed the relationship among the intentions, perceptions and translations (Finegold and Raphael, 1988). The study also attempted to generate a model for the analysis and evaluation of national curricula. The study identified the three components of science curriculum as, intended curriculum, translated curriculum and achieved curriculum. The analysis of the intended curriculum was based on science curriculum documents and other statements of curricula intent. These included the specified objectives, content, activities and resources which were expected to be used by the teachers in the classrooms. The translated curriculum was the teachers' delivery in the classroom. Included here were the teachers' beliefs and interpretation of the curriculum. This was analysed based on teachers' responses to questions about science curriculum and teaching practices. The achieved curriculum which relates to the actual transformations that occurred in the students was analysed on the basis of students' scores on science achievement test and questionnaires (Rosier & Couper, 1991).

Students were given a test and questionnaire to complete. The results of teachers' assessment of the students' opportunity to learn physics by the students were used as statements of curricular translations. This was presumed to represent teacher perceptions of what goes on in the physics class. Correlation of students' achievement with teachers' perceptions suggested that:

- Students whose teacher taught the necessary contents performed well on the achievement test;

- The higher the conceptual level of the item, the poorer the students' performances;

- Teachers' prediction of students' success on items were accurate;

- Students whose teachers considered items to be important performed well on the items.

The study concluded that there was interrelationship among the three curriculum levels. Topics that were more extensively mandated recorded higher students' achievements. It was suggested that to a reasonable extent, the pattern of student achievement reflected patterns of the intended and translated curricula.

2.7.2 Study of Inquiry-Based Curricula

Shymansky, Kyle and Alport (1990) undertook a quantitative synthesis of 105 experimental studies involving 4500 American students, on the effect of new science curricula on students' performances. Findings on the two chemistry curricula surveyed (the CHEM Study and the CBA) showed that students in the new scheme curricula out-performed their traditional programme counterparts over all. However, a re-assessment study carried out by Shymansky, Hedges and Woodward (1990) using the same meta-analysis perspective but with refined instrument revealed further important findings.

Compared to the new biology and physics curricula, the chemistry curriculum was found wanting in over-all effectiveness especially on achievement and process skills. No significant positive effect was produced by the chemistry curricula. The weak showing of the new chemistry curricula suggested that the approaches of the new programmes were not successful. Suggested possible reasons for this were the lack of difference between methods of teaching the traditional curricula and the new ones, or the lack of preparation of the teachers to implement the new curricula.

The re-analysis also confirmed that the new curricula had greater positive impact on students in urban settings than on students in suburban or rural setting on overall performance, achievement and analytic skills. It was also found that students in new programs taught by teachers who had received in-service training on the use of the materials performed significantly better than students in traditional programmes.

This finding is in agreement with findings of studies conducted by Popham (1979). and William, Kato and Khan, (2004) which showed that all curriculum projects which had the most significant effects on educational practice produced curriculum materials to implement the new curriculum schemes, as students' performances were significantly enhanced when special teacher in-service programmes accompanied curriculum implementation.

The current practice in curriculum development efforts is the provision of relevant curricular materials tailored to the curriculum provision which when appropriately utilized was found to be very effective. (American Association for Advancement of Science (AAAS) 1999. 2000)

2.7.3 Evaluation of the British National Curriculum in Science

As a result of poor comparative achievement in British schools and because of the problem of un-even development in various areas, the British Education Reform Act of 1988 was enacted to establish a British National Curriculum. The National Curriculum made provision for all British pupils to be educated from ages five to sixteen years in three core subjects of English Language, Mathematics, and Science with six other foundation subjects. Statutory orders based on advice from the National Curriculum Council were laid down for each subject.

This National Curriculum had already been subjected to a series of reviews. In one of the reviews carried out by the Office of Standard in Education and Development (OFSTED, 1994), consultations on raising educational achievement were carried out. The following constituted the consultations:

(i) Over 1400 schools in England randomly selected were invited to write their views on the curriculum;

(ii) Nine regional conferences, at which teachers and head-teachers from 550 of the schools were given opportunity to discuss issues in small groups with Senior National Council and School Examinations Assessment Council Officers and the reviewer;

(iii) Open invitation through the media to all interested parties to contribute an input to the review to which about 2300 schools and individuals responded;

(iv) Invitation to 160 other bodies and local education authorities for reviews of which 200 responses were obtained;

(v) Discussions with various organisations and individuals including the main teacher associations who provided both written and oral evidence.

The review provided information that assisted in revising aspects of the National Curriculum. Specific evaluation of the national proposals was also carried out on regular basis, to review the science and mathematics aspects of the National Curriculum prescriptions. The report of this review was based on four consultation conferences, involving 120 school teachers randomly selected to represent all types of schools; discussions with science subject's officers, chief examiners and chief moderators of General Certificate examining groups and teacher trainers. Feasibility exercises on the proposed programmes of study as well as discussions with associations and learned bodies in science and science related areas also informed the report. The bulk of the 5,879 response forms and written submissions analysed came from the schools.

The review dealt with issues such as the scope of content prescribed, progression and interrelatedness of programme areas, suggestions on courses for inclusion or omission, and topics that needed greater depth and treatment. The reviews generated focussed suggestions which were effected to an extent that another review undertaken two years later (OFSTED, 1994), indicated an increase in the amount of science taught by age 16 across Biology, Chemistry and Physics and commended the introduction of balanced science courses.

The inspection also showed that the majority of science lessons were broadly satisfactory, and that a majority of the science teachers had a degree in one of the fields of science. The deployment of teachers and exceptional support by non-teaching staff were also commended. Quality was reflected in the books and other information resources used for science and the bulk of science lessons were found to take place in the laboratories.

However, the study also pointed out that teachers' understanding of the knowledge and concepts that made up the science curriculum were inadequate and this was found to limit their effectiveness in teaching science. Laboratory apparatus were found to be often beyond serviceable life. Another issue of concern was the quality of recruitment into teacher training programmes in science.

The evaluation of senior secondary school in Nigeria, while considering a number of issues and methods adopted in the discussed studies was concerned with both the design, use and resulting effects of the chemistry curriculum as a summative exercise for use in improving on the curriculum. In the summative mode, the study looked at issues on the ground since the introduction of the curriculum in light of the existing situation before introduction and in the formative mode the study identified those areas that required improvement, inclusion, and omissions.

The study consulted documents and other studies concerned with the day-to-day translation and use of the curriculum. However, it did not involve extensive consultation of the magnitude of the Office of Standards in Education (O.F.S.TED) reviews but attempted to extend the knowledge of the existing curriculum and to act as a springboard for curriculum evaluation theory and practice in Nigeria.

2.7.4 Evaluation of curriculum from American and Asian countries

Garfield (1990) conducted a study on the affective curriculum practice in science, the importance of affective learner objectives and the factors which impede the operations of the objectives in 30 Southern Californian secondary schools. It was found that 112 practitioners, teachers and administrators were in the agreement on the importance of attitudinal objectives in the formal curriculum. However, it was also agreed that the evaluation strategies on affective outcomes were seldom or never used. Prior experience and training were found to predispose teachers to using affective curriculum elements in their teaching. It was suggested that affective outcomes should be deliberately planned into the science curriculum and that strategies for evaluating affective outcomes should be included.

Clough (1994) undertook a formative evaluation of the Biology in Community (BioCOM) curriculum in Iowan secondary schools in America. The BioCOM curriculum was developed to overcome perceived crisis caused by archaic curricula that failed to meet secondary students' needs and interests. The formative evaluation compared the desired and actual state of two units in the areas of student attitudes to and views of science, technology and society. Qualitative and quantitative techniques employed to obtain information include videotaping of lessons, student and teacher journals, questionnaires on student attitudes and preferences of the topics and objectives.

Although the formative evaluation found that the BioCom was partially successful, a number of suggestions were made for the improvement of the curriculum. These include, extensive and well planned teacher in-service programmes, improvement or removal of redundant materials found in the units, infusion of more science into the curriculum and exploration of ways and means of making teachers and students imbibe the spirit of the BioCom.

In reaction to the declining performances in secondary school biological sciences in Nigeria Anukam (1996), conducted an evaluation to examine the content of the biology curriculum and determine the mode of teaching in comparison to the American biology curriculum. The elements of the comparison were biological literacy, instructional literacy and institutional support. The study methodology included a survey of 100 teachers in 46 schools in Imo state of Nigeria, observation of 10 biology lessons and analysis of the biology syllabus.

The study revealed that the classroom instructions were heavily teacher dominated with limited emphasis on the processes of scientific enquiry and infrequent laboratory work. Other impediments to successful biology education included, overcrowded classrooms. poor funding for supplies and materials and high rate of teacher turn-over due to lack of incentives.

According to UNESCO (2002A) report on efforts in curriculum evaluation from different countries, shows the adoption of different approaches. In the Philippines, evaluation of the restructured curriculum was carried out in the public schools with the aims of:

i) determining the adequacy of the implementation support,

ii) finding out the operation of the curriculum in the schools in terms of input and process; and

iii) assessing the change in learner behaviours attributable to the curriculum as well as teacher behaviour.

Summative evaluation, to determine what had been achieved over time was also conducted to summarise programme progress and report findings to stake holders. In Malaysia, a study was conducted on the implementation of the integrated Curriculum for Secondary Schools. The findings from the summative evaluation which indicated the effectiveness of the curricular programme was utilised in making decisions on aspects of the curriculum for continuation, termination, modification or expansion.

In Mongolia, curricular reforms that started in 1990s were subjected to evaluation in 2001. The evaluation findings indicated the need for change from the subject-based approach to the competence based one. The implementation of these findings is in progress.

A common trend in all these evaluations is that there are bodies specifically responsible for monitoring and evaluation of the various curricula and the findings of the studies on the curricula were fed back into the systems (Sanders, 1994).

Rehman (2004) conducted a study on the science curriculum (chemistry) in Pakistan which although is a developing country like Nigeria has advanced to the level of space exploration and nuclear armament.

The study was conducted to know the state of the chemistry curriculum in Pakistan. Specifically the study i) analysed the policy objectives of secondary school chemistry curriculum in Pakistan, ii)analysed the curriculum process with reference to objective, content, methodology and evaluation, iii) reviewed the chemistry curriculum content to identify strengths and weaknesses, and iv) explored the opinion of curriculum experts on the worth of the science curriculum at the secondary level in Pakistan.

Data was collected by the use of questionnaires to more than 1360 teachers and policy makers, analysis of policy documents, textbooks and examination papers.

The study revealed that teachers were never involved in the curriculum development process, and that the objectives and content of the chemistry curriculum were not in consonance with the needs and aspirations of the modern era. The evaluation system was found to promote rote learning rather than comprehension, analysis and evaluation. Major recommendations include the selection of chemistry content based on development of scientific skills, attitudes and interests and daily experiences of learners. Teacher training are to be considered in global context and the examination to be based on the objectives of the curriculum.

Although this study was very comprehensive in nature, students who are also the consumers of the curriculum were not involved. Furthermore, the study only sampled teachers' opinion on the various aspects of the curriculum. A comparative and in-depth analysis of the curriculum was not carried out as in this study of the chemistry curriculum in Nigeria.

2.7.5 Evaluation of the Nuffield Chemistry in Britain

One of the various curriculum development efforts with similar development history to the S.S.S Curriculum was the Nuffield Chemistry in Britain. The Nuffield Ordinary Level Chemistry course underwent scrutiny to assess the need for a revision and to work out guidelines for review, after four years of publication (Ingle, 1984). Teachers' perceptions on all aspects of the Nuffield Chemistry Publications were assessed through the use of a questionnaire. The 20 schools that responded were visited for on- the- spot inspection. Another aspect of the evaluation was that of the course content and examination questions. The evaluation report was instrumental in the conduct of a review of the Nuffield chemistry as well as the attendant publications and support materials.

Other studies which illuminated the evaluation included that of Ingle and Shayer (1971) which explored the conceptual demands of the Nuffield Chemistry in relation to students' level of development. Students' performances in the examinations and the evaluation of the objectives of the scheme in relation to the opportunities afforded by the textbooks were also conducted to determine whether the examination was testing for the objectives.

The review also looked at the reception of the materials by the teachers and implementation in general. The findings of the review were used for the revision of the Nuffield Chemistry course and publications. The periodic reviews of the Nuffield Chemistry and other science schemes had ensured the continued use of the Nuffield scheme in many schools in Britain and elsewhere. A common feature of the Nuffield Chemistry, the CHEM Study and the CBA is that they exist as alternatives competing with other curricula, and are not nationally prescribed.

2.7.6 Studies on the implementation of the chemistry curriculum in Nigeria

Abdul-Quadri (1991) conducted a study on the problem of implementation of the Senior Secondary Chemistry Curriculum in 10 selected Lagos State Schools. The study involved a survey of teachers' problems in the use of the curriculum. The problems identified included insufficient number of chemistry teachers, inadequate periods for chemistry, lack of chemicals, lack of spacious laboratories to accommodate all the students at a time, lack of dedicated and committed teachers as well as poor condition of service and lack of incentives for the teachers. It was suggested that more attention be paid to the proper implementation of the curriculum.

Ajayi (1991) also conducted a study on the implementation of the chemistry curriculum in Lagos State. The study surveyed twenty teachers' views on available resources for teaching chemistry and other problems affecting the implementation of the curriculum. The factors which were found to affect the implementation included inadequate human and materials resources and the type of in-service training and refresher courses for the chemistry teachers as well as lack of appropriate textbooks.

Akinleye (1987) and Akpan (1995), in separate studies on practical activities in Senior Secondary school Chemistry observed that students were not being exposed to practical activities as stipulated in the curriculum. This in turn has contributed to students' poor performances. Akpan (1999) also found out that the bulk of practical work done in school was conducted between February and April in preparation for the SSC examinations due to lack of materials.

In an investigation carried out by Alebiosu (1998), on fifty chemistry teachers in twelve schools in Oshogbo, requesting the teachers' views on the need to review the senior secondary school curriculum in chemistry, the teachers noted that, all the topics except two were relevant. The two topics considered irrelevant were biology- related. It was also suggested that the topic 'nuclear chemistry' be reviewed as it was found to be too abstract.

A curriculum review conference was organised in 1991 by the implementation committee, on the National Policy on Education to formulate the guidelines in form of recommendations for the purpose of informing the review of curriculum content in the different subjects at the second stage of the review exercise (Sofolahan, 1992a) . The review conference was necessitated by the complaints from various stakeholders and the need to comply with normal practice in curriculum development. The conference was attended by a wide group of interested parties including Ministry of Education, Universities, Polytechnics, Colleges, Teachers' Union and Subject associations, educators, parastatals of Federal Ministry of Education, professional bodies, Non-Governmental Organization, and other public and private individuals interested in education.

The review conference took a global look at the curricular offerings at the primary, junior and senior secondary school levels (Sofolahan, 1992b). Deliberations were held on the 33 papers presented from five subject group meetings. The Science, Technical and Vocational Education group deliberated on was one The Implementation Committee for the National Policy on education undertook a comprehensive monitoring to evaluate the implementation at the Secondary School sector through on the spot observation.

The identified problems associated with the implementation at the secondary school included inadequate provision of consumable items and funds to purchase items for practical work such as chemicals, glass wares etc. Other problems identified included inadequate number of qualified teachers for science among other subjects, insufficient time allocation for various subjects and poor library facilities in almost all the schools studied. The need for scientific and valid on-the-spot information on areas of strength and areas of weakness of each of the current curricula was recommended.

Although the monitoring undertaken by the Implementation Committee covered the general curricular offerings in the schools, specific subjects were not scrutinized in detail. For instance, other than availability of teachers, and laboratory facilities and materials, no specific attention was paid to chemistry. All the sciences were viewed as a whole. It was also observed from the report that the various field workers who visited the schools did not use uniform assessment criteria. Thus some reports showed greater details than others, this must have led to the Implementation Committee's perception of the need for scientific and valid on- the-spot information, on the strengths and weaknesses of each of the current curricula.

Robinson (1991) also confirmed that the curricula at senior the secondary school level were found to be too voluminous, too wide in scope such that teachers could never cover the curriculum before the examinations. She also noted that the capital intensive nature of the curriculum , the very meagre funds provided for the purchase of equipment, materials and chemicals for laboratory practices, and the lack of textbooks and instructional materials were part of the problems of teaching science at the senior secondary school level.

Oloyede (1991) noted that students' performances in practical chemistry were very poor. This was attributed to the fact that many schools usually left the practical work undone until a few weeks to the examinations as a result of teachers' inadequacies. The teacher training method was also criticised as being faulty making teachers get shallow or ill prepared and fragmented view of science.

The chemistry curriculum as well as other science curricula at various levels had been the subject of various deliberations similar to the curriculum implementation committee reviews. Two of such deliberations were those of the 10th Annual Conference of the Curriculum Organisation of Nigeria (CON) and the World Council for Curriculum and Instruction (W.C.C.I) Region 2 (Sub Saharan African) Seminar. Both events held in 1997, involved a wide range of educators and practitioners concerned with the educational enterprise. Observations emerging from the two fora included among others , the need for greater attention to be paid to implementation, the identification of the recurrent problems of poor funding, heavy work load and inadequate preparation of teachers, the stagnancy of the teaching curricula since introduction, the out-datedness of the curricula in terms of reflection of current developments, and the need to strike a balance between theoretical learning and acquisition of practical skills (Taylor,1997; Adeniyi, 1997). Ivowi (1997), presented a proposal for redesigning of the science curricula at all levels to address the various concerns identified.

2.7.7 Formative Evaluation of the National School Curriculum

A formative evaluation of the National School curriculum was undertaken by the N.E.R.D.C to scrutinise the school curricula empirically for the purpose of obtaining credible information from the field implementers on the strengths and weakness of the materials and to identify needed improvements. According to Onuogha (1997), the study sought to answer eleven basic questions among which were:

Were the national subject curricula in use in the schools?

Was the curriculum content appropriate to the needs and levels of intended learners?

Was content coverage adequate in scope and sequence?

Were the recommended activities and methods appropriate, comprehensive and useful to the teacher?

Were the recommended teaching aids appropriate, adequate, improvisable and helpful?

Were the evaluation procedures realistic and adequate?

Were the recommended text books in tune with curriculum?

What major difficulties were encountered in the use of curriculum?

What major improvements were necessary on each component of the curriculum?

Chemistry was one of the subjects covered by the study at the senior secondary level. The study covered six states from the six geo-political zones of the country. The stratified random sampling technique was used to select a sample of 905 teachers from 48 schools with consideration for gender and location. The number of Chemistry teachers in the sample was not indicated in the report of the study. The teachers were requested to rate the six major features or components of a typical national curriculum namely, Topics, Objectives, Activities, Methods, Materials and Teaching Aids as well as Evaluation on a five point scale using 29 statements of attribute of a good curriculum. Validation of the only instrument used for the study, a questionnaire, was done through expert judgement and pilot testing.

The teachers' reaction to all the statements on five out of the six main components of the chemistry curriculum was positive. The components of materials and teaching aids were found to be deficient, however. Teaching aids were reported to be inadequate in scope and variety, they were also found not readily available and affordable. A large number of the teaching aids were also found not improvisable and non-substitutable. The curriculum content was considered to be too vast and detailed for the three years in addition to being too top- loaded with too many theoretical concepts and too little practical work.

Although the evaluation was termed 'formative', it was conducted more than ten years after the curriculum had been introduced into the school system. Thus the findings of the evaluation were not necessarily influential on the curriculum. Another observed shortcoming of this evaluation was that none of the curricula in the subject area was subjected to intrinsic analysis to ascertain the intrinsic worth. Rather, teachers' perceptions of the attributes of the curriculum were the overriding basis for arriving at the decision to review aspects of the curriculum. Observation of classroom transactions and interactions were not part of this evaluation, neither were students who were also users of the curriculum involved in the evaluation. Other missing aspects of the evaluation were information on the quality of teachers and the materials available to them. All these shortcomings were adequately taken care of in this study. The formative evaluation though comprehensive did not include an observation of what actually went on in the class room. neither was any reference made to the other end user of the curriculum -- the students. These were the two major areas of difference between the formative evaluation and the present study.

However, the study highlighted various issues which were useful in directing the affairs of a National Feed back Conference on the School Curriculum organised by the N.E.R.D.C in 1997, (Adeniyi, 1997). The Feed back Conference utilised the emerging issues from the various conferences, seminars, and evaluation especially the proposal by Ivowi (1997), to advocate for a redesign of the school curriculum to cater for core and optional alternatives within each subject area. The thematic approach was advocated for senior secondary school level subjects. The chemistry sub-group came up with seven themes, four of which were completely core, two partially core and partially optional and one completely optional.

2.8.0 Synopsis of the literature review

The review of literature for this study helped in shaping the focus of the evaluation The identification of the curriculum and concerns applicable to the curriculum assisted in focussing on the curriculum as a proposal designed for utilization by the teachers and the students with inputs and under certain conditions.

The review confirms the status of the chemistry curriculum for senior secondary schools, as meeting the criteria of a curriculum being a set of intentions to be tested out in practice. The process of developing the SSS curriculum was also weighed against the laid down curriculum development models and found to be wanting in the final stage of evaluation or critical scrutiny.

The review also looked at various curriculum evaluation models and focused on the comprehensive Discrepancy evaluation model proposed by Provus (1971) for use in observing the SSSCE curriculum.

From the literature on the studies conducted on science curricula in other countries, it was found that the present SSS chemistry curriculum was overdue for systematic review and summative evaluation as only formative evaluation of the curriculum had been attempted and these were found not to be specific to chemistry. Furthermore as proposed by Youtie. Bozeman and Shapira (1999), a programme is assessed as evaluable if it had been in operation for several years without a formal evaluation. The SS chemistry curriculum in the present state was found to fit this evaluability criterion as it had been in operation for several years. and there was no framework for understanding the various components of the functioning of the programme.

Since it is neither possible to determine how well objectives are being met, and the reasons for observed successes or failures, nor establish the reasons for the continuation of the use of the chemistry curriculum as is being operated at the moment without conducting a summative evaluation, this study has been undertaken as a completion of the cycle of the normal curriculum development process with a view to informing developers of the feasibility and effectiveness of their ideas and identifying strength and weaknesses of the system. The SSSCE chemistry curriculum had not undergone an evaluation since inception to either confirm its suitability, feasibility nor usefulness and comparability on a global level. The problem of students- below - expectation performances, in the SS chemistry examination made it imperative for an evaluation of this type to be conducted.

The evaluation of the Senior Secondary School chemistry curriculum was undertaken to provide the much needed information and direction to all stakeholders and to contribute to the development of science education in Nigeria.

In summary the literature revealed that there was a gap in the curriculum development process as there has been no constructive summative evaluation of the chemistry curriculum. As was to be expected, curriculum reviews based on findings from evaluation would have ensured that the chemistry curriculum remained effective, up-to-date and comparable to others on the global scale. As the curriculum document remained the only reference point for the teachers and neither revisions nor reviews had been undertaken on it since inception this evaluation study became imperative.

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter discusses the methodological procedures for the study. Evaluating a curriculum is a multifaceted activity as seen from the introductory chapter; hence it entails a variety of methodological concerns and focus. The chapter opens with a presentation of how the evaluation was conducted, methods and techniques employed for obtaining data, and the statistical analysis method used. The chapter concludes with a brief exposition on the constraints encountered in the process of the study.

3.1.0 Research Design

The descriptive research design was utilized to examine the input, process and output variables of the Provus evaluation stages. The model's comprehensiveness and applicability informed the choice. Students and teachers who were the users of the curriculum were deemed to be in the best position to give information about the curriculum. In order to illuminate the design of the curriculum, the objectives of the curriculum were subjected to analysis using Klopfer's (1971) table of specifications for science objectives.

The installation and process of the curriculum were assessed through the classroom observation and analysis of observational records, survey reports on students' practical work and mode of conduct of chemistry practical work and classroom observation as well as the reports of the Implementation Committee on the National Policy on Education (FME 1991) and the Report of school visits conducted by the NERDC in 1996 (NERDC, 1998). The product evaluation was done by analysis of SSCE results for sixteen years (1988-2004) and student's responses on skills acquired from using the curriculum. Cost evaluation was done using the checklist of minimum equipment for chemistry

3.2.0 Population and sample

The population for the study consisted of all students offering chemistry and all chemistry teachers in Nigerian senior secondary schools.

3.2.1 Sample and Sampling technique

Student Sample

The minimum sample size for the study was obtained using the formula for a study on population with variable performance level, proposed by Theodre (1972)

$$N = \frac{Z^2 pq}{E^2}$$

Where N = minimum sample size

Z = the standardized normal deviate corresponding to 95% confidence interval which is 1.96

p = average failure rate in SSSCE chemistry from 1988 to 2003= 47.85%

q =average pass rate in SSSCE chemistry from 1988 to 2003 (q=1-p)= 52.15%

E = Margin of sampling error acceptable which is 1 - 95% = 0.05

Substituting the values;

$$\text{Minimum sample size} = \frac{(1.96)^2\ (0.4785)(0.5215)}{0.05^2}$$

$$= 383 \text{ students}$$

The sample size was increased to 480 students to accommodate any failure in return of the questionnaires.

A multistage sampling procedure was followed in selecting the students' sample. First, the nation was zoned into two zones. These were, North (East and West), South (East and West). Four states were then chosen from each zone by random selection. Selection of schools was based on the list of science schools obtained from the Ministries of Education in the participating states. The schools were those that had been operating the senior secondary school curriculum since introduction into the schools. The schools were also those that were considered above average by the State Ministries of Education in terms of resources for teaching science.

Ten students were randomly selected from each of SS1, SS2, and SS3, making a total of 30 students per school. Selection of students was done using the list of chemistry students in each class and the table of random numbers. Table 3.1 gives details about the student sampled for the study.

Table 3.1. Students' Distribution by zone, state and schools.

Zone	States	Number of Schools	No of students
North-East North-West)	Bauchi, Borno Kaduna, Kebbi	2 schools from each state Total =8	60 Students from each state: Total= 240
South-East South-West)	Cross River, Enugu Oyo, Ogun,	2 schools from each state Total = 8	60 Students from each state; Total= 240
Total	8 States	16 Schools	480 Students

Teacher Sample

A combination of incidental and convenience sampling methods were used to obtain the teacher sample. This consists of 56 chemistry teachers comprising of 16 teachers from the participating schools, 22 teachers who came from the different states of the federation for the Science Teachers Association (STAN) National Conference and 18 teachers who participated in the marking of the West African Senior Secondary school Examination. Thus, the teacher sample was drawn from the schools, the conference of STAN and the SSCE marking conference.

3.3.0 Instruments

An array of measures were utilised to obtain information for the study. These consisted of two questionnaires, curriculum checklist, text checklist and examination result analysis.

3.3.1 Questionnaires

Two different questionnaires were designed for the study by the researcher. These were the Evaluation of Chemistry in Senior Secondary Schools in Nigeria Student Questionnaire (E.C.S.S.N.S.Q.) and the Evaluation of Senior Secondary Schools Chemistry Curriculum in Nigeria Teacher Questionnaire (E.S.S.S.C.C.T.Q.). Both were designed for the study by the researcher.

Teacher Questionnaire

The Evaluation of the Senior Secondary School Chemistry Curriculum Teacher Questionnaire (ESSSCCTQ) contained forty items arranged in three sections (Table 3.2). The first section required demographic information on the teacher. Teacher's perception on every aspect of the curriculum in terms of suitability of topic, content sequence and depth of treatment, available time and problems encountered, constituted the second section. In the third section, teachers rating of student difficulties in the curriculum were required. The full questionnaire is presented in Appendix I.

Table 3.2 Analysis of the Teacher Questionnaire

Section	Identification/Heading	No. of Items
A :Teacher's Profile	Experience, qualifications, professional affiliation, additional training	10
B: Chemistry Curriculum	Teacher preparation for use of curriculum Curriculum in use, rating of curriculum, availability of materials, teacher's perception of students' difficulties on topics	20
C : Chemistry teaching:	Textbooks for teaching, aids used for teaching, mode of assessment, reasons for students' poor performances ,problems encountered in teaching	10
Total	Total number of items	40

3.3.2 Student Questionnaire

The Evaluation of the Senior Secondary School Chemistry Curriculum Student Questionnaire (ESSSCCSQ) also had 40 items arranged in five sections A - E, (Appendix II). Section A dealt with student identification and section B with questions on curriculum materials. Sections C and D requested information on chemistry lessons, practical work, and chemistry curriculum/syllabus respectively. The final section sought information on students' views on suggested problems of learning chemistry and their suggested solutions to such problems. A description of the items in the students' questionnaire is shown in Table 3:3.

Table 3.3 Analysis of the Student Questionnaire

Section	Identification/Heading	No of Items
A. Student Identification	Name of school, Age and class; Reasons for studying chemistry; Attitude to chemistry	11
B. Curriculum Materials	Curriculum in use Chemistry textbook used	6
C. Chemistry Lessons and Practical work	Chemistry time-tabling; Student's reaction to chemistry lessons. Students opinion on practical work ; Mode of and extent of practical activities	18
D. Chemistry Curriculum/ Syllabus	Difficulty of topics in curriculum; Coverage of curriculum content; Revision guide for students	2
E. General	Problems encountered in learning chemistry	3
	Total	40

3.3.3 Checklist for Analysis of Curriculum Objectives

A checklist compiled from Champagne and Klopfer (1974) adaptation of curriculum analysis was utilised to plot a table of specification of the objectives of the chemistry curriculum. The student behaviours expected for each topic were checked against the various classifications of objectives. The full listing of the behaviours and classification is presented in Appendix III. Nine major behavioural classifications of objectives which are further subdivided into detailed components constituted the checklist. These are i) knowledge and comprehension, ii) processes of scientific enquiry I (observing and measuring), iii) processes of scientific enquiry II (seeing problems and seeking solution), iv) processes of scientific enquiry III(interpreting data and formulating generalisation), v) processes of scientific enquiry IV(building testing and revising a theoretical model), vi) application of scientific knowledge and methods. vii) manual skills. viii) attitudes and interests, and ix) orientation. The checklist behaviours are plotted in a grid against the various contents of the curriculum. The plotting of the checklist creates a map which is indicative of the orientation of the curriculum.

3.3.4 Checklist for Analysis of Chemistry Text

A checklist was designed for assessment of the chemistry text adapting the aspects of Jones (1975) analysis of the Nuffield Chemistry Materials and Ashman's (1985) report of chemistry in England and Wales. A combination of the objectives of the curriculum and the skills expected to be acquired by the students was utilised to arrive at some operational objectives which were then used to assess the most used textbook. The Checklist is presented in table 3.4.

Table 3.4 Checklist for Classification of Objectives for the analysis of Chemistry text

Curriculum objective	Operational definition of objective
(i) facilitate a transition in the use of scientific concepts and techniques acquired in integrated science with chemistry;	A. Accurate or careful observation and recording B. Devising an appropriate scheme of apparatus C. Classifying facts or observation D. Handling numerical data
(ii) provide the students with basic knowledge in chemical concepts and principles through efficient selection of content and sequencing;	E. Plotting and using graphs F. Drawing inferences from data without hypothesising G. inventing hypotheses and judging between them H. Competence in communicating ideas and observations in coherent form. I. Applying previous understanding to new situation e.g. in problem solving. J. Creativity in addition to that involved in other operations
iii) show chemistry in its interrelationships with other subjects	K. Show links with biology L. Show links with physics M. Show links with geology N. Show links with mathematics other than as a tool O. Show links with other school subjects
(iv) show chemistry and its link with industry, everyday life, benefits and hazards;	P. Industrial application of chemistry Q. Chemistry or chemical products in every day life R. Show social, political, or moral consequences of chemistry
(v) provide a course which is complete for students not proceeding to higher education while at the same time a reasonably adequate foundation for a post secondary chemistry course.	

3.3.5 Science Teaching Observation Schedule (STOS)

Observation of classroom interaction was done with the use of the Science Teaching Observation Schedule (STOS), Eggleston, Galton and Jones (1976). The schedule is designed to describe classroom interaction patterns of science lessons in terms of teacher talk and pupil talk. Its use in studies of teaching behaviours has been very effective (Williams, and Buseri 1988). The STOS has three major categories of teacher talk and two of pupil talk. The activity categories of the schedule are displayed below.

1. TEACHER TALK

1a Teacher asks questions (or invites comments) which are answered by
- a1 recalling facts and principles
- a2 applying facts and principles to problem solving
- a3 making hypothesis or speculation
- a4 designing of experimental procedure
- a5 direct observation
- a6 interpretation of observed or recorded data
- a7 making inferences from observations or data

Teacher makes statements:
- b1 of fact and principle
- b2 of problems
- b3 of hypothesis or speculation
- b4 of experimental procedure

1c Teacher directs pupils to sources of information for the purpose of:
- c1 acquiring or confirming facts or principles
- c2 identifying or solving problems
- c3 making inferences, formulating or testing hypotheses
- c4 seeking guidance on experimental procedure

2. TALK AND ACTIVITY INITIATED AND/OR MAINTAINED BY PUPILS

2d Pupils seek information or consult for the purpose of:
- d1 acquiring or confirming facts or principles
- d2 identifying or solving problems
- d3 making inferences, formulating or testing hypotheses
- d4 seeking guidance on experimental procedure

2e Pupils refer to teacher for the purpose of:
- e1 acquiring or confirming facts or principles
- e2 seeking guidance when identifying or solving problems
- e3 seeking guidance when making inferences, formulating or testing hypothesis
- e4 seeking guidance on experimental procedure

The categories are recorded against eleven three-minute intervals units for each lesson. The object of the schedule is to categorize both teacher and student behaviour at each three-minute interval and record the occurrence of a particular behaviour. The occurrence of each behaviour or activity is recorded only once within each three-minute interval. Where behaviour occurs and extends across the boundary between two adjacent time units, the category is recorded in both time units. The occurrence of a particular behaviour in any three-minute interval was recorded by a check against that category within that time unit. The re-occurrence of behaviour in any three-minute interval was not recorded.

3.4.0 Validation of Instrument

3.4.1 Pilot study

A pilot study was conducted in two schools in Lagos State which was not part of the final sample states. The pilot study was conducted to;

i) verify the validity and reliability of the instruments for the study

ii) identify aspects of instruments for modification and

iii) determine the feasibility of the procedure for the main study

A total of 60 students from two secondary schools responded to the students' questionnaire: 30 students chosen from each school, 10 students each from SS1, SS2 and SS3, and 12 Chemistry teachers made up of eight teachers participating in the GCE S.S.C. examination marking exercise and four chemistry teachers from the pilot sample schools completed the teacher's questionnaire.

The respondents were requested to assess the various sections of the questionnaires and to make comments on the clarity and ease of understanding of the questions and whether the questions relate to their concerns on the chemistry curriculum

The responses to the questionnaires were analysed using proportions and percentages. The following is a summary of the findings from the survey.

All the questionnaires served on the students and teachers were duly completed. The responses on the questionnaires were analysed and the comments made were used to reduce the length of the items. Recasting and reorganization of the items were also done based on the comments and suggestions made.

Three of the teachers surveyed were females while the chemistry teaching experience of the teachers ranged between one and fifteen years. Three quarters of the teachers surveyed taught other subjects in addition to chemistry. The other subjects taught included Mathematics, Integrated Science and Physics.

A large proportion of the teachers surveyed had science degrees without professional teaching qualifications. Only one third of the teachers indicated that they received some orientation on how to teach the curriculum. Three quarters of the teachers indicated that the textbooks had a major influence on their teaching. A large number of the teachers suggested the removal of the topic Earth and Space from the curriculum. Teachers complained of large classes and students' poor mathematical background as some of the problems encountered in teaching chemistry. Over half of the teachers suggested their need for some orientation training on the curriculum.

Analysis of student Questionnaire

Of the 60 students surveyed, 23 were females while 37 were males. The ages ranged between 12 and 18 years.

- Students relied mainly on the textbooks and teachers' notes.
- Students and teachers agreed on the textbooks used for chemistry.
- There was little or no participation of students in the chemistry classroom activities.
- Majority of the students even at the final class had not done any project work.
- Students knowledge of the benefits derivable from practical activities appeared to be minimal due to non-performance of experiments and project work.
- The textbooks and past examination questions had major influence on students' study pattern.

Other comments and responses to the questionnaires were utilized for further modifications.

3.4.2 Preliminary Analysis of the Chemistry Curriculum

The objectives of the chemistry curriculum were broken down to operational form and used in analysis of the textual materials. The validation of the operationalized form of the objectives was done by five science educators comprising two university and one college of Education teacher trainers and two secondary school chemistry teachers. A list of 13 operational objectives agreed on by the educators emerged from the five objectives in the curriculum. These operational definitions were used to assess the opportunity given by a chapter in one of the chemistry textbooks, for achieving the objectives.

Validation of the questionnaires and checklists were done during the pilot study. The questionnaires were validated by a group of chemistry teachers and students. The draft questionnaire was presented to ten science teachers to assess for comprehensiveness and clarity.

The teachers were requested to make comments on the suitability of the two questionnaires for obtaining information on the curriculum .As a result of the pilot study and the suggestions from students and teachers, further corrections were affected on the questionnaires. The checklists were validated by the method of inter-rater analysis. Six science educators, four from the University and two from the College of Education were served with the checklists to comment on the appropriateness of the content. Suggestions from the initial six were incorporated and the corrected versions were further served on two other university lecturers and one College of Education teacher. The level of agreement on the checklist by the three lecturers showed that the instrument was adequate for obtaining the information required.

3.4.3 Instrument Reliability

50 items were originally generated for each of the questionnaire by the researcher. These were given to five independent science educators as judges to rate the consistency Their comments together with the result of principal component analysis of the pilot study led to the reduction of the questions to 40 items. Suggestions for corrections on the two questionnaires were effected in producing the corrected version of the questionnaires which were then administered on 24 chemistry students and four teachers from four non-participating schools. Combining the responses of the three categories of respondents and using the form of Kuder-Richardson formula 21 which is adequate for dichotomously scored items, a reliability coefficient of 0.68 was obtained.

3.5.0 Procedure for Data Collection

3.5.1 Questionnaire Administration

Administration of the questionnaires was done by the researcher. The departmental heads in the schools were approached and consent sought on administering the questionnaires. Thereafter. sampling of the students from each class was done and all students were served with the questionnaires, which were taken home and completed by the students. All the students' questionnaires were completed and returned the day after administration. The chemistry teachers in each school also completed the questionnaires. Administration of the questionnaires to the schools in each state was done within two days. All the student questionnaires were also duly completed and returned.

3.5.2. Observation of chemistry lessons

Observations of 10 single chemistry lessons, six double periods (practical work) were carried out in the schools. The researcher undertook the observation using the Science Teaching Observation Schedule. Consent was obtained and observation arrangement made prior to the day of observation, to enable the teachers to make adequate preparations. Issues to be observed were not communicated to the teachers however and they were asked to teach in their usual manner. The observer tried to be as unobtrusive as possible to prevent observer influence on the lessons.

3.5.3. Procedure for Cost estimation

The available literature on cost are focussed more on cost-benefits and cost effectiveness analysis. However, since there was no indication of cost of operating the curriculum, minimum cost estimation was done, to establish a baseline on cost.

The input structure equation for cost estimation proposed by Wolf (1990) was used to compute the total baseline cost. The equation is simple, straightforward and has found usage for cost estimation for many programmes. The following system of categories was utilized to arrive at the total cost estimate of operating the chemistry curriculum.

$$TC = PC + EC + MC + FC$$

Where TC = Total cost of program

PC = Personnel cost of programme

EC = Equipment cost of programme

MC = Cost of materials for programme

FC = Cost of facilities for programme

Computation for each category was done as follows:

Personnel Cost, PC was computed as

$$PC = LP + CT$$

Where LP = Cost of laboratory personnel required for operating the curriculum and

CT = cost of chemistry teacher required for a minimum of 40 students, for the duration of the course.

The personnel cost were computed from the Federal Government salary and emolument. The salary for the Laboratory Personnel was taken as Civil Service Salary scale Level Five of the service structure in year 2004 and the cost for three years computed. The salary for the teacher was taken as Civil Service Salary scale Level Nine, for a period of three years on the assumption of one teacher to 40 students.

Computation for the cost of materials for the chemistry curriculum was done by computing the cost of equipment and material from the list of minimum for teaching secondary science generated by the Federal Ministry of Education Science and Technology, 1995). A cost survey was undertaken by the researcher for each item in the list on the estimated cost for 40 students in 2004. Detailed estimate of the cost of minimum equipment and materials are in Appendix IV. The cost of facilities (FC) was not included in the cost estimation; this is assumed to be a shared cost with the school and other science subjects since schools do not operate the chemistry curriculum in isolation. The excluded facilities categorie are classroom space and other physical facilities.

3.6.0 Procedure for Data Analysis

Non-parametric statistics was utilized in the analysis of data. Data obtained from the questionnaires were analysed using percentages. Chi-square analysis was used for the purpose of comparison of results on zonal basis at the $P<0.05$ level. Teachers' responses on topics difficulty and problems of chemistry were compared with the students' responses on some items. This is to identify those aspects of the curriculum that were difficult to both groups. Standard error calculations took account only of the estimation of errors arising from the sampling of schools and students and not those arising from the sampling of the questionnaires nor those arising from possible interactions among students.

The analysis of data was done using the Statistical Package for Social Sciences (SPSS). The data obtained from the student questionnaire was analysed on class basis. Frequencies and percentages were used to present data in most cases but the use of the Chi- Square was also undertaken in some cases.

Analysis of the Science Teaching Observation Schedule (STOS) was carried out by compiling all the data obtained from the 10 lessons observed and adding up the tally for each of the teacher and student initiated activity and obtaining the percentage over the total tally.

The reports of the school visits by the NERDC and the Implementation Committee were analysed by identifying facilities available in the schools such as laboratories. libraries and teachers. Information on the adequacy or non-adequacy of each resource was then summarised.

The analysis of the objectives in the curriculum was done using the table of specification of objectives. The student behaviours which were expected from each of the stated objectives were identified and the objectives classified accordingly. The total for each group of behaviours was then compiled. The practical examination questions were also analysed by identifying the process skills being tested. A tally for each skill being tested was made and summed up.

Analysis of the most commonly used textbook was carried out to find out whether the book provided opportunity for achieving the operational objectives of the curriculum. Each of the 28 sub-topics was cross-checked in the book and the existence of opportunity for achieving the objective was marked. A tally of opportunity for each objective was then summed up for all the sub-topics.

Analysis of the curriculum was done using a checklist for assessment of curriculum designed by Klopfer (1971). Analysis of examination results over eleven years between 1988- 2004 and the enrolment trend in chemistry compared to the total entry for the examinations were also done. Observation of 10 single chemistry and six practical lessons were carried out using the Science Teaching Observation Schedule of Eggleston, Galton and Jones (1976).

3.7.0 Constraints

The timing of data collection from the schools was made to coincide with the period when work for the year for each class was to have been nearly concluded. This period was close to the final examinations for the S.S 3 students, and slight problem was encountered in getting this set of students to complete the questionnaire. Besides the problem of long distances to the schools, very few constraints were encountered in the study. Both the teachers and students co-operated in completing the questionnaire.

CHAPTER FOUR

ANALYSIS AND INTERPRETATION OF DATA

The findings of this study are as presented in this chapter. Tables, figures and charts have been used in the presentation as deemed appropriate. Illumination of salient aspects of the tables and figures has been done with brief description of the highlights. The findings have been arranged according to the Provus (1971), Evaluation stages of Design. Installation. Process. Product and Cost. Although the cost evaluation is supposed to be presented with each stage of evaluation. it is presented in a separate section because the cost of operating the curriculum was not included in the original curriculum guideline.

4.1.0. Design evaluation

How comprehensive and adequate is the design of the SS chemistry curriculum in terms of the objectives and content?

The curriculum design evaluation involved a consideration of the objectives. content. and specified mode of assessment, using the checklists and students' and teachers' views as recorded in the questionnaires. A brief assessment of the curriculum document completes the design evaluation analysis.

4.1.1 Structure of the chemistry curriculum objectives and contents

An analysis of the curriculum content by unit, topic and class is displayed on Table 4.1. As much as 42.2% of the objectives were concentrated in the second year of the course while the first year recorded the greatest number of content (41.9%). However, only two units. "Particulate nature of matter" and "Carbon and its compounds "appeared in each the three years. All the other topics appeared only once. This does not seem to conform to the curriculum document's claim of spirality of the contents. However non-spiral nature of the contents may not be a serious problem, when viewed in the light of the United States of America's curricula which were found to be repetitive, in a bid to maintain the spiral approach. (Schmidt, McKnight & Raizen, 1997).

Table 4.1. Distribution of content and objectives by class

Unit Title	Topics	Number of content and objectives		
		S.S 1	S.S. 2	S.S. 3
Separation Technique	1.Standard separation technique	5 (4)	*	*
Particulate nature of matter	2. Particulate nature of matter 3 .Symbols, formulae and equations. 4.Periodic Table	6 (4) 6 (5) *	* * 1 (2)	* * *
Wave /Particulate nature of matter	5.Orbitals and electronic structure of the atom 6.Nuclear chemistry 7.Chemical bonding	* 0 0	0 0 0	2 (5) 2 (2) 4 (7)
Chemical combination	8.Chemical combination	2 (5)	0	0
Gaseous state and laws	9.Gaseous state and gas laws	5 (12)	0	0
Acids, bases and salts	10.Acids, bases and salts	3 (7)	0	0
Carbon and compounds	11.Carbon and its compounds	5 (5)	2 (12	6 (14)
Industrial Chemistry	12.Petroleum 13.Applied chemistry	3 (6) 2 (3)	0 0	0 0
Quantitative aspects of chemical reaction	14.Mass/volume relationship 15.Elecrolysis 16.Acid-base reactions	0 0 0	1 (4) 9 (12) 3 (11)	0 0 0
Rates, Energy and Equilibrium	17.Rates of chemical reactions 18.Energy effects and chemical equilibrium	0 0	3 (7) 2 (6)	0 0
Non-metals and their compounds	19.Hydrogen 20.Oxygen 21.Halogens 22.Nitrogen 23.Sulphur	0 0 0 0 0	1 (4) 2 (6) 1 (5) 1 (5) 2 (6)	0 0 0 0 0
Metals and their compounds	24.Metals and their compounds	0	0	9 (13)
Space and Earth chemistry	25.Space and Earth chemistry	0	0	3 (6)
	Total 93 (194)	39 (60)	28 (82)	26 (52)

(Figures in parenthesis represent the number of objectives.)

4.1.2 Assessment of the curriculum content.

The content of the Chemistry Curriculum for Senior Secondary School (CCSSS) was compared with that of the Chemical Education Material. (CHEM) Study and the Nuffield Ordinary Level Chemistry to assess the global comparability of the curriculum content. Table 4.2 shows the similarities and differences observed.

Table 4.2 Comparison of the CHEM Study and Nuffield Chemistry Content with that of the S.S.S chemistry curriculum

CHEM Study content and topics	Nuffield Chemistry content and topics
1. Chemical materials ✓	Ideas that chemists use
2.Classification of chemical elements ✓	1. Atoms in chemistry ✓
3. Chemical change ✓	2. Investigation of salt and 'salt gas' ✓
4. Chemical Laws ✓	3. Looking at the elements in light of the Periodic Table ✓
5. Energy relationships and equilibrium in chemical systems ✓	4. Finding out how atoms are arranged in elements ✓
6. Electrochemistry ✓	5. Solids , liquids and gases ✓
7. Atomic and molecular structure ✓	6. Explaining the behaviour of electrolytes ✓
8. Introductory organic chemistry ✓	7 Finding out the relative numbers of particles involved in reactions ✓
9. Chemistry of life processes #	8. How fast? Rates and catalysts ✓
10. Nuclear chemistry ✓	9. How far? The idea of dynamic equilibrium ✓
11. Earth and space chemistry #	10. Investigating substances called 'acids' ✓
12. Petroleum chemistry ✓	Getting the mastery over chemicals
13. Industrial chemistry ✓	11. Breaking down and building large molecules ✓
14. Historical development ×	12. Chemistry and the world food problem ×
15. Nature and structure of science ×	13. Chemicals and energy ✓
16. Nature of scientific enquiry ×	14. Radiochemistry ✓
17. Biographies of scientists #	
18. Measurement ×	

Note: ✓ indicates presence of topic in the CCSSS while × means topic is absent and # indicates presence of a topic in a different form or in less detail

Of the 18 topics in the CHEM Study curriculum, 13 were found in the CCSSS. Three additional topics were found to exist on a partial basis, these were *Earth and space*, Biographies of *scientists* and *Chemistry of life processes.* As can be observed the CCSSS is comparable to other curricula in terms of content coverage except in a few areas such as *Historical development, Nature and structure of science Nature of scientific enquiry and Measurement,* which appeared to belong to science generally and which were already included in the junior secondary school curriculum. The curriculum content did not make provision for the introduction of contemporary issues such as "Chemistry and the world food problem "(Nuffield Chemistry) and Environmental chemistry.

4.1.3 Teachers' views of the curriculum content

Teachers were requested to indicate those topics that they felt should be added or deleted from the curriculum. Tables 4.3 and 4.4 show their responses.

Table 4.3.Teachers' suggestions of topics for inclusion or removal from the curriculum

Suggested topics for inclusion and percentage response	Suggested topics for removal and percentage response on each
None (64.2)	None (60.7)
Chemistry in Industry (17.9)	Nuclear chemistry (17.8)
Practical aspect of saponification (17.9)	Chemistry of Earth and Space (14.3)
	Energy effects and Chemical equilibrium (7.1)

A large percentage (64.2%) of teachers felt that there was no need for the inclusion or removal of any topic in the curriculum. Two topics were suggested for inclusion in greater detail by the remaining teachers. These were "*Chemistry in Industry*" and the "*Practical aspect of saponfication*". This view is in consonance with the content offering in the CHEM Study project. Topics suggested for removal in order of magnitude of respondents were "*Nuclear Chemistry" (17.8%), "Chemistry of Earth and Space"(14.3%)* and "*Energy Effects and chemical equilibrium"(7.1%).* Although the reasons for the suggestion of these topics were not made known it might be because of difficulties encountered with the teaching and learning of the topics. For instance the topic "*Energy Effects and chemical equilibrium*" was one topic considered very difficult by both teachers and students (see table 4.72)

4.1.4. Evaluation of the objectives

Both the overall objectives of the curriculum and the performance objectives were analysed to determine their suitability and comparability with the global objectives of science curriculum.

Teachers' Assessment of the curriculum objectives.

Teachers were requested to rate the curriculum in terms of the achievement of the objectives, using a rating scale of 1 to 5 for lowest to highest level of achievement respectively. Table 4.4 shows the ratings. Relevance of the curriculum to student's future pursuit of chemistry recorded the highest rating. This supports the aim of preparing students for future vocation in chemistry. Practicability of the activities and students' understanding of the topics in the curriculum were rated very low.

Table 4.4 Teachers' rating of the achievement of the chemistry curriculum objectives

Objectives	Average Rating (1=lowest; 5=highest)
1.Relevance of curriculum to students' future pursuit of chemistry	4.32
2. Relevance of chemistry to Industry	4.25
3. Coverage of topics needed by SSS students	4.21
4. Blending of Scientific concepts acquired at JSS level with chemistry	4.00
5. Relevance of chemistry to everyday life	3.90
6. Meeting students' needs for curiosity and achievement	3.82
7. Appropriateness to level of students	3.75
8. Relating chemistry to other school subjects	3.53
9.Practicability of Activities	3.39
10. Students' understanding of topics	2.10

Assessment of the performance objectives

An analysis of the curriculum content and objectives were carried out using the Table of Specifications for Science Education developed by Klopfer (1971).The table of specification affords the characterization of any science programme through the analysis of the performance objectives to identify the student behaviours being promoted by each of the science content area of the curriculum. Student behaviours ranging from knowledge, comprehension or application to student's skills in different processes of scientific enquiry are indicated. Also included in the specification table are objectives in the attitude, manual skill, and orientation categories.

Table 4.5 is a table of specification for the chemistry curriculum for senior secondary school in Nigeria. The entries in the table are based on the analysis of the curriculum objectives and content as contained in the curriculum document. Each darkened cell on the table indicate the existence of the behaviour under a particular content area.

The table 4.5 shows that for nearly every content area, knowledge and comprehension (A1-A11) appeared among the desired objectives. As much as 44.1% of the objectives are of the knowledge and comprehension type. There was a moderate existence (19.9%) of entries under observing and measuring (B1 to B3) for most of the content areas reflecting the laboratory activities of the curriculum. There was nearly no representation of entries in category C.O (1.5%) and category D.O (8.8%) which relate to problem solving in chemistry Except for topics on the "Particulate nature of matter" and Quantitative aspects of chemical reaction . the building and testing of theoretical models by the students (E.O) were also not stressed(2.2%). The full listing of al the behaviours is presented in Appendix III. A summary of the distribution of the objectives is shown in Figure 4.1 which provides a clearer picture of the distribution of the objectives.

Table 4.6 Specification of objectives for Chemistry Curriculum for senior secondary schools

Student behavior

Content	A.0 Knowledge and Comprehension											B.0 Processes of scientific enquiry Observing & measuring					C.0 Seeing a problem & seeking way to solve it	D.0 Interpreting data and formulating generalization				E.0 Building, testing, theoretical models		F.0 Application of scientific knowledge and methods			G.0 Manual Skills		H.0 Attitude and interests	I.0 Orientation		
	A 1	A 2	A 3	A 4	A 5	A 6	A 7	A 8	A 9	A 10	A 11	B 1	B 2	B 3	B 4	B 5	C 4	D 1	D 2	D 3	D 4	E 3	E 5	F 1	F 2	F 3	G 1	G 2	H.4	I 3	L 4	L 5
Standard separation technique	x						x																	x			x					
Particulate nature of matter	x	x		x	x	x		x	x	x	x	x	x																			
Chemical combination					x							x	x	x						x												
Gaseous state and Laws	x				x	x	x	x	x			x	x	x					x				x	x			x					
Acids, bases, & salts		x		x		x	x					x	x														x					
Carbon and compounds	x	x	x		x	x				x	x	x	x							x				x	x	x	x	x	x	x	x	x
Industrial Chemistry		x			x	x	x					x	x											x			x				\	
Quantitative aspects of chemical reaction	x	x	x			x	x	x		x	x	x	x	x	x	x		x	x	x	x	x	x	x			x	x		x		
Rates ,Energy and Equilibrium		x	x	x	x	x		x			x	x	x	x	x																	
Wave and particulate nature of matter		x			x	x			x	x	x	x	x																	x		x
Non-metals and the their compounds	x	x		x		x						x	x				X	x	x								x	x				
Metals and their counpounds	x		x			x				x							X	x	x	x	x					x	x	x			X	
Sp ace adnd Earth Chemistry	x	x			x																											
Total	60 (44.1)											27 (19.9)					2 (1.5)	12 (8.8)				3(2.2)		8 (5.9)			12(8.8		4 (2.9)	8 (5.9)		

<u>Key to student behavior</u>

Knowledge and comprehension A.0

Processes of scientific inquiry.Obseving and measuring B.0

Processes of scientific inquiry.Seeing a problem & seeking way to solve it C.0

Interpreting data and formulating generalization D.0

Building, testing and revising a theoretical models E.0

Application of scientific knowledge and methods F.0

Manual skills G.0

Attitudes and interests H.0

Orientation I.0

Figure 4.1 Distribution of objectives of the SS chemistry curriculum

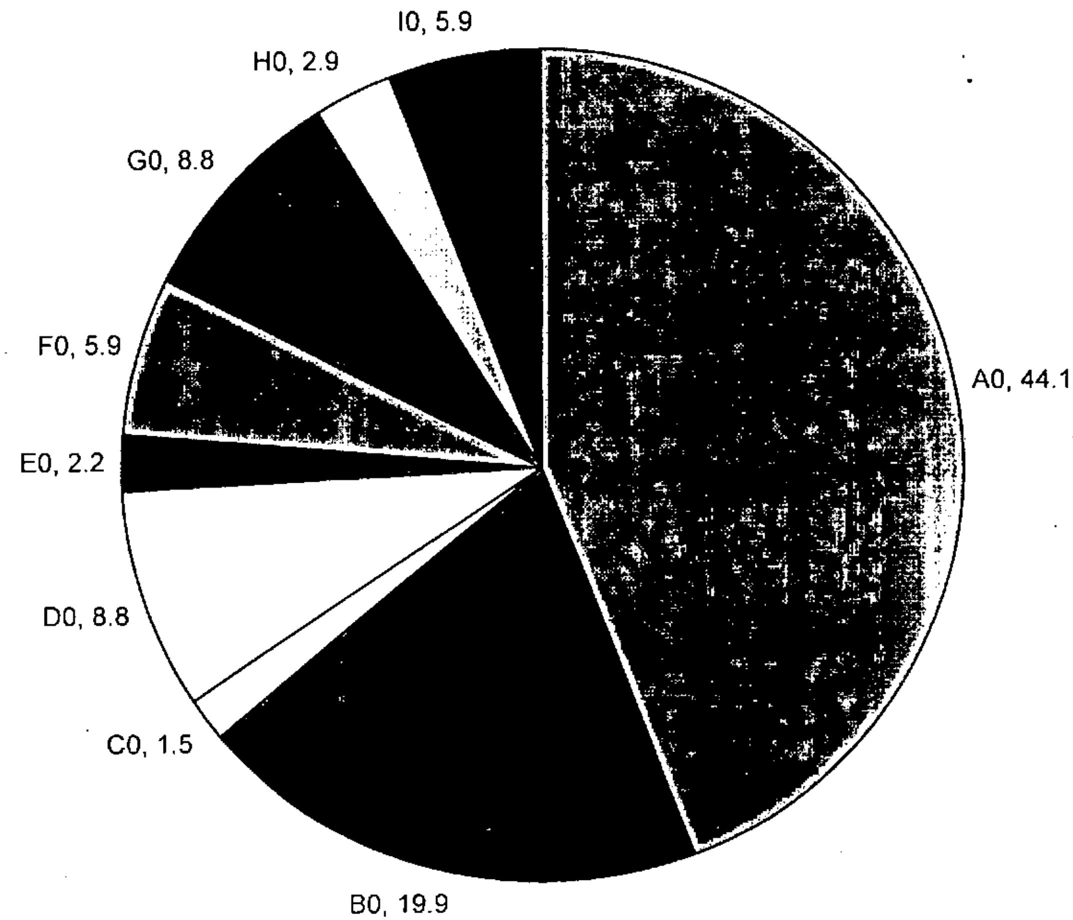


Table 4.5Specification of objectives

Figure 4.1Distribution of objectives of the sss chemistry

4.1.5 Assessment of the Curriculum Document

The curriculum document was assessed to determine its explicitness and comprehensibility. Although the document was simple and explicit, it was not comprehensive and detailed enough in some aspects. For example, there was no explanation on the guided discovery approach which the curriculum advocated. Thus any teacher who did not receive some training on the use of the curriculum may not be able to effectively use the curriculum.

4.2.0. Curriculum Installation Evaluation

(ii) Has the curriculum been adequately installed in the schools?

This section contains information relating to the installation of the curriculum in the schools. Demographic data on teachers and students are presented. Also included is information on availability of resources to execute the curriculum plans. To summarize the section is an installation checklist to assess the extent of installation of the curriculum in the schools.

4.2.1. Demographic Characteristics of Chemistry students in the Schools

Students' ages and sex were requested for, to determine category of students in senior secondary chemistry classes. Tables 4.6 and 4.7 show the distribution by age and sex respectively.

Table 4.6. Distribution of students by age and class

Age	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
13	7.5	1.3	-	2.9
14	36.2	3.7	-	13.3
15	28.7	25.0	10.0	21.3
16	8.8	25.0	27.4	20.4
17	13.8	27.5	31.2	24.2
18	1.3	11.2	18.8	10.4
19	-	-	6.3	2.1
20	2.5	1.3	6.3	3.3
Not recorded	1.3	5.0	-	2.1
Total	100	100	100	100

The large majority (65.9%) of the responding students fell within the age bracket offifteen to seventeen years. This indicated that the policy stipulations in relation to age are being adhered to. It might be deduced that these students were at ages also attributable to Piaget's the abstract thinking age.

Table 4.7 shows the distribution of students by sex and class. The ratio of boys to girls in the survey was approximately 3 to 2. More boys participated in the study than girls.

Table 4.7 Percentage Distribution of students by sex and class

Sex	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
Female	35.0	46.2	37.5	39.6
Male	55.0	53.8	62.5	60.4
Total	100	100	100	100

4.2.2. Demographic Information on Chemistry Teachers in the study

Information on the teachers is expected to provide useful insight into the installation of the curriculum in the schools. The teachers' qualifications, experience and training were therefore considered. The responses are presented in tables 4.8 to 4.12.

Table 4.8 Percentage Distribution of Teachers By Sex

Sex	Percent age	(n=56)
Male	57.1	32
Female	42.9	24
Total	100.0	56

Over half (57%) of the teacher sample were males although the female in the sample accounted for well over two-fifths of the sample. The implication of this is that there might not be much play on the gender issue.

Table 4.9 Percentage Distribution of Teachers By Years of Experience

Years of experience	Percentage	No
1 – 5 years	46.4	26
6 – 10 years	35.7	20
11 - over 21 years	17.9	10
Total	100.0	56

Majority (81.1%) of the teachers sampled had between one and ten years experience in teaching. This implies that more than half of the teachers began the teaching career in the life span of the projects, very few teachers had been teaching for some years before the curriculum introduction

Table 4.10. Percentage Distribution of Chemistry Teachers by Training

Response	Percentage	Frequency
Trained chemistry teacher	71.4	40
Not trained as chemistry teacher	28.6	16
Total	100.0	56

Nearly three-quarters (71.4%) of the teachers surveyed indicated that they were trained chemistry teachers. Those who were not trained as teachers of chemistry had the Higher National Diploma. The commonest area of specialization was Biochemistry which was recorded by half of the non-chemistry trained teachers; others were Industrial chemistry and Analytical chemistry graduates recorded by a quarter of the respondents respectively.

Training in the use of a curriculum has been recognized as a major determinant of installation. Teachers were asked to indicate whether they received some training in the use of the curriculum. Their responses are displayed on tables 4.11 and 4.12.

Table 4.11 .Percentage teacher responses to receiving orientation training on using the curriculum

Response	Percentage (n=56)
Yes	42.9
No	57.1
Total	100.0

Over half of the (57.1%) teachers surveyed had received no orientation courses on how to teach the curriculum. All those who had some orientation training responded that the orientation had helped in improving on their teaching as shown on Table 4.12.

Table 4.12 Percentage Response to how Orientation had helped in chemistry teaching.

Response	Percentage (n=24)
The orientation helped me in making chemistry real to students by teaching it practically	66.7
The orientation improved my knowledge of the 'A' level topics	8.3
The orientation helped me in making my teaching more interesting and easy	25.0

4.2.3. Curricula Materials and facilities for implementing curriculum

A major index of installation is the provision of adequate resources to implement a programme, thus the study looked into availability of relevant resources.

Table 4.13 Teachers response on type of Curriculum used for Chemistry teaching

Curriculum in use	Frequency	Percentage
The National Curriculum	50	89.3
West African School Certificate Examination syllabus	6	10.7
Total	56	100.0

All the teachers used the new curriculum, but while the large proportion made use of the teaching curriculum, about one-tenth indicated use of the examination syllabus.

Table 4.14 Students Response to "Possession of Chemistry Curriculum"

Response	SS 1 n =160	SS 2 n =160	SS 3 n =160	Total n = 480
Yes	31.2	37.5	66.2	45.0
No	67.5	61.2	32.5	53.7
Not Recorded.	1.3	1.3	1.3	1.3

Less than half of the students at the lower classes indicated having chemistry syllabus or curriculum. However, the situation seemed different at the final year class where about two-thirds of the students indicated the possession of a syllabus.

Table 4.15 Reasons for not having Curriculum/Syllabus

Reasons	SS 1	SS 2	SS 3	Total
Was not given a copy	16.7	32.7	30.8	25.6
Don't know how to get it	16.7	26.6	7.7	18.6
Too expensive	25.9	30.6	53.8	33.3
Not recorded	40.5	10.2	7.7	22.5

Nearly half of those who had no curriculum had no idea of how to go about getting it. About one-third responded that it was too expensive.

Table 4.16 Percentage of students with Chemistry Text Books

Response	SS 1	SS 2	SS 3	Total
Yes	75.0 (60)	87.5 (70)	95.0 (76)	85.8 (206
No	25.0 (20)	7.5 (6)	3.7 (3)	12.1 (29)
Not recorded	-	5.0 (4)	1..3 (1)	2.1 (5)

85.8% of the students affirmed that they had chemistry textbooks, with the proportion increasing in progression as the class. This finding is buttressed in part by that of table where half of the teachers indicated that the textbook guided their teaching most of the time.

Table 4.17 Teachers Responses on adequacy of equipment for teaching chemistry

Response	Percentage
Very adequate	28.6
Fairly adequate	50.0
Not adequate	21.4

Half of the respondents indicated that they had fairly adequate equipment for teaching chemistry while about two-fifths (21.4%) considered their equipment as not adequate. A listing of chemistry apparatus and facilities that teachers indicated as not available in the schools are displayed in Table 4.18.

Table 4.18 List of Equipment/major Facilities not available in the schools

Work gas connection/Burners
Fume chamber/oven/furnace
Weighing balance
Liebig condenser/Reflux condenser
Kip's Apparatus
Reagent bottles/Test tubes
Furniture
Desiccators
Running tap/Sink basin
Burettes
Melting point apparatus
Detachable models
Consumable chemicals
Fire extinguisher
Laboratory Attendants.

Table 4.19 is a record of the analysis of school visits made by the NERDC and the Implementation Committee on the 6-3-3-4 system .The summary of the record of available and unavailable facilities in 60 schools spread all over the geopolitical zones are shown. The findings show that although the laboratories were available in most of the schools visited, three-quarters of the available laboratories were found to be inadequate. Few of the schools had no library while over half of those available were not adequately furnished and lacked current books. The situation is similar for teachers in the schools. Only few (35%) of the schools had adequate teachers in terms of quantity and training

Table 4.19 Situation of facilities available in the schools.

Facility	Number and percentages of schools where facilities are		
	Not available n=60	Adequate n=60	Inadequate n=60
Chemistry Laboratory	11 (18.33)	12 (20.0)	37 (61.6)
Library	10 (16.7)	24 (40.0)	26 (43.3)
Teachers	10 (16.7)	21 (35.0)	29 (48.3)

4.3.0. Process Evaluation

To what extent do the implementation processes comply with that laid down for the curriculum?

Having looked into the design and installation of the curriculum, the next aspect examined was the process or implementation of the curriculum in the schools. This involved looking at the actual situation in the schools, including examination of the class size , time tabling, teacher's workload, coverage of course content, method of teaching and assessment practical activities carried out by students and other issues of implementation. This section presents the results obtained in evaluation of the curriculum process in the schools.

4.3.1. Assessment of Chemistry Classrooms

Structuring of instruction and class size are part of implementation procedures for successful execution of curriculum in the schools. Tables 4.20 and 4.21 show the findings on these aspects.

Table 4.20.Teachers Response on Average Chemistry Class Size

Number of students in each class	Frequency	Percentage
Less than 40 students	2	3.6
Between 40 and 50 students	34	60.7
Between 50 and 60 students	14	25.0
Over 60 students	6	10.7
Total	56	100.0

The common average class size in the survey was between 40 to 50 students as indicated by about three-fifths of the respondents. This class size is large for a guided -discovery curriculum.

Table 4.21. Percentage Distribution of Chemistry Teachers By Classes taught

Class	No. of Teachers	Percentage
SS 1 only	4	7.1
SS 2 only	8	14.3
SS 3 only	4	7.1
SS 1 and SS 2	4	7.1
SS 1 and SS 3	8	14.3
SS 2 and SS 3	8	14.3
SS 1, 2 and 3	28	50.0
Total	56	100.0

Exactly half the number of teachers indicated that they teach all the senior secondary classes. This is likely to be a positive state of affairs for continuity of the teaching of the course content.

Table 4.22 Number of Chemistry Periods taught in a Week

No. of periods	Frequency	Percentage
Three	5	8.9
Four	28	50.0
Six	2	3.6
Eight	3	5.4
Nine	18	32.1
Total	56	100

A little over half (58.9%) of the teachers taught between three to four chemistry lessons in a week while nearly one-third taught up to nine periods per week.

Table 4.23 Number of Chemistry Lessons per Week

No. of Lessons	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
One lesson	12.5(20)	-	1.3 (6)	5.5 (26)
Two lessons	16.3(26)	5.0 (8)	11.2 (18)	10.8 (52)
Three lessons	17.5(28)	26.3 (42)	21.3 (34)	21.7 (104)
Four lessons	53.7(86)	63.7 (102)	60.0 (56)	59.2 (284)
Five lessons	-	5.0 (8)	3.7 (6)	2.9 (7)

Over half (59.2%) of the students had four lessons of chemistry a week, one-fifth (20.7%) had three lessons and about one-tenth (5.5%) of the students had only one lesson of chemistry. A very low percentage (2.9%) had up to eight lessons a week. The highest percentage (63.6%) of the students with four lessons per week was in the SS2 class.

Although it would have been expected that students in the higher classes be exposed to a greater number of lessons per week

Table 4.24 Average Time spent on each Lesson

Average time	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
30-34 minutes	1.3 (2)	13.7 (22)	3.8 (6)	6.2 (30)
40-45 minutes	81.3 (103)	78.7 (126)	76.2 (122)	78.7 (318)
Above 50 minutes	17.0 (28)	7.5 (12)	20.1 (32)	14.9 (72)

Majority of the respondents (78%) spent about three quarters of an hour on each lesson. This is an adequate time for a science lesson of one period. If this time were to be multiplied by the average number of lessons per week in Table 4.23, it would appear that ample time is allotted for chemistry lessons.

Table 4.25 Percentage response on nu.nber of practical lessons done per week

No. of Practical work	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
None	60.0	67.5	30.0	52.5
1	22.5	20.0	33.7	25.4
2	17.5	7.5	31.3	18.7
3	-	3.7	2.5	2.1
4	-	1.3	2.5	1.3

Over half (52.5%) of the respondents indicated that they had no practical lessons in the week. This is made up largely of the SS 1 and SS 2 students and less than one-third of the respondents in SS 3. About one-third (33.7%) of the respondents in SS 3 had one practical lesson while a little less than one-third (31.3%) had two practical lessons in the week. Overall about one-fifth of the respondents had one or two practical lessons in the week. This load of practical work appears grossly inadequate for a guided -discovery oriented curriculum.

Table 4.26 Period when Practical Lessons were started

Period	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
1st term	41.2	33.7	12.5	29.2
2nd term	8.8	7.5	26.3	14.2
3rd term	15.0	10.0	21.3	15.4
Not Recorded	35.0	48.8	40.0	41.2

About half of the respondents who indicated that practical work had been started remarked that they started in the first term. An appreciable proportion (41.2%) of these started as early as first term of SS 1 class. Over two-fifths (41.2%) of the respondents however did not record any response probably indicating that practical work had not commenced in their school. More than a third of this category (40.0%) was in SS 3. This finding agrees with that obtained from Table 4.32 where more than three-quarters (76.5%) of the SS3 students indicated that practical work was not done at all.

Table 4.27 Teachers' responses on other subjects taught

Subjects taught	Frequency	Percentage
None	16	28.6
Mathematics only	12	21.4
Integrated Science only	8	14.3
Biology only	4	7.1
Integrated Science and Biology	4	7.1
Integrated Science and Agricultural Science	4	7.1
Integrated Science and Mathematics	2	3.6
Integrated Science and Physics	2	3.6
Biology and Mathematics	2	3.6
Physics and Biology	2	3.6
Total	56	100.0

4.3.2. Chemistry lessons and practical work

The conduct of theory lessons and practical work are crucial to proper implementation of an activity-oriented curriculum. The results of the observation of chemistry practical lessons and responses to questions asked on the practical aspects of the curriculum are displayed in the tables 4.28 to 4.33

Observed activities of teachers and students

Table 4.28 shows the summary of the types and frequencies of activities engaged in by both the teachers and students. The percentage of observed teachers and students activities during lessons is shown in figure 4.2.

Table 4.28 Percentage frequencies of teachers' and students' observed activities during classroom lessons

Activity	Frequency of occurrence of activity	Percentage
TALK AND ACTIVITY INITIATED AND/ OR MAINTAINED BY TEACHER		
1a Teacher asks questions (or invites comments) which are answered by :		
a1 recalling facts and principles	127	20.2
a2 applying facts and principles to problem solving	37	6.0
a3 making hypothesis or speculation	17	2.7
a4 designing of experimental procedure	8	1.2
a5 direct observation	19	3.0
a6 interpretation of observed or recorded data	16	2.5
a7 making inferences from observations or data	11	1.8
Teacher makes statements:		
b1 of fact and principle	194	30.9
b2 of problems	27	4.3
b3 of hypothesis or speculation	2	0.3
b4 of experimental procedure	33	5.3
1c Teacher directs pupils to sources of information for		
c1 acquiring or confirming facts or principles	30	4.8
c2 identifying or solving problems	7	1.1
c3 making inferences, formulating or testing hypotheses	1	0.2
c4 seeking guidance on experimental procedure	9	1.4
TOTAL	538	85.7
2.TALK AND ACTIVITY INITIATED AND/OR MAINTAINED BY PUPILS		
Pupils seek information or consult for the purpose of:		
d1 acquiring or confirming facts or principles	22	3.5
d2 identifying or solving problems	2	0.3
d3 making inferences, formulating or testing hypotheses	-	-
d4 seeking guidance on experimental procedure	18	2.9
Pupils refer to teacher for the purpose of:		
e1 acquiring or confirming facts or principles	34	5.4
e2 seeking guidance when identifying or solving problems	4	0.6
e3 seeking guidance when making inferences, formulating or testing hypothesis	1	0.2
e4 seeking guidance on experimental procedure	9	1.4
TOTAL	90	14.3

Figure 4.2 Percentage of teachers' and students' activities during lessons

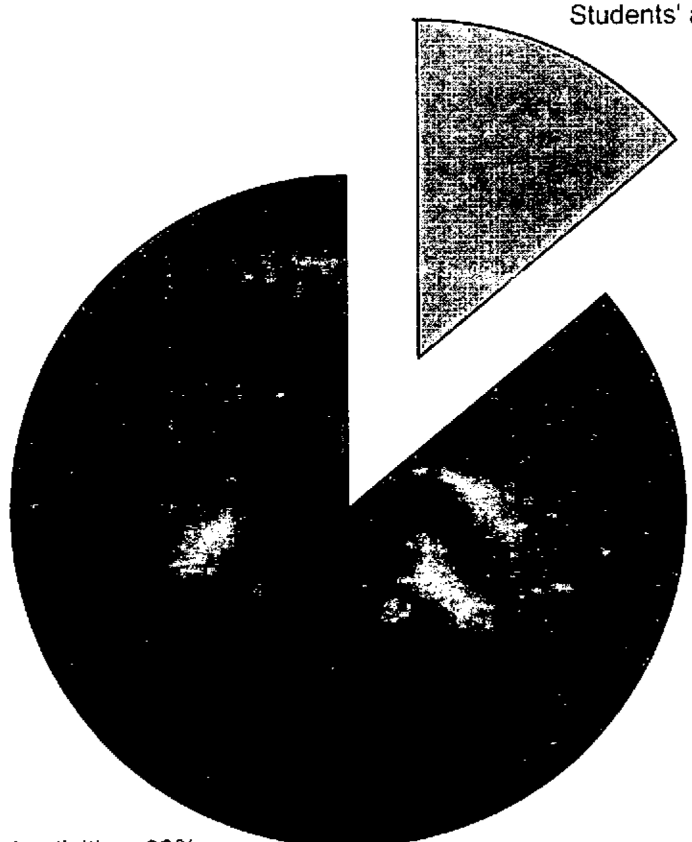


Figure 4.2 Percentage of teachers and students activities

The classrooms observed were found to be dominated by teacher- initiated activities (85.7%). Teacher talk in form of questions and statements were predominant in all the lessons observed. Teachers' statements of fact and principles were the most highly recorded activity (30.9%), this is followed by teacher questions requesting for recall of facts and principles (20.2%). Only very minute fraction of the lesson time (8.8%) was used for directing students to sources of information. Student initiated activity was noticed in only about two-fifths (26.5) of the lesson time and this was mainly for the purpose of seeking information from the teacher. Of all the student-initiated talk and activity (14.3%), student reference to the teacher for the purpose of acquiring facts and principles occurred most (5.4%), closely followed by student consultations for the purpose of acquiring or confirming facts and principles(3.5%). There was no consultation or search for information for making inferences, formulating or testing hypotheses in all the lessons observed. This situation is not appropriate for a guided-discovery student activity-oriented curriculum.

Students' and teachers' activities during practical lessons

The activities carried out by both teachers and students were observed during practical lessons. Table 4.29 shows the occurrence of activities during the lessons. Most of the activities engaged in by the teachers included stating objectives, giving information, instructing, responding, demonstrating, summarising and discussions which are related to teacher talk. Two activities, responding to students' questions and checking students' work were found to be absent.

Students' activities included listening, giving information, carrying out teachers' orders and discussion of results , all of which are passive activities as far as science is concerned . Such processes of science activities as designing experiments, hypothesizing, analysing and interpreting data. Writing reports and asking questions were found to be absent.

Table 4.29 Tally of teachers' and students' observed activities during practical lessons

Teacher Activity	Student Activity
Stating objectives Y	Listening Y
Giving information Y	Giving information Y
Instructing, directing, ordering students Y	Devising experiments X
Writing notes on the chalkboard Y	Hypothesising X
Dictating notes to the students Y	Setting up of experiments X
Eliciting information (asking questions) Y	Analysing and interpreting data X
Setting up experiments Y	Recording of experiments Y
Demonstrating experiments Y	Writing of reports X
Responding to students' questions X	Copying notes from textbooks X
Checking students' work X	Asking questions X
Summarizing of work done Y	Carrying out teachers instruction Y
Discussion of results Y	Discussion of results Y

Note: Only the occurrence of each activity and not the frequency are indicated by a Y. Non-occurrence of activity is indicated by an X

Students' responses on practical work in the curriculum

Students were requested to indicate whether they had done the experiments prescribed in the curriculum and to indicate whether the experiments had been done individually, in group or done by the teachers. Tables 4.30 to 4.32 show the responses for SS1 to SS3 classes and table 4.33 shows the total responses for all the experiments. Figure 4.3 is a chart of the total responses on mode of doing practical work.

Table 4.30 Percentage Response on Mode of doing Practical work by topic in SS 1.

(no =160).

Experiment	Work not done	Done individually	Done in group	Done by Teacher
1.Simple separation of mixture	38.7	8.8	21.3	31.2
2.Separation of impure crystalline salts	75.0	2.5	2.5	20.0
3.Colour separation using filter paper	45.0	2.5	20.0	32.5
4.Making models of atoms with clay and sand	70.0	1.3	21.3	7.5
5.Burning of Magnesium in a jar of oxygen	61.2	1.3	26.3	11.2
6.Experiment on Law of conservation of matter	57.5	6.2	20.0	16.3
7.Experiment on Law of constant composition	68.7	1.3	20.0	10.0
8.Experiment on Law of multiple proportion	65.0	1.3	20.0	13.7
9.Testing properties of compounds in solvents	70.0	-	1.3	28.7
10.Test on conductivity of Ions in solution	72.5	1.3	1.3	25.0
11.Experiment on Temperature- Volume relationship of gas	97.4	1.3	-	1.3
12.Experiment on Diffusion of Gases	91.2	-	-	8.8
13. Reactions, Acids, Bases and Salts	61.2	2.5	25.0	11.2
14. Preparation of Salts	72.5	2.5	22.5	2.5
15.Demonstration of Efflorescence Deliquescence and hygroscopy	76.2	1.3	18.7	3.7
16.Experiment on properties of Carbon	77.5	1.3	20.0	1.3
17.Experiment to show that charcoal absorbs gases	78.7	1.3	18.7	1.3
18.Experiment on carbon as a reducing agent	71.2	1.3	18.7	8.8
19.Experiment on oxidation of carbon monoxide	78.7	2.5	16.3	2.5
20. Preparation of Carbon monoxide	96.2	1.3	-	2.5
21.Preparation of C02 from local materials	96.2	2.5	-	1.3
22.Fractional distillation of crude oil	91.2	-	-	8.8
23.Preparation of soap, Cosmetics, Alcohol	71.2	-	2.5	26.3
Total	71.2	2.5	14.3	12.0

Table 4.31 Percentage of Students Response on Mode of Practical Work in SS 2

Experiments	Work not done	Done individually	Done in group	Done by teacher
1.Analysis of chlorides and metallic oxides	93.7	1.3	2.5	2.5
2.Investigation of Electrolysis	92.5	-	1.3	6.2
3.Preparation of standard solutions for titrations	91.2	3.7	2.5	2.5
4.Determination of percentage point of substances	90.0	-	3.7	6.2
5.Determination of heat of neutralization	88.8	1.3	6.2	3.7
6.Exothermic & Endothermic reactions	82.5	2.5	2.5	12.5
7.Changes in heat energy	82.5	3.7	1.3	12.5
8.Chemical Equilibrium	86.2	2.5	1.3	10.0
9.Preparation of oxygen	77.5	-	6.2	16.3
10.Preparation of H_2 O_2	81.2	1.3	8.8	8.8
11.Preparation of Sulphur (iv) oxide	80.0	1.3	6.2	12.5
12.Determination of H_2.1m solution of electrolytes	88.8	2.5	3.7	5.0
13.Action of water on Calcium	87.5	1.3	6.2	5.0
14.Test for Chlorides	87.5	3.7	3.7	5.0
15.Det. of solubility of HCL in H2O & org. solvents	88.7	1.3	3.7	6.2
16.Preparation of Nitrogen	85.0	2.5	5.0	7.5.
17.Preparation of Ammonia	62.5	3.7	5.0	28.8
18.Preparation of Ammonia tetra-oxosulphate VI	85.0	2.5	3.7	8.8
19.Test for Nitrate	86.2	5.0	3.7	5.0
20.Preparation of sulphur and compounds	86.2	3.7	2.5	7.5
21.Preparation of Alkenes and alkynes	82.5	2.5	3.7	11.2
22.Test for acidity and phenols	88.7	5.0	2.5	3.7
23.Preparation of Alkanols	88.7	1.3	1.3	8.8
Total	85.1	2.5	3.8	8.6

A larger proportion ranging (57%) from half to over nine-tenths (97.4%) of the students in the S.S1 class indicated that they had not done twenty-one of the twenty-three prescribed experiments for this class. Only two experiments simple *separation of mixtures* and *colour* *separation using filter paper* were done by more than three-fifths of the students. Of those experiments undertaken, the majority responses indicated that most of the experiments were done in group while the teacher also dominated carrying out of some experiments.

The same trend as witnessed from the SS 1 respondents also applied here, with 76.5% over respondents indicating that the practical work had not been done. This further serves to buttress the information obtained from Table 4.26 where over half of this group indicated that experiments had not been done at all. However, of the experiments carried out by this class, it appeared that teacher demonstrations as opposed to group or individual work predominated.

The Table 4.32 shows that only on two experiments did less than two-thirds of the respondents indicate that the experiment were not done, over two-thirds of the SS 3 students indicated not having done twelve of the fourteen experiments prescribed for this class. The larger proportion of the experiments done were also teacher demonstrated.

Table 4.32 Students Percentage Response on Mode of doing Practical work in SS 3

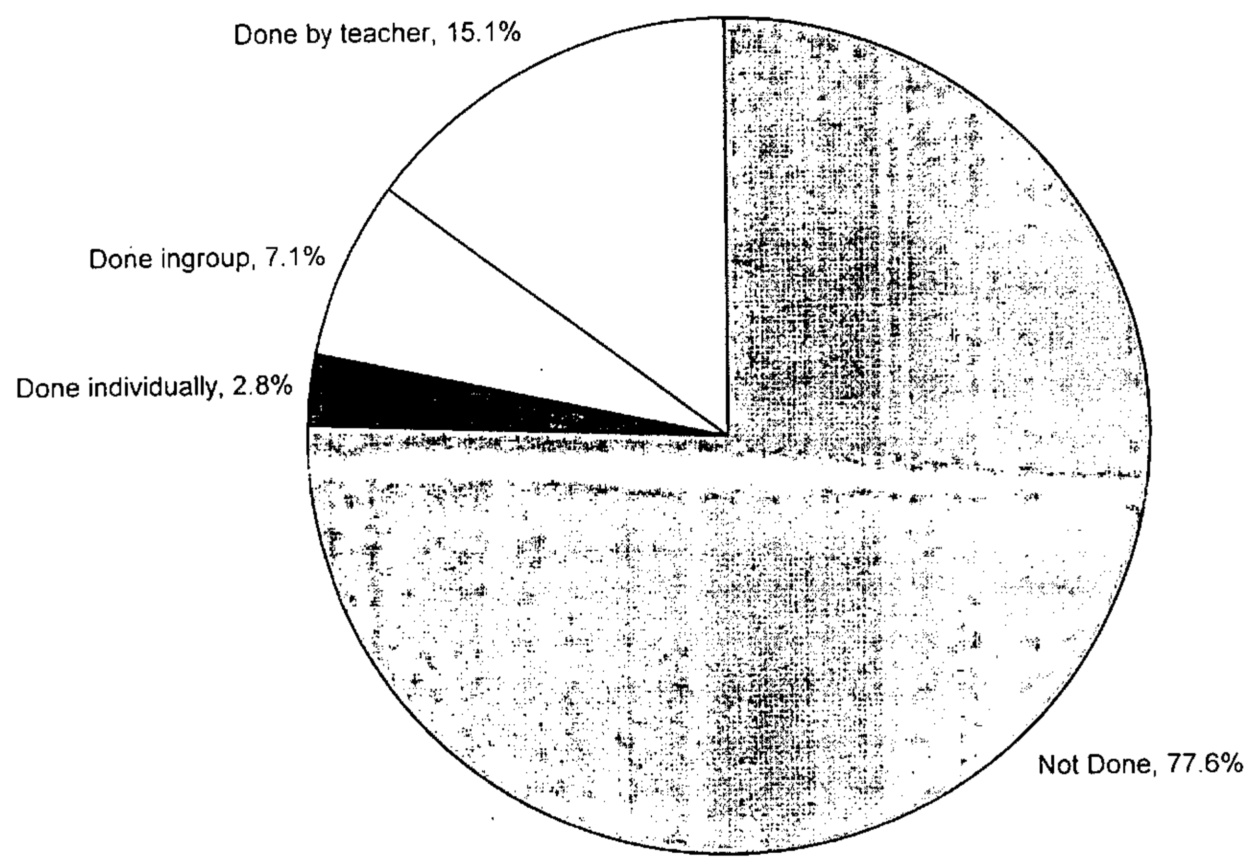
(n =160)

Experiments	Practical not done	Work done individually	Work done in group	Done by teacher
1. Action of powdered charcoal on metallic oxide	97.5	-	-	2.5
2..Properties of sodium compounds	85.0	-	1.3	13.7
3..Properties of Calcium	82.5	1.3	-	16.3
4..Preparation of Aluminium hydroxide	81.2	1.3	-	17.5
5.The brown ring test	58.7	7.5	8.8	25.0
6..Preparation of anhydrous (III) chloride	78.7	3.7	1.3	16.3
7.Rusting of Iron	67.5	7.5	2.5	22.5
8.Experiment of corrosion of Iron nail in agar mixture	80.0	5.0	5.0	10.0
9..Preparation of alkanoic acids	73.7	1.3	2.5	22.5
10 .Preparation of alkanoic	77.5	1.3	2.5	18.7
11.Separation of components of proteins	87.5	2.5	2.5	7.5
12.Preparation of polymers	80.0	1.3	1.3	17.5
13.Hydrolysis of carbohydrates to simple sugars	77.5	1.3	2.5	18.5
14.Simple test on starch sugar, fat and protein	58.7	7.5	5.0	28.8
Total	76.5	3.4	3.2	16.9

Table 4.33 Total percentage students' responses on practical work

Class	Not done	Individually	In group	By teacher
S.S.S.1	71.2	2.5	14.3	12.0
S.S.S 2	85.1	2.5	3.8	8.6
S.S.S 3	76.5	3.4	3.2	16.9
Overall	77.6	2.8	7.1	12.5

Figure 4.3 Total percentage response on mode of doing practical work



.3 Percentage students' responses on mode of doing practical work

In order to corroborate students' responses on the prescribed practical work, questions were asked on the source and mode of doing class experiments. The students' responses are presented on tables 4.34 and 4.35

Table 4.34 Students' responses on mode of doing class experiments

Mode of doing experiment	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
By selves in groups or individually	30.0	15.0	37.5	27.5
Teacher does experiments students watch	36.3	28.8	40.0	35.0
Experiment read, teacher explains but not done	33.7	56.2	22.5	37.5

This table shows that a large proportion of the students read about experiment, but never performed the experiment. Over one third (35.0%) of the students watched their teachers performing the experiments while they watched and only about one quarter (27.5%) indicated that experiments were performed by them in groups or individually.

Table 4.35 Percentage student response on source of experiments done in class

Source of experiments	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
Some experiments suggested by students	11.2	16.3	8.8	12.1
No experiments suggested by students	32.5	42.5	25.0	33.3
All experiments suggested by teacher	56.2	41.2	66.2	54.5

Over half (54.5%) of the experiments performed were suggested by the teacher. One third (33.3%) of the students indicated that they had never tried out experiments on student ideas while about one tenth (12.1%) of the students said that they had done some experiments suggested by students.

Students' responses on project work in the curriculum

Projects are avenues for independent investigative activities by students. A total of 12 projects are prescribed in the curriculum. Students were requested to indicate whether or not these projects were done and how they were done. Table 4.36 shows students' responses.

Table 4. 36 Percentage students' responses on project done and mode of doing projects

(n=480)

	Project not done	Individually	Done in group	Project done by teacher
1.Literature project on nomenclature in chemistry	80.4	6.7	0.8	12.1
2.Literature project on biographies of chemists	84.6	2.9	0.4	12.1
3.Literature project on mineral ores in Nigeria	87.9	1.3	1.3	9.5
4..Preparation of carbon dioxide from locally available materials	90.0	1.7	3.3	5.0
5.Collection of printed materials on oil exploration in Nigeria	95.4	0.4	0.4	3.8
6.Collection and distribution of several samples of crude oil	90.4	2.1	3 .3	4.2
7.Collection and distribution of different samples of locally made alcohol	93.3	1.7	1.7	3.3
8.Electrolytic experiments using tins from cans and electrode	90.8	1.7	0.8	6.7
9.Titration using extracts of flowers as indicators	92.1	2.9	2.5	2.5
10.Titration with water from different sources as solvent	88.3	5.0	3.3	3.3
11.Analysis of rock samples	91.6	2.1	1.7	4.6
12. Analysis of samples of ores.	93.7	2.1	1.3	2.9
Total	89.9	2.6	1.7	5.8

About nine-tenths (89.9%) of the students responded that they had not done the twelve projects (5.8%) prescribed in the curriculum. Of the remaining one-tenth, projects done by the teacher were preponderant (5.8%) while very small proportion (2.6%) were engaged in individually done project works. Students' responses on source of projects are shown on table 4.37.

Figure 4.4 Percentage response on mode of doing project work

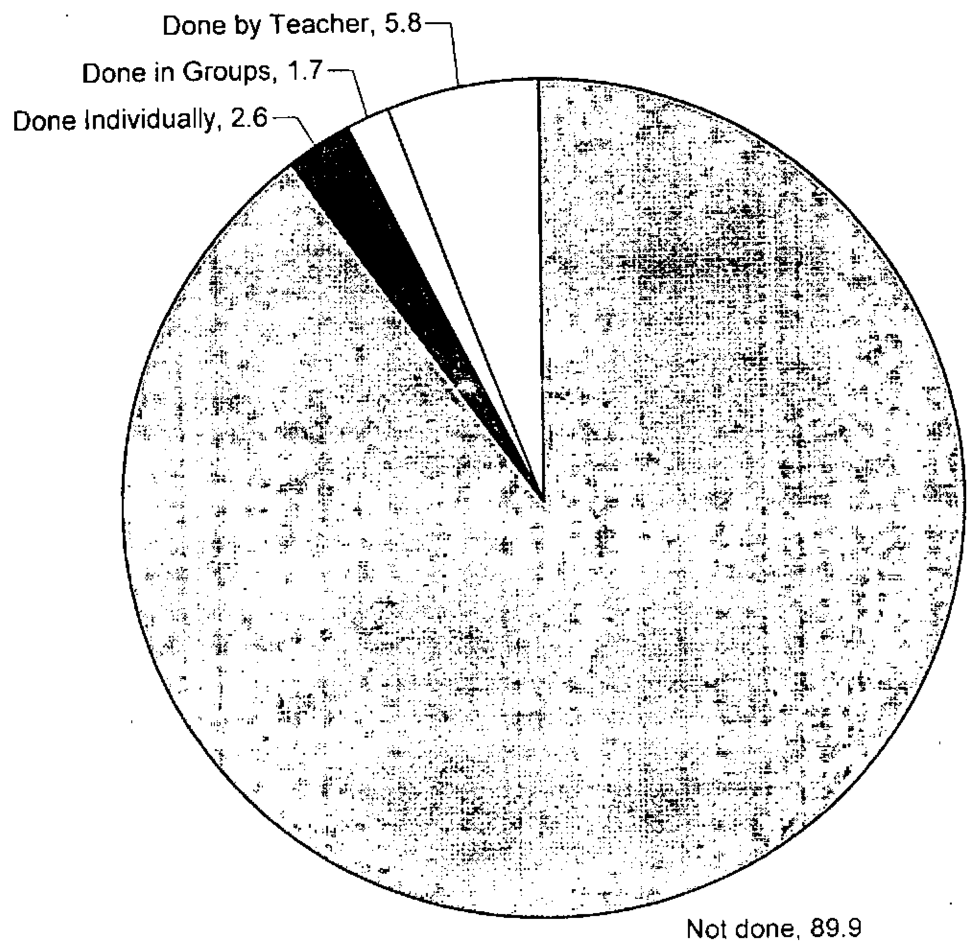


Figure 4.4 Percentage student response on mode of doing project work

Table 4. 37 Percentage Response to Source of Chemistry Projects

Source of Project	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
Teacher suggests chemistry project and explains how to do them	27.5	20.0	31.2	26.2
Students choose projects and teacher assists with difficulties	25.0	3.7	11.2	13.3
No chemistry projects done	47.5	76.2	57.5	60.4
Total	100.0	100.0	100.0	100.0

About three-fifths (60.4%) of the students indicated that they had not done any projects at all, while about one quarter(26.2%) responded that the teachers suggested the projects done. More than half of the SS 3 students (57.5%) and over three-quarters (76.2%) of the SS 2 students made this response. The table also shows that a very tiny fraction however allow students to choose projects, the longest proportion being from the SS 1 class.

Classroom transactions and Students' Perception of chemistry lessons

Questions were asked on source of chemistry ideas, acquisition of skills and students' attitude towards their chemistry lessons. The responses are presented in the following tables.

Table 4.38 Students Response on source of Chemistry Ideas

Source	S.S.1	S.S.2	S.S.3	Total
Text book	37.5	55.0	52.5	48.3
Teacher	40.0	27.5	32.5	33.3
Classroom activities	22.5	17.5	15.0	18.3
Total	100.0	100.0	100.0	100.0

Source of chemistry information and ideas is weighted on the side of the textbook with nearly half of all the respondents indicating so. The teacher ranked highest as a source of chemistry ideas for a third of the respondents while the classroom activities were identified by less than one-fifth of the students. This trend is reversed at the SS 1 level, which is understandable as this is a beginning stage. It is surprising however that the trend towards textbook is more pronounced at the SS 2 level and reduced at the SS 3 level perhaps because the students were anxious about their final examination.

Asking of questions is one of the scientific skills which aid the process skill of generating hypothesis. Both skills are inherent in the guided discovery approach. Students' responses to the issue of questioning are displayed in table 4.39.

78.8% of the respondents expressed their freedom to ask questions in class, indicating the existence of an atmosphere conducive for generating the scientific attitude. However, a small fraction (19.2%) of the students indicated their reluctance to ask questions in class. This proportion was highest at the SS 3 level (21.3%) perhaps showing these students felt that they knew much of what they needed to know already.

Table 4.39 Percentage response of students to statements on asking questions

Statement on students' freedom to ask questions	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
Free to ask questions	81.2	79.0	75.0	78.7
Does not like to ask questions	18.8	17.5	21.3	19.2
Teacher does not like questions	-	2.5	3.7	2.1
Total	100.0	100.0	100.0	100.0

Table 4.40 Students' Response to "Freedom of Holding Opinion."

Statement of opinion	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
Teacher is always right	31.3	23.8	37.7	30.8
Have different ideas about topic but reluctant to express them	22.5	35.0	31.3	29.6
When ideas are different, teacher allows discussion in class	46.2	41.2	31.3	39.5
Total	100.0	100.0	100.0	100.0

Less than one-third (30.8%) of the respondents felt that the teacher was always right. This finding is in agreement with that on Table 4.38 where about a third of the students said they got all their ideas about chemistry from the teacher. However, there were about two-fifths (39.6%) of the students who were allowed freedom to express or hold different opinions to that of the teacher. The discussion of such ideas and opinion are likely to promote the spirit of enquiry and rising of questions.

Students' enjoyment of their chemistry lesson was deemed to be an indication of positive attitude to the subject, hence students were asked to indicate their enjoyment or otherwise of their chemistry lessons.

Table 4.41 Percentage Distribution of Students' responses on enjoyment of Chemistry Lessons By Class

Do you enjoy your chemistry lessons?	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
Yes	98.7	97.5	96.2	97.5
No	1.3	2.5	3.7	2.5

Nearly all the students indicated enjc ment of their chemistry lessons and only 2.5% dissented.

Table 4.42 Students' Enjoymen of Chemistry Lessons

Response	SS 1 n=160	SS 2 N=160	SS 3 n=160	Total n=480
Chemistry lessons are fun	87.5	97.5	100.0	95.7
I would rather be doing something el:	12.5	2.5	-	5.0
Total	100.0	100.0	100.0	100.0

A large majority (95.7%) of the res ondents felt that the chemistry lessons were fun to do. Only a minute fraction (5.0%), mad up largely of students in their first year of the senior secondary school, felt that they would rather be doing something else.

Table 4.43 Students responses to Aspect of Chemistry Course most liked

Aspects of chemistry	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
Class work	20.0	13.8	12.5	15.4
Class activities	7.5	23.8	21.3	17.5
Laboratory work	3.8	15.2	20.0	12.9
Performing experiment	22.5	20.0	36.2	26.2
Solving problems	20.0	18.7	3.7	14.2
Visits to places of interest	2.5	3.7	1.3	2.5
Homework/Assignment	6.2	3.7	3.7	4.6
Project work	3.8	-	-	1.3
Not Recorded	13.7	1.3	1.3	5.4
Total	100	100	100	100

Performing experiment was the aspect of chemistry most liked by students with over a quarter (26.2%) indicating for it. Class activities and class work ranked second and third, followed by solving of problems. Students were also requested to indicate the aspect of their chemistry course most disliked. Their responses are presented in table 4.44. Solving of problems recorded the highest response of about one quarter (25.4%), followed by project work (22.5%). Reasons adduced for dislike of the aspect of the course include, difficulty in solving problems and insufficient explanation by the teacher.

Table 4.44 Students Responses to Aspects of Chemistry Course disliked

Aspect of chemistry disliked	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
Activity class work	6.2	13.7	16.2	8.7
Class activities	-	-	3.7	1.3
Laboratory work	-	2.5	2.5	1.7
Performing experiment	13.7	5.0	3.7	7.5
Solving problems	25.0	25.0	26.3	25.4
Visit to places of interest	11.2	5.0	7.5	7.9
Homework/Assignment	3.7	3.7	7.5	7.9
Project work	20.0	28.7	18.7	22.5
None	2.5	-	2.5	1.7
Not Recorded	17.5	15.0	20.0	17.5

Table 4.45 Students' reasons for dislike of aspect of chemistry course

Reasons	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
No good teacher	12.5	-	2.5	5.0
No relevant to the course I need	6.2	2.5	-	2.9
Difficult in solving problems	7.5	20.0	17.5	15.0
Teaching not clear enough	18.7	7.5	3.7	10.0
Chemistry is supposed to be done in the laboratory	6.2	10.0	7.5	7.9
It is boring and takes a lot of time	22.5	27.5	36.2	28.7
It is not done in School	-	10.0	1.3	3.7
No reason given	23.8	17.5	15.0	18.7
Dangerous to handle	-	1.3	-	0.4
Likes all aspect of chemistry	2.5	3.7	16.3	7.5

One of the factors which aid students' learning is relevance or application of school experience to their daily life experiences. Students were asked to respond to some statements on this. Table 4.46 shows students' response.

More than half (52.9%) of the students indicated that real life problems were tackled in their chemistry classes while a quarter (25.8%) indicated that such problems were never discussed in their chemistry classes; about one fifth indicated that they had never tried to solve any real life problems in their chemistry classes. The SS 3 class had the highest percentage response (65.0%) on the solution of real life problems in class; this is understandable because most topics at this level are real life -oriented.

Table 4.46 Students response on relevance of school chemistry to real life problems

Relevance of chemistry	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
Real life problems solved in chemistry classes	41.2	52.5	65.0	52.9
Never tried solving real life chemistry problems in class	26.3	20.0	17.5	21.3
Real life problems never discussed	32.5	27.5	17.5	25.8

Over half (52.9%) of the students indicated that real life problems were tackled in their chemistry classes while a quarter (25.8%) indicated that such problems were never discussed in their chemistry classes; about one fifth indicated that they had never tried to solve any real life problems in their chemistry classes. The SS 3 class had the highest percentage response on the solution of real life problems in class, this is understandable because most topics at this level are real life - oriented.

Teachers' methods and factors guiding teaching

The teachers were asked to indicate the methods used in their teaching and the frequency of use of each method. In table 4.47 the questioning method was most frequently used by majority (71.%) of the teachers. This is supported by the evidence obtained from the classroom observation where teachers' question was one of the frequent activities of the teacher. The use of textbook is also highly frequent(46.4%). The use of lecturing method was also favoured by more than two fifths (42.9%) of the teachers. This state of affairs was also observed in the classrooms visited. Teachers were also asked about factors guiding their teaching.

Table 4.47 Percentage teachers' response on frequency of use of teaching methods

Method used	Rarely	Sometimes	Frequently
Text book	32.1	21.4	46.4
Small group work	25.0	53.6	21.4
Lecturing	21.4	35.7	42.9
Questioning	-	28.6	71.4
Discussion	14.3	46.4	39.3
Students copying from textbook	82.1	17.9	39.4
Student making own notes during lesson	53.6	35.7	10.7
Field trips or special projects	60.7	35.7	3.6
Schools Radio/TV programs	85.7	14.3	-
A.V. materials (films, slide, video)	96.4	3.6	-
Industrial visits	78.6	21.4	-

Table 4.48 Percentage teachers' response on frequency of use of factors guiding teaching

Factors guiding teaching	Most of the time	Sometimes	Never
Senior School Certificate Examination Questions	71.5	28.5	-
WAEC's Chief Examiners Report	21.4	39.3	39.3
Students' Interests	42.8	28.6	28.6
Contemporary Events	25.0	46.4	28.6
Text books	50.0	39.3	10.7
Others	14.3	25.0	60.7

From table 4.48, about three-quarter (71.5%) of the respondents were guided by the SSSCE past questions while half (50.0%) indicated use of textbooks most of the time. However less than one quarter (21.4%) made use of the Chief Examiner's report in spite of using the SSSCE questions as guide.

The text book appeared to have a formidable influence on the teaching and learning of chemistry in the schools. The use of textbook topped the list of the most frequently used method of teaching adopted by the teachers. It was therefore considered important to examine the textbooks being used by teachers and students. As noted earlier, the curriculum was not accompanied by textual materials tailored directly to the dictates of the curriculum.

The teachers and students were requested to mention two textbooks commonly used for chemistry. A list of the textbooks used was compiled. Table 4.49 shows the twelve textbooks mentioned in order of the most frequently used to the least frequently used. The most popular textbook is authored by Ababio (2001). This book was also the most used by students from Osokoya's (1997) study of readability of chemistry textbooks in Oyo state. The reasons mentioned for choice of the textbooks as displayed on table 4.51 were also similar to those of Oshokoya (1997).

Table 4.49 Textbooks used in descending order of popularity of use.

List of Chemistry Textbooks Used	Author and Publisher
1. New School Chemistry	O. Y. Ababio, (2001), African First. Publ. Ltd
2. Chemistry for S.S.S.	STAN, (1989).Heinemann Educ. Books.
3. Comprehensive chemistry for SSS	J. Ezechukwu, (1999) Ajohn Publishers, Lagos
4 A New Certificate Chemistry	A. Holderness, Longe, E.I, Ikeobi, I.O& J.J. Thompson (1978). Heinemann Educ. Books.
5.Count-down to SSCE Chemistry	I.O.Uche, I.J Adenuga & Iwuagwu, S.L (1990). Evans Bros. Pub.Ltd.
6. Senior Secondary Chemistry	S.T.Bajah, B.O. Teibo, G. Onwu & A. Obikwere (1992).Longman.Nig. Plc.
7.Comprehensive Certificate chemistry	G.N. Ohia, G.I. Amasiatu & Ajagbe, J.O.(1997) University Press Plc. Ibadan
8.Chemistry: A New certificate approach	S.T. Bajah, and A. Godman (1988) Heinemann Educ. Books
9. SSS Chemistry - CESAC	CESAC (1982) .Heinemann Educ. Books
10. Concise Text in Chemistry.	D. Gravie, J. Hughes, J. Reid & A Robertson(1979) Oxford University Press

Table 4.50 Reasons for choosing Textbooks

Reasons	Percentage response
Textbook is easy to understand	(97) 20.2
Textbook gives adequate information	(49) 10.2
Textbook is recommended	(252) 52.5
Textbook is tailored to the curriculum	(83) 17.2

4.3.3. Assessment of Chemistry textbook

An analysis of chemistry textbook was conducted to draw attention to any mismatch between the objectives of the SSS and the opportunities for achieving them provided by the most commonly used textbook by the teachers and the students. Table 4.51 shows the profile obtained from the book SSS chemistry by Ababio (2001). It was found that there was fairly good agreement between the stated objectives of the SSS curriculum and the opportunities which the textbook provided for achieving the objectives. However, one objective that did not receive much attention was the objective R involving 'social, moral and conservation issues in chemistry'.

Table 4.51 Profile of sub-topics by operational objectives in chemistry textbook

Operational objective	Number of sub-topics with opportunity
A(Accurate or careful observation and recording)	27
B(Devising an appropriate scheme of apparatus)	27
C (Classifying facts or observation)	7
D. (Handling numerical data)	4
E. (Plotting and using graphs)	2
F. Drawing inferences from data without hypothesising	16
G. inventing hypotheses and judging between them	13
H. Competence in communicating ideas and observations in coherent form.	10
I. Applying previous understanding to new situation e.g. in problem solving	14
J. Creativity in addition to that involved in other operations	1
K. Show links with biology	2
L. Show links with physics	1
M. Show links with geology	2
N. Show links with mathematics other than as a tool	2
O. Show links with other school subjects	8
P. Industrial application of chemistry	12
Q. Chemistry or chemical products in every day life	10
R Show social, political , or moral consequences of chemistry	7

4.3.4 Assessment of Senior Secondary School Certificate examination questions

Analysis of the skills tested in the SSS practical examinations between 1995 and 2000 was done to ascertain whether the skills tested are in line with the curriculum objectives. Table 4.52 shows the process skills tested in the examinations.

Table 4.52 Frequency of tested skills in the practical SSCE 1995-2000

Year	Observing	Inferring	Collecting. Recording data.	Measuring	Experimenting	Communicating	Identifying	Comparing	Manipulating variables
1995	2 (11.1)	1 (5.5)	2 (11.1)	1 (5.5)	2 (11.1)	5 (27.7)	2 (11.1)	1 (5.5)	-
1996	2 (7.6)	2 (7.6)	2 (7.6)	1 (3.8),	3 (11.5),	3 (11.5),	8 (30.8)	1 (3.8),	-
1997	3 (11.5)	1 (3.8)	1 (3.8)	1 (3.8)	4 (15.4)	4 (15.4)	5 (19.2)	2 (7.6)	1
1998	3 (11.5)	(3.8),	3(11.5)	1 (3.8),	4 (15.4)	4 (15.4)	5 (19.2)	-	1
1999	2(9.5)	1(4.8)	2(9.5)	2(11.8)	3(14.30)	4 (19.05)	3(14.30)	-	-
2000	1(5.9)	1(5.9)	2(11.8)	2(11.8)	3(17.5)	3(17.5)	1(5.9)	-	-

Figures in parenthesis are the percentages

The examination appears to test skills proposed in the curriculum. Skills in communicating and identifying were predominantly tested in the years analysed. The absence of questions on formulating and testing of hypotheses might imply that these skills were not considered important

Table 4.53 Mode of Assessing Student's Work

Mode of Assessment	Rarely/Never	Sometimes	Frequently
Teacher made objective tests	10.8	32.1	57.1
Performance in homework	10.8	42.8	46.4
Performance on project	35.7	53.6	10.7
Others	46.4	32.1	21.4

4.3.5 Teachers' responsibilities and competencies.

Teachers' responsibilities and competencies were also examined in terms of preparation of work schemes, methods of teaching and assessment of student's work, professional affiliations and improvement.

Table 4.54 Percentage teachers' response to question 'Who Designs the Scheme of Work?

Designer of scheme of work	Frequency	Percentage
Teacher	46	82.1
Head of Department	2	3.6
State Ministry of Education	8	14.3
Total	56	100.0

The chemistry teachers designed the scheme as indicated by over four-fifths (82.2%) of the respondents, while the State Ministry of Education did in over one-tenth of the cases. Only a very minute proportion (3.6%) had the chemistry scheme of work designed by the head of department. Being the major designer of work scheme implies that the teacher be knowledgeable and up-to-date on skills for teaching chemistry.

Questions were asked on teachers' affiliation with professional organisations and materials available for up-dating knowledge. Tables 4.55 to 4.57 show teacher responses on these issues.

Table 4.55 Teachers' membership of professional union/association

Response	Frequency	Percentage
Yes	38	67.9
No	18	32.1
Total	56	100

More than two-thirds of the teachers indicated that they were members of professional associations. This large fraction might be due to the fact that nearly one-third of the teachers sample were drawn from a Science Teachers' Association conference. The teachers were further asked for the specific associations to which they belonged. Table 4.56 shows that the STAN was the professional association to which more than half of the teachers belonged. This can be taken as a positive development if the teachers are actively involved in the activities of the association.

Table 4.56 Professional Union/Association to which teachers are affiliated

Name of association	Frequency of response	Percentage response
Nigerian Union of Teachers	16	42.1
Science Teachers Association of Nigeria (STAN)	20	52.7
Graduate Teachers Association	2	5.2
Total	38	100

Although the teachers were largely members of professional associations only half of them recorded that they had professional journals or periodicals in their schools. This does not seem to be encouraging as the journals or periodicals are expected to keep teachers abreast of new developments in science.

Table 4.57 Scientific, Chemical or Technological Journals available in the school

Title of Journal	Frequency	Percentage
None	28	50.0
STAN Journal	16	28.6
American Journal of Chemistry	4	7.1
Women and Technology	2	3.6
British Chemical Society journal	4	7.1
Chemical Society of Nigeria	2	3.6
Total	56	100.0

Table 4.58 Teachers' responses on frequency of reading journals and periodicals on science teaching

Response	Frequency	Percentage
Rarely	26	46.4
Sometimes	18	32.1
Regularly	12	21.4
Total	56	100.0

An inquiry-based curriculum requires teachers who will encourage students to search for and to have current sources of information. The situation whereby nearly half of the respondents rarely consulted journals and periodicals on teaching is not encouraging. Perhaps these materials were not available in the schools.

Table 4.59 Percentage response on in-service

No. of in-service course	Frequency	Percentage
None	26	46.4
1 - 2 courses	16	28.6
3 - 4 courses	6	10.7
5 - 6 courses	6	10.7
7 courses and above	2	3.6
Total	56	100.0

Nearly half (46.4%) of the teachers surveyed had not received any in-service course in the previous five years to the study. Reasons adduced for not having attended any in-service course are displayed in Table 4.60 Prominent among courses attended by those who had attended courses were courses organised by the Science Teachers' Association of Nigeria (STAN) and by West African Examinations Council (WAEC).

Table 4.60 Reasons adduced for not having attended In-Service Courses

Reason	Frequency of response	Percentage
1. Non- release by school authority	9	34.6
2. Lack of sponsorship	5	19.2
3. Non-awareness of training courses	9	34.6
4. Non provision of training opportunity by employer	3	11.5
Total	26	100.0

Non-release by school authority and non-awareness of training courses constituted the two main reasons for teachers' non-attendance of in-service courses. Lack of sponsorship was another major reason given.

4.4.0. Product Evaluation

To what extent are the goals of the curriculum being achieved in the schools?

In evaluating the curriculum product attention was placed on the outcome of the use of the curriculum. This included a look at the performance and enrolment over a ten-year period, students' perception of chemistry, coverage of the syllabus and problems encountered and how these could be overcome.

4.4.1. Situation of chemistry in the schools

The situation of chemistry can be determined in part by the enrolment and performance trends, methods of science teaching and students perception or the attitude to science. The results obtained to this effect are hereby displayed.

Enrolment and Performance in SSCE Chemistry

The teachers were asked to indicate their opinion on students' performances. As shown in table 4.61, the teachers' opinion on students' performances appeared divided. Half of the responding teachers felt that the performances were generally poor, the other half felt otherwise.

Table 4.61 Teachers' Opinion on Students' Performances in Chemistry

Teachers opinion	Percentage (n=56)
Students performances are generally poor	50.0
Students performances are not poor	50.0

A clearer picture of the trend of students' enrolment and" performances were obtained from the analysis of SSCE results over a period of eleven years, this is displayed in table 4.62 and Figures 4.4 to 4.6. While there seemed to be an increase in enrolment, the number of students who "failed" to obtain distinction or credit passes seemed to be on the increase. The objective of preparing students for further education in chemistry appeared to be met for only a third of the students in only five years (1995, 1996, 2001, 2002 and 2004). This situation appeared to be serious considering the fact that less than credit passes do not qualify students for places in higher institutions. More than two-fifths of the students failed the examination outright in all the years except in 1995 and 1996.

Table 4.62 Trends of enrolment and performance in SSSCE chemistry from 1988 -2004 1990 4.1

Year	No. of Candidates	Credit and above (A1-C6)	Failed "(P7- F9)
1988	34508	20.7	79.30
1989	35708	10.8	89.20
1990	80059	4.1	95.90
1991	144990	10.6	89.60
1992	140856	19.0	81.00
1993	170537	23.0	77.00
1994	161232	23.7	76.30
1995	133188	36.7	63.30
1996	144990	33.46	66.54
1997	172383	23.58	76.42
1998	182659	21.39	78.81
1999	223307	31.08	69.78
2000	160933	32.02	67.98
2001	301740	36.25	63.75
2002	262824	34.42	65.58
2003	282120	50.98	49.02
2004	279774	38.97	61.03

Figure 4.5 Trend of enrolment for SSCE chemistry, 1988-2004

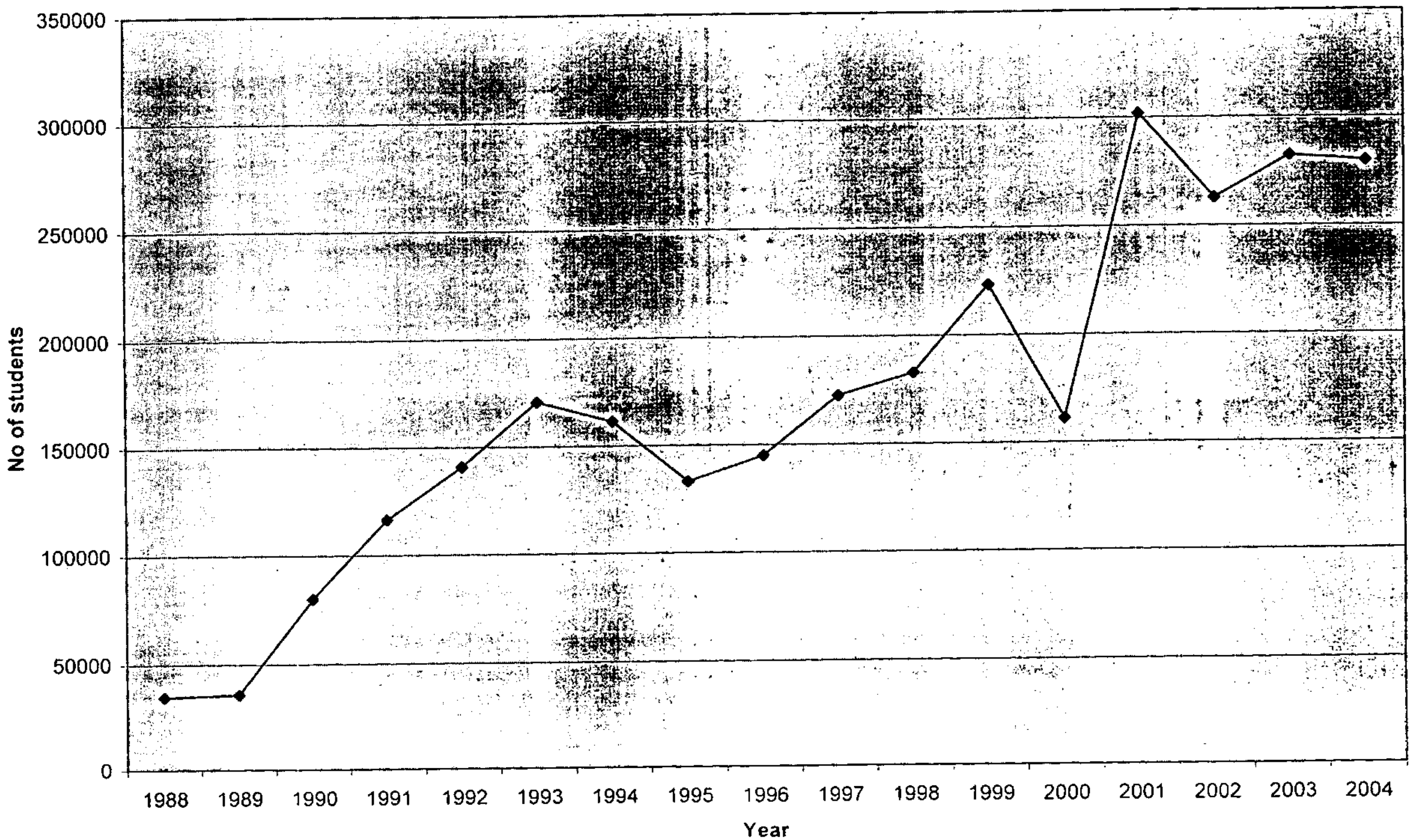


Figure 4.5 Percentage of students obtaining credit and above in SSCE Chemistry by year.

Figure 4.6 Percentage of students with credit and above, 1988-2004

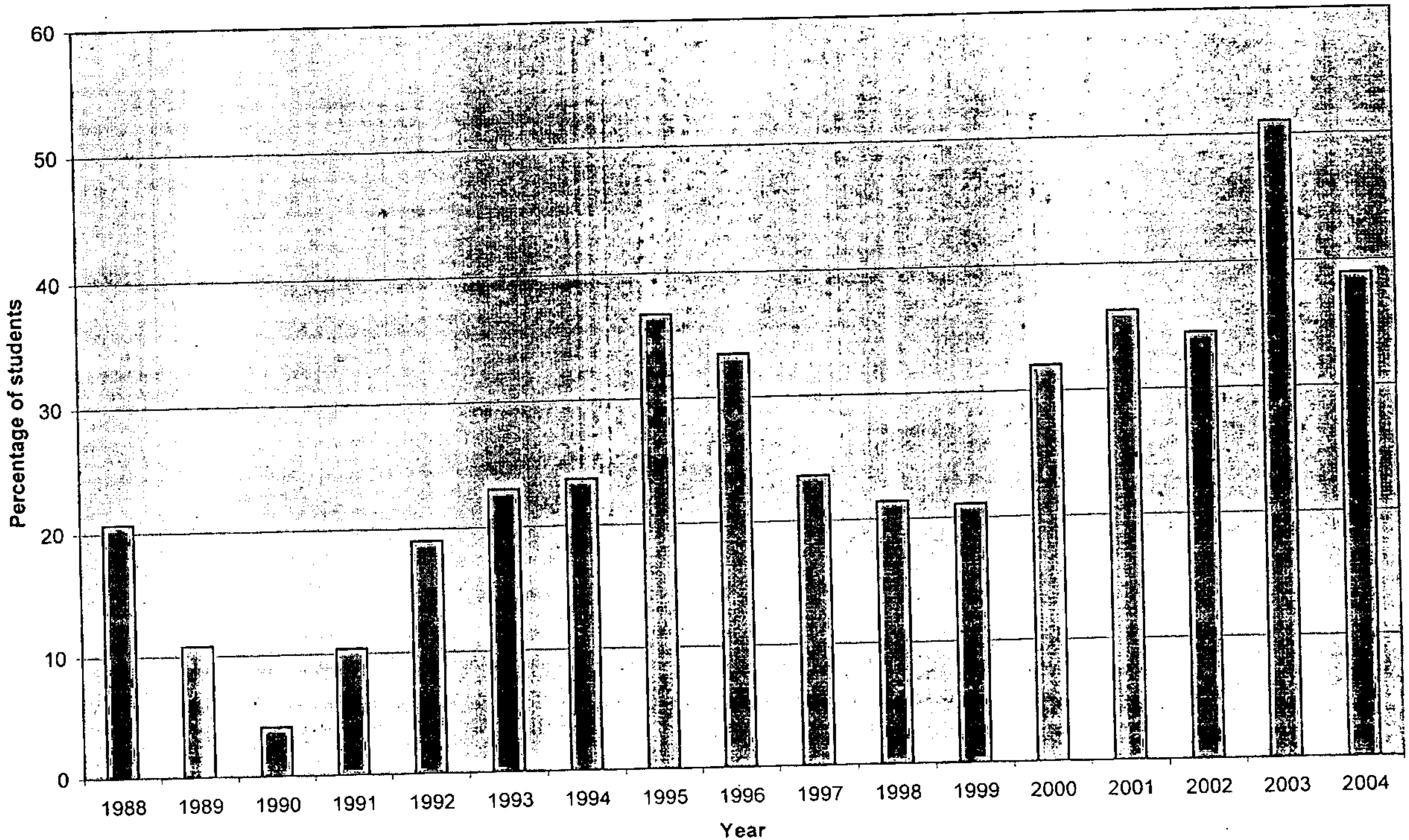
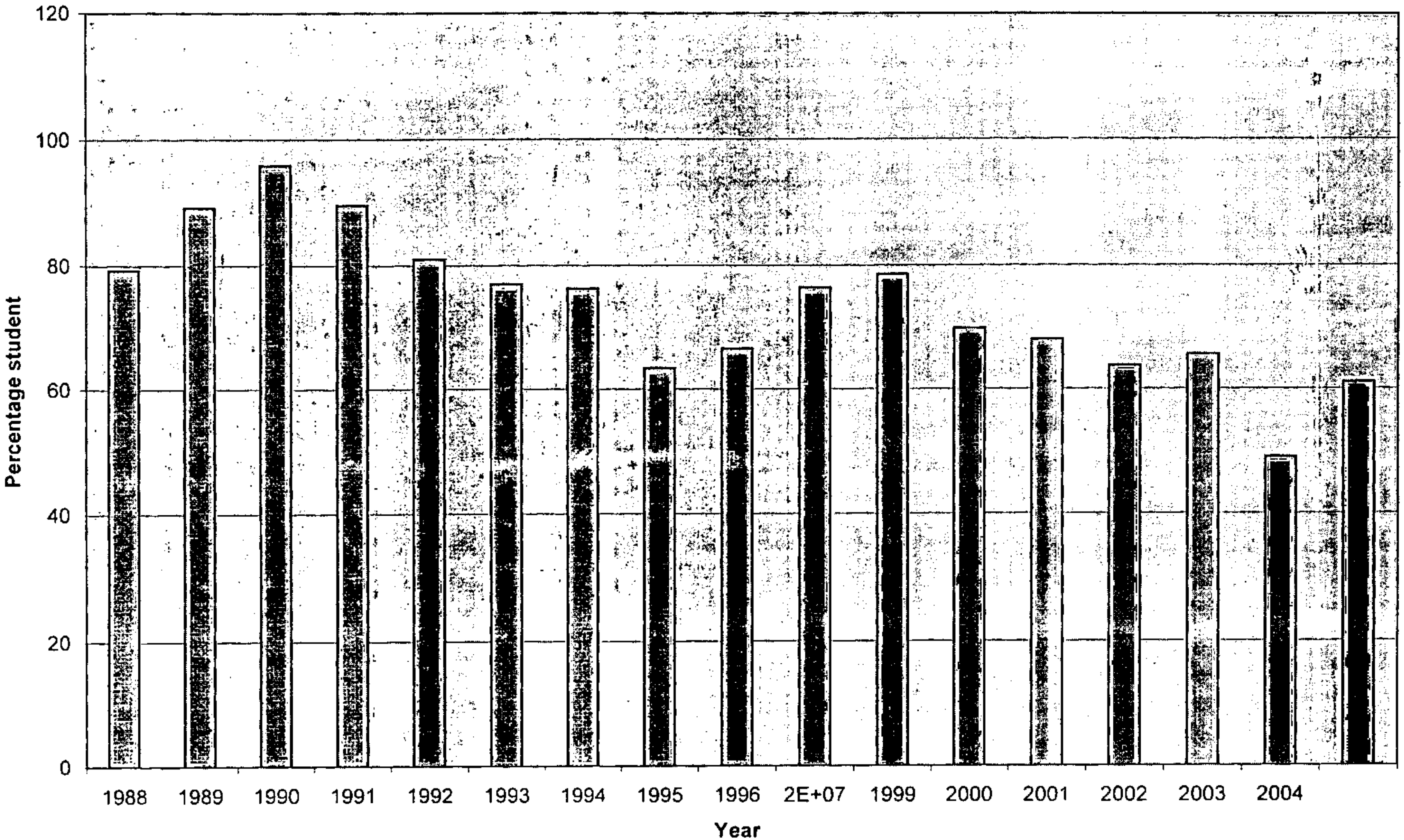


Figure 4.6 Percentage student failure in SSCE 1988-2004 Chemistry by year.

Figure 4.7 Percentage of students failure in SSCE chemistry, 1988-2004



Students' perception of chemistry

Developing a favourable attitude towards science is a part of the goals of a science curriculum. Exploring students' perception is a way of assessing their attitudes.

Table 4.63 Percentage students' responses on feeling towards chemistry

Statement of student's feeling towards chemistry	SS 1 n=160	SS 2 n=160	3 SS n=160	Total n=480
I like chemistry	98.7	97.5	96.3	97.5
I dislike chemistry	1.3	2.5	3.7	2.5
Total	100.0	100.0	100.0	100.0

Only 2.5% of the students indicated that they disliked chemistry, the remaining students stated their likeness for chemistry. This is in agreement with the response in Table 4.42 except that here, the first year students had the highest percentage responses (98.7%) in favour of liking chemistry.

At the time of the study the students should have completed a large proportion of the prescribed course content for the class. This was however not the case for nearly half (45.4%) of the students.

Table 4.64 Percentage Students' responses on coverage of syllabus for Class?

Response	SS 1 n=160	SS 2 n=160	SS 3 n=160	Total n=480
Yes	60.0	33.3	56.6	50.9
No	40.0	60.0	39.6	45.4
Not Record.	-	3.8	3.8	3.7

Table 4.65 Students Response to "Relevance of school Chemistry to life"

Relevance statement	SS 1 n=160	SS 2 n=160	SS3 n=160	Total n=480
School chemistry useful out of school	80.0	81.2	82.5	81.2
Cannot see usefulness of school chemistry out of school	3.7	1.3	7.5	4.2
School chemistry useful only for the future	16.3	17.5	10.0	14.6
Total	100.0	100.0	100.0	100.0

A large proportion of the students felt that chemistry was useful outside the school. however. of this group, over four-fifth (81.2%) indicated that they found relevance of their school chemistry even when not at school while less than one-fifth (14.6%) believed that their school chemistry was only useful for the future. Only a very few of the students indicated that they could not see the usefulness of their chemistry at all. Zonal variations of students' perceived relevance of chemistry to life are presented on table 4.66. The responses across the Zones confirm the overall view.

Table 4.66 Zonal comparison of students' response in percentage to "Relevance of school Chemistry to life"

Group N	All 480	North East 120	North West 120	South East 120	South West 120
1. A. The chemistry we do in class is very useful to me even when I am not in school	81.2	76.7	85.0	93.4	70.0
B. I cannot see the usefulness of class chemistry.	4.2	5.0	6.7	3.3	1.7
C. Chemistry we do in class might be useful only for the future	14.6	18.3	8.3	3.3	28.3

Tables 4.67 and 4.68 present students' responses to question on the benefits they felt they have acquired from doing practical work. Most of the benefits which students said they derived were of the affective type such as developing interest, enjoyment of chemistry, co-operating with others and behaving better in class. However, the students' responses on the skill type benefits are found to be very low. For instance, the skills of designing experiments had the highest negative responses followed by the skills of handling apparatus and drawing conclusions all of which are essential for thorough grounding in science through the enquiry approach.

Variations in the responses from the zones show that same trend of benefits. Howe ever, the Southwest zone had a higher response than the average on the skill of designing experiment to investigate problem (table 4.68) even though not up to half (48.3%) of the respondent shared in this benefit.

Table 4.67 Percentage Responses on Benefits derived from practical work

Benefits	Yes	No
Developed interest and enjoyment of chemistry	72.1	27.9
Can draw conclusions from experimental results	55.8	44.2
Recognised that theory explains observable behaviour	71.3	28.7
Able to work safely and tidily in laboratory	60.4	39.6
Able to record observation and results	68.7	31.3
Acquired skills in handling apparatus	52.9	47.1
Able to design experiment to investigate a problem	29.2	70.8
Behave better in class	75.0	25.0
Saw the need for co-operation in group work	73.3	26.6

Table 4.68 Percentage zonal responses on benefits derived from practical work

Benefits	ALL	NE	NW	SE	SW
Developed interest and enjoyment of chemistry	72.1	50.0	81.7	75.0	81.0
Can draw conclusions from experimental results	55.8	35.0	43.3	65.0	79.9
Recognized that theory explains observable behaviour	71.3	61.7	68.3	73.3	81.9
Able to work safely and tidily in laboratory	60.4	53.3	61.7	60.0	66.6
Able to record observation and results	68.7	50.0	71.7	71.7	31.3
Acquired skills in handling apparatus and chemicals	52.9	36.7	50.0	63.3	61.7
Able to design experiment to investigate problem	29.2*	23.3*	10.0*	35.0*	48.3
Behaved better in class	75.0	73.3	70.0	81.7	75.0
Saw the need for co-operation in group work	73.3	66.7	80.0	65.0	81.7

Teachers' and students' assessment of aspects of the curriculum

The teachers were requested to assess the curriculum objectives and to indicate reasons for students' poor performances in chemistry. The responses are presented on tables 4.69 to 4.70.

Table 4.69.Teachers' Rating of the Chemistry Curriculum by the Objectives

Objectives	Rating (Maximum score = 5)
Relevance to students' future pursuit of chemistry	4.32
Relevance of chemistry to Industry	4.25
Coverage of topics needed by SSS students	4.21
Blending of Scientific concepts acquired at JSS level with chemistry	4.00
Relevance of chemistry to everyday life	3.96
Meeting students' needs for curiosity and achievement	3.82
Appropriateness to level of students	3.57
Relating chemistry to other School subjects	3.5
Practicability of Activities	3.39
Students' understanding of topics	2.10

Teachers were requested to rate the curriculum in terms of meeting the laid down objectives. The rating was done on a scale of 1 to 5, from least to highest. Table 4.69 shows the objectives in descending order of satisfaction of the objectives. Even though the teachers rated the curriculum high on the objective of relevance to students' future pursuit of chemistry the SSCE results negate this as less than half of the students were considered capable of proceeding for further studies based on their performances. The lowest rating on student's understanding of topics has serious implications. Without understanding of the topics learning could not be said to have taken place. This appeared to be a serious shortcoming of the curriculum

Table 4.70 Teachers Perception of Factors Responsible for Student's Difficulties in Chemistry

Factors responsible	Frequency	Percentage
Inadequacy of teaching aids	22	39.3
Poor mathematical ability	10	17.9
Student not studying enough	20	35.7
Abstract nature of topics	4	7.1
Total	56	100.0

Teachers' perception of the problems that students have in learning chemistry are displayed on table 4.70. Inadequacy of teaching aids was indicated by about two-fifths of the teachers, insufficient studying and poor mathematical ability of students were also implicated. Table 4.71 shows students ranking of some problems of learning chemistry in order of perceived seriousness.

Table 4.71 Students perception of problems encountered in chemistry

Problems encountered	Frequency	Percentage
Problems with equation and its application	14	2.9
Poorly equipped laboratory	12	2.5
Text books too expensive	12	2.5
Insufficient explanation by the teacher	442	92.1
Total	480	100.0

The larger percentage (92.1%) of students responded that 'insufficient explanation by the teacher was a major problem encountered. This is to be expected considering that majority of the teachers did not undergo orientation training on the use of the curriculum

Table 4.72 Students ranking of problems of learning Chemistry in order of perceived seriousness.

Statement	Score (Maximum=5)
Laboratories are not equipped	4.66
Students failure to do extra work	3.00
Inadequate educational materials	2.96
Teacher is not well paid	2.89
Teacher does not teach regularly	2.62
Text books too expensive	2.54
Lack of interest among students	2.54
Teacher does not check homework	2.31
Teacher is not sure of self	2.27
Little or no counselling advice for students	2.22

Non- equipment of laboratories ranked highest among the problems encountered by the students. Other high ranking problems included *failure to do extra work, inadequate educational materials* and *non-payment of teachers. Expensive textbooks* and *lack of interest among students were ranked as moderate problems.*

The students and teachers were requested to indicate their perception of level of difficulty or otherwise of the topics in the curriculum. The average responses for each topic was then coded. Table 4.73 displays the comparison of the responses.

Table 4.73 Comparison of students responses with the teacher responses on perceived degree of difficulties of the curriculum topics

Key: *A* = Not difficult B = Slightly difficult C = Very difficult

Item and choice	Students' responses	Teachers' responses
1. Standard separation of mixture	A	A
2. Particulate nature of matter	A	A
3. Symbols formulae and equations	A	A
4. Chemical combination	A	A
5. Gaseous state and gas Laws	A	A
6. Acids, bases, salts	A	A
7. Carbon and its Compounds	A	A
8. Petroleum	B	A
9. Applied Chemistry	B	A
10. Periodic Table	A	A
11. Mass-volume Relationship	B	A
12. Electrolysis	A	A
13. Acid- Base reactions	A	A
14. Rates of Chemical Reaction	B	B
15. Energy effects & Chemical Equilibrium	C	C
16. Non-metal and their Compounds	A	A
17. Organic Chemistry	B	A
18. Orbital and Electronic structure	A	A
19. Nuclear Chemistry	A	A
20. Chemical Bonding	A	A
21. Metals and Compounds	A	A
22. Earth and space chemistry	A	A

Only five out of the twenty two major topics (Petroleum, Applied Chemistry, Mass-volume Relationship, Rates of Chemical Reaction and Organic Chemistry) were perceived as slightly difficult by the students as against one indicated by the teachers. The topic 'Rates of chemical reaction" was deemed so by both teachers and students. The topic "Energy effects and chemical equilibrium" was considered very difficult by both the teachers and students.

A comparison between the teachers and students perception of factors responsible for poor performances in chemistry was carried out using the Chi-square statistic. Table 4.74 shows the results.

Table 4.74 Percentage students' and teachers' responses and chi-square values on factors responsible for poor performances in chemistry

Factors	Not a problem	A problem	Chi-square	P- value
Expensive textbooks	72.9	26.3	16.7	<.05
Mathematics involved in chemistry makes it difficult	18.7	81.3	19.29	<.05
Student's failure to do homework	25.8	74.2	44	0.00
Little or no counselling advice for students	25.0	75.0	65	<.05
Practical classes not done at the same time with the theory	51.7	48.3	22.7	<.05
Too many classes for teacher	25.0	75.0	44.41	<.05
Chemistry is not as easy as other subjects	12.1	87.9	19.78	<.05

Chi square values were found to greater than the table values on the factors indicated and thus significant. The factors of expensive textbooks, mathematics of chemistry , default in doing homework, non-concurrence of practical classes with theory classes and heavy workload for teacher as well as the inherent difficulty of chemistry. Some of these factors were also found to be responsible for the "demise" of chemistry characterised by decline in enrolments and general lack of interest in chemistry among students in the United Kingdom (RSC, 2005).

Table 4.75 Students' suggestions on how to make Chemistry better

Suggestions	Frequency of response	Percentage
Having the text books	24	5.0
Having qualified teachers	16	3.3
Extra coaching	16	3.3
Having well equipped laboratory with more laboratory work	424	88.3
Total	480	100.0

4.5.0 Cost Evaluation

An estimation of the minimum cost of operating the curriculum was computed for three years, from SS1 to SS3. The total cost of the program was obtained by summing up the personnel , equipment and material costs. The cost of laboratory buildings were omitted. Table 4.76 shows a summary of the categories and estimated cost of operating the curriculum for 40 students.

Table 4.76 Estimated cost of operating the curriculum for 40 students (2004)

Cost Category	Cost in Naira
1.Personnel Cost, PC	
a) Laboratory Personnel salaries per annum x 3 years	306,000.00
b) Teacher's salaries for 3 years	532,000.00
2. Equipment cost (EC). Material Cost (MC)	3,019,700.00
Sub- Total	3,857,700.00
4. Contingency (10%)	385,770.00
Total Cost (TC) =(PC + EC + MC)	4,243,470

The minimum cost of operating the curriculum in a school is estimated at four million, two hundred and forty three thousand and four hundred and seventy Naira(N4,243,470.00). This cost excludes the cost of training and other installation costs. This is the cost of operating the curriculum for 40 students which was the average number for a science classroom as provided for in the document of equipment for the curriculum (FMEST, 1993). As indicated by the report of the visit to the schools there was no school with only 40 students, and the total amount allocated to each school for science is far below this amount, thus this amount cannot be allotted to chemistry alone. This indicates that funds were not adequately provided for operating the curriculum.

CHAPTER FIVE
DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

The study is an evaluation of senior secondary school chemistry curriculum undertaken to satisfy the need for comprehensive information and data on the curriculum. Without a credible evaluation it would not be possible to identify how the curriculum is faring and what improvements are required. This chapter contains a brief discussion of the findings and the conclusions of the study. The recommendations for improvement on the curriculum and suggestions for further research conclude the chapter.

5.1.0. Discussion of findings

In the course of this study the following research questions were asked.

(i) How comprehensive and adequate are the objectives and content of the SS chemistry curriculum?

(ii) Has the curriculum been adequately installed in the schools?

(iii) Do the implementation processes comply with that laid down for the curriculum?

(iv) Are the goals of the curriculum being achieved in the schools?

(vi) How adequate have the cost implications of the curriculum been especially in terms of materials and equipment input?

(vi) What are the discrepancies arising from the design, installation, process, product and cost evaluation with respect to the officially prescribed curriculum?

(vii) What suggestions could be made for the improvement of the chemistry curriculum in Nigerian Schools?

Answers to the questions are answered in this section by highlighting the study findings under the various evaluation concerns of the Provus Discrepancy evaluation model. These are Design, Installation, Process and Product and Cost evaluation. Attempts have been made to identify areas of possible improvements in the design and execution of the study for improvement of curriculum evaluation in particular and the educational enterprise in general.

5.1.1 Design Evaluation of the Senior Secondary Chemistry Curriculum.

(i) How comprehensive and adequate are the objectives and content of the SS chemistry curriculum?

Comparisons of the process of designing the curriculum with other similar curricula have shown that the curriculum had followed the necessary channels of curriculum design. However, the design fell short of other similar curricula with the absence of attendant curricular materials in form of student's text books, work books and teacher's guide tailored specifically to the philosophy and objectives and processes advocated by the curriculum.

The curriculum though premised on the guided discovery approach did not reflect much of these in the objectives as shown by the few objectives in the processes of science related to guided discovery. Hence, teachers did not utilize the approach in their teaching as observed in the classroom practice. The possible reason for non-usage of the approach is that teachers were not taught or guided on how to teach using the approach and the curriculum document has not provided instructions on it. This was probably mainly responsible for the paucity of practical and project work in the schools, as reported by the students.

The absence of textual materials while contributing to the problem had been found not to be solely responsible for the poor showing of students in the senior secondary schools (AAAS 1999, AAAS, 2001). As found by Welch (1968), provision of induction or training programme on new curricula have been very helpful in making their implementation successful. This however was not the case with the chemistry curriculum. Concerted and systematic efforts were not made to provide majority of the teachers with appropriate skills for effective delivery of the curriculum. A large proportion (57.1%) of the teachers had not received any induction in the use of the curriculum. Teachers who received training expressed the usefulness of the training to their teaching practice.

The curriculum appeared adequate in complexity as both teachers and students expressed satisfaction with the contents coverage. However, there was a suggestion for the removal of the topic on Earth and Space Chemistry. This topic was one of the topics suggested for removal in the National Curriculum for Science in Great Britain Schools Curriculum (SCAA 1994). These two topics were also among those that were rated negatively in terms of importance, worthwhileness, practicability and meaningfulness by teachers in a study conducted by Busari (1997). Both teachers and students rated the topic *Energy effects and equilibrium* as extremely difficult for the students to understand. But teachers felt that students had more difficulties with more topics than the students indicated in their own responses, this might indicate that the topics were not beyond the level of complexity of the students. Such contemporary topics as Chemistry and the world food problems, environmental chemistry (oil spillages, acid rain. pollution)which are of great importance were not found in the curriculum.

5.1.2 Curriculum Installation Evaluation

(ii) Has the curriculum been adequately installed in the schools?

A synthesis of the findings on installation showed some shortcomings in installation of the curriculum. Using the consistency -of -programme –delivery checklist to find out whether the programme had been effectively installed, it was found that:

(i) not all the teachers received the same type of training in the use of the curriculum.

(ii) not all the teachers teaching the curriculum received the same amount of training,

(iii) there seemed to be insufficient orientation for school administration on the new curriculum

(iv)neither the teachers nor the students received adequate materials for the curriculum implementation,

(v) there seemed to be neither monitoring nor follow-up on the use and implementation of the curriculum,

(vi)there appeared to be no system of periodic feedback to teachers on how well they were implementing the curriculum (except perhaps through the final examination result which is not a true test of implementation)

(vii) not all the teachers used the Chief Examiner's Report to guide their lessons.

(viii) no opportunities have been provided for the teachers to ask questions on how the programme should be implemented.

(ix)supplies needed (laboratory, chemicals, models ,charts, films) to support the programme were not uniformly available in all schools. As much as 61.6% of the schools had inadequate laboratories

(x) the methodology of guided discovery approach had not been adhered to by the teachers, rather the traditional methods appeared to have prevailed as witnessed from the lesson observation. This is similar to Aboaba (1990)'s finding that chemistry teachers spent more than half of the total lesson time lecturing while students' participation were found to be for only 13.3% of the lesson time. Even project works which could have compensated for some methodological lapses were not properly conducted as students indicated that as much as 89.9% of the project work were not done at all.

The foregoing findings are indicative of the discrepancies in the installation of the curriculum in the schools. Perhaps the hurried way in which the curriculum was introduced into the schools was responsible for these observed lapses. Ivowi (1992) noted that the curricula in most of the science subjects did not completely follow established curriculum development procedures. as there were no trial-testing, before introduction into the schools on the full scale.

The situation of equipment of the teachers for effective monitoring of the students had been affected by the same condition as the skills for teaching. Teachers were not inducted adequately to effectively monitor homework and projects which are crucial to attainment in the curriculum. In the Nuffield Chemistry curriculum which bore similarities with the SSSCE curriculum, sample texts were designed to go along with the curriculum to guide the teachers in assessing students work. The fact that non-specialist chemistry teachers were also teaching in the schools might be responsible for this situation as was the case in Britain where the Royal Society of Chemistry (RSC) found out that the non- specialist teachers' lacked the confidence to deliver the practical aspects of the subject (RSC, 2006)

The teachers agreed that the curriculum contents were adequate to the cognitive level of the students. The teaching of chemistry before the SSS curriculum was introduced was didactic and teacher dominated (Ajeyalemi 1987, Soyibo 1983), and the SSS curriculum was designed with a focus on the guided discovery approach premised on students' activities, which requires an opposite orientation to the existing one. It would have been expected that teachers to teach the new curriculum would have been given some systematic training and orientation programmes with the curriculum in focus, however this was found not to be so. Rather, the teachers still maintained the status quo to a large extent. This in turn affected the students' active involvement and initiation of activities. Students were hardly involved in much practical activities not to talk of guided discovery activities. Project work were also not given prominence. All these were in negation of the spirit of the guided-discovery approach. According to Akusoba (1985) teachers uncertainty of the appropriate skills to encourage in the students as well as the constraints of time and large classes (Busari ,1996) might also have contributed to this problem.

Students perception of chemistry appeared to be on the positive side, as majority of the students' showed interest in chemistry. and were studying it because they liked it. However, the enrolment for chemistry when compared to other subjects in the curriculum seemed to be on the decline.

As discussed in the previous section, teachers were not adequately prepared to teach the new curriculum. Concerted efforts were not made to induct and re-orientate teachers to the new approach which the curriculum envisaged . .

5.1.3. Process Evaluation

(iii) Do the implementation processes comply with that laid down for the curriculum?

The lapses highlighted in the previous section flow into this section. In discussing the findings for process evaluation, mention must be made of the proposed methodology and expected student behaviour in the schools One of the problems identified by the students was that of not doing practical work with the theoretical aspects. This finding is in agreement with Busari (1996) where teachers were found to concentrate mainly on the theory aspects instead of integrating the theory with the practical wok.

The curriculum documents prescribed the guided discovery approach implying provision of continuous experiences for the acquisition of the skills of defining problems, critical thinking, hypothesizing, collecting, testing and evaluating data, and manipulating variables among others. This method was not being used in the school perhaps because the teachers were not given adequate induction in the use of the methodology or in other skills needed for teaching the approach

Large class size and heavy work-load were also mitigating factors to effective teaching . These were also found to be the situation in the schools and may have been implicated in the inadequacy of practical lessons. The few practical lessons done were found to be done towards the latter portion of the three-year course and most of these were teacher-demonstrated. The situation was also the same for the prescribed projects. Students were did not appear to have adequate exposure to independent work and generation of ideas.

5.1.4 Product Evaluation

(iv) Are the goals of the curriculum being achieved in the schools?

The students' performances were found to fluctuate from year to year although less than half of the chemistry entrants passed the SSSCE yearly. This trend may still continue unless the short comings in the curriculum installation and process are adequately addressed. Provision of adequate facilities as well as adequate retraining of teachers, would assist in this direction

Teachers, positive high rating of the objective of relevance to students' future pursuit of chemistry as opposed to the low rating accorded students' understanding of the topics might imply that the chemistry curriculum is probably biased in favour of students pursuing higher education.

Suggested problems and factors responsible for poor performances included non-equipment of laboratories, inadequacy of teaching aids which are all hallmarks of proper installation of curriculum. Other factors are related to students' cognitive abilities.

The product obtained from the use of the curriculum was to be expected given the way the curriculum stages were executed.

5.1.5 Cost Evaluation

(vii) How adequate have the cost implications of the curriculum been especially in terms of materials and equipment input?

Cost evaluation applies to all the evaluation stages, from the design to product stage. Without financial enablement, proper execution of the curriculum would be impossible. There was no indication of the possible cost of operating this curriculum hence cost effective analysis or cost benefit analysis could not be done. However from the computation of cost of equipment and personnel and judging by the shortfall in equipment in the schools visited it was evident that the curriculum did not receive adequate funding.

5.2.0. Conclusions

This evaluative study set out to assess the situation of the chemistry curriculum for senior secondary schools in Nigeria with a view to understanding the dynamics better from the perspectives of the end-users and in comparison with similar curricula elsewhere.

The curriculum though found to be philosophically sound, did not measure up in terms of adequacy of the objectives for science education at the secondary school level. Inclusion of more objectives to encourage student behaviour in the area of critical thinking, hypothesis and theory-building and application of scientific knowledge would help in achieving the guided discovery approach prescription.

The contents were found adequate in scope but, the prescribed methodology was not adequately communicated to the teachers either in the document or through induction courses. Thus teachers taught as best as they knew which was not always in line with expectations. The curriculum was also found to be biased in favour of higher education hopefuls and not the majority of students. This may be one of the factors responsible for the mass failure over the years.

Availability of equipment and materials for teaching chemistry was also faulted. Laboratories were lacking in major requirements for the execution of the curriculum. Large portion of prescribed experiments and projects were not done leading to students' non-acquisition of the expected skills and persistent under-achievement in the final examinations.

The curriculum though being operated in all Nigerian secondary schools was not adequately introduced to the teachers. Adequate methods of feedback and assessments were also not put in place.

The textbooks being used were all tailored to the curriculum with the attendant shortcomings as enumerated in the foregoing. The textbooks were therefore, found not to be guided -discovery oriented.

For this evaluation study to be useful, suggestions for improvement must be made. These are presented in the next section.

5.3.0. Recommendations

This section answers the question, What recommendations could be made for improvement, for the students, teachers, curriculum developers, government and all persons concerned with education? The following recommendations are presented for consideration for improving the curriculum.

1).The chemistry curriculum should be revised and updated.

The format and organization of the curriculum document should be maintained but the curriculum should be revised and updated as follows:

i. Curriculum should be restructured to accommodate students of varying ability and not only the brilliant ones. This will debunk students' impression that chemistry is a difficult subject.

ii. There should be a built- in system of feedback and monitoring for the curriculum whereby teachers and even students can report on their use of the curriculum. Such feedback would be useful for the review of the curriculum.

ii). The curriculum document should be more explicit in respect of the methodology to employ. Specific information should be provided on the guided-discovery approach or any approach expected to be used.

iii. The content of the curriculum should be updated to make provision for contemporary issues in science and chemistry.

iv. The objectives should be reviewed to reflect the activity- orientation that was proposed.

v. There should be an indication of the level of performance expected from the curriculum so that it would be obvious when there is underperformance.

2. All stakeholders in the chemistry education should have specific roles and responsibilities in curriculum implementation and maintenance.

i. The body responsible for curriculum should see to the development, monitoring, evaluation and feedback of the curriculum on a regular and consistent manner.

ii. A systematic programme of training in the use of appropriate approach in the curriculum should be designed to assist the teachers to cope with the challenges of the curriculum as well as share ideas with other teachers.

iii. Teachers should be empowered to conduct assessment and feedback on the curriculum as they use it in the schools.

iv. There should be a restructuring of the methodology of teacher preparation programmes in chemistry education to make the teachers more relevant in the delivery of their lessons.

3.. There should be an estimate of the implication of operating the curriculum in terms of teacher needs, equipment and materials, timing and other logistical inputs necessary.

4. There should be a built- in system of feedback and monitoring for the curriculum whereby teachers and even students can report on their use of the curriculum. Such feedback would be useful for the review of the curriculum and also track best practices and weaknesses.

5. Provision should be made in the review of the curriculum for the views of teachers and students on the use of the curriculum. These are to be collected and processed at stipulated intervals from the schools and be used for further refinement of the curriculum.

6. The use of participatory approaches and active learning processes which promote students taking active part in their own learning should also be included in teacher training programmes.

7. The various reports of the monitoring exercises by the Implementation Committee of the National Policy on Education and the Nigerian Educational Research and Development Council, should be made available to the State Ministries of Education and subsequently to the schools so that any shortcoming observed could be adequately corrected.

8. Adequate funding of schools and regular payment of teachers' salaries are to be made top priorities in order to stimulate general interest and devotion across board.

9. Curriculum development efforts should be more thorough and be made to include cost implications

10. Evaluation should be a compulsory component of every stage of development and execution of projects in Nigeria.

5.4.0. Suggestions for Further Research

Further research is suggested in the following areas.

i.) Feasibility of feedback networking scheme that can be used by all teachers teaching chemistry in secondary schools in Nigeria.

ii.) Similar evaluative study on the other science subjects (physics, biology, health science) at the secondary school level .

iii). A follow-through study on the performances of post SSS chemistry students to see how the SSS has prepared them for higher education.

iv). A study of the feasibility of the guided- discovery approach in Nigerian schools.

v.) An exploration of the feasibility of using participatory approaches for teaching science.

vi. Research on the cost effective analysis of the curriculum.

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APPENDICES

APPENDIX III

KEY TO THE SPECIFICATION OF OBJECIVES

Detailed Description of student's behaviours

Ao KNOWLEDGE AND COMPREHENSION
A1 -knowledge of specific facts
A2 -knowledge o f scientific terminology
A3 -knowledge of concepts of science
A4 -knowledge of conventions
A5 - knowledge of trends and sequences
A6 -knowledge of classifications, categories and sequences
A7 -knowledge of scientific techniques and procedure
A8 - knowledge of scientific principles and laws
A9 -knowledge of theories or major conceptual themes
A10 - identification of knowledge in a new context
A11 - transformation of knowledge from one symbolic form to another

B0 PROCESSES OF SCIENTIFIC ENQUIRY I - OBSERVING AND MEASURING
B1 -observation of objects and phenomena
B2 - description of observation using appropriate language
B3 -measurement of objects and changes
B4 -selection of appropriate measuring instrument
B5 -estimation of measurements and recognition of limits in accuracy

C0 PROCESSES OF SCIENTIFIC ENQUIRY II -SEEING PROBLEMS AND SEEKING SOLUTION
C1 -recognition of a problem
C2 - formulation of working hypothesis
C3 - selection of suitable tests of a hypothesis
C4 -design of appropriate procedure for performing experimental tests

D0 PROCESSES OF SCIENTIFIC ENQUIRY III -INTERPRETING DATA AND FORMULATING GENERALISATION

D1 -processing of experimental data
D2 -presentation of data in the form of functional relationships
D3 -interpretation of experimental data and observations
D4 - extrapolation and interpolation
D5 - evaluation of a hypothesis under test in the light of the experimental data obtained
D6 - formulation of generalizations warranted by relationships found

E0 PROCESSES OF SCIENTIFIC ENQUIRY IV -BUILDING TESTING AND REVISING A THEORETICAL MODEL

E1 -recognition of the need for a theoretical model
E2 -formulation of a theoretical model to accommodate knowledge
E3 - specification of relationships satisfied by a model
E4 - deduction of new hypotheses from a theoretical model

E5 - interpretation and evaluation of tests of a model
E6 - formulation of a revised, refined or extended model

F0 APPLICATION OF SCIENTIFIC KNOWLEDGE AND METHODS
F1 - application to new problems in the same field of science
F2 - application to new problems in a different field of science
F3 application to problems outside of science including technology

G0 MANUAL SKILLS
G1 - development of skills in using common laboratory equipment
G2 - performance of common laboratory techniques with care and safety

H0 ATTITUDES AND INTERESTS
H1 -Manifestation of favourable attitudes towards science and scientists
H2 - acceptance of scientific enquiry as a way of thought
H3 -adoption of scientific attitudes
H4 -enjoyment of science learning experiences
H5 - development of interests in science and science-related experiences
H6 - development of interests in pursuing a career in science

I0 ORIENTATION
I1 - relationship among various type of statement in science
I2 -recognition of the philosophical limitations and influence of scientific enquiry
I3 - historical perspectives: recognition of the background of science
I4 -realisation of the relationships among science, technology and economics
I5 -awareness of the social and moral implications of scientific enquiry and its results

APPENDIX IV

Cost of minimum item of apparatus and chemicals

Item No	DESCRIPTION	QUANTITY	COST IN NAIRA
1	Ammeters	40	14,000
2	Asbestos mats	40	22,000
3	Aspirator 10 & 25 litres	4 & 3	12,000
4	Balances Electrical +Triple beam	1 & 2	135,000
5	Barometer tubes	5	3,000
6	Basins, porcelain	40	32,000
7	Batteries 6 volts	2	3,000
8	Beakers (100cm , 250cm ,2000cm	40, 50, 5	62,000
9	Bell jars	2	2,400
10	Boss heads	40	20,000
11	Beehive shelves	2	1,500
12	Boyle's Law tubes	2	7,000
13	Burettes/ Burettes brushes	40/10	50,500
14	Bucket, polythene	1	250
15	Bunsen burners	40	30,000
16	Carbon rods	10	6,000
17	Calorimeters	5	17,500
18	Cobalt blue glasses	40	30,000
19	Combustion tubes & boats	5 & 5	7,000
20	Clips, Mohr	10	4,000
21	Condensers, Liebig 50cm	5	22,500
22	Copper plates	10	12,000
23	Corks(assorted)/ borer/sharpener/press	5 packs/1set/1/1	17,000
24	Cotton wool	1 bundle	850
25	Crucibles, porcelain with lid	40	34,000
26	Petri dishes 10cmx 5cm	40	28,000
27	Deflagrating spoons	6	4,800
28	De-ionizer, with spare cartridges	1	90,000
29	Desiccators	2	5,000
30	Drying tubes & drying towers	10 & 2	8,900
31	Eudiometer	2	3,000
32	Funnels, polythene/ glass	40/5	16,250
33	Funnels, separating/thistle	2/10	8,900
34	Filter, paper/pump/flask	20 packs/1/2	55,700
35	Fire extinguishers CO2	2	12,000
36	flask flat bottom, 250cm3/500cm3	80/2	136,000
37	flask volumetric, 2000cm3/1000cm3	2/5	20,000
38	flask ,250cm3,distilling with side arms/conical	5/120	66,000
			1,000,050

Item No	DESCRIPTION	QUANTITY	COST IN NAIRA
	Brought forward		1,000,050
39	Gas jar cover for gas jar	10	1,500
40	First aid box(fully equipped)	1	35,000
41	gas jars, 20 x 5cm	10	8,500
42	Gas troughs, glass, 28cm x 12cm	5	9,000
43	Gas wash bottles(Woulff)	5	2,000
44	Gas measuring tubes with stop-cock,50cm3	10	3,500
45	Glass rods, 5-6mm	2kg	800
46	Glass cutter, tungsten carbide tipped		2,000
47	Glass tubing (assorted)	4kg	4,000
48	Graduated cylinders, 25cm3/100cm3 glass	10/10	10,500
49	Graduated cylinders,100cm3 polypropylene	2	1,300
50	Graduated gas syringe, plastic, 50cm3	40	24,000
51	Glass wool	1kg	1,500
52	Galvanometer-centre zero(24 ohms)	2	9,000
53	Grease (Vaseline)	250g	250
54	Indicator bottle, plastic 50cm3	20	9,000
55	Kipp's apparatus, 100cm3,borosilicate	2	9,000
56	Mercury tray, 38cm x 23cm	1	2,000
57	Meter rules	10	4,500
58	Molecular models	2 boxes	5,000
59	Mortar and pestles, 15cm	3	5,700
60	Nichrome wire. SWG 28	1 roll	850
61	Pipe clay triangles, side of triangle 50mm	40	26,000
62	Pipette, bulb, 25cm3	40	20,000
63	Pipette, straight, graduated 0-25cm3	10	5,000
64	Dropping pipette(Teat), glass	40	8,000
65	platinum electrodes	4	3,000
66	Porous pots 3 x 18cm	5	4,500
67	Periodic table	1	2,000
68	Reagent bottles, normal mouth, 250cm3	40	20,000
69	stoppered, amber	40	20,000
70	Reagent bottles, wide mouth, 250cm3, stoppered, plain	40	20,000
71	Retort, glass, borosilicate, stoppered 250cm3	3	1,500
	Sub-total		278,900
			2,279,000

Item No	***DESCRIPTION***	***QUANTITY***	***COST IN NAIRA***
	Brought forward		*2,279,000*
72	*Retort stands,45cm rod base 20x15cm*	*40*	*26,000*
73	*Retort clamps*	*40*	*26,000*
74	*Retort rings,7cm*	*2*	*1,600*
75	*Rubber stoppers, assorted single and double holes*	*150*	*45,000*
76	*Rubber stoppers, assorted, solid*	*200*	*60,000*
77	*Stands, burette, wooden, heavy base, 20x15x2.5cm*	*40*	*26,000*
78	*Spatula, nickel,15cm (Chattaway)*	*40*	*10,000*
79	*Test tube rack to hold 10 tubes*	*40*	*26,000*
80	*Splints, wood*	*12 bundles*	*10,200*
81	*Stop clock*	*2*	*9,000*
82	*Switches, electrical*	*10*	*1,500*
83	*Sand buckets*	*4*	*1,200*
84	*Test tubes, borosilicate, 16x 150mm*	*500*	*7,500*
85	*Test tube, boiling, borosilicate, 24x24x25mm*	*20*	*9,000*
86	*Test tube holders, wooden*	*40*	*10,000*
87	*Tapers ,wax*	*0.5kg*	*150*
88	*Thermometers, - 10 C to 105 C by 1*	*40*	*26,000*
89	*Thermometers, 0 C to 360*	*5*	*3,750*
90	*Torch bulbs*	*10*	*500*
91	*Tongs, crucibles, 15cm, stainless steel*	*40*	*14,000*
92	*Tubing, rubber, 5mm internal diameter*	*10*	*4,500*
93	*Tiles, White, 10cmx10cm*	*10*	*4,500*
94	*(Tripod stands to suit standard Bunsen burners(20cm high)*	*40*	*2,600*
95	*U-tubes long (manometer)*	*2*	*1,900*
96	*U-tubes short with arms (absorption)*	*5*	*4,750*
97	*Voltameters (Hofmann)*	*1*	*15,000*
98	*Voltameters, 0-5V,DC*	*5*	*2,250*
99	*Wash bottles, polythene, 250cm3*	*40*	*11,200*
100	*Wire gauze with asbestos cntre,15cm2*	*40*	*6,000*
101	*wash glasses, 7.5cm*	*80*	*12,000*
102	*weighing bottles with cap, 25x50mm,glass*	*2*	*1,300*
103	*Water baths*	*2*	*50,000*
104	*Fire extinguishers CO2*	*4*	*24,000*
	Sub-Total		*453,400*
			2,732,400

Item No	DESCRIPTION	QUANTITY	COST IN NAIRA
	Brought Forward		2,732,400
104	Protective goggles	40	14,000
105	Acetic (Ethanoic) Acid	2 ½	11,500
106	Aluminium metal	500g	1,850
107	Ammonia Solution	2 x 2.5 L	9,000
108	Ammonium Oxalate	500g	3,500
109	Ammonium Sulphide	2.5L	15,000
110	Acetone	2.5L	8,750
111	Animal Charcoal	5kg	52,500
112	Barium Chloride	1kg	5,000
113	Calcium Chloride(Anhydrous)	2kg	13,000
114	Calcium Hydroxide(slaked lime)	1kg	6,500
115	Calcium carbonate	1kg	4,500
116	calcium nitrate	1kg	4,500
117	Calcium Sulphate	1kg	4,500
118	Calcium Oxide	500g	3,000
119	Copper turnings	500g	5,500
120	Copper foil	500g	3,500
121	Copper(II)sulphate	2kg	13,000
122	Copper(II)carbonate	500g	4,350
123	Methylated Spirit	2 x 2.5 L	5,000
124	Diethyl ether(Ethyl ethane)	2.5	21,250
125	Hydrochloric acid(conc.)	4 x 2.5 L	7,000
126	Iron metal(filings)	1kg	3,000
127	Iron (II)sulphate(anhydrous)	500g	3,000
128	Iron(II)chloride	500g	3,000
129	Iron(III)chloride	500g	3,000
130	Iodine	500g	9,500
131	Lead ethanoate (acetate)	1kg	4,500
132	Lead dioxide	250g	4,500
133	Lead (II)nitrate	1kg	3,500
134	Lead acetate paper (pack of 10 books)	6 packs	27,000
135	Litmus paper blue (pack of 10 books)	12 packs	9,600
	Sub-total		287,300
	Total		3,019,700

item no	*DESCRIPTION*	*QUANTITY*	*COST IN NAIRA*
	Brought forward		*3,019,700*
136	*Litmus paper red(pack of 10 books)*	*12 packs*	*9,600*
137	*Litmus solution*	*500g*	*4,500*
138	*Liquid paraffin*	*2.5L*	*11,000*
139	*Magnesium ribbon*	*100g*	*2,950*
140	*magnesium nitrate*	*500g*	*3,850*
141	*Methanol*	*2.5L*	*11,250*
142	*Methyl orange indicator*	*25g*	*3,000*
143	*Methyl red indicator*	*25g*	*3,000*
144	*Mercury*	*2kg*	*17,000*
145	*Nitric acid(conc.)*	*2 x 2.5L*	*9,000*
146	*Paraffin wax*	*1kg*	*4,500*
147	*Potassium sulphate*	*500g*	*4,500*
148	*Potassium dichromate*	*500g*	*4,500*
149	*Potassium hexacyanoferrate(III)*	*500g*	*3,950*
150	*Potassium hydroxide*	*5kg*	*52,500*
151	*Phenolphthalein*	*100g*	*3,000*
152	*Sodium metal*	*500g*	*3,500*
153	*Sodium chloride*	*1kg*	*3,000*
154	*Sodium nitrate*	*1kg*	*3,000*
155	*Sodium hydroxide*	*5kg*	*52,500*
156	*Sodium carbonate(decahydrate)*	*1kg*	*4,000*
157	*Sulphur*	*500g*	*3,500*
158	*Sulphur Acid(conc.)*	*2 x 2.5L*	*11,500*
159	*Silver nitrate*	*250g*	*22,500*
160	*Zinc nitrate*	*500g*	*3,500*
	Sub total		*255,100*
	Grand Total		***3,374,800***