UNIVERSITY OF EDUCATION, WINNEBA

EVALUATION OF CLASSROOM IMPLEMENTATION OF ELECTIVE CHEMISTRY PROGRAMME IN SELECTED SCIENCE AND MATHEMATICS COLLEGES OF EDUCATION IN THE VOLTA REGION, GHANA

FRANCIS KOKU RAS KUMABIA

2014

UNIVERSITY OF EDUCATION, WINNEBA

EVALUATION OF CLASSROOM IMPLEMENTATION OF ELECTIVE CHEMISTRY PROGRAMME IN SELECTED SCIENCE AND MATHEMATICS COLLEGES OF EDUCATION IN THE VOLTA REGION, GHANA

FRANCIS KOKU RAS KUMABIA

A Thesis in the Department of Science Education, Faculty of Science Education, submitted to the School of Graduate Studies, University of Education, Winneba in partial fulfillment of the requirements for award of the Master of Philosophy degree in Science Education (Chemistry)

AUGUST, 2014

DECLARATION

Candidate's Declaration

I hereby declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree in this university or elsewhere.

Candidate's Signature: …………………………… Date: …………………………..

Name: Francis Koku Ras Kumabia

Supervisors' Declaration

We hereby declare that the preparation and presentation of this thesis was supervised in accordance with the guidelines on supervision of thesis as laid down by the University of Education, Winneba.

Principal Supervisor's Signature……………………………Date …..…………………

Name: Prof. John K. Eminah

Co-supervisor's Signature ………………………………. Date: ……………………

Name: Dr. Victus B. Samlafo

ACKNOWLEDGEMENTS

I wish to express my first and foremost heartfelt appreciation to my principal supervisor, Prof. J. K. Eminah, and my co-supervisor, Dr. V. B. Samlafo who are in the Department of Science Education, University of Education, Winneba, for the technical guidance, constructive criticisms and encouragements I received from them as supervisors during the conduct of this study.

I also wish to render my sincerest gratitude to all other lecturers in UEW especially Prof. M.K. Amedeker, Prof. Raheem Kolawole, Dr. T. Tachie Young, Dr. E. Ngman-Wara, Dr. K.D. Taale, Dr. Nana Annang and Mr. L. H. Bobobee; as well as Prof. J. Ghattey Ampiah at UCC, for the support and assistant rendered to me towards effective conduct of this research.

My profound gratitude also goes to the principals, staffs and students of St. Francis College of Education, Hohoe and Akatsi College of Education, Akatsi for allowing me to undertake this study in these institutions.

I also acknowledge the assistance given to me by my course mates especially: James G. Lurri, Emmanuel Battels, Alphonso Taylor, Mary Ayeriga, Mbage Bawa, Chris Degbor and Edward Adagudugu.

Finally, my appreciations go to my mother: Tenuvia and my siblings: Offey, Mefanawo, Esenam and Mawufemor for standing together by my side throughout my education.

Thank you all.

DEDICATION

This work is dedicated to my wife; Cynthia Akotoye and my children; Amanda, Marcus, and Malcolm Kumabia, for whom I aspire to stand tall.

TABLE OF CONTENTS

Content **Page**

CHAPTER TWO: REVIEW OF RELATED LITERATURE

CHAPTER THREE: METHODOLOGY

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

LIST OF APPENDICES

Appendix

Page

ABSTRACT

This study evaluated the classroom implantation process of the elective chemistry programme at selected science and mathematics colleges of education in the Volta Region of Ghana. The target population was the science students and their tutors at the 15 designated science and mathematics colleges of education in Ghana. The accessible population consisted of second year elective chemistry students and their chemistry teachers at the two designated science and mathematics colleges of education in the Volta Region. Purposive sampling technique was used to select 123 chemistry students and 5 chemistry teachers for the study. A combination of qualitative and quantitative data collecting instruments including questionnaire, interviews, observation schedules, and document analysis were used in the study. The data analysis involved the use of multiple statistical procedures which included simple percentages, means, standard deviations and independent sample 2-tailed t-test of significance. The data analysis results indicated that majority (60%) of the chemistry teachers were qualified chemistry teachers. The rest 40%

were qualified laboratory technicians. The results also showed that the colleges lacked adequate material resources which are essential pre-requisites for effective chemistry programme implementations. It was found out that the duration allocated to the study of chemistry was not sufficient. Teachers were also found to have employed implementation strategies which did not lead to the achievement of the programme objectives. It was recommended that government should supply enough materials to these colleges to ensure proper organisation of practical lessons in chemistry. Periodic in-service training programmes should also be organised for the teachers of college chemistry. Finally, adequate time should be allocated to the chemistry programme implementation processes.

CHAPTER ONE

INTRODUCTION

Overview

This chapter covers the background, statement of the problem, purpose of the study and the objectives of the research report. It also includes the significance, research questions, delimitations and the limitations. It finally covers the terminologies used in the study and organization of the research report.

Background to the Study

According to Rosser-Cox (2011) teacher education refers to the policies and procedures designed to equip prospective teachers with the knowledge, attitudes, behaviours, and skills they require to perform their tasks effectively in the classroom, school and wider community.

To ensure the achievement of these objectives, teacher education is based on the following principles:

1. To prepare teachers to function effectively in the basic schools.
2. To provide a comprehensive teacher education programme through pre-service and in-service training that would produce competent, committed and dedicated teachers to improve the quality of teaching and learning at the basic education level and also to develop school based support for teachers.

To achieve these goals certain priorities have been put in place (Rosser-Cox, 2011). These include:

1. Targeting school-based in-service training for school heads and teachers.
2. Continuous in-service training of all district education personnel particularly Assistant Directors (in charge of supervision) and Circuit Supervisors.
3. Improving on pre-service training of the teacher.
4. Improving on the performance of tutors in the colleges.

In addition, the core function of teacher education is the management and implementation of in-service teacher education and training through up-dating of knowledge and skills on innovative pedagogy. To accomplish these tasks effectively, colleges of education in Ghana were supplied with well organised, structured and comprehensive syllabi and course outlines in all subjects including chemistry. These serve as guides towards the impartation and reception of knowledge appropriately and expectedly.

A curriculum is a plan or programme of all experiences which the learner encounters under the direction of a school (Tanner & Tanner, 1995). According to Gatawa (1990), a curriculum is the totality of the experiences of children for which schools are responsible. For others such as Beach and Reinhatz (1989), a curriculum outlines a prescribed series of courses to take based on the cognitive levels of the pupils.

It is possible to infer from the views which were stated above that a curriculum has the following characteristics:

1. It is planned.
2. It has content.

3. It is a series of courses to be taken by students
4. It comprises the experiences of children for which the school is responsible.
5. It is evaluated to provide a feed-back.

In addition, a curriculum considers the learners and their interaction with each other, the teacher and the materials. The output and outcomes of a curriculum are evaluated. Bringing all these points together, the curriculum is viewed as a composite whole including the learner, the teacher, teaching and learning methodologies, anticipated and unanticipated experiences, outputs and outcomes possible within a learning institution within a period of time.

In order to ensure that a curriculum which is under implementation exhibits its desired attributes, it needs to be thoroughly evaluated. According to Gatawa (1990), the term curriculum evaluation has three major meanings. These are:

a) The process of describing and judging an educational programme or subject.
b) The process of comparing a student's performance with behaviourally stated objectives.
c) The process of defining, obtaining and using relevant information for decision-making purposes.

Olivia (1988) defined curriculum evaluation as the process of delineating, obtaining, and providing useful information for judging alternative decision. The primary alternative decision to consider based upon the evaluation results are: to maintain the curriculum as it is; to modify the curriculum, or to eliminate the curriculum.

From the definitions stated above, curriculum evaluation could be viewed holistically as the collection and provision of evidence on the basis of which decisions can be made about the feasibility, effectiveness and educational value of curricula through well organised and systematic processes. In line with the definitions above, Urevbu (1985) has identified some functions of curriculum evaluation as informing decision-makers on the state of affairs of certain curriculum programmes or syllabuses, and enabling teachers to evaluate themselves. The future of every country including Ghana lies in knowledge. But our ability to generate new knowledge and use it innovatively depends upon having a scientifically literate population. Although people learn throughout their lives, good science education is a vital preparation for scientific literacy in later life.

To ensure a continuous supply of science teachers to the basic schools, 15 out of the existing 38 public colleges of education in Ghana have been designated in 2007 to run a special science and mathematics programme. Course outlines in the various sciences (biology, chemistry and physics) were designed to that effect and the implementation process of the programme is underway.

The programme objectives, according to Teacher Education Division [TED] (2007), are to enable the students to:

1. Acquire the relevant scientific knowledge on topics treated in the science programme.
2. Organise their knowledge into concepts.
3. Acquire relevant manipulative skills to enable them to handle and operate science equipment and materials.

4. Solve conceptual problems related to topics treated in the science programme.
5. Apply the knowledge and skills acquired in the science programme to the organisation of science lessons.
6. Relate the knowledge acquired in the science program to situations in everyday life.

The programme was divided into sections that deal with content and the practical aspects in Biology, Chemistry and Physics as separate entities. Each unit (and sub-unit) comprises topics that are closely related or deal with identical or similar concepts. Such concepts are expected to be treated sequentially to aid understanding.

However, the chemistry programme, which is the focus of this study, has its own description and objectives. As provided by TED (2007), the chemistry programme was designed to consolidate the content and skills students have acquired from their lessons in elective and integrated science chemistry at the Senior High School (SHS) level. The course covers the following topical areas: Structure of atom; relative atomic mass; atoms, molecules and ions as building blocks of matter; chemical bonding, chemical reactions, amount of substance, solutions, reaction rates and water.

More specifically, the chemistry course will enable students to:

i. Acquire knowledge of basic concepts on the nature and constituents of matter.
ii. Apply the knowledge acquired in the course to explain various phenomena in science.

iii. Undertake simple practical activities related to different aspects of the course.

It is, therefore, the aim of this study to conduct a comprehensive evaluation on the classroom implementation process of the chemistry programme, which forms part of the science programme, slated for the designated science and mathematics colleges of education in Ghana. This will help to establish the level achievement of the programme stated objectives.

The main aim of this study was to evaluate the classroom implementation process of the chemistry programme of selected designated Science and Mathematics Colleges of Education in the Volta Region of Ghana. The choice of the topic was based on the fact that in 2007, the Government of Ghana, in collaboration with the Ministry of Education, the Ghana Education Service, the Teacher Education Division, and the Institute of Education of the University of Cape Coast; selected and mandated 15 out of the existing 38 public colleges of education to run a special science and mathematics programme according to stated aims, goals and objectives.

However, my preliminary checks and methodical findings revealed that no one had evaluated the implementation process of the chemistry programme since its inception. The implications of this oversight or inadvertent delay include the fact that the programme designers, the teachers and other interested parties would not have any feedback on the success or otherwise of its implementation process. In effect, the quality of the students who study this programme will be questionable since there were no empirical tests to confirm their conformity to the objectives and the demands of the programme they have studied.

According to Gatawa (1990), the content of a curriculum must be evaluated in order to establish whether it is relevant to the needs and aspirations of the society. When evaluating curriculum content, the focus should be on the effect it has on learners. It is important to determine whether the methodology is consistent with the curriculum objectives and appropriate for the content. This implies that evaluation of the content as well as the implementation process will provide a feedback which will in turn allow the curriculum developers and implementers to be certain about the functions of the curriculum put in place, as well as provide information on the effectiveness of the instructional materials and pedagogical skills employed.

Curriculum implementation entails putting into practice the officially prescribed courses of study, syllabuses and subjects. The process involves helping the learner acquire knowledge or experience (University of Zimbabwe, 1995). Curriculum implementation, however, cannot take place without the learner. The learner is therefore the central figure in the curriculum implementation process. Implementation takes place as the learner acquires the planned or intended experiences, knowledge, skills, ideas and attitudes that are aimed at enabling the same learner to function effectively in a society.

Curriculum implementation also refers to the stage when the curriculum itself, as an educational programme, is put into effect. Putting the curriculum into operation requires an implementing agent. Stenhouse (1979) Implementation takes place when the teacher-constructed syllabus, the teacher's personality, the teaching materials and the teaching environment interact with the learner (University of Zimbabwe, 1995). Curriculum implementation, therefore, refers to how the planned or officially designed course of study is translated by the teacher into syllabuses, schemes of work and lessons to be delivered to students.

Implementation is an interaction between those who have created the programme and those who are charged to deliver it. According to Ornstein and Hunkins (1998), even though large sums of money are spent on implementing new curriculum, several of these efforts have failed. According to Sarason (1990), the main reason for the failure is the lack of understanding of the culture of the school by both experts outside the school system and educators in the system. Successful implementation of curriculum requires understanding the power relationships, the traditions, the roles and responsibilities of individuals in the school system. Implementers (whether they be teachers, principals, and district education officers) should be well-versed with the contents of the curriculum. They must be clear of the purpose, the nature, and the real and potential benefits of the innovation.

A curriculum must be implemented if it is to make any desired impact on students and to attain its goals. And unless it is implemented, it cannot be evaluated for betterment. In spite of careful planning and design, it is possible that a curriculum fails to meet the needs for which it is developed (Ornstein & Hunkins, 1988). They pointed out that implementation involves attempts to change individuals knowledge, actions and attitudes.

The role of teachers in curriculum implementation is crucial (Eminah, 1993). During curriculum implementation, teachers select teaching and learning materials, assign tasks to learners, conduct assessments and provide a variety of learning experiences and environments. However, effective teaching and learning, which form the core components of curriculum implementation, cannot be brought about by these roles alone. Research on effective curriculum programme implementation must focus fairly and squarely on teachers' qualification and their areas of specialization and on activities in the classroom, in particular on the type of interactions between teacher and pupil (Ololube, 2006). It must also cover aspects of learner characteristics which include gender and pupils' attitude as well as collegial factors such as the type resources available for the effective implementation of a curriculum programme.

In view of these, aspects such as college chemistry teachers' qualifications and areas of specialization as well as the resources (human and material) available at the colleges for the implementation of the chemistry programme will be investigated. Observations of how the classroom implementation of the course was being done alongside the attitudes of both the teachers and students of college elective chemistry were the main focus of this study.

Statement of the Problem

The nationwide drift away from science by majority of Ghanaian students despite its importance in everyday life calls for a re-structuring of pre-university science in Ghana. This requires bold and novel science teaching and learning approaches, particularly at the pre-university level (Teacher Education Division, 2007). To address this situation in Ghana, the ministry of education upgraded the teacher Training Certificate Programme to a diploma programme and the setting aside 15 colleges of education to pursue a quasi specialist programmes in science and mathematics education. This was one of the innovative strategies to improve the teaching and learning of science and mathematics in the colleges and in basic schools in Ghana.

Since the designation of 15 public colleges of education in Ghana in 2007 to run the special science and mathematics programmes, no comprehensive formal evaluation work had been done to determine how well or otherwise the implementation of the chemistry programme was on going. This was evident by the fact that no document(s) on the evaluation or change inputs had been received by these colleges from either the designers of the programme or any interested individual informing them of the success or otherwise of the programme.

One area of concern is the yearly chief examiners' reports which indicate that the performance of the science students in chemistry had generally been lower and incidentally suggested that students performed abysmally low in chemistry than in biology and physics. Incidentally, biology and physics are other science subjects studied by the same students. This trend could be attributed to a number of factors. These factors could have been visualized adequately if a comprehensive evaluation had been conducted on the entire science programmes in general and the chemistry programme in particular.

According to Anamuah-Mensah (1999) any science education programme that fails 40% or more of its students needs to be re-examined. No country can develop its science and technology effectively if over 40% of the students fail to understand basic concepts in the subject. Teachers are known to be one of the solutions to educational problems. It was, therefore, imperative to conduct an evaluation on the design and implementation processes of the programme so as to inform the key players in education on the adequate innovative strategies that should be employed for the achievement of national educational objectives.

This study was intended to evaluate the classroom implementation process of the chemistry programme of designated Science and Mathematics Colleges of Education in the Volta Region of Ghana. The focus would not only be on the nature of the classroom interactions between the teachers and students during elective chemistry lessons, but also on teachers, students and specific environmental factors that militate against the effective implementation of colleges of education elective chemistry programme.

Purpose of the Study

The study sought to evaluate the classroom implementation process of the chemistry programme of selected designated Science and mathematics Colleges of Education in the Volta Region of Ghana. The main focus of the study was on the implementation activities as deduced from the teachers' and students' verbal and non-verbal behaviours during chemistry lessons. These included the types of interactions that existed between teachers, students and resources during chemistry lessons.

In addition, the study was to find out the teachers' qualification and areas of specialization. The study further sought to find out the resources that were available at the designated colleges of education for the implementation of the elective chemistry programme. Finally the study sought to investigate the perception of teachers and students on the nature of the implementation process of the chemistry programme as being experienced at the selected colleges.

Research Objectives

The objectives of this research were to:

1. Identify the factors which influence the role of teachers and students during the classroom implementation of the college elective chemistry programme.
2. Investigate the availability, adequacy and the level of use of educational resources during classroom implementation of the college elective chemistry programme.
3. Identify the nature of classroom interactions that exist between teachers, students, and resources during the implementation process of the elective chemistry programme.
4. Determine the conformity of the implementation strategies employed by teachers of college elective chemistry to stated programme objectives.

Research Questions

In order to achieve the research objectives, the following research questions were formulated to direct the study:

1. What factors influence the roles of teachers and students during the classroom implementation of college elective chemistry programme?
2. What resources are available at the designated science and mathematics colleges of education for classroom implementation of the elective chemistry programme?
3. Which types of classroom interactions exist between teachers, students, and resources during the implementation process of the elective chemistry programme?
4. Do the implementation strategies employed by teachers of colleges of education elective chemistry conform to the stated programme objectives?

Significance of the Study

This study would produce a document that reports on the factors that influence the effective classroom implementation process of the elective chemistry programme at the designated science and mathematics colleges in the Volta region of Ghana.

Firstly, the study would provide science educators, college chemistry programme planners and designers as well as the Ministry of Education with the detailed information about the actual practices that go on during the teaching and learning of elective chemistry at the designated science and mathematics colleges of education in the Volta region. This would enable them to determine the success or otherwise of the classroom implementation process of the college elective chemistry programme.

Secondly, the findings of the study might lead to the development of training programmes in Ghana which would help science teachers in general and college chemistry teachers in particular to acquire the pedagogical skills needed for effective chemistry teaching.

Thirdly, the study would produce information to help the teachers and students of college chemistry on some of the effective classroom interactions as well as some basic approaches which enhance the teaching and learning of chemistry at the college level. Finally, the study would unveil the available resources at the colleges of education as well as the expected resources to be provided towards the effective implementation of the elective chemistry programme.

Limitations of the Study

The subjects used for the study were limited to 123 second year elective chemistry students and five (5) chemistry teachers from two (2) out of the fifteen (15) designated science and mathematics colleges of education in Ghana. Hence results of this study cannot be generalized to all the designated science and mathematics colleges of education in Ghana. However, the results of the study can be generalized to subjects that have similar characteristics in the same settings.

Delimitations of the Study

Even though there are 38 public Colleges of Education in Ghana, this study was limited to the 15 designated science and mathematics colleges only. In order to ensure a good coverage, the study was again restricted to only the two designated science and mathematics colleges of education in the Volta region. This was because these colleges are involved in the implementation process of the chemistry programme. In addition, the study was limited to only the second year elective science students at these colleges. The first year science students were excluded from the study because as at the time the actual study was conducted, they had not studied chemistry for at least a semester. This could not give them the opportunity to provide basic information, such as grade obtained in chemistry from the previous semester's examinations, for the study

This study focused on the tutors' and students' verbal and non-verbal classroom behaviours. It did not involve their knowledge of the subject matter in the chemistry programme. Data was collected on the second year science students and their tutors. More specifically the study was centered on only the classroom implementation process of the chemistry programme and not on other branches of science such as physics and biology.

Definition of Terms

The terminologies used in this report write-up have been provided below. They were used for the sake of convenience and confinement of this study only.

1. College A — St. Francis College of Education, Hohoe – VR
2. College B — Akatsi College of Education, Akatsi – VR

Organisation of the Report

The research report was organised under five chapters. Chapter one presents the introduction of study consisting of the background to the study, the statement of the problem, purpose of the study and objectives of the research. It also presents the research questions, significance of the study, delimitations and the limitations of the study. Chapter two provides the theoretical framework and the review of the literature which are related to the study. Chapter three gives detailed information about the methodology used in the study, describing the research design, areas of the study, the population, sample and sampling procedure, instrumentation, validity and reliability of the main instruments, data collection procedures and methods of data analysis.

In chapter four, the data collected have been organised and presented in line with the research questions. The findings / results of the study have been presented in this chapter.

In addition, interpretations and analysis of the findings with reference to the results of related research work have been presented as the discussion in this chapter. The final chapter, chapter five provides the summary of the major findings, the conclusion of the study, recommendations and suggestions for further research work.

CHAPTER TWO

LITERATURE REVIEW

Overview

This Chapter comprises a review of relevant and related literature on the topic under investigation. A critical conceptual and theoretical framework was done to justify the need for the study under the headings and sub-headings listed below:

1. The relevance of teacher education to individuals and society.
2. Factors that influence the roles of teachers and students during the classroom implementation of the college elective chemistry programme.
3. Resources available for practical elective college chemistry teaching.
4. Types of classroom interaction and its influence on students' science concept acquisition.
5. Significance of curriculum programme evaluation as related to college chemistry programme.

The Relevance of Teacher Education to Individuals and Society

Education is the act or process of imparting or acquiring general knowledge, developing the powers of reasoning and judgment; and generally preparing oneself or others intellectually for mature life, or acquiring particular knowledge or skills, as for a profession (Collins English Dictionary, 2009). The concept of education has been viewed in many ways out of which other concepts such as basic education, secondary education, teacher education and university education evolved.

Teacher education around which this study was centered refers to the policies and procedures designed to equip prospective teachers with the knowledge, attitudes, behaviours, and skills they require to perform their tasks effectively in the classroom, school and wider community (Wikipedia, 2013). Although ideally teacher education should be conceived of, and organised as, a seamless continuum, teacher education is often divided into these stages:

i. Initial teacher training / education (a pre-service course before entering the classroom as a fully responsible teacher);
ii. Induction which is the process of providing training and support during the first few years of teaching or the first year in a particular school;
iii. Teacher development or continuing professional development (an in-service process for practicing teachers).

Teacher Education in Ghana has passed through many stages resulting in various categories of teachers who possess different professional qualifications – certificate, diploma, and degree in the system. Currently, the training of teachers in Ghana is mainly located in the Colleges of Education (formerly Teacher Training Colleges) and two universities – University of Cape Coast, and University of Education, Winneba. The colleges of education train teachers in 'Diploma in Basic Education' for the Basic Schools (Basic 1–9) level, while the universities prepare and equip prospective teachers with Certificate, Diploma, and Degree for basic, secondary and tertiary levels (Wikipedia, 2013).

Teacher education in Ghana is structured to include aspects such as mathematics education, English language studies, vocational skills and art education, and science education among others. College science in Ghana is divided into two. The first is integrated science which is studied by students offering programmes such as General, Early-Childhood Development, French, and Technical skills. Whilst the second, which is referred to as elective science, comprising biology, chemistry and physics, is studied by students admitted to offer the designated Science and Mathematics programmes (TED, 2007).

Norris and Philips (2003) contend that the term scientific literacy has been used to include various components from the following:

(a) Knowledge of the substantive content of science and the ability to distinguish from non-science;

(b) Understanding science and its applications;

(c) Knowledge of what counts as science;

(d) Independence in learning science;

(e) Ability to think scientifically;

(f) Ability to use scientific knowledge in problem solving;

(g) Knowledge needed for intelligent participation in science-based issues;

(h) Understanding the nature of science, including its relationship with culture;

(i) Appreciation and comfort with science, including its wonder and curiosity;

(j) Knowledge of the risks and benefits of science; and

(k) Ability to think critically about science and to deal with scientific expertise.

Whilst the public image of science education may be one of simply learning facts by rote, science education in recent history also generally concentrates on the teaching of science concepts and addressing misconceptions that learners hold regarding science concepts. Science education has been strongly influenced by constructivist thinking (Taber, 2009).

Constructivism in science education has been informed by an extensive research programme into students' thinking and learning in science, and in particular exploring how teachers can facilitate conceptual change towards canonical scientific thinking. Constructivism emphasizes the active role of the learner, and the significance of current knowledge and understanding in mediating learning, and the importance of teaching that provides an optimal level of guidance to learners (Taber, 2011).

According to Diamond (2011), the science curriculum at any level is a statement about the elements of science we choose to teach which are selected from a much larger set of possibilities. These choices, for example determines the purpose of education and what values individuals and society cherishes, and about the balance between intrinsic and instrumental reasons for learning. Empirical evidence may inform these choices, but it cannot determine the choices.

According to TED (2007), the need for re-structuring of pre-university science teaching and learning has been felt for quite some time now in Ghana. This was partly because of the importance of science in everyday life as well as part of our global cultural literacy. Ironically there is currently a nationwide drift away from science by majority of students. To reverse this trend requires bold and novel science teaching and learning approaches, particularly at the pre-university level.

The colleges of education programme was designed in such a way that there is a separate section on content, methodology and practical activities, each of which has been coded and weighted. This helped to avoid the previous practice of subsuming practical activities under the content and methodology sections. The separation of the syllabus into the three components is to ensure that by the end of the programme, students will acquire the relevant competencies with respect to Junior High School science teaching (TED, 2007). The format of the syllabus was such that the contents were separated into Physics, Biology and Chemistry. The chemistry aspect was sub-divided into Chemistry 1 (FDC 114C and FDC 114CP) which are theoretical and practical aspects respectively to be studied in year one semester one; and Chemistry 2 (FDC 224C and FDC 224CP), which are theoretical and practical aspects respectively, to be studied in the second semester of the second year.

The first year chemistry course was designed to consolidate the content and skills students have acquired from their lessons in Elective and Integrated Science Chemistry at the Senior High School level. The course, as a result, covers topical areas as: Structure of the atom; relative atomic mass; atoms, molecules, and ions as building blocks of matter; chemical bonding; chemical reactions; amount of substance; solutions; reaction rates and water (TED, 2007).

The syllabus provides that at the end of the first year the learner should be able to:

1. Acquire knowledge of basic concepts on the nature and constituents of matter.
2. Apply the knowledge acquired in the course to explain various phenomena in science.
3. Undertake simple practical activities related to different aspects of the course.

In addition the second year chemistry course was designed to increase the knowledge and skills of students on topics learnt in Elective Chemistry and Integrated Science Chemistry at the Senior High School level. The course covers topics such as acids, bases and salts;

chemistry of carbon compound – alkanes, alkenes alkynes, alcohols, alkanoic acids, alkyl alkanoates, and synthetic polymers.

The teacher of the college chemistry programme is to ensure that at the end of the second year the students will be able to:

i. Obtain a full understanding of the concept of acids, bases and salts and their characteristics.
ii. Acquire an in-depth knowledge of the chemistry of carbon compounds.
iii. Identify and classify natural and synthetic polymers.

Factors which Influence the Roles of Teachers and Students during College Chemistry Programme Implementation

Ornstein and Hunkins (1998) explained that effective implementation of innovations requires time, personal interaction and contacts, in-service training and other forms of people-based support. Curriculum implementation requires winning people over and it takes time. Teachers need to feel appreciated and their efforts recognised. Some players in education may argue that teachers should be given financial rewards but there is evidence to suggest that external motivation contributes minimally to the venture. Individuals contribute their best talents when they are internally motivated and derive a good feeling from being involved.

Without doubt, teachers are the most important persons in the curriculum programme implementation process. With their knowledge, experience and competencies, teachers are central to any curriculum improvement effort. Regardless of which philosophical belief the education system is based on, teachers influence students' learning (Ornstein & Hunkins, 1998). Better teachers foster better learning. Teachers are most knowledgeable about the practice of teaching and are responsible for introducing the curriculum in the classroom. The key to getting teachers committed to an innovation is to enhance their knowledge of the programme. This means teachers need to be trained and workshops have to be organised for their professional development. Unfortunately, in the college chemistry programme implementation process in Ghana, not all teachers have the benefit of such exposure. This is because there are just too many teachers and insufficient funds to go around. The most common approach is to have one-day workshops given by experts with the lecture method being the dominant pedagogical strategy. Among the many extrinsic factors identified which could impede curriculum programme implementation are adequacy of resources, time, school ethos and professional support. The intrinsic factors are; professional knowledge, professional adequacy and professional interest and motivation (Fullan & Pomfret, 1977).

The following factors can influence the roles of the teacher in curriculum programme implementation:

1. **Adequacy of resources:** Adequacy of equipment, facilities and general resources required for implementing a new curriculum programme.
2. **Time:** Time available for preparing and delivering the requirements of the new curriculum. For example, teachers need enough time to develop their own understanding of the subject they are required to teach.
3. **School ethos:** Overall school beliefs towards the new curriculum. Status of the curriculum as viewed by staff, administrators and community. For example the

school administration recognises the importance of the subject in the overall school curriculum.

4. **Professional support:** Support for teachers from both within the school and outside. This include opportunities to receive ongoing curriculum professional support
5. **Professional adequacy:** Teachers' own ability and competence to teach the curriculum. i.e. confidence in teaching
6. **Professional knowledge:** Knowledge and understandings teachers possess regarding the new curriculum. For instance the knowledge in different ways of teaching in order to foster students' learning.
7. **Professional attitude and interest:** Attitudes and interest of teachers toward the new curriculum. For example how keen he/she is to teach the subject (SCIQ, 2004).

Hence, professional development of teachers of college elective chemistry is an important factor which contributes to the success of its implementation. To what extents have teacher education programmes required prospective teachers to study curriculum implementation and evaluation? Some actors in education view teachers as technicians and as such do not include curriculum implementation and evaluation in their teacher education programmes. Certainly an adequate teacher education programme should include curriculum implementation and evaluation (both the theory and the practical work) if teaching is to be a profession and if educational opportunities for learners are really to be improved.

It is, therefore, important for college chemistry teachers to understand both the philosophy behind the chemistry programme as well as how the new programme may impact students, parents, administrators and other stakeholders. Teachers might find the chemistry programme introducing content with that unfamiliar, which they have not taught in a while, or is familiar but presented in an unfamiliar way.

The learner, on the other hand, is the primary reason of developing the curriculum. Everything in a curriculum revolves around the learner's interest, skills and abilities. They are the primary concern of every teacher during the teaching process. Therefore, the target of the college chemistry programme was to help the learner to achieve the following at the end of programme study:

i. Acquisition of knowledge of basic concepts on the nature and constituents of matter
ii. Application of the knowledge acquired in the course to explain various phenomena in science
iii. Undertake simple practical activities related to different aspects of the course

These are further discussed below:

Acquisition of knowledge of basic concepts on the nature and constituents of matter

During the classroom implementation process of the college chemistry programme, it is expected of the teacher to ensure that the students acquire knowledge of basic concepts on the nature and constituents of matter as stated in the syllabus. Matter should not be confused with mass, as the two are not quite the same in modern physics (Mongillo, 2007). For example, mass is a conserved quantity, which means that its value is unchanging with time, within closed systems. However, matter is not conserved in such systems, although this is not obvious in ordinary conditions on earth, where matter is approximately conserved. Still, special relativity shows that matter may disappear by conversion into energy, even inside closed systems, and it can also be created from energy, within such systems. In addition, because mass (like energy) can neither be created nor destroyed, the quantity of mass and the quantity of energy remain the same during a transformation of matter (which represents a certain amount of energy) into non-material (i.e., non-matter) energy. This is also true in the reverse transformation of energy into matter (Mongillo, 2007). However, although matter may be created or destroyed, neither the quantity of mass nor energy changes during the process.

Science colleges of education chemistry students are expected to be introduced to the idea that matter is composed of atoms and molecules that are attracted to each other and in constant motion. The students are required to explore the attractions and motion of atoms and molecules as they experiment with and observe the heating and cooling of a solid, liquid, and gas (TED, 2007). The teacher is expected to help students to design experiments to test whether the temperature of water affects the rate of evaporation and whether the temperature of water vapor affects the rate of condensation. Students should also look in more detail at the water molecule to help explain the state changes of water (American Chemical Society, 2013).

Students should experiment with objects that have the same volume but different mass and other objects that have the same mass but different volume to develop the concept of density. Students must also experiment with density in the context of sinking and floating and look at substances on the molecular level to discover why one substance is more or less dense than another. In order to help students to acquire the concept of chemical bonding, the students are expected by the college chemistry syllabus to look more deeply into the structure of the atom and play a game to better understand the relationship between protons, neutrons, electrons, and energy levels in atoms and their location in the periodic table. Students should also explore covalent and ionic bonding (TED, 2007).

With respect to the teaching of the concept of water, college chemistry students are expected to investigate the polarity of the water molecule and design experiments to compare water to less polar liquids to determine evaporation rate, surface tension, and ability to dissolve certain substances. Students also discover that dissolving applies to solids, liquids, and gases. In addition, students are also expected to be able to draw the structure of water, know the various sources of water, uses of water, and the water cycle. Some unique properties of water such as the anomalous expansion of water, water as a universal solvent, hardness of water, and the polar nature of water. As part of their practical activity, college chemistry students are expect to be assisted by their teacher to construct a simple water filtration apparatus after a visit to the nearest water treatment plant.

Application of knowledge acquired in the course to explain various phenomena in science

According to the National Academy of Sciences [NAS] (1998), scientific method is a way of learning or a process of using comparative critical thinking. Things that are not testable or falsifiable in some scientific or mathematical way, now or in the future, are not considered science. Falsifiability is the principle that a proposition cannot be scientific if it does not admit the possibility of being shown false. Science takes the whole universe and all phenomena in the natural world under its purview, limited only by what is feasible to study given our current physical and fiscal limitations. Anything that cannot be observed or measured or shown to be false is not amenable to scientific investigation.

Explanations that cannot be based on empirical evidence are not a part of science (NAS, 1998). To accomplish these colleges chemistry students are mandated to study nature of science and its implication for teaching and learning. Here the teacher is to help the students understand the relationship between science and technology, as well as between science and traditional beliefs (TED, 2007). They should also be made to understand reaction rates; during which factors that affect reaction rates and types of catalysts that affect reaction rates should be explained to them.

According to Scriven (1973) scientific explanations are limited. Scientific knowledge is necessarily contingent knowledge rather than absolute, and therefore must be evaluated and assessed, and is subject to modification in light of new evidence. It is impossible to know if we have thought of every possible alternative explanation or every variable.

Understanding of the nature of science - the goals, values and assumptions is inherent in the development and interpretation of scientific knowledge (Lederman, 1992). He explained further that knowledge of the nature of science can enable individuals to make more informed decisions with respect to scientifically based issues; promote students' in-depth understandings of "traditional" science subject matter; and help them distinguish science from other ways of knowing.

By sticking to certain accepted "rules of reasoning," scientific method helps to minimize human influence on results. Thus, science is seen as a pathway to study phenomena in the world, based upon reproducibly testable and verifiable evidence. This pathway may take different forms; in fact, creative flexibility is essential to scientific thinking, so there is no single method that all scientists use, but each must ultimately have a conclusion that is testable and falsifiable; otherwise, it is not science (McLelland, 2006).

Both college chemistry teachers their science students should understand that the scientific method in actuality is not a set sequence of procedures that must happen, although it is sometimes presented as such. Some descriptions actually list and number three to fourteen procedural steps. No matter how many steps it has or what they cover, the scientific method does contain elements that are applicable to most experimental sciences, such as physics and chemistry, and is taught to students to aid their understanding of science.

In the view of McLelland (2006), the scientific method may include some or all of the following "steps" in one form or another: observation, defining a question or problem, research (planning, evaluating current evidence), forming a hypothesis, prediction from the hypothesis (deductive reasoning), experimentation (testing the hypothesis), evaluation and analysis, peer review and evaluation, and publication. According to National Science Teachers Association [NSTA] (1998), theories are powerful tools. Scientists therefore, seek to develop theories that;

1. are firmly grounded in and based upon evidence;
2. are logically consistent with other well-established principles;
3. explain more than rival theories; and
4. have the potential to lead to new knowledge

Scientific theories are falsifiable and can be re-evaluated or expanded based on new evidence. This is particularly important in concepts that involve past events, which cannot be tested. Take, for example the theory of biological evolution as it pertains to the past that explain all of the facts so far gathered from the past, but cannot be verified as absolute truth, since we cannot go back to test them.

More and more data will be gathered on each to either support or disprove them. The key force for change in a theory is, of course, the scientific method (NTSA, 1998).

Undertake simple practical activities related to different aspects of the course

It is often argued that practical work is central to teaching and learning in science and that good quality practical work helps develop pupils' understanding of scientific processes and concepts (Lunetta et al., 2007). Practical work involves learning experiences in which students interact with materials or with secondary sources of data to observe and understand the natural world. "When well planned and effectively implemented, science education laboratory and simulation experiences situate students' learning in varying levels of inquiry requiring students to be both mentally and physically engaged in ways that are not possible in other science education experiences" (Lunetta et al., 2007, p. 405).They opined that students and their teachers need to understand something about the nature of science if they are to appreciate the limits and value of practical activities.

Practical work, both in the classroom and outdoors, is an absolutely essential component of effective college chemistry teaching. Appropriate practical work enhances pupils' experience, understanding, skills and enjoyment of science. Moreover, practical work "allows science education to become something that learners participate in, rather than something they are subject to and supports aspirations towards further study and science-related work." (House of Lords, 2006, p.195)

Roberts (2002) mentioned that the supply of people with science, technology, engineering, and mathematics skills highlights the quality of school science laboratories as a key concern. These, it argues, “are a vital part of students’ learning experiences and should play an important role in encouraging students to study science at higher levels” (Roberts, 2002, p.66). It goes on to recommend that the governments and local education authorities should prioritise school science laboratories, and ensure that investment is made available to bring all such laboratories up to a good or excellent standard - a standard which is representative of the world of science and technology today and that will help to inspire and motivate students to study these subjects further (Roberts, 2002)

There is also evidence that students find practical work relatively useful and enjoyable as compared with other science teaching and learning activities. In survey responses of over 1,400 students of a range of ages, Cerini, Murray, & Reiss (2003) found out that 71% chose ‘doing an experiment in class’ as one of the three methods of teaching and learning science they found ‘most enjoyable’. A somewhat smaller proportion (38%) selected it as one of the three methods of teaching and learning science they found ‘most useful and effective’. In both cases, this placed it third in rank order.

Despite the widespread use of practical work as a teaching and learning strategy in school science, and the commonly expressed view that increasing its amount would improve science education, some science educators have raised questions about its effectiveness. Hodson (1991) mentioned that, as practiced in many schools, practical work is ill-conceived, confused and unproductive to many children. What goes on in the laboratory contribute little to their learning of science.

Wellington (1998) suggests that it is time for a reappraisal of the role of practical work in the teaching and learning of science. The importance of practical work in science is widely accepted and it is acknowledged that good quality practical work promotes the engagement and interest of students as well as developing a range of skills, science knowledge and conceptual understanding.

Resources Available for Practical Elective College Chemistry Teaching

There are many purposes for doing practical work in college chemistry. Some of the most frequently stated purposes by teachers are to:

1. Encourage accurate observation and description;
2. Make phenomena more real;
3. Arouse and maintain interest;
4. Promote a logical and reasoning method of thought.

In order to ensure proper organisation and involvement of practical activities in college science (chemistry) teaching, the Government of Ghana in collaboration with the Ministry of Education and the Teacher Education Division has built modern science laboratories in all the 15 designated Science Colleges of Education across the country. Chemicals and modern laboratory equipment have also been supplied to facilitate the proper implementation of the Science (chemistry) programme. Below is a review of literature on the need of science laboratories in science teaching and learning as related to the classroom implementation of the college chemistry programme.

The Role of the Laboratory in College Chemistry Teaching

Science educators have believed that the laboratory activities are an important means of instruction in science since the late 19th century. Laboratory activities were used in high school chemistry in the 1880s Osborne, (1993). Laboratory instruction was considered essential because it provided training in observation, supplied detailed information and aroused pupils' interest.

Shulman and Tamir, in the Second Handbook of Research on Teaching (Travers, ed., 1973), listed five groups of objectives that may be achieved through the use of the laboratory activities in science classes:

1. Skills - manipulative, inquiry, investigative, organizational, communicative.
2. Concepts - for example, hypothesis, theoretical model, taxonomic category.
3. Cognitive abilities - critical thinking, problem solving, application, analysis, synthesis.
4. Understanding the nature of science - scientific enterprise, scientists and how they work, existence of a multiplicity of scientific methods, interrelationships between science and technology and among the various disciplines of science.
5. Attitudes - for example, curiosity, interest, risk taking, objectivity, precision, confidence, perseverance, satisfaction, responsibility, consensus, collaboration, and liking science.

Writing about laboratory teaching at the college level, Svinicki and McKeachie (2012) mentioned that laboratory teaching assumes that first-hand experience in observation and manipulation of the materials of science is superior to other methods of developing understanding and appreciation. Laboratory training is also frequently used to develop skills necessary for more advanced study or research.

From the standpoint of theory, the activity of the student, the sensorimotor nature of the experience and the individualization of laboratory instruction should contribute positively to learning. Information cannot usually be obtained, however, by direct experience as rapidly as it can from abstractions presented orally or in print. Thus, one would not expect laboratory teaching to have an advantage over other teaching methods in the amount of information retention, in ability to apply learning, or in actual skill in observation or manipulation of materials (Gage, 1993).

Pickering (1980) identified two misconceptions about the use of the laboratory in college science. One is that laboratories somehow "illustrate" lecture courses - a function that, in his opinion, is not possible in a simple one-time exercise. Pickering contended that most scientific theories are based on a large number of very sophisticated experiments. He suggested that, if lecture topics are to be illustrated, this should be done through the use of audio-visual aids or demonstrations. The second misconception is that laboratories exist to teach manipulative skills. Pickering argued that the majority of students in science laboratory classes do not have a career goal of becoming a professional scientist. Further, many of the skills students learn in laboratories are obsolete in science careers. If these skills are worth teaching, it is as tools to be mastered for basic scientific inquiry and not as ends in themselves.

Positive research findings on the role of the laboratory in science teaching do exist. Laboratory activities appear to be helpful for students rated as medium to low in achievement on pretest measures (Boghai, 1997). Godomsky (1971) reported that laboratory instruction increased students' problem-solving ability in physical chemistry and that the laboratory could be a valuable instructional technique in chemistry if experiments were genuine problems without explicit directions. Working with older, disadvantaged students in a laboratory setting, McDermott (1980) used activities designed to create disequilibrium in order to encourage cognitive development.

In addition to the presence of the science laboratories, the judicious use of other resources during the implementation of the college chemistry programme is a professional requirement of the teachers. For instance the use of Teaching and Learning Materials (TLMs) and other improvised materials during lesson preparation and delivery shows the teacher's level of competence and degree of mastery of the content and methodology of the subject. TLMs is a generic term used to describe the resources teachers use to deliver instruction.

Besides teacher qualifications and school facilities, another important determinant of quality of education is the teaching and learning materials and it is essential for quality materials to be made available to the teachers and students in adequate quantities to support the teaching and learning processes (UNESCO, 2013). This was entrenched in the TED (2007) where chemistry students are expected to study improvisation – principles to consider when improvising and the importance of improvisation.

Teaching materials are the resources a teacher uses to deliver instruction. Each teacher requires a range of tools to draw upon in order to assist and support student learning. These materials play a large role in making knowledge accessible to a learner and can encourage a student to engage with knowledge in different ways. Flexibility in teaching materials and the use of multimedia make it possible to reach out to all learning styles (University College Cork, 2013). They further explained that multimedia via blackboard or a course website can provide the syllabus, assignments, discussion groups, projects, class notes, video material and the PowerPoint for the lectures. Links to other websites that can provide additional representations of a topic being discussed or as scaffolds or supports for student learning can also be provided via blackboard (University College Cork, 2013).

Teaching materials such as realia, textbooks, pictures, charts, and models can support student learning and increase student success. Ideally, the teaching materials will be tailored to the content in which they are being used to the students in whose class they are being used and the teacher. Teaching materials come in many shapes and sizes, but they all have in common the ability to support student learning. It is therefore very imperative of the colleges of education chemistry teacher to make adequate use of TLMs during the entire lesson preparation and delivery as this will enhance a better understanding of scientific concepts and hence concept acquisition by the students.

Types of Classroom Interaction and its Influence on Science Concept Acquisition

There was a time when the traditional approach of teaching was adopted by most of the teachers, where the learner used to be dependent only on the lecture delivered by the teacher. Learners were not exposed to enough practice of speaking on their own and hence the interaction among the learners in the classroom was almost absent. But as the education system changed with time so has the teaching methods. Education system now demands more of student interaction rather than just listening to the instructor. Hence, classroom interaction is very essential in today's education system (Ghosh, 2010).

Objectives of Classroom Interaction

1. This type of interaction helps the learners to identify their own learning methods.
2. This interaction guides the learners to communicate with their peers easily and give them an exposure to the vase genres of language learning.
3. It helps the learner to come face to face with the various types of interaction that can take place inside the classroom.
4. Classroom Interaction aims at meaningful communication among the students in the target language.
5. It also aims at probing into the learner's prior learning ability and his way of conceptualizing facts and ideas.
6. This practice helps the teacher to have a detailed study of the nature and the frequency of student interaction inside the classroom.

Interaction can proceed harmoniously or it can be fraught with tension and every interaction situation has the potential for co-operation or conflict (Malamah-Thomas, 1987). How the situation actually develops depends on the attitudes and intentions of the people involved, and on their interpretations of each other's attitudes and intentions. Needless to say, only when there is co-operation between both sides can communication effectively take place and learning occurs. Interaction is mainly achieved by two means of resources: language and non-verbal means of expression.

Non-verbal resources play just as important part as language does. This holds true for a classroom as well as for other social situations. The one thing that makes the classroom different from any other social situation is that it has a primary pedagogic purpose. Teachers spend a lot of time talking, lecturing, asking questions, demonstrating, and giving instructions. The teacher does not only use language for these functions, but he or she demonstrates and uses mime a lot (Ghosh, 2010).

There are most frequent ways of organising classroom interaction depending on who communicates with whom. However, the college chemistry programme demands that the following forms of classroom interaction should be experienced in any chemistry lesson either jointly or severally: Teacher – Learners, Teacher – Learner/group of Learners, Learner – Learner, Teacher – Resources, and Learner(s) – Resources. Schematically, the expected interactions in any college chemistry classroom are shown below.

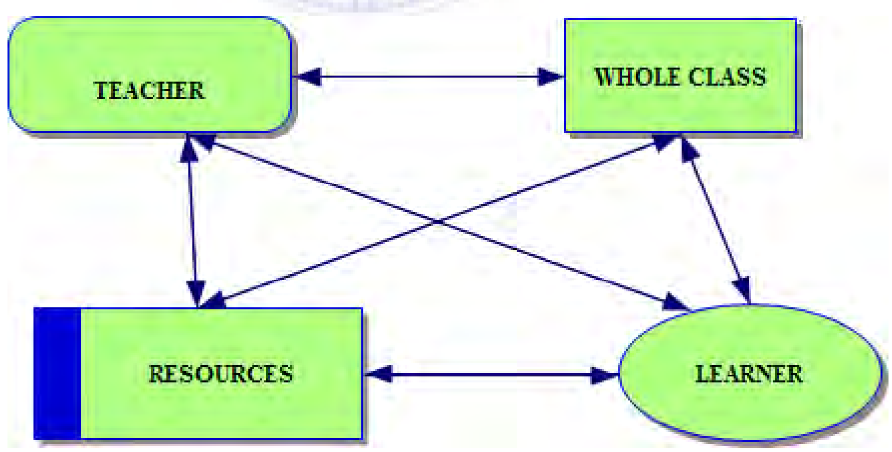


Figure 1: Types of classroom interactions

The first form of interaction (Teacher – Learners) is established when a teacher talks to the whole class at the same time. He takes the role of a leader or controller and decides about the type and process of the activity. The primary function of such interaction is controlled practicing of certain language structures or vocabulary. Mostly, they are in the form of repeating structures after the teacher (the model). This type of practice is also referred to as 'a drill' (Mateja, 2004).

In the teaching of college chemistry, the teacher is expected to use this form of interaction to help students acquire the appropriate terminologies and vocabularies as related to chemistry. The teacher is expected to do much of the talking and assume leadership roles in the introduction of concepts and new vocabularies and also in the explanation of the meaning of such concept in context. Failure to do this may mean a reduction in students' level of vocabulary acquisition.

Mateja (2004) explained that the second arrangement (teacher – learner/group of learners) is conducted when the teacher refers to the whole class, but expects only one student or a group of students to answer. It is often used for evaluation of individual students. This arrangement can also be used for an informal conversation also referred to as introduction which usually takes place at the beginning of the lesson or for leading students into a less guided activity.

The Learner – Learner form of interaction is called 'pair work'. Students get an assignment, which they have to finish in pairs. The teacher holds the role of a consultant or adviser, helping when necessary. After the activity, he puts the pairs into a whole group and each pair reports on their work. The Learners – Learners type of classroom interaction is called ‘group work’. As with pair work, the teacher’s function here is that of a consultant and individual groups report on their work as a follow-up activity.

The Learner - Learner and the Learner – Learners ways of organisation are particularly useful for encouraging interaction among students. In large classes, they present the only possibility for as many students as possible to interact. Nunan (1992) mentioned that students use more language functions in pair- and group-work than in other forms of interaction. It has also been proven that students perceive them as the most pleasant ways of learning, because they feel relaxed and subsequently communicate better (Hatch, 1992). Such work encourages independent learning and gives some responsibility for learning to students. It approaches real-life communication where students talk to their peers in small groups or pairs. Nevertheless, whole-class organisation should not be completely neglected since it is still more appropriate for guided and controlled activities.

The role of the teacher during these sessions is passive yet very crucial. It is the responsibility of the teacher to create a learning atmosphere inside the classroom. It is through these interactive sessions that the teacher can extract responses from learners and motivate them to come out with new ideas related to the topic. He is an observer who helps the learners to construct an innovative learning product through group discussions, debates and many more. He will define himself as a planner who plans out the best of the modules of interaction that would be effective to invite the learners in classroom interaction (Ghosh, 2010).

The Teacher – Resources form of interaction is very crucial in curriculum or program implementation. Resources as used here refers to anything used by teachers and trainers to develop into their own materials to use when delivering lessons or training, such as books, models, journals, websites, bibliographies, databases, and equipment. In the selection of what resource(s) to use for a particular lesson, the teacher should ensure that the activities within each topic area are supported by teacher notes, student worksheets, pictures, diagrams, and all other resources needed to deliver the lesson, such as PowerPoint slides, videos and interactive quizzes. They are designed so that the teacher can use them in their entirety or adapt them to suit the educational needs. The teacher should, therefore, be responsible for the selection of the resources.

Gunta (2004) explains that selection means choosing from the available resources, those materials considered being the best, most appropriate and/or most suitable for the particular learning activity and rejecting what is inferior, inappropriate, unsuitable or unacceptable. The teacher is also expected to collect the resources. These include traditional and electronic resources as itemised below:

1. Print resources, for example, books (reference, fiction, non-fiction), periodicals, newspapers, pamphlets [lyrics, manuscripts];
2. Graphic resources, for example, posters, pictures, maps, models, real objects, kits;
3. Audiovisual resources, for example, videocassettes, fiche, film, slides;
4. Electronic resources, for example, computer software, multimedia, audio and data Compact-Disk-Read Only Memory (CD-ROM), Digital Video Disk (DVD), databases, World Wide Web (WWW) based resources.

The teacher is to allow access to the resources by providing opportunities for all children and students, regardless of race, sexuality, gender and cultural diversity, to seek out and use information and learning materials (Gunta, 2004).

Within the Learner(s) – Resources form of interaction, the learner(s) is/are allowed by the teacher to freely handle, manipulate, and communicate with the resources that have been made available to them. Children and students come into contact with a vast array of print, visual and multimedia materials in their daily lives. Their exposure to such materials is mediated by parents and other caregivers, by legislation and by social conventions. Educators also have a duty of care to ensure that the teaching and learning resources with which children and students are presented, or towards which they are directed, are appropriate to their developmental growth and relevant to the achievement of appropriate learning outcomes. (Gunta, 2004)

Allowing learners to interact with the teaching and learning resources helps them in gaining first-hand learning experience. It also introduces them to skill acquisition and development. Students become self-reliant and competent as they explore the world around them. Therefore the college chemistry teacher is expected to expose the students to these resources and allow them to interact with them.

Significance of Curriculum Programme Evaluation to the College Chemistry Programme

Many writers have defined curriculum evaluation differently. This write-up will consider but a few of these. According to Gatawa (1990), the term curriculum evaluation has three major meanings:

1. The process of describing and judging an educational programme or subject.

2. The process of comparing a student's performance with behaviourally stated objectives.
3. The process of defining, obtaining and using relevant information for decision-making purposes

Programmes are evaluated to answer questions and concerns of various parties. The public want to know whether the curriculum implemented has achieved its aims and objectives; teachers want to know whether what they are doing in the classroom is effective; and the developer or planner wants to know how to improve the curriculum product.

According to Olivia (1988), curriculum evaluation is the process of delineating, obtaining, and providing useful information for judging alternative decisions. The primary alternative decisions to consider based upon the evaluation results are: to maintain the curriculum as it is; to modify the curriculum; or to eliminate the curriculum. Ornstein and Hunkins (1998) defined curriculum evaluation as a process or cluster of processes that people perform in order to gather data that will enable them to decide whether to accept, change, or eliminate something- the curriculum in general or an educational textbook in particular.

McNeil (1997) saw curriculum evaluation as an attempt to throw light on two questions: Do planned learning opportunities, programmes, courses and activities as developed and organised actually produce desired results? How can the curriculum offerings best be improved? Clearly such definitions do not limit curriculum evaluation to the appraisal of learning outcomes but actually extend it to other aspects of the curriculum, such as:

1. The teaching – learning materials being used,
2. The programme of the studies being pursued under the curriculum,

3. The context or conditions within which the curriculum is operating,
4. The level of effectiveness of instructional methods being employed,
5. The competence of teachers and other personnel implementing the curricula and
6. The suitability of the objectives being pursued and so on.

It could be realised from the definitions above that any curriculum or programme of study that has been implemented should, as a matter of necessity, be thoroughly evaluated. This will appropriately inform both the designers, the implementers, interested parties and the general public on the success or otherwise of the programme.

The Curriculum Evaluation Model Employed for this Study

How should someone go about evaluating curriculum or programme of study? Several experts have proposed different models describing how and what should be involved in evaluating a curriculum or programme of study. Models are useful because they help the evaluator to determine the parameters of an evaluation, what concepts to study and the procedures to be used to extract important data.

Numerous evaluation models have been proposed but the only model considered for this study was the Context, Input, Process, Product (CIPP) model proposed by Stufflebeam in 1971. This was because the areas of interest to the researcher were identified by this model. These were the environment (context) in which the chemistry programme is being implemented; the resources (inputs) that are available at the environments (colleges) where the implementation is being carried out; the circumstances under which the evaluation is being done (whether continuous or periodically) and the very final outcomes of the implementation as well as the evaluation processes.

In addition, this model was considered very appropriate because the main aim for the study was to find out and establish, through very authentic means, the success or otherwise of the college chemistry programme implementation. It also aimed at informing the designers of the programme for them to decide on type of innovation, improvement and change strategies to employ. These were all identified by Stufflebeam in his CIPP model.

According to Stufflebeam (1971), the CIPP approach when applied to education, aims to determine if a particular educational effort has resulted in a positive change in school, college, university or training organisation. A major aspect of the Stufflebeam's model is centered on decision making or an act of making up one's mind about the programme introduced. He mentioned that for evaluations to be done correctly and aid in the decision making process, curriculum evaluators have to:

i. First delineate what is to be evaluated and determine what information that has to be collected (for example how effective the new science programme has been in enhancing the scientific thinking skills of children in the basic school levels)
ii. Second is to obtain or collect the information using selected techniques and methods (for example interview teachers and collect test scores of students);
iii. Third is to provide or make available the information (in the form of tables, graphs) to interested parties. To decide whether to maintain, modify or eliminate the new curriculum or programme. Information is obtained by conducting the following four (4) types of evaluation: context, input, process and product.

Stufflebeam's model of evaluation relies on both formative and summative evaluation to determine the overall effectiveness of a curriculum programme.

Evaluation is required at all levels of the programme implemented. This is schematically shown below:

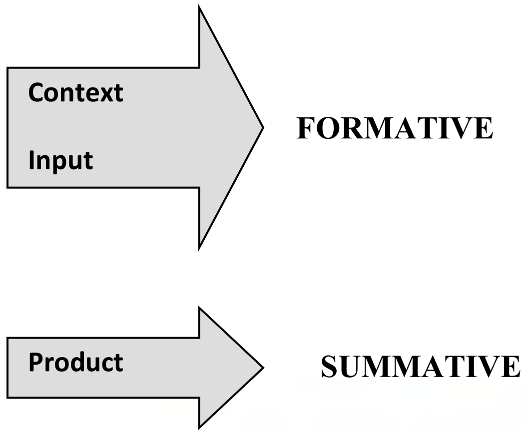


Figure 2: Stufflebeam's model of curriculum programme evaluation

The various stages of context, input, process and product (CIPP) model are further explained below:

a) Context Evaluation (What needs to be done and in what context)?

This is the most basic kind of evaluation with the purpose of providing a rationale for the objectives. The evaluator defines the environment in which the curriculum is implemented which could be a classroom, school or training department. The evaluator determines needs that were not met and reasons why the needs are not being met.

Also identified are the shortcomings and problems in the organisation under review (for example a sizable proportion of students in secondary schools are unable to read at the desired level, the ratio of students to computers is large, a sizable proportion of science teachers are not proficient to teach in English). Goals and objectives are specified on the basis of context evaluation. In other words, the evaluator determines the background in which the innovations are being implemented. The techniques of data collection would include observation of conditions in the school, background statistics of teachers and interviews with players involved in implementation of the curriculum.

b) Input Evaluation (How should it be done?)

Is it the purpose that evaluation to provide information for determining how to utilise resources to achieve objectives of the curriculum? The resources of the school and various designs for carrying out the curriculum are considered. At this stage the evaluator decides on procedures to be used. Unfortunately, methods for input evaluation are lacking in education. The prevalent practices include committee deliberations, appeal to the professional literature, the employment of consultants and pilot experimental projects.

c) Process Evaluation (Is it being done?)

Is there evidence of provision of periodic feedback while the curriculum is being implemented?

d) Product Evaluation (Did it succeed?)

These are the outcomes of the initiative. In this case, data is collected to determine whether the curriculum managed to accomplish what it was set out to achieve (for example, to what extent students have developed a more positive attitudes towards science?). Product evaluation involves measuring the achievement of objectives, interpreting the data and providing information that will enable the programme designers and stake holders to decide whether to continue, terminate or modify it. For example, product evaluation might reveal that students have become more interested in chemistry and are more positive towards the subject after introduction of the new chemistry programme.

Below is a diagrammatic representation of the CIPP model as proposed by Stufflebeam in 1971, showing the interactions at each level.

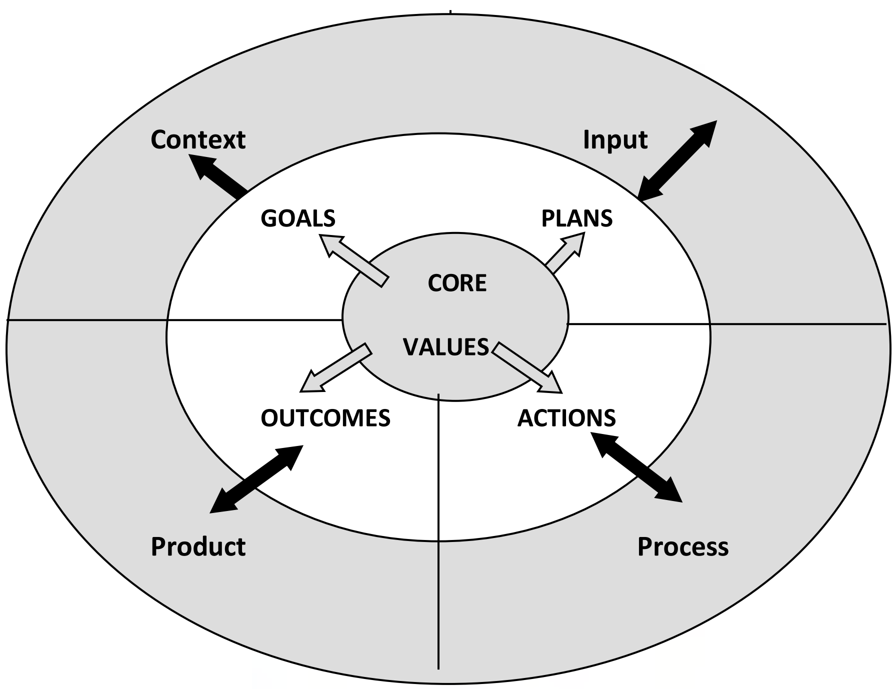


Figure 3: Diagrammatic representation of Stufflebeam's CIPP model

Based on these findings the decision may be made to implement the programme throughout the remaining colleges of education in the country.

CHAPTER THREE

METHODOLOGY

Overview

This chapter presents the procedure used to carry out the research. It focuses on the design, the population, the sample as well as the sampling procedures used for the study. It also highlights the instruments used, validity, reliability, and trustworthiness of the instruments, the scoring of the instruments, data collection procedures and how the data collected were analysed.

Research Design

A research design is the plan, which specifies how the subjects are going to be obtained and what is going to be done with them with the view to reaching conclusions about the research problem (Huysamen, 1994). The descriptive survey design was used for this study. The major purpose of a descriptive survey research was to observe, describe, and document aspects of a situation as it occurs naturally (Amedahe & Asamoah, 2001).

Similarly, Polit and Hungler (1995) mentioned that a descriptive survey aims predominantly at describing, observing and documenting aspects of a situation as it naturally occurs rather than explaining them. Amedahe and Asamoah (2001) again maintained that descriptive research ranges from simple surveys that do little more than ask questions and report answers about the status of something (phenomena) to studies that present explicit statements about relationships and variables.

Best and Khan (1998) also maintained that a descriptive survey is concerned with the conditions or the relationships that exist, such as determining the nature of prevailing conditions, practices and attitudes, opinions that are held, processes that are ongoing; or trends that are developed. It is therefore, appropriate when a researcher attempts to describe some aspects of a population by selecting unaided samples of individuals to complete questionnaires, interviews or test (Frankel & Wallen, 2000).

However, Seifert and Hoffnung (1994) observed that there is the difficulty in ensuring that the questions to be answered using the descriptive survey design are clearer and not misleading. This is because survey results can vary significantly depending on the exact wording of questions. They also mentioned that untrustworthy results may be produced because questions may delve into private matters that people may not be completely truthful about. They further maintained that questionnaires require respondents who can articulate their thoughts in writing. Therefore, questionnaire is limited by disability and literacy.

This study involved both quantitative and qualitative approaches. The quantitative approach involved the use of questionnaire to collect data from both the science teachers who teach elective chemistry at the selected science colleges of education and science students who study chemistry as an elective course at these colleges of education. The teachers' questionnaire helped to identify science (chemistry) teachers' qualification and areas of specializations. It also helped to find out the resources that were available in the teaching and learning of chemistry at these colleges.

Furthermore it was used to find out the types of verbal and non-verbal interactions that prevail in the classroom implementation of colleges of education chemistry programme. The students' questionnaire further helped to gather students' views about how they perceive the chemistry programme, the resources that were available for the implementation of the chemistry programme in their colleges as well as how the subject was taught.

The questionnaire also helped to collect data on the students' attitude towards the teaching and learning of chemistry. The modified version of the Barbados Workshop Instrument was used to observe and collect quantitative data on how the classroom implementation of the college chemistry programme was done.

The qualitative approach on the other hand involved interviewing the college chemistry teachers and the elective chemistry students to answer the research questions for the study. Analysis of the documents available at the two colleges was also used to gather information on the resources that were available for the classroom implementation of the colleges of education elective chemistry programme.

Descriptive research may not answer all of the fundamental questions, but it provides useful data which can serve as a basis for further research using more rigorous experimental design. Descriptive survey design was therefore the most appropriate for this study because it only found out the ideas of teachers and their students on some aspects of the implementation of the colleges of education elective chemistry programme.

Area of the Study

The municipality and the district, within which the colleges of education involved in the study are located, are described below:

1. Hohoe Municipal

Hohoe Municipality is one of the twenty five (25) and also one of the one hundred and seventy (170) administrative districts of Volta region and Ghana respectively. It has a total land surface area of 1,172 km^2 which constitute 5.6 percent of the Regional and 0.05 percent of the National land surface areas. The Municipality is located within longitude 0◦ 15'E and 0◦ 45'E and latitude 6◦ 45'N and 7◦ 15'N and lies almost in the heart of the Volta Region. The Hohoe Municipal Assembly was established in 1989 by Legislative Instrument (LI) 1869 with its capital at Hohoe.

There are 20 Traditional Areas with a population of about 153,047. It shares boarders with the Republic of Togo on the East, forming part of Ghana's international boarder; on the southeast and south with Ho Municipal Assembly; on the southwest with South Dayi Districts; on the North with Jasikan District; and on the Northwest with Kpando and Biakoye Districts.

2. Akatsi South District

The Akatsi south district is located in the South-Eastern part of the Volta region. The district is located in the South-Eastern part of the Volta region. It has a total land area of about 960.445 square kilometres. The total land under cultivation is about 51,438.12

hectares. The district is bounded to the South by the Keta municipal, to the East by the Ketu North district: to the North by North Tongu districts to the West, Adaklu Anyigbe district and the republic of Togo to complete the demarcation of the Akatsi district. The district is located between latitude 6° S - 7° North 0° W - 1 ° W.

Figure 4: Map of Volta Region Showing the Municipality and the District within which the Colleges of Education Used for the Study are Located.

Key: △ Hohoe Municipality ☆ Akatsi South District

Population

The target population for this study was all the science students and their tutors at all the 15 designated science and mathematics colleges of education in Ghana. However, the accessible population was drawn from the two science and mathematics colleges of education in the Volta region. This comprised the 78 second year science students and the three (3) chemistry tutors at one college (College A) and the 45 second year science students and the two (2) chemistry tutors at the other college (College B). These provided a total sample size of 123 science students and 5 chemistry tutors for the study.

The sample size was purposively selected because according to the three year colleges of education programme in Ghana, science students study chemistry in two different semesters; that is in the first semester of the first year, and in the second semester of the second year. This implies that the category of subjects selected as the sample size might have studied chemistry in the first semester of first year and for that matter might have been introduced to the college chemistry programme.

In addition, out of the seven college of education in the Volta region, these two colleges are the only colleges of education that offer the designated science and mathematics programmes.

Sample and Sampling Procedure

Purposive sampling technique was employed to select the year group and tutors for the study. Makhado (2002) agrees with the use of purposive sampling technique by stressing on the fact that it is important to select information rich cases as this will help the researcher to address the purpose of the research. McMillan and Schumacher (2001) further recommended purposeful sampling because the samples that are chosen are likely to be knowledgeable and informative about the phenomenon the researcher is investigating.

Two Science and Mathematics Colleges of Education in the Volta region were purposively sampled for the study. Data was collected from second year science students and their chemistry tutors at these colleges through interviews, Barbados Workshop Observation Instrument (checklist) and administration of questionnaires.

Two sets of questionnaires were administered. The first set was administered to all the five chemistry teachers and the second set was administered to all the 123 second year science students from these colleges. All the five chemistry teachers were as well interviewed. In addition, a simple random sampling method was used to select ten students from each of the two colleges of education and interviewed. Furthermore, three live lessons were observed for each of the five chemistry teachers involved in the study.

Research Instruments

The study employed a combination of quantitative and qualitative data collecting instruments. These included questionnaires, interviews, a lesson observation instrument and document analysis. The questionnaire and the modified version of the systematic Barbados workshop observation instrument were used to collect quantitative data while the interviews and the document analysis were used to collect quantitative data for the study.

Questionnaire

In the development of the questionnaire for this study, it was to ensure that the questions were unambiguous, unbiased, not loaded, relevant, succinctly conceptualized as well as avoiding vagueness as suggested by May & Flack (2001). Nworgu's (1991) characteristics of a good questionnaire were also applied in designing the questionnaires for the study. The characteristics are: relevance, consistency, usability, clarity, quantifiability and legibility.

In all, two sets of questionnaires were used for the study. One set was for the science teachers who teach chemistry and the other was for the elective science students. The teachers' and the students' questionnaires were open and close-ended types, and consisted of two sections A and B in each case (Appendix A and Appendix B).

The science teachers' questionnaire was made up of 24 items for the teachers to answer. The close-ended type items were in the form of multiple choice questions to enable respondents answer them easily whilst the open-ended items were meant for soliciting subjective data from the respondents. Section A which was made up of six items sought background information and characteristics about the respondents. All the items in this section were open-ended types.

The questions sought to find out the highest qualification of the science teachers who teach college elective chemistry, their areas of specialization, as well as the number of years they have been teaching elective chemistry.

Section B consisted of 19 items out of which 16 were close-ended. The close-ended items were of a five point Likert rated on a 1-to-5 Disagree-Agree response scale. They were formulated to find out the type(s) of interaction(s) (verbal and non-verbal) that are experienced during chemistry lessons. The items required the respondents to indicate the availability and the state of the science resources available at the colleges for the implementation of the chemistry programme. Some of the items were also meant to find out chemistry teachers' attitude and interest towards the implementation of the chemistry programme, as well as the types of pedagogical skills (practical or theoretical approaches) employed during the classroom implementation of the college chemistry programme.

One of the remaining three items was an objective type in which possible answers were provided for the respondents to circle the choice that was most appropriate for the statement made. The other item required a 'Yes' or 'No' response. The last item was an open-ended type. Here the respondents were required to provide their views on whether the elective college chemistry programme should be allowed to stay or not. They were to indicate any two areas that they thought needed improvement or innovation and how they wished it should be done.

The students' questionnaire consisted of 21 items. Section A of the students' questionnaire was made up of four items to find out background information and characteristic of students. All the items in this section were open-ended. Section B of the students' questionnaire was made up of 17 items which focused on the science resources available at the colleges under study for the effective implementation of the chemistry programme. Fifteen of the items under this section were close-ended and of the five-point Likert type scale.

The positive items were scored as follows: Strongly Agree (5), Agree (4), Not Sure (3), Disagree (2) and Strongly Disagree (1). In addition, negative items were scored as follows: Strongly Agree (1), Agree (2), Not Sure (3), Disagree (4) and Strongly Disagree (5).

The 16th item was divided into 'A' and 'B'. The 'A' part was made up of a 'Yes' or 'No' type of item; whilst the 'B' part was an open-ended type. Finally, the last item was an open-ended type in which the respondents were expected to suggest ways by which some challenges that they have identified, about the classroom implementation of the elective chemistry programme, could be controlled.

Interview

Interviews were used to collect information from the respondents to find out their views on the topic under study and to enhance the quality of the data gathered. The interviews were used to determine whether the expressed views of the students and their teachers were consistent with their questionnaire responses, and also to help in interpreting and explaining the research findings. In other words, the interviews were used for the purpose of data triangulation. This was in line with King (1994) assertion that where quantitative study has been conducted, qualitative data are required to validate particular measures or to clarify and illustrate the meaning of the findings, and to see whether their experiences agree with the ratings on the measure.

The students' interview schedule (Appendix C) was made up of twelve (12) items of which ten were close-ended demanding 'Yes' or 'No' responses, whilst the rest two (2) demanded open-ended responses. The interview sought to find out background information about the students and the availability of science resources for the effective implementation of the colleges of education elective chemistry programme. In addition, it sought the views of the students about the level of interest they had for the chemistry programme as well as the types of lesson delivery activities (practical, group work and individual work) which dominated their chemistry lessons, and the way those approaches influenced their basic scientific knowledge acquisition and application in everyday life.

The teachers' interview schedule (Appendix D) consisted of 15 items. The interview schedule was made up of eight items that demanded 'Yes' or 'No' responses. The other seven which demanded open-ended responses were used to collect additional information on the science resources that were available in the colleges for the effective implementation of the chemistry programme, students' attitude and interests towards the chemistry course and some of the challenges teachers of college chemistry encounter during its classroom implementation.

Observation Schedule

During chemistry lessons, observations were made in the classroom to find out how the elective chemistry programme was being implemented in the two colleges under study. That was to identify the normal classroom session factors that influence the implementation of the elective chemistry programme at these colleges. It was also used to determine whether the views expressed by the respondents in both the questionnaires and the interviews were consistent with the outcomes of what the researcher observed. This was to enable the triangulation of the data collected.

There are different types of observational procedures or techniques that have been used to examine effective teaching (e.g. charts, rating scales, checklists, and narrative descriptions). However, the most widely used procedure or research method has been systematic classroom observation which is based on narrative coding systems (Waxman, 2005). These interactive coding systems allow the observer to record nearly everything that pupils and researchers do during a given time interval. These interaction systems are very objective and typically do not require the observer to make any high inferences or judgments about the behaviour they observe in the classroom. In other words these low-inference observational systems provide specific and easy identifiable behaviours that observers can easily code. For this study, a time bout of one minute was used to enable the researcher code a lot of activities which occur within short intervals of each other.

For the purpose of this study, the modified version of the Barbados Workshop Instrument which was used by Eminah (1993) was adapted. This can be located in Appendix E of this write-up. The Barbados Workshop Observation Instrument was originally developed in

1986 at a workshop held in the University of Liverpool, England. The instrument was then used at a workshop held in the Barbados in 1987 to find out the extent to which pupils used process skills when learning science. The instrument was made up of three forms namely Form 1, Form 2, and Form 3 respectively. Form 1 was used to code the behaviours of a group of pupils on activities throughout the lesson by the observer ticking in a box opposite the categorized behaviour within a time interval of two minutes. Form 2 was used to code the behaviour of the teacher (excluding his/her movements). The work of the observer was just to watch and listen to whatever the teacher did or said, and code him/her as described in Form 1. The third form, Form 3 which is a blank form was used by the observer to code the teacher's movement in class. Pupils' group positions were marked with 'X's and lines were drawn to show routes taken by the teacher as well as pauses along the routes taken by him/her. Pauses made less than two minutes were marked with small dots in a circle. Pauses that lasted between four to six minutes were also indicated with a dot in two concentric circles. For any one lesson, three observers were required with each observer scoring with one of the forms.

The modified version of the Barbados Workshop Observation Instrument adapted for this study consisted of a set of verbal and non-verbal behaviours of both teachers and learners coded as A, B, C, D, and E. the teacher's verbal behaviours/activities were categorized under A (that coded from A1 to A7) and B (that is coded from B1 to B8) on Form 1. His/her non-verbal activities/behaviours were also coded under C (from C1 to C7). The pupils' verbal and non-verbal activities/behaviours were categorized under D (that is coded from D1 to D7) and E (that is coded from E1 to E7) respectively on Form 2.

The verbal activities/behaviours of teachers were divided into two parts, A and B. Part A contains items on the cognitive levels of his/her questions. Items in this part were constructed in line with Bloom's taxonomy, which demands that questions eliciting for knowledge and comprehension responses be classified as lower cognitive and those requiring application, analysis, synthesis and evaluation classified as higher cognitive. It also consisted of a category of observational questions to reflect the demands of the designated science and mathematics colleges of education elective chemistry programme.

The syllabus requires students to be able to acquire knowledge of basic concepts and apply the knowledge acquired in the course to explain various phenomena in science (TED, 2007). In addition, behaviours categorized in the part B of the teacher's verbal activities consisted of those specified as procedural principles as well as others characterized as the 'lecture' method of lesson presentations.

The non-verbal activities coded from C1 to C7 included items on how the teacher uses the chalkboard to record students' findings or ideas, performs demonstrations or practical experiments, distributes materials, and gives class exercises.

Students' verbal activities which was coded from D1 to D7 included items on how students answer questions, ask questions related to the topic being taught, ask questions which are not related to the topic being taught, ask for help about procedures among others. Students' non-verbal activities which was coded from E1 to E7 also included behaviours of students on how they perform practical activities, record findings into notebooks, make notes from the chalk board or as the teacher dictates, do class activities, handle equipment during practical lessons and how they present their finding on the chalkboard.

Eminah (1993) effected some modifications in the original Barbados Workshop Observation Instrument which he did with the procedural principles of the colleges of education elective chemistry course. He modified the coding procedures and some items in Forms 1 and 2 of the original instrument. Form 3 of the original instrument, which was meant to follow the teacher's movement in class, indicate the layout of student' tables as well as the positions of students, was also modified.

In the modified instruments, the observer was required to show a layout of the students' desks, teacher's table, chalkboard, doors and windows of the classroom. The observer was also required to record student group sizes and the teaching and learning materials used by the teacher during the teaching and learning process. In addition, the time the teacher spent with each student group was to be recorded. However, the circles and dots used to indicate these in the original instrument were ignored.

Finally, the students' and the teachers' behaviours were to be coded at one minute intervals instead of two minutes interval indicated in the original instrument. This was done because a lot of activities happen within short intervals of each other and if it took so long to code them, anyone who saw the raw data might not picture well the actual things that went on in the classes observed.

Document Analysis

This study considered the analysis of curriculum documents as an important aspect. This is because curriculum documents help in comparing the intended curriculum with the actual implemented curriculum. In the case of this study, the intensions of the designers of the colleges of education elective chemistry programme were compared with the actual implementations that were made. As a result, the study obtained documents such as elective chemistry course outline (syllabus), college chemistry time table, students' chemistry handouts, students' exercise books and college from the heads of science departments, the teachers of the chemistry course and the science students at the two colleges of education under study. These documents were collected to help find out how elective college chemistry programme was being implemented in the classroom as well as the resources that were available at the colleges of education for the successful implementation of the chemistry programme.

Validation of the Instruments

The data collection instruments which included the modified version of Barbados Workshop Observation Instrument used by Eminah (1993), the questionnaire and the interview guides were validated by the researcher's supervisors and other experts in the science department of the University of Education, Winneba. These individuals have considerable knowledge in the concept area. Their comments were used to redefine the test items before they were administered.

Reliability of the Instruments

Pilot testing of the instruments reduces ambiguity of items and therefore enhances their reliability (Meriwether, 2001). To determine the reliability of the instruments for this study, both students' and teachers' questionnaires were pilot tested using 20 college students who study integrated science chemistry but not elective chemistry and 5 college science teachers who teach integrated science but not elective chemistry at a different college of education in the Volta region. This college was outside the accessible population because the college does not run the designated science and mathematics programme as categorized by the Ministry of Education and the Teacher Education Division. The observation instrument was also pilot-tested in this college. This college was chosen because it had similar characteristics to that of the accessible population. The results from the pilot test helped me to identify and modify some aspects of the instruments before administering them to the accessible population.

Trustworthiness of the Study

Traditionally, the criteria for examining the rigour in both qualitative and quantitative researches have been internal and external validity, reliability and objectivity (Punch, 2005). However, Wolcott (1990) argues that these criteria do not satisfy qualitative research methodology because of differences that exist between the axioms of interpretivism and positivism. It is impossible to employ the criteria established to judge the quality of positivist study and to judge the rigour of qualitative inquiry.

According to Lincoln (1992) accommodation between and among paradigms on axiomatic grounds is simply not possible. Hence Guba (1992) argues that 'trustworthiness criteria' is employed to judge the quality of a study located in an interpretivist qualitative framework. The elements of 'trustworthiness criteria' include credibility, transferability and confirmability (Guba, 1992).

The credibility of this research will be ensured trough triangulation. Triangulation, according to Cohen, Manion and Morrison (2000), involves the use of two or more methods of data collection in a study of some aspect of human behaviour. Employing two or more methods helps researchers to offset the limitations associated with one method (Punch, 2005) and to determine the accuracy of the information gathered (Bush, 2002).

Bush (2002) explains different types of triangulation and these include methodological and respondent triangulation. Methodological triangulation involves using different procedures to gather information about a problem under study. Therefore structured questionnaires, modified Barbados Workshop Observation Instrument, interviews, and curriculum documents were used to gather information for this study, hence achieving methodological triangulation.

According to Bush, (2002), respondent triangulation involves employing the same instrument to collect data from different participants. As a result, by using the structured questionnaires, modified Barbados Workshop Observation Instrument, interviews, and curriculum documents to collect data from both the science students and their teachers at two colleges of education (colleges A and B), respondent triangulation was achieved.

Although triangulation is an approach for ensuring the credibility of this research, it could become problematic if there are contradictions in the data collected from the two sources. This could result in differences in the interpretation of the information and the analysis of the data. This could represent methodological confusion and inappropriate decisions. In spite of this limitation, the importance of triangulation in achieving credibility of this research cannot be underestimated.

Data Collection Procedures

There were five stages involved in data collection for this study. These are outlined as follows:

Stage 1 - Seeking approval to access the colleges for the study: An introductory letter was obtained from the Head of Science Education Department of the University of Education, Winneba and sent to each of the principals of the two colleges of education used for the study to seek their approval for the study to be conducted in their respective colleges. This letter helped me to be introduced by the principals to the teaching staff and the students involved in the study for their needed cooperation.

Stage 2 – Distribution and administration of the questionnaire: In all, one hundred and twenty eight (128) respondents in the two Science and Mathematics Colleges of Education in the Volta region were selected for the study. These consisted of one hundred and twenty three (123) second year science students and five (5) chemistry teachers. The questionnaires were distributed to the respondents and the instructions well explained to them.

To ensure a high return rate of the questionnaires, I personally supervised the distribution and collection of the entire questionnaire after completion and achieved a 100% return rate for both the students and the teachers. This was possible since the instruments were administered during class time.

Stage 3 – Observation of chemistry lessons: I observed three different lessons at different days and on different topics in chemistry as taught by each of the five (5) teachers at their respective colleges. This was done, in accordance with the teaching time table used at these colleges, using the modified version of the Barbados Workshop Observation Instrument (Appendix E). During the teaching and learning process, all observable behaviours (verbal and non-verbal) of both the teacher and the students were tallied within one minute interval.

Stage 4 – Interview: All the five teachers were interviewed after they had taught their last lesson. Five (5) students from each of the two colleges, who were randomly selected, were also interviewed after the observation of the last lesson. This was to avoid the introduction of any information which could influence a change in attitude and general behaviour of the respondents during classroom interactions.

Stage 5 – Collection of curriculum documents from the colleges: In the final stage of research data collection, I collected curriculum documents from the heads of science departments, the chemistry teachers as well as from the students at College A and College B for analysis. The curriculum documents obtained included: college chemistry course outline, teaching handouts and prepared notes/pamphlets, students exercise books, laboratory materials stock book, as well as the chemistry chief examiners reports on previous end-of-semester examinations. These enabled me to obtain information about programme delivery, resources available, and the pedagogical skills employed in chemistry programme implementation at these science and mathematics colleges of education.

Scoring of the Instruments

Items on both students' and teacher' questionnaires measured on the five point Likert scale were scored as follows: strongly agree = 5, agree = 4, not sure = 3, disagree = 2, and strongly agree = 1for positive statements. The negative worded items were reversed and scored as follows: strongly agree = 1, agree = 2, not sure = 3, disagree = 4, and strongly disagree = 5. The open ended items on the questionnaire were, however, analysed qualitatively.

Data collected with the Barbados Workshop Observational Instrument were scored by tallying every coded behaviour observed within a time bout of one minute. The relative frequency was calculated for each 'behaviour' and then converted into percentages for analysis.

Data Analysis

This study employed both qualitative and quantitative methods of data analysis. Quantitative data collected were analysed using descriptive statistics, which included frequency counts, percentages, means and inferential statistics of t-test. The responses to the items on the interview schedule for the teachers and the students, as well as data collected on school documents were analysed using descriptive / qualitative method.

To answer research question one, the data obtained from teachers' and students' questionnaires were analysed using descriptive statistical methods involving percentages. Responses to open-ended questions were coded into categories and the frequency of teachers' and students' responses in each case was determined.

To answer research question two, the data obtained from teachers' and students' questionnaires were analysed using descriptive statistical methods involving percentages. Responses to open-ended questions were coded into categories and the frequency of teachers' and students' responses in each case was determined. Responses on the scale items were also coded in relation to the items so that the number and percentage that corresponded to 'strongly agree', 'agree', 'not sure', 'disagree', and 'strongly disagree', were calculated using version 16.0 of SPSS statistical tool.

Research question three was answered using data from students' and teachers' questionnaires as well as observation instrument. These data were analysed using descriptive statistical methods involving percentages. Responses to open-ended questions were coded into categories and the frequency of teachers' and students' responses in each case was determined. Responses on the scale items were also coded in relation to the items so that the numbers and percentages that corresponded to ‘all the time’, ‘most of the time’, ‘some time’, ‘not often’ and ‘never’ were calculated using version 16.0of SPSS statistical tool. In addition, responses which were coded and corresponded to ‘good’ and ‘very good’ were as well calculated using version 16.0 of SPSS statistical tool.

Observation data from each of the 2 colleges of education were taken from three observation sheets used for each of them. The total relative frequencies of all categories in A, B, C, D, and E were computed and converted into percentages. The total average percentages of total teacher and student behaviours observed (categorised in A, B, C, D, and E) were then calculated for analysis for the selected colleges.

The data collected using categories D and E of the observation instrument were used to compute the percentages of students’ activities which were practical activities. Also, the percentages of teacher – student interactions were determined by referring to the appropriate categories in D of the Barbados Workshop Observation Instrument. The average values for these behaviours were then calculated for the two collages. Data collected on students’ group sizes during activity lessons were coded and analysed. The averages of this data were determined and converted into percentages.

Data obtained for research question four was analysed using inferential statistics and analysis of documents. Inferential statistics using t-test were calculated to find out whether there was significant difference between the implementation strategies employed by teachers and the objectives of the elective chemistry programme.

Descriptive method of data analysis was used to analyze data collected on college documents to support the findings. Transcription of teachers’ and students’ interview responses was also analysed descriptively to answer the research question. Detailed presentations of research findings have been made in the next chapter.

CHAPTER FOUR

RESULTS AND DISCUSSION OF DATA

Overview

This chapter consists of the empirical data presentation, interpretation and analysis of responses from the sample under study. Tables were provided to illustrate and support the findings. Frequency distribution tables with percentages, and bar charts based on the Likert scale items were constructed. Analysis of data involved inferential statistics of t-test significance. Qualitative analysis of the interviews and college documents were done. Data collected were analysed to answer the specific research questions. The results were presented in the order in which the research questions were presented in chapter one of this report.

This chapter also contains the discussion of the data collected. The discussions were based on the data obtained from the respondents' questionnaires and interviews, classroom observations and document analysis. The evidence from the literature was used to support the arguments. The discussion was also based on the research questions.

Presentation of the Analysed Data by the Research Questions

Research Question 1

What factors influence the roles of teachers and students during the classroom implementation of the college elective chemistry programme?

The responses on the factors that influence the roles of teachers and students during the implementation of the college chemistry programme were sought using items 1, 2, 7,8 and 10 of students' questionnaire (Appendix A) and items 1- 4 plus 10 - 13 of the teachers' questionnaire (Appendix B).

The results indicated that out of a total of 123 student respondents, 49 (39.8%) of them strongly disagreed that their colleges were well resourced for the teaching of chemistry; 26 students representing 21.1% disagreed to the statement whilst only 9 (7.3%) of them strongly agreed to the statement. In response to the statement that teachers at the two colleges (College A and College B) have a good understanding of the science knowledge, skills and attitudes to promote teaching of chemistry, majority of the student respondents 67 (46.3%) agreed. In addition, 52 (42.3%) respondents strongly agreed to that item on the questionnaire. The results have been summerised in Table 1.

Table 1: Students' Responses on Factors Influencing College Chemistry Programme Implementations

Item	SD	D	NS	A	SA	Total
The college is well resourced for the teaching of chemistry.	49 (39.8%)	26 (21.1%)	20 (16.3%)	19 (15.4%)	9 (7.3%)	123 (100%)
Teachers are adequately prepared to teach chemistry.	1 (0.8%)	5 (4.1%)	4 (3.3%)	61 (49.6%)	52 (42.3%)	123 (100%)
Teachers at this college have a good understanding of the science knowledge, skills and attitudes to promote teaching of chemistry.	4 (3.2%)	2 (1.6%)	4 (3.3%)	67 (46.3%)	56 (45.5%)	123 (100%)
Enough time is allocated on the college time table for the teaching and learning of chemistry.	13 (10.6%)	20 (16.3%)	14 (11.4%)	58 (47.2%)	18 (14.6%)	123 (100%)
Teachers at this college have the opportunity to receive professional upgrading towards the teaching of chemistry.	4 (3.3%)	6 (4.9%)	18 (14.6%)	53 (43.1%)	42 (34.9%)	123 (100%)
The facilities at this college promote the teaching of chemistry.	28 (22.8%)	41 (33.3%)	17 (13.9%)	34 (27.6%)	3 (2.4%)	123 (100%)

Source: Fieldwork, 2014.

Note: SD = Strongly Disagree, D = Disagree, NS = Not Sure, SA = Strongly Agree and percentages are in parenthesis.

The college chemistry teachers' responses on the factors that influence the roles of teachers and students during the implementation of the college chemistry programme were sought using items 1- 4 and 10 - 13 of the teachers' questionnaire. The results showed that four teachers, out of the total of five teachers, which represent 80%, agreed to the questionnaire item that their colleges have adequate equipment, facilities, laboratories and general resources required for implementing the chemistry programme (SN1). Only one of them strongly agreed to the statement, whilst none of them strongly disagreed (SD), disagreed (D) or was not sure (NS) of the statement.

All the five (5) teachers agreed to the questionnaire item (SN3) which sought to find out the overall college beliefs towards the chemistry programme, and the status of the programme as viewed by other members of staff. It also sought to find out whether administrators and the entire college community recognise the importance of chemistry in the overall college curriculum. This represented 100% of the total responses. None of the respondents strongly disagreed (SD), disagreed (D), was not sure (NS), or strongly agreed (SA) to the statement. Table 2 is a representation of their responses. Appendix B provides details of the items under the Serial Number (SN) column.

Table 2: Teachers' Response on Factors Influencing the Teaching of Chemistry

SN	SD	D	NS	A	SA	Total
1	0	0	0	4	1	5
	(0.0%)	(0.0%)	(0.0%)	(80.0%)	(20.0%)	(100.0%)
2	0	0	0	4	1	5
	(0.0%)	(0.0%)	(0.0%)	(80.0%)	(20.0%)	(100.0%)
3	0	0	0	5	0	5
	(0.0%)	(0.0%)	(0.0%)	(100.0%)	(0.0%)	(100.0%)
4	0	2	2	1	0	5
	(0.0%)	(40.0%)	(40.0%)	(20.0%)	(00.0%)	(100.0%)
10	0	4	0	1	0	5
	(0.0%)	(80.0%)	(0.0%)	(20.0%)	(0.0%)	(100.0%)
11	0	0	0	5	0	5
	(0.0%)	(0.0%)	(0.0%)	(100.0%)	(0.0%)	(100.0%)
12	0	0	0	3	2	5
	(0.0%)	(0.0%)	(0.0%)	(60.0%)	(40.0%)	(100.0%)
13	0	0	0	2	3	5
	(0.0%)	(0.0%)	(0.0%)	(40.0%)	(60.0%)	(100.0%)

Source: Fieldwork, 2014.

Note: SN = Serial Number, SD = Strongly Disagree, D = Disagree, NS = Not Sure, SA = Strongly Agree and percentages are in parenthesis.

Teacher qualification and specific area of specialization were identified as important factors that could influence the classroom implementation of the college chemistry programme (Table 3). Out of the five chemistry teachers identified and used for this study, 2 (40%) had Master of Philosophy degrees with specialization in chemistry; 1 (20%) had a Bachelor of Education degree in science with chemistry as the major area; whilst the rest 2 (40%) had Higher National Diploma with specialization in laboratory technology.

Table 3: Teachers' Responses on Their Highest Qualification

Qualification	Area of Specialisation	Frequency	Percentages
HND	Lab. Tech	2	40%
B.ED Science	Chemistry	1	20%
M. Phil Sci. Edu.	Chemistry	2	40%
TOTAL		**5**	**100%**

Source: Fieldwork, 2014

Table 4 presents data on college chemistry teachers' mastery of the content area as identified through the use of the Barbados Workshop Observation Instrument. Averagely, all the five (5) teachers who were observed exhibited high competency level in the various criteria (K1 – K6) that were observed. Out of all the fifteen lessons observed (three for each teacher) all of the teachers scored 'Yes' for all the items in the criteria specified, except for criteria K4 where one teacher scored 'Satisfactory' for relating concepts to students' experiences. The rest of the points that could be scored were: 'No; Needs Improvement; and Not Applicable' (Appendix E).

Table 4: Teachers' Mastery of Content Area as Indicated on Barbados Workshop Observation Instrument

Criteria		Yes	Satisfactory	Total
K1	Appears Knowledgeable	15	0	15
K2	Appears well organised	15	0	15
K3	Explains concepts clearly	15	0	15
K4	Relates concepts to students' experiences	14	1	15
K5	Selects learning experiences appropriate to level of students	15	0	15
K6	Delivers a well planned lesson	15	0	15
	TOTAL	**89**	**1**	**90**

Source: Fieldwork, 2014

Research Question 2

What resources are available at the designated science and mathematics colleges of education for classroom implementation of the elective chemistry programme?

Items 1-10 of the students' questionnaire were used to elicit information on the availability and state of the resources at the selected colleges that will help in effective implementation of the elective chemistry programme.

The results indicated that 43 student respondents, which represented 35.0% of the total respondents, strongly disagreed that the science laboratories at their colleges were well equipped for the teaching of chemistry. At the same instance, 39 (31.7%) of them disagreed to the same statement. Some 16 (13.0%) of them were not sure of the statement, whilst 19 (15.4%) of them agreed to the statement. However, only 6 (4.9%) respondents strongly agreed that the science laboratories at their respective colleges were well equipped for the teaching of chemistry (Appendix H).

In another instance, 51 (41.5%) student respondents agreed whereas 16 (13.0%) strongly agreed that there are adequate reading materials available to enhance their study of elective chemistry. However, some 15 (12.2%) and 28 (22.8%) of them strongly disagreed and disagreed respectively to that statement. Finally, 13 (10.5%) of the student respondents were not sure of that statement.

When asked to indicate whether their college libraries were well stuffed with chemistry books for references during private studies, whilst some 49 (39.8%) and 25 (20.4%) respondents agreed and strongly agreed respectively, others 24 (19.5%) and 7 (5.7%) disagreed and strongly disagreed to that statement. The rest 18 (14.6%) were not sure of the statements. Table 5 illustrates these responses.

Table 5: Students' Response on Resources Available for the Teaching of Chemistry

Item	SD	D	NS	A	SA	Total
The science laboratory is well equipped for the teaching of chemistry.	43 (35.0%)	39 (31.7%)	16 (13.0%)	19 (15.4%)	6 (4.9%)	123 (100%)
There are adequate reading materials available to you to enhance your study of chemistry.	15 (12.2%)	28 (22.8%)	13 (10.5%)	51 (41.5%)	16 (13.0%)	123 (100%)
The college library is well stuffed with chemistry books for your reference during private studies.	7 (5.7%)	24 (19.5%)	18 (14.6%)	49 (39.8%)	25 (20.4%)	123 (100%)

Source: Fieldwork, 2014

Note: SD = Strongly Disagree, D = Disagree, NS = Not Sure, SA = Strongly Agree and percentages are in parenthesis.

When the students were required to indicate whether their colleges have modern science laboratories for the teaching and learning of chemistry, 38 respondents which represented 30.89% strongly disagreed and 31 (25.20%) of them disagreed to the statement. At the same time, some 38 (30.89%) of them agreed whilst 7 (5.69%) strongly agreed that there colleges have modern laboratories for the implementation of the chemistry programme.

However, 9 respondents which make up 7.32% of the total respondents were just not sure of the statement. The data in Table 6 shows the distributions of the responses.

Table 6: Availability of Modern Science Laboratories for the Chemistry Programme

RESPONCES:	**SD**	**D**	**NS**	**A**	**SA**	**TOTAL**
Frequency:	38	31	9	38	7	123
Percentage:	30.89%	25.20%	7.32%	30.89%	5.69%	100%

Source: Fieldwork, 2014

Note: SD = Strongly Disagree, D = Disagree, NS = Not Sure, SA = Strongly Agree.

The data in Table 7 indicates that all the chemistry teachers 1 (20%) and 4 (80.0%) strongly disagreed and disagreed that the college in which they teach have adequate resources required for the implementation of the elective chemistry programme. They unanimously also disagreed 5 (100%) to the statement that they have ready access to science materials and resources for the implementation of the chemistry programme.

Table 7: Teachers' Response on Resources Available for the Teaching of Chemistry

Item	SD	D	NS	A	SA	Total
The college has adequate resources required for teaching chemistry	1 (20.0%)	4 (80.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (100%)
You have ready access to science materials and resources for the implementation of the chemistry programme	0 (0.0%)	5 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (100%)

Source: Fieldwork, 2014

Note: SD = Strongly Disagree, D = Disagree, NS = Not Sure, SA = Strongly Agree and percentages are in parenthesis.

Research Question 3

Which types of classroom interactions exist between teachers, students, and resources during the implementation process of the elective chemistry programme?

The results from Table 8, which was extracted from the administered modified version of the Barbados Workshop Observation Instrument (Appendix E), show that the proportions of questions that teachers asked during their elective chemistry lessons (categorised under code A) included; questions demanding recall of facts, principles ideas and definitions, 1.83%; questions demanding restate, retell or summary of information, 1.31%; questions requiring application of knowledge, logical deductions, designing experimental procedures, compare data, and answer from direct observation together made up 4.42% of the total observations.

The proportion of other verbal activities or behaviours observed in their chemistry lessons (coded under B) included; teachers giving information / ideas to students, 9.69%; giving instructions / hints on procedure, explaining meaning of words / terms, answering students' questions, and answering own questions were 11.35%; identifies students to make contributions, reading from textbook, puts students into groups, dictates notes and gives commendations were 17.13%. The results also show that the average proportions of non-verbal activities of the teachers (coded under C) included; teachers writing on the chalkboard, 12.23%; performing demonstrations / experiments, demonstrating activities, distributing materials, monitors / supervises students' activities, offers assistance to individuals / groups and giving class exercises were together recorded as 12.40%.

In addition, the data indicate the average percentage of total students' verbal and non-verbal activities categorised under codes D and E respectively. The average percentages of verbal activities undertaken by students in the two colleges included; answering teachers questions, 4.80%; asking questions on the topic, make contributions to the lessons, asking questions not related to the topic, 5 (77%). Others included; asking for help about procedure, making voluntary statements to contribute to the lesson, and reading from textbook / computer, 5.06%. However, the total non-verbal activities of the students which consisted of performing practical activities / experiments, recording activities in notebooks, copying notes from the chalkboard, copying notes as teacher dictates, handling materials / equipment, writing on the board and doing class exercises, all together represented 13.96%.

It could be inferred from the data in Table 8 that college elective chemistry teachers devote most of their teaching time (60 – 120 minutes), that is one to two credit hours, either writing on the chalk board 140 (12.23%), or in giving information and ideas 111 (9.69%) to students whilst allowing students to use only 18 (1.57%) of their chemistry lessons in performing practical activities / experiments.

Table 8: Average Frequencies and Percentages of Total Teacher and Student Behaviours Observed for the two Colleges under Study

Categories	Frequencies	Percentages
A1 Recall facts, ideas, principles & definitions	21	1.83
A2 Restate, retell, summerises information	15	1.31
A3 Apply previous ideas to new situations	13	1.13
A4 Make logical deductions from data/observations	9	0.77
A5 Design experimental procedure, make hypothesis	5	0.44
A6 Compare and contrast data/information	9	0.77
A7 Answer from direct observation	15	1.31
B1 Gives information/ideas	111	9.69
B2 Gives instruction/hints on procedure	45	3.93
B3 Explains meaning of words/term/concepts	44	3.84
B4 Answers students' questions/gives constructive feedback	33	2.88
B5 Answers own questions	8	0.70
B6 Identifies students to make contributions (individuals/group)	64	5.59
B7 Read from textbook/prepared handout notes/computer	54	4.72
B8 Puts students into groups	12	1.05
B9 Dictates notes	39	3.41
B10 Commends	27	2.36
C1 Writes on chalk board	140	12.23
C2 Performs demonstration/experiment	23	2.01
C3 Demonstrates activity/what to do	19	1.66
C4 Distributes materials/equipment	21	1.83
C5 Monitors/supervises individuals/group activities	42	3.67
C6 Offers assistance to individuals/groups	26	2.27
C7 Give class exercises	11	0.96
D1 Answers teacher's questions	55	4.80
D2 Ask questions on the topic	9	0.79
D3 Make contributions to the lesson (when requested by teacher)	56	4.89
D4 Ask questions not related to the topic	1	0.09
D5 Ask for help about procedure	14	1.30

Table 8 continued

Categories	Frequencies	Percentages %
D6 Make voluntary statements to contribute to the lesson	22	1.92
D7 Reads from textbook/handout/prepared notes/computer	22	1.92
E1 Performs practical activities/experiments	18	1.57
E2 Records activities in notebook	18	1.57
E3 Copy notes from chalkboard	41	3.58
E4 Copy notes as teacher dictates	33	2.88
E5 Handle materials and equipment	17	1.48
E6 Write on the chalkboard	22	1.92
E7 Do class exercises	11	0.96
TOTAL	**1145**	**100%**

Source: Fieldwork, 2014

In Table 9, 55 (44.7%) and 62 (50.4%) of the students indicated that their chemistry teachers make use of sufficient resources (teaching and learning materials) during their chemistry lessons all of the time and most of the time respectively. However, 5 (4.1%) of them responded that their teachers used sufficient resources some of the time, whereas only 1 (0.8%) student indicated that his/her teachers do not often use these resources during their lessons. They also indicated that 27 (22.0%) of the respondents were allowed by their teachers to ask questions on what was not clear to them all of the time; whereas 56 (45.5%) of them were allowed to ask questions on what was not clear to them most of the time. But some 36 (29.20%) of them said they were never allowed to ask questions during lessons in order to seek clarifications on things they did not understand. When they were asked to declare whether their teachers involved them in practical activities, 38 (30.9%) of them said they were involved in practical activities most of the time. At the same instance, 71 (57.7%) of them indicated that they were involved in the practical activities some of the times, whilst the remaining 14 (11.4%) of them stated that their teachers did not often involve them in practical activities. This implies that students were involved in theoretical work more than in practical work. The study also revealed that students at the two colleges turn to do individual studies than group studies. This is because only 26 (21.1%) and 19 (15.4%) of them said they worked in groups with other classmates and held discussion with their colleagues on the various topics respectively as compared to 57 (46.3%) of them who said they read chemistry textbooks / handouts and made their own notes.

The results again revealed that even though students were taken through practical lessons / activities in chemistry, they were not allowed to handle materials and equipment by their teachers all the time 0 (0.0%). However, 15 (12.2%) of them indicated that they were allowed to handle materials and equipment most of the time, whereas as much as 72 (58.5%) of them said they were allowed to do so some of the times. Whilst 34 (27.7%) of them said they were not allowed to handle materials and equipment often, the rest 2 (1.6%) of them said they were never allowed by their teachers to do so.

When it got to the questionnaire item on teachers' method of assessment of students' performance and understanding of concepts taught them, 6 (4.9%) and 70 (56.9%) of them indicated that their teachers used quizzes, exercises, assignments and projects to assess their work all of the time and most of the time respectively. This implies that the college chemistry teachers employed various forms of programme and lesson evaluation tools in determining the degree of achievement of programme and lesson objectives respectively. However, 46 (37.4%) of them indicated that even though they were given exercises and quizzes, most of their teachers did not often marked the quizzes and class exercises on time and provided them with feedback on their performances accordingly.

Table 9: Frequency and Percentage Distributions on Students' Responses on Activities during Chemistry Lessons

	During my Chemistry Lessons:	All of the time	Most of the time	Some times	Not often	Never	Tota
11	The teacher makes use of sufficient resources	55	62	5	1 0.8%	0 0.0%	12
	(pictures, tables, animations, computers, etc)	44.7%	50.4%	4.1%			100
12	I am allowed to ask questions to aid my	27	56	4	36	0 0.0%	12
	understanding of concepts.	22.0%	45.5%	3.3 %	29.20%		100
13	The teacher involves me in practical activities	0 0.0%	38	71	14	0 0.0%	12
			30.9%	57.7%	11.4%		100
14	I work in groups with other classmates	1	26	40	56	0 0.0%	12
		0.80%	21.1%	32.5%	45.5%		100
15	I hold discussions with others on the various	0 0.0%	19	32	47	25	12
	topics.		15.4%	26.0%	38.2%	20.3%	100
16	I read chemistry textbooks/handouts and make my	3 2.4%	57	56	7 5.8%	0 0.0%	12
	own notes.		46.3%	45.5%			100
17	I copy the notes that the teacher dictates/writes on	38	68	17	0 0.0%	0 0.0%	12
	the board.	30.9%	55.3%	13.8%			100
18	Enough time is allocated on the college time table	1 0.8%	1 0.8%	16	65	40	12
	for the teaching and learning of chemistry.			13.0%	52.8%	32.6%	100
19	The teacher allows me to handles materials and	0 0.0%	15	72	34	2 1.6%	12
	equipment.		12.2%	58.5%	27.7%		100
20	The teacher uses various tools (quizzes, exercises,	6 4.9%	70	38	9 7.3%	0 0.0%	12
	assignments, projects, etc) to assess my work.		56.9%	30.9%			100
21	The teacher marks my quizzes and class exercises	1 0.8%	12	64	46	0 0.0%	12
	on time and gives me a feedback accordingly.		9.8%	52.0%	37.4%		100

Source: Fieldwork, 2014

Item 22 of student questionnaire was used to seek information from the students on how they could describe the nature and type of interactions that were mostly experienced in their chemistry classrooms. Their responses are displayed in Table 10.

The data shows that, majority of the student respondents 57 (46.34%) indicated that they mostly experienced the Teacher – Student form of interaction in their chemistry classroom. Next to that was the group that said they experienced the Student – Resources 36 (29.27%) form of interaction most. Whilst some 22 (17.87%) of them selected the Teacher – Resources type of interaction as the mostly experienced form of interaction, only 8 (6.50%) selected the Student – Students type of interaction as the one they experienced mostly in their chemistry classrooms (See Table 10).

Table 10: Students' Responses on the Type of Interactions that Existed Mostly in their Chemistry Classrooms

Type of Interactions	Frequency	Percentages (%)
1. Teacher – Students	57	46.34%
2. Teacher – Resources	22	17.87%
3. Student – Student	8	6.50%
4. Student – Resources	36	29.27%
TOTAL	**123**	**100%**

Source: Fieldwork, 2014

The data in Table 11 also shows the various interactions that were experienced during the lessons observed. It was indicated that of all the fifteen lessons that were observed, the teachers - students interactions which fell in line with the items listed on the table were far above average. The teachers' ways of soliciting students' inputs were rated as very good (11 out of 15) and the rest 4 were rated as good. In addition, the teachers were seen to involve a variety of students in their lesson delivery as they scored 'Good' on that item in 13 of the observed lessons.

Table 11: Average Teacher - Student Interactions as Deduced from Barbados Workshop Observation Instrument

T	Type of Interactions	Very Good	Good	TOTAL
T1	Solicited student input.	11	4	15
T2	Involved a variety of students.	2	13	15
T3	Demonstrated awareness of individual student learning needs.	11	4	15
T4	Invited class discussion.	1	14	15
T5	Asked questions to monitor students understanding through questions.	4	11	15
TOTAL		**29**	**46**	**75**

NB: T = Observed Teachers Activities **Source:** Fieldwork, 2014

During practical lessons, students were expected to either work individually or in groups. Table 12 revealed that 8.5% of the organised practical lessons which were observed involved 2 – 5 students in a group, 4.7% of the groups had 6 – 10 students and 2.3% of the groups contained 11 – 15 students. However, it was indicated that majority of the teachers used the whole class as this gave as much as 84.5% of the total group sizes observed. None of the teachers used groups comprising 16 – 20 or 21 -25 students.

Table 12: Average Observed Group Sizes During Practical Activities

Code	Group Size	Percentage
Y1	2 – 5 Students	8.5
Y2	6 – 10 Students	4.7
Y3	11 – 15 Students	2.3
Y4	16 – 20 Students	-
Y5	21 – 25 Students	-
Y6	Whole Class	84.5
TOTAL		**100**

Research Question 4

Do the implementation strategies employed by teachers of colleges of education elective chemistry conform to the stated programme objectives?

To answer this research question, hypothesis was formulated and tested and programme documents were also analysed.

Testing of Hypothesis Associated with Research Question 4

The independent one sample 2-tailed t-test was used to test the hypothesis at a p-value of 0.05 and the results are as follows:

Hypothesis

H_O: There is no significant difference in the implementation strategies employed by teachers of colleges of education elective chemistry to the stated programme objectives ($\mu = 0$).

The statistics shown in Table 13 displayed sample size of 123 and a mean of 46.920. The standard deviation of 8.521 is indicative of the scattering nature of the responses gathered.

Table 13: One Sample Test Statistics

	Number	Mean	Std. deviation	Std. Error Mean
Scores	123	46.920	8.521	0.768

Source: Fieldwork, 2013

Table 14 displays one sample 2–tailed t-test for the significance of the implementation strategies employed by teachers. It showed a mean value of 46.919, degree of freedom of 122 as well as t-value of 61.070. Since the p-value of 0.00 is less than the alpha value of 0.05, the null hypothesis (H_O) is rejected. It is therefore concluded that implementation strategies employed by teachers of colleges of education elective chemistry to the stated programme objectives is significant.

Table 14: One Sample 2-Tailed T-Test Statistics

	Test Value = 0			95% confidence Interval of the Difference		
	t-value	**d.f**	**p-value**	**mean**	**lower**	**upper**
Score	61.070	122	0.00*	46.919	45.400	48.440

* = Significant at $p < 0.05$ **Source:** Fieldwork, 2013

Document Analysis

To answer research question fours, analysis of documents was done. This helped to describe the intended programme objectives which could be compared with the actual or implemented programme of study. During the data collection phase, the researcher obtained various chemistry programme documents from the heads of science departments and from the teachers of college elective chemistry who were involved in the study.

The analysis of the science programme outline revealed that it was based on two sets of objectives. The first set was the overall science programme (biology, chemistry and physics) objectives which, according to TED (2007) were to enable the student to:

> Acquire the relevant scientific knowledge on topics treated in the science programme; organise their knowledge into concepts; acquire relevant manipulative skills to enable them to handle and operate science equipment and materials; solve conceptual problems related to topics treated in the science programme; apply the knowledge and skills acquired in the science programme to the organisation of science lessons; relate the knowledge acquired in the science program to situations in everyday life (p.5).

To achieve these, the chemistry programme was sub-divided into four main groups: FDC 114C and FDC 114 CP, which were to be studied in the first semester of the first year at college; and FDC 224C and FDC 224 CP, which were to be studied in the second semester of the second year. The FDC 114C / FDC 224C were the theoretical areas whilst the FDC 114 CP and FDC 224 CP were the practical aspects of the chemistry programme. Students' progresses were to be evaluated formatively and independently for both the theory and the practical. At the end of the study of FDC 114C, the student would have acquired the knowledge of basic concepts on the nature and constituents of matter, be able to apply the knowledge acquired to explain various phenomena in science, and be able to undertake simple practical activities related to different aspects of the course. At the end of the study of FDC 224C the objectives required the student to obtain a full understanding of the concept of acids, bases and salts and their characteristics as well as be able to identify and classify natural and synthetic polymers.

The course outline also suggested that three (3) credit hours should be allocated on the time table to the theoretical aspects of the course whilst the practical aspects should take one (1) credit hour per week (TED, 2007). Analysis of the various teaching time tables at the two colleges of education revealed that the credit hours were reduced to 2 hours for the theoretical aspects (FDC 114C and FDC 224C) whereas that of the practical lessons were maintained. This reflected in the responses given by students to item 18 of their questionnaire (Table 9 and Appendix I) in which as much as 65 (52.8%) and 40 (32.6%) totaling 105 (85.4%) of the total student respondents indicated that the time allocated on the colleges' time table for the teaching of chemistry was not enough.

It could be inferred, from the various topics stated in the course outline, that the subject matter contents to be covered by the teachers were very broad. However, the outline gave a guideline to the teachers about the various activities to be performed and the expected duration (in weeks) to be used for each topic. The expectations were that when teachers adhere to the guidelines strictly, they would be able to effectively undertake the classroom implementation of the programme as intended.

The performance of students in the final end of semester examinations could provide information on the reflection of teachers' adherence to the stated programme objectives during programme implementations. To ascertain this, students' final results in two chemistry courses (FDC114C, Theory and FDC114CP, Practical) were obtained and their various grades analysed as presented in Table14 below: From the table, it could be seen that 5 (4.1%) and 4 (3.3%) of students obtained grade A in the two courses respectively. Some 59 of them which represents 47.9% obtained either grade B+ or B in FDC 114C whereas 66 of them representing 53.7% of the total sample obtained either grade B+ or B in FDC 114CP. In addition, 38 (30.9%) obtained either grade C+ or C in FDC 114C whilst 34 (27.6%) got grade C+ or C in FDC 114CP. It was only 1 (0.81%) who obtained grade E in FDC 114CP but not in FDC 114C (Table15).

Exercise books and quiz papers were records which were sampled and analysed provided evidence of continuous assessment practices (Context, Input, Process, Product) model which was proposed by Stufflebeam in 1971. It was evident that teachers used exercises, quizzes and assignments to periodically assess the performance of students. However it was discovered that teachers do not often mark some of these works and gave students feedback on their performances.

Table 15: Summary of Grades Students Obtained in Two Chemistry Courses

GRADE	INT.	FDC114C	(%)	FDC114CP	(%)
A	Excellent	5	4.1%	4	3.3%
B+	Very Good	26	21.1%	32	26.1%
B	Good	33	26.8%	34	27.6%
C+	Very Satisfactory	27	22.0%	19	15.4%
C	Satisfactory	11	8.9%	15	12.2%
D+	Very Fair	13	10.6%	11	8.9%
D	Fair	8	6.5%	7	5.7%
E	Unsatisfactory	-	-	1	0.8%
TOTAL		**123**	**100%**	**123**	**100%**

NB: INT = Interpretation **Source:** Fieldwork, 2014

One of the objectives of the science programme was to make the students acquire manipulative skills to enable them handle and operate science equipment and materials. This was taken into consideration by the teachers as they try to involve a variety of materials during lessons. From Table 16 it could be realised that 8 (53.33%) of laboratory equipment as well as 5 (33.33%) of improvised materials were used during practical lessons. It also indicated that a lot of textbooks / handouts other than those supplied by GES / TED which summed up to 13 (86.67%) were made use of. Furthermore, it was clear that a lot of technology was employed during lessons because computer simulations which included videos, audios, still pictures, and animations made up 80.00% of the materials used during all the observed lessons.

Table 16: Average Materials/Equipment Used in Chemistry Lesson

Code	**Materials/Equipment**	**Count**	**Percentage**
X1	Laboratory Equipment	8	53.33
X2	Improvised materials	5	33.33
X3	Items supplied by GES/TED	3	20.00
X4	Textbooks/Handouts	13	86.67
X5	Computer simulations	12	80.00
X6	No materials apart from chalk	-	0.00

NB: The counts are independent of each other **Source:** Fieldwork, 2014

Discussion of the Results

1. Factors that Influence Classroom Implementation of the College Chemistry Programme

Some factors which were identified as being able to influence the implementation of the college chemistry programme at College A and College B included the educational qualification of teachers and their mastery of content area, the availability of modern science laboratories and the state of the college libraries. Others are the recognition of the chemistry programme by the colleges' administrations as part of the overall college curriculum and teacher willingness to teach chemistry.

On teacher qualification, the study revealed that out of the five (5) teachers involved, 2 (40%) held Master of Philosophy in Science Education with chemistry as a major subject area. 1 (20%) had a Bachelor of Education degree in science with chemistry as his major subject area. However, information from the transcribed teachers' interview (Appendix G) revealed that this teacher is a candidate for the award of Master of Philosophy in Science Education with specialisation in chemistry. These three teachers were responsible for the theoretical aspects of the college chemistry programme implementation (FDC 114C and FDC 224C).

The remaining 2 (40%) were holders of Higher National Diploma with specialisation in laboratory technology. They were responsible for organisation and conduct of practical activities and lessons. They were also said to have enrolled into various programmes at the various universities leading to the acquisition of Bachelor of Science degrees in chemistry. There were indications of collaborative teaching among these teachers. The influence of teacher qualification on teaching as well as programme implementation was supported by Ornstein and Hunkins (1998) when they stated that regardless of which philosophical belief the education system is based on, teachers influence students' learning. They added that better teachers foster better learning. Teachers are most knowledgeable about the practice of teaching and are responsible for introducing the curriculum in the classroom. The key to getting teachers committed to an innovation is to enhance their knowledge of the programme. This means that teachers need to be trained and workshops have to be organised for professional development. Unfortunately, it was identified during interview with teachers that workshops and seminars were not regularly organised for the teachers. This has limited the extent to which they update themselves with the more appropriate pedagogical skills to employ during teaching as well as the novel approaches to develop towards the programme implementation.

The next factor which was identified was availability and the state of college laboratories. Table 6 revealed that although there were science laboratories at both College A and College B, but they were not of modern standard. This was confirmed by as much as 56.09% (SD + D) of respondents as indicated in Table 6. However, Svinicki and McKeachie (2012) mentioned that laboratory teaching (especially at the college level) assumes that first-hand experience in observation and manipulation of the materials of science is superior to other methods of developing understanding and appreciation. Laboratory training is also frequently used to develop skills necessary for more advanced study or research. It implies that chemistry students at these two colleges were being denied these benefits of laboratory involvement in chemistry lessons.

On the flip side, 36.58% (A + SA) of the respondents thought the nature of the laboratories could be described as being modern. During Teachers' interview it was mentioned that adequate and efficient practical lessons could not be held regularly due to the unavailability of laboratory chemicals and equipment. This set back could seriously interfere with the intended processes of programme implementations.

In terms of the college libraries, Table 5 indicated that the libraries were available at the two colleges and were well stuffed with reference books and other supplementary reading materials to enhance teaching and learning of chemistry. This was supported by 60.2% of the respondents (A + SA). In addition, all the 5 teachers agreed, as shown in Table 2, to the statement that the administrators and the entire college community recognised chemistry as one of the programmes in the general college curriculum.

The data in Table 1 indicated that 91.9% of the student respondents agreed (A + SA) that the science teachers at the two colleges were willing to teach chemistry. Since teachers are the agents of curriculum implementation as declared by University of Zimbabwe (1995), their level of understanding and willingness to implement a programme of study could either positively or negatively influence the outcomes.

2. **Resources that were Available at the two Science Colleges for Chemistry Programme Implementation**

For effective implementation of an academic programme, it is expected that both human and material resources must be in sufficient and regular supply. Human resources include people who are knowledgeable enough to take the students through theoretical and practical aspects of the programme. These individuals could be qualified teachers, laboratory assistants, or resource persons from the communities. Material and structural resources such as college science laboratories, science equipment and improvised materials, as well as libraries with recommended reference books are very important (Tiawo, 2005) to implement the chemistry programme.

This study revealed that there were libraries at the two colleges which were well stuffed with chemistry books for reference purposes (Table 5). This was confirmed by the majority of the students74 (60.2%) who agreed to that assertion.

Laboratory adequacy is a factor which has been reported to affect the performance of students in chemistry (Raimi, 2002). Farounbi (1998) argued that students tend to understand and recall what they see more than what they hear as a result of using laboratories in the teaching and learning of science. Ironically, the laboratory situations at the colleges under study were different. Even though there were science laboratories at these colleges, they are not of modern standard. Table 5 revealed that the science laboratories were not well equipped for the teaching of chemistry. These implies that the chemistry students in these two colleges would not benefit from the recommendation by Svinicki and McKeachie (2012) that laboratory teaching of science assumes that first-hand experience in observation and manipulation of the materials is superior to other methods of developing understanding and appreciation. Laboratory training should also be frequently used to develop skills necessary for more advanced study or research.

Usually, the principal intended learning outcome is tacit knowledge of the processes of scientific enquiry expressed through practical capability (the ability to plan, design and carry out a scientific investigation), though the aim may also, to a greater or lesser extent, be to develop a more reflective, declarative knowledge of the nature of science. There is some evidence that experience of carrying out extended practical projects can provide students with insights into scientific practice and can increase their interest in science and give them a motivation to continue its study (Jakeways, 1986; Woolnough, 1994).

Data from the transcribed students' and teachers' interview (Appendix F and G) also confirmed the fact that materials and equipment at the laboratories of both College A and College B were either inadequate or obsolete, This was supported by 56.09% of the respondents in Table 6 who disagreed that to the statement that the colleges have modern science laboratories for the teaching of chemistry. It was also revealed that consumable materials such as chemicals and reagents have never been supplemented after the initial nationwide distribution in 2008 by the government.

The data in Table 7 further revealed that teachers in the two colleges do not have ready access to teaching and learning resource for the effective implementation of the chemistry programme. These prevailing conditions disagreed with the declaration by University of Zimbabwe (1995) that adequacy of equipment, facilities and general resources are required for implementing a new curriculum programme. UNESCO (2013) also revealed that besides teacher qualifications and school facilities, another important determinant of quality of education is the teaching and learning materials and it is essential for quality materials to be made available to the teachers and students in adequate quantities to support the teaching and learning processes. Quality and effective teaching and learning of chemistry was, therefore, not likely to take place at these two colleges as the facilities and equipment necessary for the programme implementation were in limited supply.

3. Types of Classroom Interactions that Existed During Chemistry Lessons

Interactions in the classroom can proceed harmoniously or they could be fraught with tension and every interaction situation has the potential for co-operation or conflict (Malamah-Thomas, 1987). How the situation actually develops depends on the attitudes and intentions of the people involved, and on their interpretations of each other's attitudes and intentions. Communication can effectively take place only when there is co-operation between both sides, then, learning occurs. Interaction is mainly achieved by two means of resources: language and non-verbal means of expression. There are most frequent ways of organising classroom interaction depending on who communicates with whom (Ghosh, 2010).

The study revealed that 46.34% of the total interactions experienced in the classroom at the two colleges were teacher – student related (Table 10). This agrees with the explanations given by Nolasco and Arthur (1987) that the purpose of teacher – student interaction is the creation and maintenance of social relationships, the negotiation of status and social roles, as well as deciding on and carrying out joint actions. In addition, 46.34% of Teacher - Student interactions did not depart from what Littlewood (1981) said about a traditional classroom; he said the teacher had the dominant role of an all-knowing leader who 'filled' students' empty heads with knowledge.

However, he added that this role has changed and the teacher has now got many roles depending on different classroom situations. In a broad sense, he is a 'facilitator of learning', a general overseer of learning, who coordinates the activities so that they form a coherent progression from lesser to greater communicative ability. He is a classroom manager, who is responsible for grouping activities into lessons and for their overall organisation. In free communicative activities he will act as a consultant or adviser, helping where necessary. He may move around the classroom and monitor student's progress, strengths and weaknesses. Sometimes he will participate in an activity as a 'co-learner' with the learners. He may encourage learners without taking their main role. These roles are frequently interrelated with some others which include assessor and observer (Harmer, 2001).

Table 11 also gave a good representation of the Teacher – Student interactions during chemistry lessons at the two colleges as deduced from the Barbados Workshop Observation Instrument. It was realised that the teachers' ways of soliciting students' inputs during lessons were averagely rated as 11 (Very Good) out of the 15 observations made. In addition, their way of involving a variety of students during lesson delivery was rated as 13 (Good) out the 15 lessons observed.

The study also revealed that 29.27% of the interactions experienced in elective chemistry classroom at College A and College B were the Student – Resource type. This implies that students were allowed to handle and manipulate the materials which were available at the colleges during the implementation of the chemistry programme. This agreed with what was transcribed from both the teachers' and students' interviews that any time an activity related lesson was held, students were allowed to handle and manipulate the materials that were provided. Students also mentioned that they were allowed to use the reference materials at the college library to supplement classroom work (Appendices F and G).

The number of students who were put into a group during group work, practical lessons and other activity oriented lessons also gave an indication of the level of Student – Student type of interaction as experienced during chemistry lessons. The data in Table 12 indicated that full class instructions were mostly used during chemistry practical lessons. This was realised as it gave an average of 84.5% of the total observed class sizes. It was also revealed that smaller groups which were made up of 2 - 5 and 6 - 10 students were not commonly used during practical activities since these produced only 8.5% and 4.6% respectively.

The question as to whether smaller classes are better than larger classes continues to be debated among education policy makers, teachers, administrators and parents as well as in the research community. However, Robinson (1990) concluded that research does not support the expectation that classes will of themselves result in greater academic gains for students. He observed that the effects of class size on student learning vary by grade level, pupil characteristics, subject areas, teaching methods and other learning interventions. Adeyela (2000) found that large class size is not conducive for serious academic work. Also Afolabi (2002) found no significant relationship among the class size and students' learning outcomes. It was noticed that the chemistry programme developers did not specify any expected number of students to be put into a particular group during group work. The course objectives only recommended that students be made to undertake simple practical activities related to different aspects of the course (TED, 2007). However, observations show that teachers find it difficult to do effective class control and give attention to individual students when they are crowded into a group during lessons than when they are put into smaller groups.

The method of full class teaching has been found to contribute to the poor performance of students in science related courses. According to Palmer (1990), lecturing students rather than engaging them in practical activities is not only an effort to quickly cover the topics, but also to overload and overwhelm them with data, making it likely that students will confuse the facts presented to them.

Furthermore, Table 10 revealed that much attention was not given to the Student – Student form of interaction during chemistry lessons. This is because only 6.50% of such interaction was recorded during the conduct of this study. But the importance of student – student interaction during lessons cannot be underestimated. In reality, two forms of this interaction exits, the one called ‘pair work’ in which students get an assignment which they have to finish in pairs. After the activity, the teacher puts the pairs into a whole group and each pair reports on their work. The other form is called ‘group work’ in which students are put into groups of about three or more students (Mateja, 2004). It is therefore unfortunate that teachers of chemistry at these two colleges did not give much attention to this type of interaction during their lessons.

Through classroom interaction the students will be able to get themselves involved with concepts, ideas, materials and various other devices and products associated with the chemistry programme. It is reasonable to believe that improving learner – learner interaction helps to center the individual in a learning process that is as active and cognitively complex as possible. According to Jonassen (1993) common understandings regularly result from social negotiation of meaning which is supported by collaborative construction of knowledge. Learners become active participants in social communities and construct identities that relate to those communities (Hannon & Atkins, 2002). This leads to greater depth of learning.

4. Compliance of Teachers' Implementation Strategies with Stated Programme Objectives

The researcher's interest in formulating this research question was to identify some classroom implementation strategies that were employed by the teachers of elective chemistry at the two colleges under study (College A and College B), and to compare same with the objectives stated in the programme document. The reason was to find out the compliance to or deviation from the stated programme objectives.

The programme documents which were analysed included the chemistry programme course outline, students' end of semester results and the teaching time table at both College A and College B. The programme outline document revealed that students were to be made to acquire manipulative skills to enable them to handle and operate science equipment and materials. To do this effectively students should be taken through a lot of practically related lessons. Table 16 represents the average materials and equipment that were used during lessons that were observed. It shows that 53.33% of the laboratory equipment were used during practical lessons.

This agreed with the statement made by House of Lords (2006) that whether practical work is done both in the classroom or outdoors, it is an absolutely essential component of effective college chemistry teaching. Practical work enhances pupils' experience, understanding, skills and enjoyment of science. They added that practical work allows science education to become something that learners participate in, rather than something they are subject to and supports aspirations towards further study of science-related work.

In addition, chemistry teachers' adherence to the programme objectives could reflect in students' performance in final examinations. From the data in Table 15, 3.33% of the students obtained grade 'A' in chemistry practical (FDC 114CP); 26.7% obtained grade 'B+' whilst 27.6% obtained grade 'B'. These together gave a 67% above average performance in this aspect of the subject. This performance supports the evidence given by Roberts (2002) that students find practical work relatively useful and enjoyable as compared with other science teaching and learning activities.

Another way to determine the adherence of chemistry teachers at the two colleges to the stated programme objectives was for me to formulate and test research hypothesis for this particular research question. The null hypothesis was:

H_O: There is no significant difference in the implementation strategies employed by teachers of colleges of education elective chemistry to the stated programme objectives ($\mu = 0$).

Statistically, for the null hypothesis to be rejected, the p-value must be less than the alpha value of 0.05. The study made use of a sample size of 123 which upon analysis gave a mean of 46.920 and standard deviation of 8.521 (Table 13). This indicated the scattering nature of the responses gathered. It was observed that the p-value was 0.00. Since the p-value of 0.00 is less than the alpha value of 0.05, the null hypothesis (H_O) was rejected.

It was therefore clear that the implementation strategies employed by chemistry teachers at College A and College B to the stated programme objectives were significant. This implies that chemistry teachers at the two colleges used programme implementation strategies that did not conform to the requirements of the programme objectives which were stated in the TED (2007) designated science programme document.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Overview

This chapter discusses the main outcomes of the study. It includes a summary of the major findings, conclusions and recommendations. The chapter also contains contributions and suggestions for further studies.

Summary

The fundamental purpose of this study was to evaluate the classroom implementation of colleges of education elective chemistry programme. The study was focused on the two designated science and mathematics colleges of education in the Volta region of Ghana. For the purpose of this study and for ethical reasons, these colleges were coded as 'College A' and 'Collage B'.

The research was a descriptive survey type with four research questions formulated to achieve the objectives of the study.

The objectives of the study were to find out:

1. The factors that influence the roles of teachers and students during classroom implementation of the college elective chemistry programme.
2. The resources which were available at the designated science and mathematics colleges for classroom implementation of the elective chemistry programme.

3. The types of classroom interactions that existed between teachers, students, and resources during chemistry lessons.
4. The implementation strategies employed at the science colleges of education to identify their conformance with the stated chemistry programme objectives.

The instruments that were used to collect data included: questionnaire, interviews, and classroom observations. Analysis of college documents also contributed to data for the study. The purposive sampling technique was used to select the subjects for the study. Questionnaires were completed by 123 second year elective science students who also study chemistry and 5 chemistry teachers at College A and College B in the Volta region of Ghana. All the five chemistry teachers and ten randomly selected science students were interviewed. Fifteen (15) live chemistry lessons (three for each teacher) were observed.

The data collected was analysed to answer the specific research questions. The analysis of data involved the use of frequencies, percentages, means, standard deviations and independent sample t-test of significance. Interviews and school documents were also analysed using qualitative methods of data analysis.

The discussion of the major findings followed the main research objectives of the study. The data collected and its subsequent analysis yielded the following major findings:

1. The study revealed that factors which influenced the implementation process of the college chemistry programme at College A and College B included teacher qualification, availability of modern science laboratories, availability of chemistry reference books at the college library, teacher willingness to teach chemistry and the recognition of chemistry by the college administration as one of the academic

programmes in the overall college curriculum. It came up that 40% of the chemistry teachers had master of philosophy degree in science education with specialisation in chemistry, 20% of them had a bachelors degree in science education (B.ED Science) with specialisation in chemistry, and the rest 40% had a higher national diploma (HND) with specialisation in laboratory technology. It was revealed that three of the teachers were on various educational and professional programmes to upgrade and enhance their qualification towards the teaching of college chemistry. However, teachers did not have the opportunity to attend workshops and seminars regularly in order to update themselves on expected programme implementation strategies to employ. In terms of the availability of modern science laboratories, 56.09% of the respondents indicated that the laboratories were not of modern standard. In addition, 60.2% of the respondents agreed that the colleges had libraries which had a lot of chemistry books for reference purposes. It was again revealed by 91.9% of the student respondents that the science teachers at the two colleges were willing to teach chemistry. There was a total of 100% support by teachers and students of the statement that the administrators and the entire college community of the two colleges recognise chemistry as one of the programmes in the general college curriculum.

2. The study also disclosed that the two colleges lacked sufficient and regular supply of laboratory chemicals, materials and equipment which are very important in effective and efficient chemistry programme implementations (Appendix H) This, however, did not affect the performance of students in the final end of semester examinations organised by the Institute of Education of the University of Cape

Coast. The results showed that 52 % of the students had either grade A, B+ or B whilst the rest 48% had either grade C+, C, D+, or D, in FDC 114C. It was revealed that students' end of semester examinations in the practical aspect of the programme (FDC 114CP) had not been hands-on since the inception of the elective chemistry programme in 2007. This implies that students' level of mastery of practical chemistry could not be evaluated effectively. This means that the 70% (grades, A, B+ or B) above average performance by students in FDC114CP cannot be attributed to the fact that students have acquired adequate knowledge of practical chemistry.

3. As regards the types of classroom interactions that existed at the two colleges during chemistry lessons, the study results show that 46.34% of the total interactions were Teacher – Student related. 17.8% of Teacher – Resources interactions was observed whereas Student – Resources interactions were 29.2%. The least form of interaction observed was the Student – Student type which yielded 6.50% of the total observed interactions (Table, 10). It was also indicated in Table 12 that full class instructions were mostly used during chemistry practical lessons. This was because an average of 84.5% of the total observed class sizes were whole class interactions.
4. In order to assess students' performance and teachers' adherence to programme objectives at College A and College B, the study revealed that 61.8% of the teachers used various assessment tools such as quizzes, class exercises, assignments, and projects. However, only 10.6% of the teachers marked these

quizzes and class exercises on time and gave feedback to students accordingly (Table 9).

5. It was also gathered during the researcher's interactions with both the teachers and the students at the two colleges that, the teachers only teach students towards how to pass the end-of-semester examinations without ensuring that students acquired concepts and relevant manipulative skill that would enable them to handle and operate science equipment and materials as stated in the TED (2007) science programme outline. The results from Table 9 show that 29.3% of the students were not allowed to handle and manipulate materials and equipment during practical lessons as compared to 12.2% of students who were allowed to handle and manipulate materials. The outcome would be that the achievement of this particular programme objective was not possible at the two colleges.
6. There was significant difference in the implementation strategies employed by teachers of elective chemistry at both College A and College B to the stated programme objectives [$t\ (122) = 61.070$, $p < 0.05$]. Chemistry teachers at these colleges used programme implementation strategies which did not conform to the requirements of the programme objectives. Hence the null hypothesis (Ho) which stated that there is no significant difference in the implementation strategies employed by teachers of colleges of education elective chemistry to the stated programme objectives ($\mu = 0$), was rejected for College A and College B.

Conclusion

Teacher qualification, availability of modern science laboratories, availability and state of the college library, time allocated to the teaching and learning of chemistry, number of students in a group during practical activities and teacher willingness to teach chemistry were some factors identified to have influence on the chemistry programme implementations at College A and College B.

The present study reveals that majority (60%) of the teachers at the two colleges had a minimum professional qualification of Bachelor of Education degree in science with specialisation in chemistry. The rest 40% who had no professional qualification studied laboratory technology at the Higher National Diploma level. The colleges had science laboratories for practical chemistry lessons but the laboratories lack adequate chemicals and equipment to ensure organisation of effective practical lessons. The study also revealed that the two colleges had libraries which were stuffed with enough chemistry books and other reference materials. Science teachers at the two colleges were willing (91.9%) to teach chemistry. Furthermore, it was concluded that the college administration recognises chemistry as a programme in the overall college curriculum. However the time allocated on the teaching time table for the teaching of chemistry was found to be inadequate.

It was clear that College A and College B had required human resources but lack adequate material resources. Little effort had been made by the college administrations, the GES/TED and the central government to supply the colleges with the recommended material resources for the effective implementation of the chemistry programme.

Most chemistry teachers at the two colleges used whole class 84.5% during lessons. This did not create the chance for more Student – Resources and Student – Student interactions. As much as 29.3% of students were not allowed to handle and interact freely with materials and equipment that were available at the laboratory or during lessons. Only 12.2% of the students were allowed to handle these materials.

Chemistry teachers at the two colleges used various assessment tools; quizzes, class exercises, assignments and projects to assess students' progress but only10.6% of the teachers marked these works and gave feedback to students on time.

Finally, it was concluded that the implementation strategies that chemistry teachers at College A and College B employed did not conform to the stated overall programme objectives. This was because the null hypothesis for research question 4 was rejected as p-value (0.00) was less than 0.05.

These conclusions agreed with the assertion by Taiwo (2005) that insufficient funding of science programmes, lack of standard laboratories, and lack of general teaching resources limit the effective teaching and learning of science. He went on to say that lack of qualified, dedicated and knowledgeable teachers who have specialized in an aspect of science, and lack of qualified laboratory assistants negatively affect the effective implementation of a science programme. He also stated that inadequate time budgeting and improper composition of students' task groups will further affect the study of science negatively.

This study agreed with the findings of Eminah (1993) that there was a gap between the objectives of the intended chemistry programme with respect to classroom implementations and the actual classroom practices of the teachers and students in the two colleges of education under study. Chemistry teachers at these colleges should be asked to endeavour to use a lot of learner – centred approaches during the teaching of chemistry. This should include more of Student – Student and Student – Resources interactions than Teacher – Student and Teacher – Resources type of interactions that were more prevalent during chemistry lessons at theses colleges. This will help in ensuring that the students acquire the necessary manipulative skills needed for handling materials and equipment at the classrooms and in their communities.

Recommendations

From the findings of this study, it is obvious to mention that the classroom implementation process of the colleges of education elective chemistry programme in College A and College B as used for the study, needs much to be desired. Based on this, the following recommendations have been made:

1. In-service trainings, workshops and seminars should be organised periodically for chemistry teachers at College A and college B to keep them well informed about the appropriate and expected pedagogical skills to be employed during the implementation of the programme. This is because there is a growing consensus that improving students' learning depends on a teaching force with appropriate beliefs and attitudes towards teaching and learning; and who possess content and pedagogical knowledge quite distinct from the usual instructional practice in most classrooms (Even, 1999; Zaslavsky and Leikin, 2004). While initial teacher training

nurtures these characteristics, it is insufficient to prepare teachers for the greater challenges of everyday teaching, where, time constraints and pressure from summative assessments overwhelm both newly qualified and experienced teachers. Whereas in-service teacher education complements initial teacher training, there is lack of adequate and appropriate opportunities for most practicing teachers to enhance their skills and align their practice to the reform visions in education (Clegg, Macfarlane, & Ottevanger, 2005), as well as build professional competence in them. Moreover, professional development which focuses on practice alone without reflective lenses in terms of theoretical perspectives (Even, 1999) runs the risk of reinforcing traditional instruction or promoting practices misaligned with changing trends in education.

2. The government should refurbish the science laboratories at College A and College B and upgrade them to modern status to enhance effective organisation of hand-on practical activities and lessons. Many topics in the chemistry programme included activities whose primary aim was to develop students' understanding of scientific enquiry (and their ability to engage in it) and also, perhaps, their ideas about the nature of scientific knowledge. These often centre on practical work of a more extended and investigative character, where students have some freedom to choose equipment and methods and interpret their findings. Hence a well organised laboratory would be needed to promote the effectiveness in exposing college students to this enquiry based scientific learning.
3. There should be regular supply of chemicals, reagents, apparatus and general teaching and learning materials to the laboratories at these two colleges. This will

help in ensuring that outdated, expired and antiquated materials, chemicals and equipment will not be used to teach modern concepts in chemistry. Teachers should also be well motivated and encouraged to improvise materials from the college communities to supplement scares and sophisticated ones during lessons.

4. Monitoring, supervision and systematic formative evaluation should form core components of the chemistry programme implementations. The college administrations, MOE/GES/TED, programme developers and other stakeholders in science education should intensify their supervisory roles in these colleges through periodic visits. It is only then that they can identify most of the challenges associated with the programme implementations and hence be able to suggest solutions to them.
5. To be an effective chemistry teacher, one must continuously practice self-evaluation and self-critiquing as a learning tool. This will make them reflective and able to evaluate their own lessons in order to improve upon their programme implementation strategies. Chemistry teachers at the two colleges should also be encouraged to engage in collaborative teaching during which they can discuss and share ideas about content, procedure and pedagogy with their colleagues prior to and after lesson delivery.
6. Teachers of college chemistry should be encouraged to adopt various classroom interactive strategies during chemistry lessons. They should minimize the use of whole class Teacher – Students interactions as this gives room for limited attention to individuals and the various ability groups which are found in the classroom. Chemistry teachers should employ the learner-centred approach of lesson delivery.

7. The use of technological devices such as computer simulations, videos, Power-Point presentations and internet based research should be encouraged among both the teachers and students of college chemistry programme at the two colleges. These will help to expose them to divergent knowledge acquisitions.
8. The current system in which chemistry is only studied in only two semesters of the entire 3-year Diploma in Basic Education programme should be reviewed. Government should increase the duration for the study of college chemistry by increasing the number of credit hours and allowing the programme to be studied in all the semesters of students' on-campus period. The college administrations should also be asked to increase the time allocated to the study of chemistry on the college time table.
9. End of semester examinations in practical chemistry courses (FDC 114CP and FDC 224CP) which are organised and supervised by the Institute of Education, University of Cape Coast should be strictly hands-on whilst that of theory oriented courses (FDC114C and FDC 224C) should be strictly minds-on. This will help increase the level of commitment in the students and the desire of the chemistry teachers to organise practical lessons and activities during the programme implementations.

Contributions and Suggestions for Further Studies

In Ghana and elsewhere, many studies have been made to investigate the teaching and learning of science as well as the factors that militate against effective teaching and learning of science in schools and colleges. This study has contributed new knowledge by engaging chemistry teachers and students at the colleges of education level in classroom observations to get a true picture of how the elective chemistry program was being implemented. Whilst the previous studies revealed lack of laboratories and lack of qualified teachers as the critical issues affecting the teaching and learning of chemistry, this present study indicated that the classroom implementation (teaching and learning) strategies employed by chemistry teachers were at variance with the principles and objectives which were intended to guide the programme implementations. This led to students' acquisition of limited knowledge of practical concepts in chemistry. The study also revealed that in-service trainee sections, workshops and seminars to update the teachers' knowledge in the expected and appropriate pedagogical skills to be employed for effective programme implementations were not periodically organised for teachers at College A and college B. It was also identified that the time provided for the teaching and learning of chemistry was not enough at the two colleges.

Although a descriptive survey design was used in this study, the findings cannot be said to be representative of the situations in all other 13 designated science and mathematics colleges of education in Ghana. It is, therefore, suggested that similar survey be carried out in other designated science and mathematics colleges of education as well. This will help to provide a good basis for more generalization of conclusions to be made on some aspects of the classroom implementation of the elective chemistry programme at the science and mathematics colleges of education.

An observation which was made in the laboratories at the two colleges used for this study was the complete absence of laboratory inventory record books and evidence of availability of improvised materials at the science laboratories. It is my wish that a comprehensive study is conducted on the role of laboratory inventory records on college chemistry programme implementation. This would help students, teachers and educational policy makers to understand the essentials of laboratory organisation and management as related to college chemistry programme implementation.

REFERENCES

Adeyela, J. (2000).*Problems of teaching science in large classes at the junior secondary school Level: Implications for learning outcome.* Unpublished M.Ed Thesis. University of Ibadan, Ibadan.

Afolabi, F. (2002).*School factors and learner variables as correlates of senior secondary physics achievement in Ibadan.* Unpublished Ph.D Thesis. University of Ibadan, Ibadan.

Amedahe, F. K. & Asamoah, E. G. (2001).*Introduction to educational research*. UCC: Mercury Press.

American Chemical Society (2013).*Middle school chemistry: lesson plans.* Retrieved 14th December, 2013. Website: http://www.middleschoolchemistry.com/lessonplans

Anamuah-Mensah, J. (1999). *Science and technology education in Ghana.* A paper delivered at the National education Forum on the theme: Towards Sustaining an Effective National Education System, held at the Accra International Conference Centre, Accra, 17-19th November, 1999.

Beach, D. M., & Reinhatz, J. (1989).*Supervision: focus on instruction*. New York: Harper and Row

Best, J. W., & Kahn, J. V. (1989).*Research in education*. New Delhi: Program Press.

Boghai, D. M. (1997).*A Comparison of the effects of laboratory and discussion sequences on learning college chemistry*. New York Press

Bush, T. (2002). Authenticity, reliability, validity and triangulation.In M. Coleman, & A. R. J. Briggs (Eds.), *Research methods in educational leadership and management* (pp. 91-105). London: Paul Campman Publishing Ltd.

Cerini, B., Murray, I., & Reiss, M. (2003).*Student review of the science curriculum: Major findings.* London: Planet Science/Institute of Education University of London/Science Museum. Retrieved: November 27, 2013, Website: http://www.planet-science.com/sciteach/review.

Clegg, A., Macfarlane, I., & Ottevanger, W. (2005). Science and mathematics education development in Namibia after independence: The INSTANT Project. *Journal of International Cooperation in Education*, *8*(1), 35–44.

Cohen, L., Manion, L., & Morrison, K. (2000).*Research methods in education* (5th ed.), London: Routledge Falmer.

Collins English Dictionary (2009).*Complete & Unabridged*: 10th Edition © William Collins Sons & Co. Ltd. 1979, 1986 © HarperCollins Publishers 1998, 2000, 2003, 2005, 2006, 2007, 2009

Diamond, I. (2011). Science education in schools: issues, evidence and proposals. A Commentary by the Teaching and Learning Research Programme. *A Journal of the Association for Science Education.*Institute of Education, University of London Publishers. Retrieved: August 20, 2013. Website: http://www.tlrp.org/pub/documents/TLRP_Science_Commentary_FINAL.pdf

Duckworth, E. (1990). *Science Education: A Minds-on Approach for the Elementary Years*. Hillsdale, NJ: Lawrence Erlbaum.

Eminah, J. K. (1993). The implementation of the JSS science curriculum: A study of the alignment of classroom practice and actual behaviours. Unpublished M.Phil.Thesis, UCC.

Even, R. (1999).The Development of Teacher Leaders and in-service Teacher Educators. *Journal of Mathematics Teacher Education*, *2*(1), 3–24.

Farounbi, M. (1998).*Resource concentration, utilization and management correlates of students'. Learning outcomes: a study in school quality in Oyo State.* Unpublished Ph.D Thesis University of Ibadan, Ibadan.

Frankel, J. R. & Wallen, N. E. (2000).*How to design and evaluate research in education (4th ed.)* New York: MacGraw-Hill.

Fullan, M., & Pomfret, A. (1977).Research on curriculum and instruction implementation. *Review of Educational Research*, *47*(1), 335-397.

Gage, N. L. (1993). *Handbook of research on teaching.*Chicago: Rand McNally & Co.

Gatawa, B. S. M. (1990). *The politics of the school curriculum: An introduction*. Harare: Jongwe Press.

Ghosh, A. (2010). *Classroom Interaction – Part 1*: Definition, Objectives, Types, Teacher's Role and Merits. Examiner.com. Retrieved 16th December, 2013. Website:http://www.examiner.com/article/classroom-interaction-part-1-definition-objectives-types-teacher-s-role-and-merits

Godomsky, S. F., Jr. (1971). Programmed instruction, computer-assisted performance problems, open-ended experiments and student attitude and problem solving ability in physical chemistry laboratory. *Dissertation Abstracts, 31*(11), 5873A.

Guba, E. C. (Ed.). (1992). *The alternative paradigm*. London: Sage Publications Ltd.

Gunta, G. (Ed.). (2004). *Choosing and using teaching and learning materials: Guidelines for preschools and schools*. DECS Publishing. South Australia. ISBN 0 7308 7672 1 Hannon, J., & Atkins, P. (2002) *All About Interactivity.* Frontiers Project. Retrieved June 7, 2014 from TAFE. Website: http://learnwebct.vetonline.vic.edu.au/IACTIVE/index.html

Harmer, J. (2001).*The Practice of English Language Teaching.* Harlow: Longman.

Hatch, E. (1992).*Discourse and Language Education*. Cambridge University Press

Hodson, D. (1991). Practical work in science: Time for a reappraisal. *Studies in Science Education, 19,* 175–184. House of Lords Science and Technology Committee (2006).*Tenth Report of Session 2005-06 Science Teaching in Schools*. Available at: http://www.publications.parliament.uk/pa/ld200506/ldselect/ldsctech/257/25706.htm#a12. Retrieved: 20th November, 2013.

Huysamen, G. K. (1994). *Methodology for the social and behavioural sciences*, Half way house, ITP Southern.

Jakeways, R. (1986). Assessment of A-level physics (Nuffield) investigations. *Physics Education*, 21, 12-14.

Jenkins, E. (1985). History of science education. In Husén, T.; Postlethwaite, T.N. *International Encyclopedia of Education*. Oxford: Pergamon Press. pp. 4453–6. ISBN 0080281192.

Jonassen, D. (1993). A Manifesto to a constructivist approach to the use of technology in higher education, In T.M. Duffy, et al. (Eds.), *Designing environments for constructive learning.* NATO ASI series, F105 (pp. 231-247). New York: Heidelberg, Springer-Verlag. Retrieved 20 May, 2014, from http://apu.gcal.ac.uk/clti/papers/TMPap er11.html

King, N. (1994). The qualitative research review. In C. Cassel and G. Symon. (eds.) *Qualitative Methods in organisational research* (pp.271). London: Sage.

Lederman (Ed.). (1992). *Handbook of Research on Science Education* (pp. 393–431). Mahwah, NJ: Lawrence Erlbaum Associates.

Lincoln, Y. (1992). The making of a constructivist. In E. Guba (Ed.), *The alternative paradigm* (pp. 67-87). London: Sage Publications.

Littlewood, W. (1981). *Communicative language teaching.* Cambridge University Press.

Lunetta, V. N., Hofstein, A., & Clough, M. P. (2007). Teaching and learning in the school science laboratory. An analysis of research, theory, and practice. In, S. K. Abell and N. G. Lederman (Eds.),*Handbook of Research on Science Education* (pp. 393–431). Mahwah, NJ: Lawrence Erlbaum Associates.

Makhado, N. D. (2002). *Challenges educators experience in the provision of environmental education at schools in curriculum.* Johannesburg: Rand Afrikaans University.

Malamah-Thomas, A. (1987). *Classroom Interaction*. Oxford University Press.

Mateja, D. (2004). *Classroom interaction and communication strategy in the learning of English as a foreign language.* University of Ljubljana, Slovenia. ISSN 1581-8918

May, T. S. & Flack, J. A. (2001). *Journal of environmental education*, summer 2001, 32 (4), 5-8. McDermott, L. (1980). Helping minority students succeed in science, II: Implementation of a curriculum in physics and biology. *Journal of College Science Teaching, 9*, 201-205.

McLelland, C. V., (2006). *The nature of science and the scientific method*. The geological society of America. Retrieved: 15th December, 2013. Website: http://www.geosociety.org/educate/NatureScience.pdf

McMillan, J. H. & Schumacher, S. (2001). *Research in education: a conceptual introduction* (5th ed.). New York.

McNeil, J. D. (1997). *Curriculum: A Comprehensive Introduction* (3rd ed.) Boston. Little Brown and Company.

Meriwether, N. (2001). *12 easy steps to successful research papers*. (2nded.). Lincolnwood IL: National Textbook Company.

Mongillo, J. (2007). *Nanotechnology 101*. Greenwood Publishing. 30. ISBN 0-313-33880-9.

National Academy of Sciences, (1998). *Teaching about evolution and the nature of science*, Working Group on Teaching Evolution. NAS.

National Science Teachers Association (1998). *Teaching about evolution and the nature of science*. NSTA Press. ISBN13: 978-0-30906-364-7. Retrieved: 15th December, 2013. Website: http://www.nsta.org,

Nolasco, R., & Arthur, L. (1987). *Conversation.* Oxford University Press.

Norris, S. P., & Phillips, L. M. (2003). *How literacy in its fundamental sense is central to scientific literacy*. Science Education, *87*, 224-240.

Nunan, D. (1992). *Research method in language learning*. Cambridge University Press

Nworgu, B. G. (1991). Opportunities, achievements and choice: Women and minority students in science and mathematics. *Review of research in education*, 68, 153-222.

Olivia, P. F. (1988*). Developing the curriculum*. Glenview, Scott, Foesman And Co.

Ololube, N. P. (2006). *A study of academic and professional qualification on teachers' job effectiveness in Nigerian secondary schools*. Published Ph.D. Thesis. University of Helsinki.

Ornstein, C., & Hunkins, P. (1988) *Curriculum: Foundations, Principles and Issues,* New Jemy, Prentice Hall.

Ornstein, A., & Hunkins, F. (1998). Curriculum: Foundations, Principle and Issues: In Allyn & Bacon. *Chapter 10: Curriculum implementation.* Boston, MA

Osborne, J. (1993). Alternatives to practical work. *School Science Review, 75*(271), 117–123.

Osuala, E. C. (1993). *Introduction Research Methodology.* Onitsha: African FED Publishers.

Palmer, P. J. (1990). Good teaching: A matter of living the mystery. *Chang,* 22(1), 11-16.

Polit, D. F. & Hungler, B. P. (1995). *.Nursing research: Principles and methods (6th ed.)* Philadelphia: Lippinocott, Williams & Wilkins.

Pickering, M. (1980). Are Laboratories courses a waste of time? *The Chronicle of Higher Education, USA* p. 80.

Punch, K. (2005). *Introduction to social research: Qualitative and quantitative approaches* (2nd ed.). London: Sage Publications.

Raimi, S. M. (2002): *Problem-solving techniques and laboratory skills as supplements to laboratory teaching in senior secondary school students' learning of volumetric analysis*. Unpublished Ph.D. Thesis University of Ibadan, Ibadan.

Roberts, S. G. (2002). *SET for success. The supply of people with science, technology, engineering and mathematics skills.* London: HM Treasury. Retrieved: November 27, 2013, website: http:// www.hm-treasury.gov.uk/documents/enterprise_and_productivity/research_and_enterprise/

Robinson, G. E. (1990). Synthesis of Research on the Effects of Class size. *Educational Leadership* (April) pp80-90

Rosser-Cox, M. (2011).*Cultural responsiveness and motivation in preparing teachers: pre-service teachers: does cultural responsiveness affect anticipated self-determination to teach in specific settings?*. LAMBERT Academic Publishing. 172.ISBN 3844384693

Sarason, S. B. (1990). *The predictable failure of educational reform: can we change course before it's too late?* San Francisco: Jossey-Bass.

Scriven, M. (1973). The methodology of evaluation. In B. R. Worthen and J. R. Sanders (Eds.), *Educational evaluation: Theory and practice*. Worthington, OH: C. A. Jones.

Seifert, K. L., & Hoffnung, R. J. (1994). *Child and adolescent development*. Bosten: Houghton Mifflin.

Stenhouse, L. (1979). Research *as the basis of teaching*. C.A.R.E., University of East Anglia, Norwich mimeo.

Stufflebeam, D. L. (1971).*Educational evaluation and decision making.* Itasca, IL: Peacock.

Svinicki, M. D., & McKeachie, W. J. (2012). *McKeachie's Teaching Tips: strategies, Research and Theory for College and University Teachers.*14th ed. USA. ISBN-13:978-1-133-93679-4.

Taber, K. S. (2009). *Progressing science education: Constructing the scientific research programme into the contingent nature of learning science.* Springer. ISBN 978-90-481-2431-2.

Taber, K. S. (2011). Constructivism as educational theory: Contingency in learning, and optimally guided instruction. In J. Hassaskhah. *Educational theory*. Nova. ISBN 9781613245804

Taiwo, O. O. (2005). The status and quality of secondary science teaching and learning in Lagos state, Nigeria: *Published Ph.D Thesis.* Edith Cowan University, Australia.

Tanner, D., & Tanner, L. (1995).*Curriculum development: Theory into practice* (3rd ed.). Englewood Cliffs, NJ: Merrill.

Teacher Education Division(2007).*Diploma in basic education curriculum for designated science and mathematics teacher training colleges.* Science. GES

SCQI (2004).*The Science Curriculum Implementation Questionnaire*. Retrieved: 24th April, 2014. Website: http://www.researchgate.net/publication/233666134

Travers, R. M. Ed. (1973). *Second handbook of research on teaching.* Chicago: Rand McNally & Co.

UNESCO, (2013). *Systematic monitoring of education for all:* Module A4: Use of Information in monitoring, planning and management. UNESCO. Retrieved: 16th December, 2013. Website: http://www4.unescobkk.org/education/efatraining/module-a4/8-learning-materials/

University College Cork, (2013) *Teaching Materials: Variety in Teaching Materials.* Cork University Press, Ireland. Retrieved: 16th December, 2013. Website: http://www.ucc.ie/en/teachlearn/resources/udl/materials/

University of Zimbabwe, (1995). *Curriculum implementation, change and innovation*. (Module EA3AD 303). Harare: Centre for Distance Education, University of Zimbabwe.

Urevbu, A. O. (1985). *Curriculum studies*. Ikeja: Longman.

Verma, G. K., & Mallick, K. (1999). *Researching education: Perspectives and techniques*. London; Falmer Press.

Waxman, H. C. (2005). Classroom observation of effective teaching. In A. C. Ornstein (Ed.), *Teaching: Theory into practice,* Needham Heights, M A:Allyn and Bacon.

Wellington, J. (1998). Practical work in science: Time for a reappraisal. In J. Wellington (Ed.), *Practical work in school science: Which way now?* (pp. 3–15). London: Routledge.

Wikipedia, (2013). *Teacher education*: retrieved 20th December, 2013 website: http://en.wikipedia.org/wiki/Teacher_education

Wolcott, H. F. (1990). On seeking and rejecting – validity in qualitative research. In E. Eisner, & A. Preshkin (Eds.), *Qualitative research in education: the continuing debate* (pp.21-152). New York: Teachers' College Press.

Woolnough, B. E. (1994). *Effective Science Teaching*, chapter 4. Buckingham: Open University Press.

Zaslavsky, O., & Leikin, R. (2004). Professional Development of Mathematics Teacher Educators: Growth Through Practice. *Journal of Mathematics Teacher Education*, *7*(1), 5–32. 9.

APPENDIX A

Students' Questionnaire

Dear respondent,

This questionnaire seeks information on the topic: *An evaluation of classroom implementation of the chemistry programme for selected science and mathematics colleges of education in the Volta region, Ghana.* The exercise is purely academic. Any information given is solely for academic purposes. The questions are intended to seek your views on how you undertake the classroom implementation process of the elective chemistry programme. You are highly assured of confidentiality and anonymity. Thank you.

SECTION A:

1. Coded name of the college……………………2. Sex of student………………
3. Grade in FDC 114C……………….4. Grade in FDC 114CP…………………..

SECTION B: Resources Available for Teaching Elective Chemistry

Please tick (√) inside the box that corresponds to your choice of response. Your objectivity and fairness in response selection will be highly recommended and appreciated. The rating is as below:

SD = Strongly Disagree; D = Disagree; NS = Not Sure; A = Agree; SA = Strongly Agree

SN	Resource Item Description	SD	D	NS	A	SA
1	The college is well resourced for the teaching of chemistry.					
2	The facilities at this college promote the teaching of chemistry					
3	The college has a modern science laboratory for the teaching of chemistry					

4	The science laboratory is well equipped for the teaching of chemistry.					
5	There are adequate reading materials (textbooks, handouts, notes etc.) available to you to enhance your study of chemistry.					
6	The college library is well stuffed with chemistry books for your reference during private studies.					
7	Teachers at this college have a good understanding of the science knowledge, skills and attitudes to promote teaching of chemistry.					
8	Teachers are adequately prepared to teach chemistry.					
9	Teachers at this college are reluctant to teach chemistry.					
10	Teachers at this college have the opportunity to receive professional upgrading towards the teaching of chemistry.					

SECTION C: How often do the following activities occur during your chemistry lessons?

	During my Chemistry Lessons:	**All of the time**	**Most of the time**	**Some times**	**Not often**	**Never**
11	The teacher makes use of sufficient resources (pictures, tables, animations, computers,… etc)					
12	I am allowed to ask questions to aid my understanding of concepts.					
13	The teacher involves me in practical activities					
14	I work in groups with other classmates					
15	I hold discussions with others on the various topics.					
16	I read chemistry textbooks/handouts and make my own notes.					
17	I copy the notes that the teacher dictates/writes on the board.					
18	Enough time is allocated on the college time table for the teaching and learning of chemistry.					
19	The teacher allows me to handles materials and equipment.					
20	The teacher uses various tools (quizzes, exercises,					

	assignments, projects, etc) to assess my work.					
21	The teacher marks my quizzes and class exercises on time and gives me a feedback accordingly.					

22. In totality, I can describe the type of interaction in my chemistry classroom as mostly:

i) Teacher – Students **ii)** Student – Student

iii) Teacher – Resources **iv)** Student – Resources

23. Do you wish to further your carrier in chemistry to the highest level? YES☐ NO ☐

24. A) Do you have some challenges in the chemistry programme you are pursuing? YES ☐ NO ☐

B) If yes, mention two of the challenges

i)…………………………………………………………………………………

ii)…………………………………………………………………………………

25. Suggest ways by which you think the challenges you have identified in item 16 above can be minimized or controlled.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

APPENDIX B

Teachers' Questionnaire

Dear respondent,

This questionnaire seeks information on the topic: *An evaluation of classroom implementation of the chemistry programme for selected science and mathematics colleges of education in the Volta region, Ghana.* The exercise is purely academic. Any information given is solely for academic purposes. The questions are intended to seek your views on how you undertake the classroom implementation process of the elective chemistry programme. You are highly assured of confidentiality and anonymity. Thank you.

SECTION A

a) Coded Name of college…………….. **b)** Coded Name of Teacher………………

c) Sex…………… d) Qualification: Academic/ Professional………………………

e) Area of Specialization…………………………………………………………….

f) Number of years teaching college elective chemistry……………………………..

SECTION B

Please tick (√) inside the box that corresponds to your choice of response. Your objectivity and fairness in response selection will be highly recommended and appreciated. The rating is as below:

SD = Strongly Disagree; D = Disagree; NS = Not Sure; A = Agree; SA = Strongly Agree

SN	ITEM DESCRIPTION	SD	D	NS	A	SA
1	Your college has adequate equipment, facilities, laboratories and general resources required for implementing the chemistry programme.					

2	You have a good understanding of the chemistry. i.e knowledge, skills and attitudes needed to promote in the teaching of college chemistry.					
3	Overall college beliefs towards the chemistry programme. Status of the curriculum as viewed by staff, administrators and community. e.g. college administration recognises the importance of chemistry in the overall school curriculum.					
4	There is enough support for teachers from both within the college and outside. e.g. opportunities to receive ongoing curriculum professional support					
5	You have adequate knowledge and understandings regarding the chemistry programme. e.g. different ways of teaching to foster student learning.					
6	You are highly competent and able to implement the chemistry programme. i.e. confidence in teaching.					
7	You are very interested and exhibit excellent attitudes towards the chemistry programme e.g. keen to teach chemistry.					
8	There is enough time available for preparing and delivering the requirements of the chemistry course. e.g. enough time to develop your own understanding of the subject you are required to teach.					
9	You have a sound understanding of alternative ways of teaching scientific ideas to foster students' learning of chemistry.					
10	You have a strong motivation to ensure chemistry is taught at this college.					
11	You have ready access to science materials and resources in this college to enable you implement the chemistry programme as demanded by the objectives of the programme.					
12	The college curriculum is crowded. Chemistry suffers because of this.					
13	You have the opportunity to undertake professional development in chemistry to enhance your role in the classroom implementation of college chemistry programme.					
14	During lesson delivery you introduce activities that promote mutual learning among students as well as encourage students to initiate collaborative inquiry-based learning.					

15	The chemistry programme enables students to acquire the relevant manipulative skills that enable them to handle and operate science equipment and materials effectively at the end of the lessons.					
16	You are well informed about your role as a teacher in curriculum implementation and hence about the college chemistry programme.					

SECTION C

17) How often do you assess your students understanding of the principles and concepts taught them in chemistry? Please ***circle*** the letter that corresponds to your choice of response.

A) At the end of each lesson. B) At the end of teaching each topic.

C) During organised semester quizzes. D) End of semester before the start of end of semester examinations.

18) In your opinion, do you think the college chemistry programme is a good initiative and should be allowed to stay? YES ☐ NO ☐

SECTION D

19) If you think the programme should be allowed to stay, mention two areas that you think needs improvement or innovation and how you wish it should be done.

i)……………………………………………………………………………………………

……………………………………………………………………………………………

ii)……………………………………………………………………………………………

……………………………………………………………………………………………

APPENDIX C

Interview Schedule for Students

The purpose of this interview is to help study the way the elective chemistry programme is being implemented at this college. Kindly answer the following questions. Your responses will be treated very confidentially. Thank you for your cooperation.

Interview items

1. Do you have chemistry teachers at this college?
2. Do you have laboratory technicians at this college?
3. a) Do you have a laboratory for undertaking practical lessons in chemistry?

   b) If yes, how often do you go there for practical lessons in chemistry in a week?
4. Is the laboratory well equipped enough with chemicals, equipment, charts, etc for your practical lessons in chemistry?
5. Do your teachers use materials and equipment other than those in the laboratory during chemistry lessons?
6. Are you given the opportunity to interact with teaching and learning materials during chemistry lessons?
7. Is your college library well equipped with chemistry books for studies?
8. Do you think your teachers are interested in teaching chemistry?
9. Do you wish to continue the study of chemistry and pursue a career in it?
10. a) Do you have some challenges with regards to the study of chemistry in this college?

    b) If yes, mention two some of the challenges.
11. How do you think the challenges that you have mentioned could be minimized?

APPENDIX D

Interview Schedule for Chemistry Teachers

The purpose of this interview is to help study the way the elective chemistry programme is being implemented at this college. Kindly answer the following questions. Your responses will be treated very confidentially. Thank you for your cooperation.

1. What is your highest academic/professional qualification?
2. How long have you been teaching chemistry at this college?
3. Is the college well equipped with both human and material resources for the teaching of chemistry?
4. a) Is the college having a science laboratory for the teaching of chemistry?

   b) If yes, is the laboratory equipped with chemicals, equipment and other materials for effective organisation of practical lessons in chemistry?
5. Are there regular supply of laboratory materials and equipment from the college, MOE/GES, or TED to supplement used and outdated ones?
6. a) Do you have the opportunity to attend in service trainings, workshops, seminars, and conferences towards effective implementation of college chemistry programme?

   b) If yes, how often are they organised in an academic year?
7. Do you allow your students to interact with teaching and learning materials during chemistry lessons?
8. How often do you organise practical activity lessons in chemistry in a week?

9. Do you think your students are interested in the chemistry programme and hence will wish to pursue a career in it?
10. Do you recommend the continuation of the implementation of the chemistry programme at the designated colleges?
11. What are some of the challenges that you encounter during the classroom implementation of the elective chemistry programme at this college?
12. Suggest ways by which the challenges that you have identified could be minimized or totally overcome.

APPENDIX E

Modified Version of Barbados Workshop Observation Instrument

Form 1

Coded Name of College……………… Coded Name of Teacher……………………….

Age Group of Teacher………………….Sex of Teacher…………………………………

Topic…………………………………Subtopic………………………………………

Lesson…………….…………………....Duration………………………………………

CODE	VERBAL/NON-VERBAL ACTIVITY	TALLY OF OBSERVED BEHAVIOUR
A	**Verbal Activities of Teachers**	
A1	Recall facts, ideas, principles & definitions	
A2	Restate, retell, summerises information	
A3	Apply previous ideas to new situations	
A4	Make logical deductions from data/observations	
A5	Design experimental procedure, make hypothesis, and produce new arrangement.	
A6	Compare and contrast data/information	
A7	Answer from direct observation	
B	**Verbal Activities of Teachers**	
B1	Gives information/ideas	
B2	Gives instruction/hints on procedure	
B3	Explains meaning of words/term/concepts	
B4	Answers students' questions/gives constructive feedback	

B5	Answers own questions	
B6	Identifies students to make contributions (individuals/group)	
B7	Read from textbook/prepared handout notes/computer	
B8	Puts students into groups	
B9	Dictates notes	
B10	Commends	
C	**Non-Verbal Activities of Teachers**	
C1	Writes on chalk board	
C2	Performs demonstration/experiment	
C3	Demonstrates activity/what to do	
C4	Distributes materials/equipment	
C5	Monitors/supervises individuals/group activities	
C6	Offers assistance to individuals/groups	
C7	Give class exercises	

Teacher-Student Interactions

T	**Type of Interactions**	**Never**	**Poor**	**Satisfactory**	**Good**	**Very Good**
T1	Solicited student input					
T2	Involved a variety of students					
T3	Demonstrated awareness of individual student learning needs					
T4	Invited class discussion					
T5	Asked questions to monitor students understanding through questions					

Teacher's Mastery of Content Area

K	Criteria	Yes	Satisfactory	No	N/I	N/A
K1	Appears Knowledgeable					
K2	Appears well organised					
K3	Explains concepts clearly					
K4	Relates concepts to students' experience					
K5	Selects learning experiences appropriate to level of students					
K6	Delivers well planned lesson					

- N/I (Needs Improvement)
- N/A (Not Applicable)

NB: All characteristics may not be observed in one classroom session.

Modified Version of Barbados Workshop Observation Instrument

Form 2

CODE	VERBAL/NON-VERBAL ACTIVITY	TALLY OF OBSERVED BEHAVIOUR
D	**Verbal Activity of Students**	
D1	Answers teacher's questions	
D2	Ask questions on the topic	
D3	Make contributions to the lesson (when requested by teacher)	
D4	Ask questions not related to the topic	
D5	Ask for help about procedure	
D6	Make voluntary statements to contribute to the lesson	
D7	Reads from textbook/handout/prepared notes/computer	
E	**Non-Verbal activity of students**	
E1	Performs practical activities/experiments	
E2	Records activities in notebook	
E3	Copy notes from chalkboard	
E4	Copy notes as teacher dictates	
E5	Handle materials and equipment	
E6	Write on the chalkboard	
E7	Do class exercises	

Modified Version of Barbados Workshop Observation Instrument

Form 3

Sizes of Groups for Practical Activities

Code/Groups	**Number of Students in each Group**				
	2-5	**6-10**	**11-15**	**16-20**	**21-25**
Y1 : Group 1					
Y2 : Group 2					
Y3 : Group 3					
Y4 : Group 4					
Y5 : Group 5					
Y6 : Whole Class					

Materials/Equipment Used in Lesson Delivery/Presentation

Code	**Materials/Equipment Used**	Tick (√)
X1	Laboratory Equipment	
X2	Improvised materials	
X3	Items supplied by Ministry of Education/GES/TED	
X4	Textbooks/Handouts other than those supplied by GES/TED	
X5	Computer simulations -: videos/audios/still pictures/animations	
X6	No materials apart from chalk and chalkboard	

APPENDIX F

Transcription of Students' Interview

R: My name is Ras Kumabia, what is your name?

Std: My name is Tortor Eric

R: Do you have chemistry teachers at this college?

Std: Yes, but I think we need more.

R: How many are they and why do you think you need more of them?

Std: Sir, we have three of them, two (2) teachers teach the theory and one (1) practical.

R: Why did you say you want more?

Std: You see, this college runs both the General and the Science programmes and it is the same teachers who teach the General students the chemistry aspect of their integrated science

R: Do you have laboratory technicians at this college?

Std: Yes Sir. They are those who teach us the practical aspects of chemistry.

R: Do you have a laboratory for undertaking practical lessons in chemistry?

Std: Yes Sir.

R: How often do you go there for practical lessons in chemistry in a week?

Std: It is supposed to be ones every week according to the time table, but mostly we don't do practical work when we go there. He teaches us theoretically instead.

R: Is the laboratory well equipped enough with chemicals, equipment, charts, etc for your practical lessons in chemistry?

Std: No Sir. That is the main reason why we don't do the actual practical work. So we only do it say ones or two times in a semester.

R: Do your teachers use materials and equipment other than those in the laboratory during chemistry lessons?

Std: Yes but not very often.

R: Are you given the opportunity to interact with materials during chemistry lessons?

Std: Hmmm Sir, sometimes we are allowed but it is not for most lessons.

R: Is your college library well equipped with chemistry books for studies?

Std: Yes. But some of them are not modern.

R: Do you think your teachers are interested in teaching chemistry?

Std: Yes Sir. They are all very willing to teach the course. They are not lazy at all.

R: Do you wish to continue the study of chemistry and pursue a career in it?

Std: Yes Sir. I like chemistry so much. I wish to get to the highest level in it.

R: Do you have some challenges with regards to the study of chemistry in this college?

Std: Yes Sir. I have a lot.

R: Mention two some of the challenges.

Std: Firstly, the time allocated for the study of chemistry is not enough. Secondly, there are no chemicals, materials, and general equipment for the teaching and learning of chemistry.

R: How do you think the challenges that you have mentioned could be minimized?

Std. First, I wish chemistry is studied at all the semesters of the programme. Currently we study it only in the 1st semester of 1st year and then in the 2nd semester of the 2nd year. And the time allocation on the time table for the study of chemistry should be increased.

Second, government or whoever is responsible should see to it that our laboratories are well supplied with modern chemicals and equipment to enable us undertake proper practical activities.

APPENDIX G

Transcription of Chemistry Teachers' Interview

R: My name is Ras Kumabia, what is your name?

Tr: My name is Ambrose Ayikue

R: What is your highest academic/professional qualification?

Tr: I have B.ED in Science (Chemistry). But I am a candidate for Master of Philosophy in Science Education (Chemistry Option)

R: How long have you been teaching chemistry at this college?

Tr: This is the fifth year

R: Is the college well equipped with both human and material resources for the teaching of chemistry?

Tr: I think the human aspect is 'Yes', but with the material resources, It is 'No'.

R: Is the college having a science laboratory for the teaching of chemistry?

Tr: Yes, there is a big storey building laboratory built for the college.

R: Is the laboratory equipped with chemicals, equipment and other materials for effective organisation of practical lessons in chemistry?

Tr: No! There are some but they are not enough.

R: Are there regular supply of laboratory materials and equipment from the college, MOE/GES, or TED to supplement used and outdated ones?

Tr: No! After the built of the laboratory, chemicals and some equipment were supplied only ones as far back in 2008 and there has not been any supply since then.

R: Do you have the opportunity to attend in service trainings, workshops, seminars, and conferences towards effective implementation of college chemistry programme?

Tr: Yes,

R: If yes, how often are they organised in an academic year?

Tr: Not very often. Not even ones in an academic year. The last one I attended was far back in 2010.

R: Do you allow your students to interact with teaching and learning materials during chemistry lessons?

Tr: Yes. Anytime practical activities are organised, they handle the materials and equipment.

R: How often do you organise practical activity lessons in chemistry in a week?

Tr: It is not regular, not even ones a week or ones in every two weeks. That is a big challenge to me. This is because the chemicals and most materials are not there. Some chemicals have expired! The college administration does not release money for regular purchase of items for practical work. We cannot levy the students to pay any extra fee for the purchase of these items.

R: Do you think your students are interested in the chemistry programme and hence will wish to pursue a career in it?

Tr: Why not? They are very interested in the programme.

R: Do you recommend the continuation of the implementation of the chemistry programme at this college?

Tr: Yes.

R: What are some of the challenges that you encounter during the classroom implementation of the elective chemistry programme at this college?

Tr: My brother, they are many. But the pressing ones are the lack of chemicals, materials and equipment at the laboratory. Even the building itself needs to be renovated. The time allocated for the teaching of the course is also not enough.

R: Suggest ways by which the challenges that you have identified could be minimized or totally overcome.

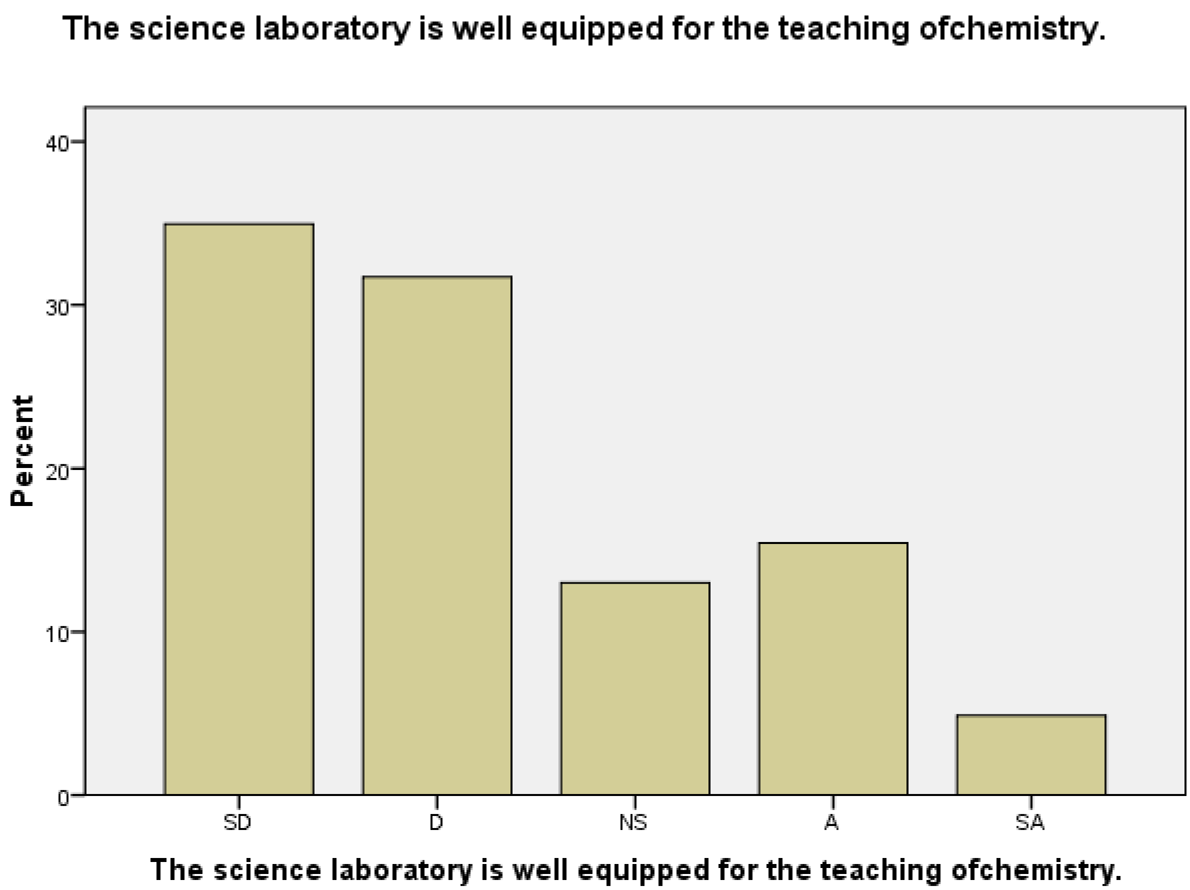
Tr: Simple, there should be regular supply of these chemicals, materials and equipment to enable us organise proper practical activities. More time should also be allowed for the teaching of the course. In addition more workshops and seminars should be organised regularly to help introduce us to some of the expected ways of implementing the programme.

R: Thank you.

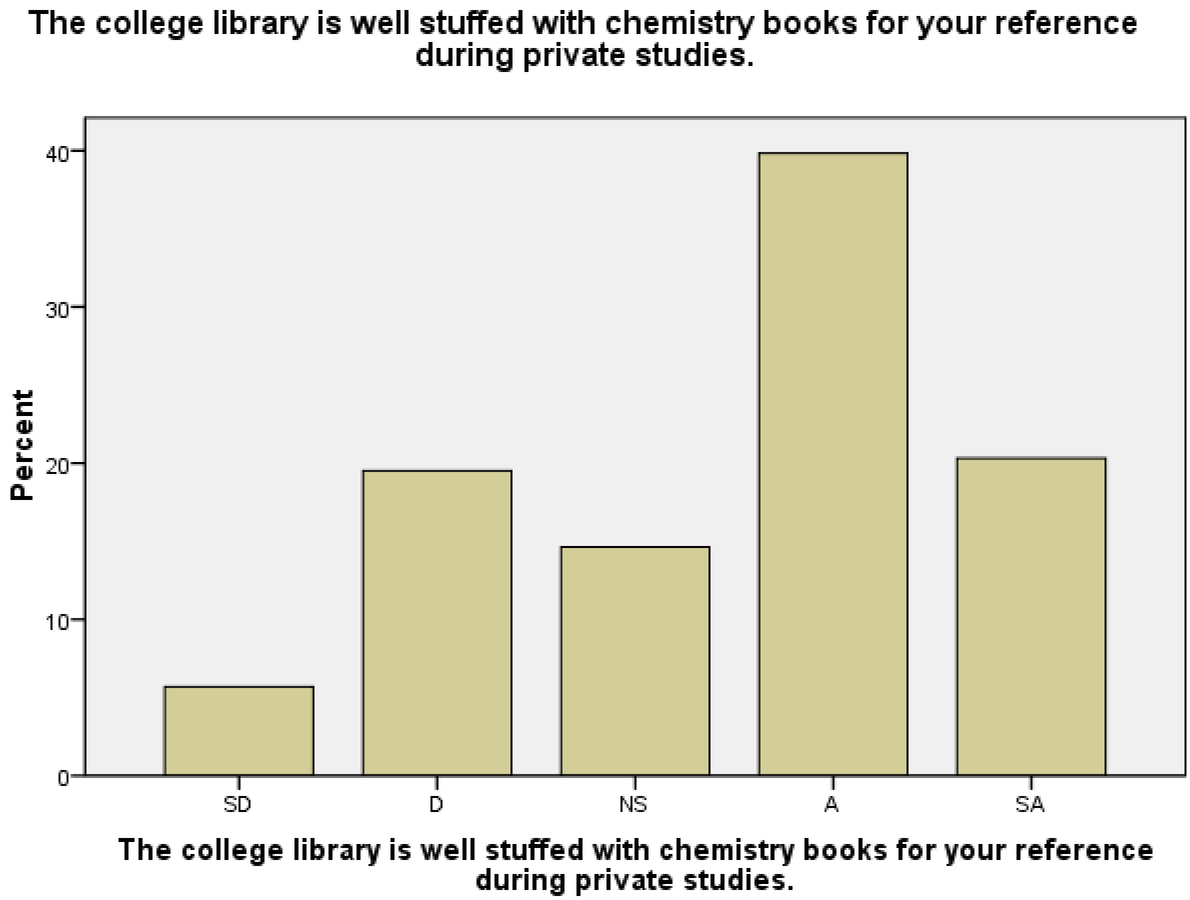
Tr: You are welcome.

APPENDIX H

SPSS Diagrammatic Output of Some Questionnaire Responses



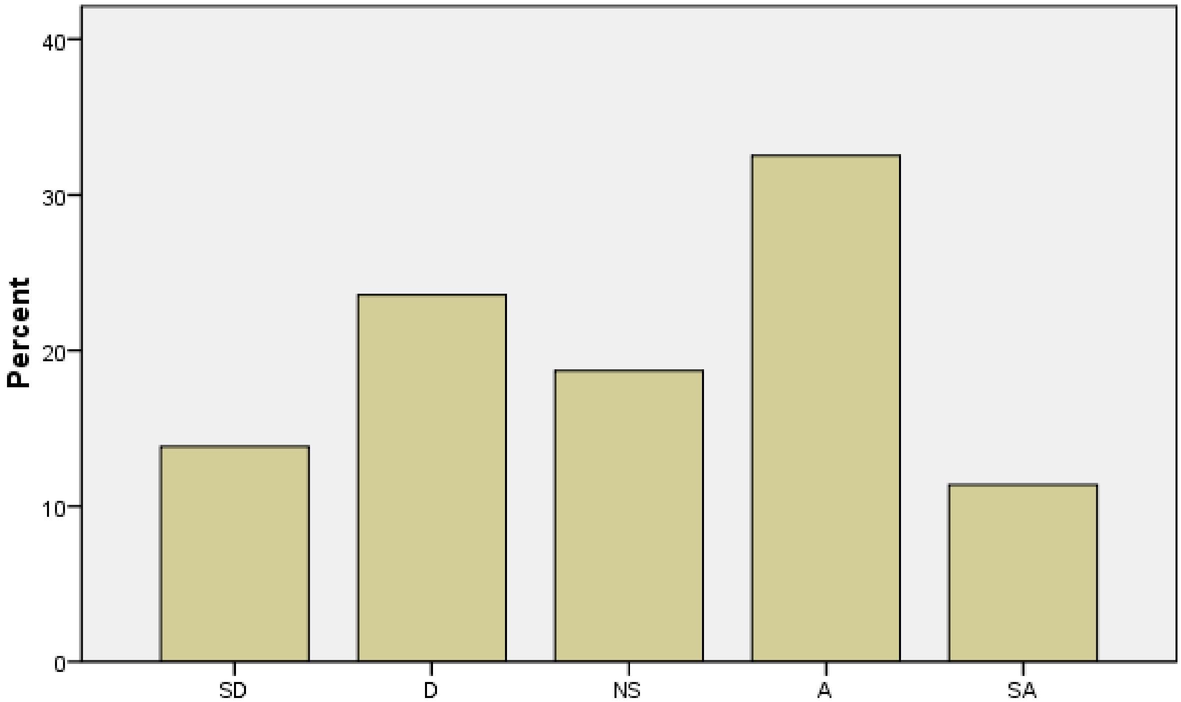
Output 1



The college library is well stuffed with chemistry books for your reference during private studies.
Percent
40
30
20
10
0
SD
D
NS
A
SA
The college library is well stuffed with chemistry books for your reference during private studies.

Output 2

The College administration recognises the importance of chemistry as a subject in the overall school curriculum.



Output 3